

# JVP

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Program and Abstracts

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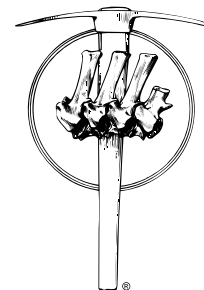
## 68<sup>th</sup>

**Annual Meeting Society  
of Vertebrate Paleontology**

Cleveland Museum of Natural History  
Case Western Reserve University  
*Renaissance Cleveland Hotel*  
Cleveland, Ohio USA  
**October 15-18, 2008**

09

**Save the Date!**



The Society of Vertebrate Paleontology



[www.vertpaleo.org](http://www.vertpaleo.org)

**SVP 69th  
Annual Meeting**

**September 23-26, 2009**

University of Bristol  
Bristol, United Kingdom



# **JOURNAL OF VERTEBRATE PALEONTOLOGY**

VOLUME 28, SUPPLEMENT TO NUMBER 3  
September 2008

## **ABSTRACTS OF PAPERS**

## **SIXTY-EIGHTH ANNUAL MEETING SOCIETY OF VERTEBRATE PALEONTOLOGY**

**CLEVELAND MUSEUM OF NATURAL HISTORY  
CASE WESTERN RESERVE UNIVERSITY**

RENAISSANCE CLEVELAND HOTEL  
CLEVELAND, OHIO, USA

**OCTOBER 15-18, 2008**

### **HOST COMMITTEE**

Darin Croft, Chair; Michael J. Ryan, Vice-Chair; Glenda Bogar, Marie Graf, Michael Grenier, Dick Heislman,  
Bill Lynerd, Kate Pierce, Patricia Princehouse, Scott Simpson

### **EXECUTIVE COMMITTEE**

Catherine Badgley, President; Blaire VanValkenburgh, Vice-President; Annalisa Berta,  
Past-President; Christopher A. Brochu, Secretary; Ted Vlamis, Treasurer;  
Ana Baez, Member-at-Large; Michael Gottfried, Member-at-Large;  
P. David Polly, Member-at-Large

### **SYMPOSIUM CONVENORS**

Phil Anderson, Gloria Arratia, Michael Coates, Matt Friedman, Terry Grande,  
Yohannes Haile-Selassie, Grant Hurlburt, Mary Silcox, Scott Simpson

### **PROGRAM COMMITTEE**

Jason Head, Chair; Jonathan Bloch, Matthew Carrano, Kristi Curry Rogers, Ted Daeschler, David Fox,  
Nadia Fröbisch, Anjali Goswami, Michael Gottfried, F. Robin O'Keefe,  
Emily Rayfield, William Sanders, Rebecca Terry, Jessica Theodor





## Welcome to Cleveland! October 15–18, 2008

The Society of Vertebrate Paleontology and hosts of the Cleveland Museum of Natural History and Case Western Reserve University welcome you to Cleveland for the SVP 68th Annual Meeting. While here, we hope you take advantage of the outstanding educational, networking and social events and also make time to enjoy some of the many activities the city has to offer.

### CLEVELAND MUSEUMS

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#### DOWNTOWN

##### *Rock & Roll Hall of Fame*

(about one mile north of the conference hotel)

[www.rockhall.com](http://www.rockhall.com)

Filled memorabilia, this museum is a must-see for any popular music fan.

##### *Great Lakes Science Center*

(about one mile north of conference hotel)

[www.greatscience.com](http://www.greatscience.com)

The Great Lakes Science Center invites visitors of all ages to “learn by doing” with their 400 hands-on exhibits. There is also an adjacent OMNI-MAX theatre.

#### SOUTH OF DOWNTOWN

##### *A Christmas Story House*

(two miles south of conference hotel)

[www.achristmasstoryhouse.com](http://www.achristmasstoryhouse.com)

You’ve seen the movie, now visit the house! Directly across the street from the house is the official A Christmas Story House Museum.

##### *Cleveland Metroparks Zoo*

(five miles south of the conference hotel)

[www.clemezoo.com](http://www.clemezoo.com)

The Cleveland Metroparks Zoo is amidst 165 wood acres. Favorite exhibits include the African elephants, the “Wolf Wilderness” exhibit and the latest addition, the “Australian Adventure”, a two acre, enclosed rain forest.

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#### UNIVERSITY CIRCLE

University Circle is the cultural and intellectual center of Greater Cleveland and is located approximately five miles from the conference hotel; it can be accessed easily by car or public transportation. University Circle, Inc. has its own Web site with current activities and insights into associated institutions, etc.

[www.universitycircle.org/content](http://www.universitycircle.org/content)

##### *Cleveland Botanical Garden*

[www.cb garden.org](http://www.cb garden.org)

The Cleveland Botanical Garden features several outdoor gardens plus a spectacular 18,000 square foot glass house.

##### *Cleveland Museum of Art*

[www.clevelandart.org](http://www.clevelandart.org)

One of the United States’ most important art museums, the Cleveland Museum of Art is the only major museum in the country to still offer free admission to its permanent collection.

##### *Western Reserve Historical Society (including the Crawford Auto-Aviation Museum)*

[www.wrhs.org](http://www.wrhs.org)

The Western Reserve Historical Society is actually two museums—the History Museum and the Crawford Auto-Aviation Museum. The History Museum consists of two gracious, late 19th century mansions and extensive exhibits on the settlement of Cleveland and the surrounding Western Reserve. The Auto-Aviation Museum showcases 200 classic automobiles, among them 80 cars that originated in Cleveland.

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#### FURTHER OUT

##### Cuyahoga Valley National Park

(about 25 miles south of downtown)

[www.nps.gov/cuva](http://www.nps.gov/cuva)

The scenic area offers history, hiking, bicycling and winter sports.

Holden Arboretum (about 30 miles northeast of downtown in Kirkland, Ohio)

[www.holdenarb.org](http://www.holdenarb.org)

The Holden Arboretum is a 3,000 acre showplace for indigenous Ohio plants, flowers, trees and wildlife.

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**Phil Fraley Productions, Inc.**  
is proud to support the **Society of Vertebrate Paleontology**  
as a **Gold Sponsor** of the 68<sup>th</sup> Annual SVP Convention.



2008 SVP SCHEDULE OF EVENTS (subject to change)

| Event/<br>Functions                  | Tuesday, October 14  | Wednesday, October 15  | Thursday, October 16  | Friday, October 17   | Saturday, October 18   |
|--------------------------------------|--|--|---|--|--|
| Registration/<br>Membership<br>Desk  | 4 pm – 7 pm<br>Coat Room, Mezzanine<br>Level   | 7 am – 5 pm<br>Coat Room, Mezzanine Level  | 7 am – 5 pm<br>Coat Room, Mezzanine Level   | 8 am – 5 pm<br>Coat Room, Mezzanine Level  | 8 am – 5 pm<br>Coat Room, Mezzanine Level  |
| Plenary<br>Session/<br>Welcome       | 8 am – 8:15 am<br>Grand Ballroom   | 8 am – 8:15 am<br>Grand Ballroom   | 8 am – 12:15 pm<br>Symposium: New Directions in the Study of<br>Fossil Endocasts: a Symposium in Honour of<br>Harry J. Jerison<br>Ambassador Ballroom, Lobby Level  | 8 am – 10 pm<br>Symposium: Early Homimid Evolutionary<br>Tempo and Mode Between 3 Ma and<br>4.5 Ma<br>Ambassador Ballroom, Lobby Level | 8 am – 12:15 pm<br>Symposium: Fossils and<br>the Evolutionary Patterns of<br>Ostariophysans, One of the Largest<br>Vertebrate Clades<br>Ambassador Ballroom, Lobby Level |
| Symposium                            | 8:15 am – 12:30 pm<br>Symposium: The Cleveland Shale and<br>Beyond: Early Vertebrate Form, Function and<br>Phylogeny<br>Ambassador Ballroom, Lobby Level                         | 8:15 am – 12:30 pm<br>Technical Session I<br>Grand Ballroom  | 8 am – 12:15 pm<br>Grand Ballroom   | 8 am – 12:15 pm<br>Technical Session X<br>Grand Ballroom   | 8 am – 12:15 pm<br>Technical Session XVI<br>Grand Ballroom   |
| A.S. Romer<br>Prize<br>Presentations |  |  | 8 am – 12:15 pm<br>Grand Ballroom   |  |  |
| Preparators'<br>Session              |  |  | 8 am – 12:15 pm<br>Gold Room  |  |  |
| Technical<br>Session                 |  | 8:15 am – 12:30 pm<br>Technical Session II<br>Gold Room  |   | 8 am – 12:15 pm<br>Technical Session XI<br>Gold Room   | 8 am – 12:15 pm<br>Technical Session XVII<br>Gold Room   |
| Technical<br>Session                 |  | 1:45 pm – 4:15 pm<br>Technical Session III<br>Ambassador Ballroom, Lobby Level   |   | 10:15 pm – 12:15 pm<br>Technical Session XII<br>Ambassador Ballroom, Lobby Level   | 1:45 pm – 4:15 pm<br>Technical Session XVIII<br>Ambassador Ballroom, Lobby Level   |
| Technical<br>Session                 |  | 1:45 pm – 4:15 pm<br>Technical Session IV<br>Grand Ballroom  | 1:30 pm – 4 pm<br>Technical Session VI<br>Ambassador Ballroom, Lobby Level  | 1:30 pm – 4 pm<br>Technical Session XIII<br>Ambassador Ballroom, Lobby Level   | 1:45 pm – 4 pm<br>Technical Session XIX<br>Grand Ballroom  |
| Technical<br>Session                 |  | 1:45 pm – 4:15 pm<br>Technical Session V<br>Gold Room  | 1:30 pm – 4 pm<br>Technical Session VII<br>Grand Ballroom A   | 1:30 pm – 4 pm<br>Technical Session XIV<br>Gold Room   | 1:45 pm – 4:15 pm<br>Technical Session XX<br>Gold Room   |
| Technical<br>Session                 |  |  | 1:30 pm – 4 pm<br>Technical Session IX<br>Grand Ballroom B  | 1:30 pm – 4 pm<br>Technical Session XV<br>Grand Ballroom B   |  |
| Workshops/<br>Educational<br>Events  | 1 pm – 4 pm<br>Introduction to Basic Casting<br>and Molding Techniques<br>Workshop<br>CMNH<br>7 pm – 8 pm<br>Special Lecture by Neil<br>Shubin (CMNH sponsored<br>event)<br>CMNH | 12:30 pm – 1:45 pm<br>Digital Media Basics for Publication Seminar<br>Ambassador Ballroom, Lobby Level<br>12:30 pm – 1:45 pm<br>SVP Town Meeting on Evolution VI<br>Grand Ballroom | 12:15 pm – 1:15 pm<br>Communicating with the Media - Making Your<br>Point in the Popular Press<br>Halle Room, Conf. Level<br>12:15 pm – 2:15 pm<br>Evolution Education Workshop<br>Case Room, Conf. Level<br>12:15 pm – 1:15 pm<br>Women in Paleontology Luncheon<br>Ambassador Ballroom, Lobby Level |  | 8:30 am – 4 pm<br>Educators' Workshop<br>CMNH<br>12:15 pm – 1:45 pm<br>Climate Change Forum<br>Grand Ballroom  |

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|--|---------------------|--|---|---|---|
| Workshops/<br>Educational<br>Events<br>Continued                     |                     | 5 pm – 6 pm<br>Current Funding Trends and Future Research<br>Prospects for Paleobiology by Ray Brenor<br><b>Grand Ballroom</b> | 7:30 pm – 9 pm<br>Franz Lanting: Life: A Journey Through Time<br><b>Grand Ballroom</b>            |   |   |
| Poster Set-up  |                     | 7:30 am – 9:30 am<br>Poster Session I Set-up<br><b>Exhibit Hall</b>  | 7:30 am – 9:30 am<br>Poster Session II Set-up<br><b>Exhibit Hall</b>                              | 7:30 am – 9:30 am<br>Poster Session III Set-up<br><b>Exhibit Hall</b>                             | 7:30 am – 9:30 am<br>Poster IV Set-up<br><b>Exhibit Hall</b>  |
| Poster Viewing   |                     | 9:30 am – 6:15 pm<br>Poster Session I Viewing<br><b>Exhibit Hall</b>   | 9:30 am – 6 pm<br>Poster Session II Viewing<br><b>Exhibit Hall</b><br>(Colbert Award Competition) | 9:30 am – 6 pm<br>Poster Session III Viewing<br><b>Exhibit Hall</b>                               | 9:30 am – 6:15 pm<br>Poster Session IV Viewing<br><b>Exhibit Hall</b>   |
| Exhibit/Poster<br>Reception  |                     | 4:15 pm – 6:15 pm<br><b>Exhibit Hall/Whitehall Room</b>  | 4 pm – 6 pm<br><b>Exhibit Hall/Whitehall Room</b>   | 4 pm – 6 pm<br><b>Exhibit Hall/Whitehall Room</b>   | 4:15 pm – 6:15 pm<br><b>Exhibit Hall</b>  |
| Exhibit<br>Viewing   |                     | 2 pm – 6:15 pm<br><b>Whitehall Room</b>  | 9:30 am – 6 pm<br><b>Whitehall Room</b>   | 9:30 am – 6 pm<br><b>Whitehall Room</b>   | 9:30 am – 1 pm<br><b>Whitehall Room</b>   |
| Annual Business<br>Meeting/Open<br>Executive<br>Committee<br>Meeting |                     |  | 5 pm – 6 pm<br>Annual Business Meeting<br><b>Grand Ballroom</b>                                   | 12:15 pm – 1:30 pm<br>Open Executive Committee Meeting<br><b>Ambassador Ballroom, Lobby Level</b> |   |
| Press<br>Conference  |                     |  | 4 pm – 5 pm<br><b>Severance Room, Conf. Level</b>   |   |   |
| Social Events  |                     |  |   |   | <b>Awards Banquet</b><br>7 pm – 10 pm<br><b>Grand Ballroom</b><br><br><b>After Hours Party</b><br>10 pm – 2 am<br><b>Ambassador Ballroom, Lobby Level</b> |
| Beverage<br>Service  |                     |  | 7 am – 8 am<br><b>Grand/Gold Ballroom Foyer</b>   | 7 am – 8 am<br><b>Grand/Gold Ballroom Foyer</b>   | 7 am – 8 am<br><b>Grand/Gold Ballroom Foyer</b>   |
| Beverage<br>Service  |                     | <b>Welcome Reception</b><br>7 pm – 10 pm<br><b>CMNH</b>  | 10 am – 10:15 am<br><b>Grand/Gold Ballroom Foyer</b>  | 10 am – 10:15 am<br><b>Grand/Gold Ballroom Foyer</b>  | 10 am – 10:15 am<br><b>Grand/Gold Ballroom Foyer</b>  |
| Speaker Ready<br>Room  |                     | 7 am – 5 pm<br><b>George Bush Room</b>   | 7 am – 5 pm<br><b>George Bush Room</b>  | 7 am – 5 pm<br><b>George Bush Room</b>  | 7 am – 3 pm<br><b>George Bush Room</b>  |
| Committee<br>Mtg. Rooms  |                     | 7 am – 7 pm<br><b>Carnegie Room, Conf. Level</b>   | 7 am – 7 pm<br><b>Carnegie Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Carnegie Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Carnegie Room, Conf. Level</b>  |
| Committee<br>Mtg. Rooms  |                     | 7 am – 7 pm<br><b>Case Room, Conf. Level</b>   | 7 am – 7 pm<br><b>Case Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Case Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Case Room, Conf. Level</b>  |
| Committee<br>Mtg. Rooms  |                     | 7 am – 7 pm<br><b>Halle Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Halle Room, Conf. Level</b>   | 7 am – 7 pm<br><b>Halle Room, Conf. Level</b>   | 7 am – 7 pm<br><b>Halle Room, Conf. Level</b>   |
| Committee<br>Mtg. Rooms  |                     | 7 am – 7 pm<br><b>Rocketfeller Room, Conf. Level</b>   | 7 am – 7 pm<br><b>Rocketfeller Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Rocketfeller Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Rocketfeller Room, Conf. Level</b>  |
| Committee<br>Mtg. Rooms  |                     |  | 7 am – 7 pm<br><b>Stouffer Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Stouffer Room, Conf. Level</b>  | 7 am – 7 pm<br><b>Stouffer Room, Conf. Level</b>  |

**PROGRAM AT A GLANCE**

|       | WED        | WED            | WED             | THURS      | THURS          | THURS         | THURS      | FRI            | FRI        | FRI            | SAT           | SAT             | SAT            |               |
|-------|------------|----------------|-----------------|------------|----------------|---------------|------------|----------------|------------|----------------|---------------|-----------------|----------------|---------------|
|       | Ambassador | Grand Ballroom | Gold Ballroom   | Ambassador | Grand Ballroom | Gold Ballroom | Ambassador | Grand Ballroom | Ambassador | Grand Ballroom | Gold Ballroom | Ambassador      | Grand Ballroom | Gold Ballroom |
| 8:00  |            | OPENING        |                 | Goujjet    | Schmitz        | Temme         |            | Plavcan        |            | Pardo          |               | Arattia         |                |               |
| 8:15  | Carr       | Novacek        | Ferrusquia      | Sanders    | Corfe          | E. Fitzgerald |            | Jablonski      |            | Huittenlocker  |               | Gottfried       |                | Ladevèze      |
| 8:30  | Anderson   | Browne         | Rivals          | Evans      | Clifford       | Fox           |            | Simpson        |            | Modesto        |               | Reichenbacher   |                | Penkrot       |
| 8:45  | Snively    | Zack           | Feranec         | Dufeu      | Burger         | Cavigelli     |            | Levin          |            | Tsuji          |               | Coburn          |                | Hooker        |
| 9:00  | Maisey     | Asher          | Higgins         | Tsuhiji    | Tomita         | Keilor        |            | Ward           |            | Bickelmann     |               | Murray          |                | Koenigswald   |
| 9:15  | Coates     | Martin         | Schulz          | Ridgely    | Pyenson        | Smith         |            | Viola          |            | Reisz          |               | Grande          |                | Wood          |
| 9:30  | Blom       | Goswami        | Belmaker        | Hurlburt   | Brazeau        | Nixon         |            | Haile-Selassie |            | Fröbisch       |               | Orti            |                | Mühlbacher    |
| 9:45  | Wilson     | Behrensmeyer   | O'Keefe         | Macrini    | Georgi         | Holland       |            | Su             |            | Kammerer       |               | Lopez           |                | Wang          |
| 10:00 | Long       | Rougier        | Barnosky        | COFFEE     | COFFEE         | COFFEE        |            | COFFEE         |            | COFFEE         |               | COFFEE          |                | Joomun        |
| 10:15 | COFFEE     | COFFEE         | COFFEE          | Rodgers    | Fanke          | G. Brown      |            | Ruf            |            | Ruta           |               | Dadhul          |                | COFFEE        |
| 10:30 | Johanson   | Scott          | Lindsey         | Ekdale     | Prieto-Marquez | Sanders       |            | Coleman        |            | Sidor          |               | Malabaaba       |                | Shockey       |
| 10:45 | Zhu        | Case           | Carrasco        | Walsh      | Turner         | Crawford      |            | Boyer          |            | Angielczyk     |               | Davis           |                | Ludtke        |
| 11:00 | Schultze   | Bloch          | Terry           | Dozo       | DeSilva        | Burnham       |            | Williams       |            | Gao            |               | Chang           |                | Cooper        |
| 11:15 | Charest    | Missiaen       | Blois           | Silcox     | Samuels        | Nelson        |            | Seiffert       |            | Sues           |               | Hirt            |                | Marcot        |
| 11:30 | Holland    | Secord         | Hadly           | Kay        | Longrich       | Mason         |            | Smith          |            | Beck           |               | Lundberg        |                | Prothero      |
| 11:45 | Downs      | Anemone        | Rountrey        | Gingertch  | Miller         | M. Brown      |            | Shi            |            | Sears          |               | Albert          |                | Kaiser        |
| 12:00 | Dewar      | Fisher         | Fisher          | Jerison    | Zamo           | Finlayson     |            | MacLachy       |            | Kilbourne      |               | Grande          |                | Wang          |
| 12:15 | Bolt       | Levering       | Conroy          | LUNCH      | LUNCH          | LUNCH         |            | LUNCH          |            | LUNCH          |               | LUNCH           |                | Brakora       |
| 12:30 | LUNCH      | LUNCH          | LUNCH           | LUNCH      | LUNCH          | LUNCH         |            | LUNCH          |            | LUNCH          |               | LUNCH           |                | LUNCH         |
| 12:45 | LUNCH      | LUNCH          | LUNCH           | LUNCH      | LUNCH          | LUNCH         |            | LUNCH          |            | LUNCH          |               | LUNCH           |                | LUNCH         |
| 1:00  | LUNCH      | LUNCH          | LUNCH           | LUNCH      | LUNCH          | LUNCH         |            | LUNCH          |            | LUNCH          |               | LUNCH           |                | LUNCH         |
| 1:15  | LUNCH      | LUNCH          | LUNCH           | LUNCH      | LUNCH          | LUNCH         |            | LUNCH          |            | LUNCH          |               | LUNCH           |                | LUNCH         |
| 1:30  | LUNCH      | LUNCH          | LUNCH           | LUNCH      | LUNCH          | LUNCH         |            | LUNCH          |            | LUNCH          |               | LUNCH           |                | LUNCH         |
| 1:45  | Jones      | M. Bell        | Tomiya          | Hopkins    | Kraatz         | Lyson         |            | Bibi           |            | Boyd           |               | Matton          |                | LUNCH         |
| 2:00  | Moazen     | Goodwin        | Spaulding       | Evans      | Martin         | Jackson       |            | Croft          |            | Hayashi        |               | Elliott         |                | O'Leary       |
| 2:15  | Wu         | Patrick        | Gishlick        | Holroyd    | Rinaldi        | Joyce         |            | Flynn          |            | Arbour         |               | Gess            |                | Boessenecker  |
| 2:30  | Mueller    | Johnson        | Tseng           | Barrow     | McGuire        | Hastings      |            | Oreutt         |            | Fröbisch       |               | Leathy          |                | Clemeniz      |
| 2:45  | Lindgren   | Koenig         | Wheeler         | Holbrook   | Stevens        | Kellner       |            | Solounias      |            | Woodruff       |               | Richter         |                | Uhen          |
| 3:00  | Smith      | Thomas         | Meachen-Samuels | Teaford    | Buchholtz      | O'Connor      |            | Mörs           |            | Hübner         |               | Gonzalez-Barba  |                | Geisler       |
| 3:15  | Conrad     | Daniel         | Binder          | Scott      | Wolf           | Therrien      |            | DeSantis       |            | Guenther       |               | Ehret           |                | Fitzgerald    |
| 3:30  | Head       | Foreman        | Berg            | Hoffman    | Gaudin         | Sadleir       |            | MacFadden      |            | Lee            |               | Xu              |                | Betta         |
| 3:45  | Bhullar    | Moore          | Finarelli       | Uno        | Kalthoff       | Brochu        |            | Campbell       |            | Folie          |               | López-Arbarello |                | Staley        |
| 4:00  | McCartney  | Western        | Polly           | Beatty     | Zalmout        | Wheatley      |            | Alroy          |            | Marjanovic     |               | Friedman        |                | Lambert       |
| 4:15  |            |                |                 |            |                |               |            |                |            |                |               | Newbrey         |                | Fordyce       |
| 4:30  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |
| 4:45  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |
| 5:00  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |
| 5:15  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |
| 5:30  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |
| 5:45  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |
| 6:00  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |
| 6:15  |            |                |                 |            |                |               |            |                |            |                |               |                 |                |               |

Poster Session I

Poster Session II

Poster Session III

Poster Session IV



## WEDNESDAY MORNING, OCTOBER 15, 2008

### SYMPOSIUM: THE CLEVELAND SHALE AND BEYOND: EARLY VERTEBRATE FORM, FUNCTION AND PHYLOGENY

#### AMBASSADOR BALLROOM

MODERATORS: MICHAEL COATES AND MATT FRIEDMAN

- 8:15 Carr, R. and Jackson, G. THE CLEVELAND SHALE FAUNA REVISITED: IS THE FAUNA THE STANDARD FOR COMPARISON IN THE FAMENNIAN AND LATE DEVONIAN?
- 8:30 Anderson, P. MORPHOLOGICAL AND FUNCTIONAL DISPARITY IN LATE DEVONIAN ARTHRODIRES
- 8:45 Snively, E., Anderson, P., Ryan, M. and Wilson, M. FROM GOGO TO *GORGONICHTHYS*: VARIATION OF STRUCTURAL MECHANICS IN ARTHRODIRE JAWS
- 9:00 Maisey, J. *CLADOSELACHE*: AN ICONIC DEVONIAN SHARK
- 9:15 Coates, M. and Friedman, M. *TEGEOLEPIS*: SOMETHING UNUSUAL FROM THE EARLY RECORD OF ACTINOPTERYGIAN FISHES
- 9:30 Blom, H. ANASPID MORPHOLOGY AND THE SHAPING OF THE GNATHOSTOME BODY PLAN
- 9:45 Wilson, M. and Märss, T. MORPHOLOGY AND SQUAMATION OF FORK-TAILED THELODONTS (THELODONTI: FURCAAUDIFORMES): NEW OBSERVATIONS AND INSIGHTS
- 10:00 Long, J. and Trinajstić, K. DEVONIAN PLACODERM EMBRYOS AND THE ORIGINS OF VERTEBRATE SEX
- 10:15 **BREAK**
- 10:30 Johanson, Z., Trinajstić, K., Brazeau, M. and Smith, M. PLACODERMS WITH TEETH THAT BITE BACK
- 10:45 Zhu, M., Zhao, W. and Jia, L. NEW FOSSIL EVIDENCE FOR THE SILURIAN RADIATION OF PLACODERMS AND OSTEICHTHYANS
- 11:00 Schultze, H. THE CHEEK REGION OF THE ACTINOPTERYGIAN *DIALIPINA*
- 11:15
- 11:30 Charest, F. and Cloutier, R. EVOLUTION OF MEDIAN FINS MODULARITY IN OSTEICHTHYANS
- 11:45 Holland, T. ENDOCRANIAL MORPHOLOGY OF *GOGONASUS* (TETRAPODOMORPHA) REVEALED BY HIGH RESOLUTION MICRO-TOMOGRAPHY
- 12:00 Downs, J., Daeschler, E., Jenkins, Jr., F., and Shubin, N. THE CRANIAL ENDOSKELETON OF *TIKTAALIK ROSEAE* (TETRAPODOMORPHA, ELPISTOSTEGALIA)
- 12:15 Bolt, J. and Lombard, E. PALATE AND BRAINCASE OF THE MISSISSIPPIAN STEM-TETRAPOD *WHATCHEERIA DELTAE*

#### TECHNICAL SESSION I

#### GRAND BALLROOM A&B

MODERATORS: JONATHAN BLOCH AND ANJALI GOSWAMI

- 8:00 **OPENING REMARKS**
- 8:15 Novacek, M. and ATOL Mammal Morphology Team A TEAM-BASED APPROACH YIELDS A NEW MATRIX OF 4,500 MORPHOLOGICAL CHARACTERS FOR MAMMALIAN PHYLOGENY
- 8:30 Browne, I. and Weil, A. TESTING CHARACTERS IN THE DEVELOPMENT OF HYPOTHESES OF RELATIONSHIP AMONG BASAL MAMMALIA
- 8:45 Zack, S. PALEOGENE TAXA AND THE HIGHER-LEVEL INTERRELATIONSHIPS OF EUTHERIAN MAMMALS
- 9:00 Asher, R. MORPHOLOGICAL FEATURES OF A “MOLECULAR” CLADE: DEVELOPMENT IN A FROTHERIAN MAMMALS

- 9:15 **Martin, J. and Geisler, J.** IMPROVING CONGRUENCE BETWEEN MORPHOLOGICAL AND MOLECULAR DATA USING IMPLIED WEIGHTING
- 9:30 **Goswami, A., Weisbecker, V. and Sanchez-Villagra, M.** DEVELOPMENTAL MODULARITY AND THE MARSUPIAL-PLACENTAL DICHOTOMY
- 9:45 **Behrensmeyer, A. and Whatley, R.** A WINDOW INTO EARLY MAMMALIAN PALEOECOLOGY: PALEOENVIRONMENTAL AND TAPHONOMIC INVESTIGATION OF THE GOLD SPRING QUARRY "BLUE LAYER," KAYENTA FM., ARIZONA
- 10:00 **Rougier, G., Paez, N. and Gaetano, L.** THE SOUTH AMERICAN MAMMALIAN MESOZOIC RECORD: A BIOGEOGRAPHIC REEVALUATION
- 10:15 **BREAK**
- 10:30 **Scott, C., Fox, R. and Brinkman, D.** MULTITUBERCULATES (MAMMALIA, ALLOTHERIA) FROM THE LATE CRETACEOUS (CAMPANIAN) BELLY RIVER GROUP OF SOUTHERN ALBERTA, CANADA
- 10:45 **Case, J., Meredith, R. and Person, J.** A PRE-NEOGENE PHALANGERID POSSUM FROM SOUTH AUSTRALIA
- 11:00 **Bloch, J., Cadena, E., Hastings, A., Rincon, A. and Jaramillo, C.** VERTEBRATE FAUNAS FROM THE PALEOCENE BOGOTA FORMATION OF NORTHERN COLOMBIA
- 11:15 **Missiaen, P., ESCARGUEL, G., Hartenberger, J. and Smith, T.** NEW DENTAL AND POSTCRANIAL REMAINS FROM A SINGLE POPULATION OF *PALAEOSTYLOPS* FROM THE LATE PALEOCENE OF THE FLAMING CLIFFS IN MONGOLIA
- 11:30 **Secord, R., Chester, S., Bloch, J., Boyer, D. and Krigbaum, J.** THE FIRST NORTH AMERICAN EQUIDS: A HIGH RESOLUTION STRATIGRAPHIC STUDY IN THE PALEOCENE-EOCENE THERMAL MAXIMUM
- 11:45 **Anemone, R., Dirks, W., Watkins, R., Nachman, B. and Van Regenmorter, J.** GEOLOGY AND VERTEBRATE PALEONTOLOGY OF PALEOCENE AND EOCENE DEPOSITS IN THE GREAT DIVIDE BASIN OF SOUTHWESTERN WYOMING
- 12:00 **Dewar, E.** PALEOECOLOGICAL DISPARITY OF CHADRONIAN FAUNAS BETWEEN THE WHITE RIVER GROUP AND RENOVA FORMATION
- 12:30 **Levering, D. and Hopkins, S.** LOCOMOTOR ECOLOGY AND COMMUNITY STRUCTURE OF PREDATOR/PREY RELATIONS IN OLIGOCENE AND RECENT LARGE MAMMALS.

## TECHNICAL SESSION II

### GOLD BALLROOM

**MODERATORS: ELIZABETH HADLY AND F. ROBIN O'KEEFE**

- 8:15 **Ferrusquia-Villafranca, I. and De Anda-Hurtado, P.** A NEW LATE PLEISTOCENE FAUNA FROM CENTRAL MEXICO AND ITS PALEOBIOLOGICAL-ENVIRONMENTAL SIGNIFICANCE
- 8:30 **Rivals, F., Schulz, E. and Kaiser, T.** UNGULATE DIETARY ADAPTATIONS AND DIVERSITY IN THE MIDDLE AND LATE PLEISTOCENE OF WESTERN EUROPE: VARIATION THROUGH TIME AND SPACE
- 8:45 **Feranec, R., Hadly, E. and Paytan, A.** INTRA-TOOTH VARIATION IN ISOTOPE VALUES OF LATE PLEISTOCENE BISON (*BISON*) AND HORSE (*EQUUS*) REVEALS SEASONAL RESOURCE COMPETITION AT RANCHO LA BREA, SOUTHERN CALIFORNIA
- 9:00 **Higgins, P. and MacFadden, B.** INTERPRETING PAST CLIMATE USING MACROPHYSICAL CLIMATE MODELING AND ISOTOPIC ANALYSIS OF MAMMAL TEETH: TWO METHODS, ONE STORY?
- 9:15 **Schulz, E. and Kaiser, T.** TOOTH WEAR SIGNATURES OF EXTANT EQUIDS CORRELATE WITH HABITAT PARAMETERS - A TOOL TO INFER PLEISTOCENE HOMINID ENVIRONMENTS
- 9:30 **Belmaker, M.** ANALYSIS OF UNGULATE DIET DURING THE LAST GLACIAL (MIS 5-2) IN THE LEVANT: EVIDENCE FOR LONG-TERM STABILITY IN A MEDITERRANEAN ECOSYSTEM
- 9:45 **O'Keefe, F.** POPULATION-LEVEL RESPONSE OF THE DIRE WOLF, *CANIS DIRUS*, TO CLIMATE CHANGE IN THE UPPER PLEISTOCENE

- 10:00 **Barnosky, A.** QUATERNARY EXTINCTIONS AND THE GLOBAL TRADEOFF IN MEGAFUNA BIOMASS
- 10:15 **BREAK**
- 10:30 **Lindsey, E. and Barnosky, A.** TIMING OF EXTINCTIONS AMONG LATE-PLEISTOCENE MEGAMAMMAL TAXA IN SOUTH AMERICA
- 10:45 **Carrasco, M. and Barnosky, A.** ASSESSING THE HUMAN IMPACT ON MAMMALIAN SPECIES DIVERSITY DURING THE END-PLEISTOCENE EXTINCTION: CLUES FROM THE LAST 30 MILLION YEARS
- 11:00 **Terry, R.** QUANTIFYING THE SCALE AND DYNAMICS OF TIME-AVERAGING IN GREAT BASIN HOLOCENE CAVE DEPOSITS THROUGH AMS <sup>14</sup>C DATING OF KANGAROO RAT (*DIPODOMYS*) BONES
- 11:15 **Blois, J., Hadly, E., McGuire, J. and Barnosky, A.** SMALL MAMMAL RESPONSE TO THE PLEISTOCENE-HOLOCENE TRANSITION IN NORTHERN CALIFORNIA
- 11:30 **Hadly, E.** LINGERING EFFECTS OF PAST HOLOCENE CLIMATE IN FOREST COMMUNITIES OF SMALL MAMMALS IN YELLOWSTONE NATIONAL PARK, WYOMING, USA.
- 11:45 **Rountrey, A., Fisher, D. and Haynes, G.** GROWTH INCREMENT AND STABLE ISOTOPE ANALYSES OF A JUVENILE AFRICAN ELEPHANT TUSK: AN INTERPRETIVE REFERENCE FOR STUDIES OF JUVENILE WOOLLY MAMMOTH TUSKS
- 12:00 **Fisher, D., Rountrey, A. and Tedor, R.** PALEOBIOLOGICAL ANALYSIS OF A HOLOCENE MAMMOTH TUSK, ST. PAUL, PRIBILOF ISLANDS, BERING SEA
- 12:15 **Conroy, G., Anemone, R., Van Regenmorter, J. and Addison, A.** GOOGLE EARTH, GIS, AND THE GREAT DIVIDE

## WEDNESDAY AFTERNOON, OCTOBER 15, 2008

### TECHNICAL SESSION III

#### AMBASSADOR BALLROOM

**MODERATORS: JACK CONRAD AND JOHANNES MUELLER**

- 1:45 **Jones, M., Tennyson, A., Evans, S. and Worthy, T.** THE FIRST PRE-PLEISTOCENE RECORD OF A TUATARA (*SPHENODON*)-LIKE ANIMAL FROM NEW ZEALAND AND IMPLICATIONS FOR THE OLIGOCENE DROWNING
- 2:00 **Moazen, M., Curtis, N., Evans, S., Jones, M. and Fagan, M.** THE ROLE OF CRANIAL SUTURES IN A LIZARD SKULL: A FINITE ELEMENT ANALYSIS INVESTIGATION
- 2:15 **Wu, X., Lu, J., Ji, S. and Dong, Z.** AN UPPER CRETACEOUS LIZARD WITH A COMPLETE LOWER TEMPORAL BAR
- 2:30 **Mueller, J., Wuttke, M., Kardjilov, N. and Hilger, A.** A BURROWING, LACERTID-LIKE SQUAMATE FROM THE EOCENE OF MESSEL, GERMANY
- 2:45 **Lindgren, J. and Lee, A.** CONVERGENCE OF GIGANTISM IN MOSASAURS DOES NOT REFLECT A CONVERGENCE OF GROWTH STRATEGY
- 3:00 **Smith, K., Rieppel, O. and Habersetzer, J.** A COMPLETE NECROSAUR (SQUAMATA: ANGUIMORPHA) FROM THE MIDDLE EOCENE LAGERSTÄTTE OF MESSEL, GERMANY
- 3:15 **Conrad, J., Gao, K., Ast, J., Rieppel, O. and Grande, L.** NEW DATA ON THE EVOLUTION OF VARANIDAE (SQUAMATA: GOANNASURIA)
- 3:30 **Head, J. and Holroyd, P.** ASSEMBLY AND BIOGEOGRAPHY OF NORTH AMERICAN PALEOGENE SNAKE FAUNAS BASED ON AN EXPANDED FOSSIL RECORD.
- 3:45 **Bhullar, B., Scanferla, A., Bever, G. and Smith, K.** A NEARLY COMPLETE MACROSTOMATAN SNAKE FROM THE EOCENE OF TEXAS

- 4:00 **McCartney, J., Kley, N. and O'Leary, M.** BODY SIZE OF THE GIANT EOCENE SNAKE *PALAEOPHIS COLOSSAEUS* (SERPENTES: PALAEOPHIIDAE) ESTIMATED FROM RECENTLY COLLECTED MATERIAL FROM MALI

#### TECHNICAL SESSION IV

##### GRAND BALLROOM A&B

MODERATORS: MARK GOODWIN AND JASON MOORE

- 1:45 **Bell, M. and Travis, M.** HOW THE STICKLEBACK LOST ITS PELVIS: GENES, NATURAL SELECTION, AND A MICROSTRATIGRAPHIC SEQUENCE
- 2:00 **Goodwin, M. and Holroyd, P.** FRACTIONATION IN FOSSIL BIOAPATITE: PHYLOGENY AS A CONFOUNDING FACTOR
- 2:15 **Patrick, D. and Wegleitner, P.** GEOCHEMICAL AND CRYSTALLOGRAPHIC VARIATIONS IN FOSSIL BIOAPATITE
- 2:30 **Johnson, E. and Schweitzer, M.** THE MICROBIAL ROLE IN EARLY DIAGENETIC MINERALIZATION OF VERTEBRATE SOFT TISSUE WITHIN BONE
- 2:45 **Koenig, A., Rogers, R. and Trueman, C.** VISUALIZING FOSSILIZATION HISTORIES IN BONES USING HIGH RESOLUTION ELEMENTAL MAPPING
- 3:00 **Thomas, D., Gordon, K., Fordyce, R., Frew, R. and Gordon, K.** RAMAN SPECTROSCOPY OF FOSSIL AND SYNTHETIC APATITES TRACKS DIAGENETIC ALTERATION IN FOSSIL BONE USED FOR ISOTOPE STUDIES
- 3:15 **Daniel, J. and Witmer, L.** WHAT CAN SEDIMENT PATTERNS TELL US ABOUT SOFT TISSUE?: AN ACTUALISTIC TAPHONOMIC STUDY OF OSTRICH HEADS DURING AND POST-BURIAL
- 3:30 **Foreman, B., Fricke, H. and Rogers, R.** A MULTI-PROXY, MULTI-DEPOSITIONAL ENVIRONMENT APPROACH TO RECONSTRUCTING PALEOHYDROLOGIC CONDITIONS USING STABLE ISOTOPES ACROSS THE LATE CRETACEOUS (CAMPANIAN) FORELAND BASIN OF MONTANA
- 3:45 **Moore, J., Varricchio, D. and Jackson, F.** IDENTIFYING TAPHONOMIC PATHWAYS IN MODERN BONE ASSEMBLAGES USING ORDINATION ANALYSIS
- 4:00 **Western, D. and Behrensmeyer, A.** THE LIVING AND THE DEAD: HOW BONES RECORD 40 YEARS OF ECOLOGICAL CHANGE IN THE AMBOSELI ECOSYSTEM OF SOUTHERN KENYA

#### TECHNICAL SESSION V

##### GOLD BALLROOM

MODERATORS: WENDY BINDER AND MICHELLE SPAULDING

- 1:45 **Tomiya, S.** SUCCESSION OF MIDDLE EOCENE CARNIVOROUS MAMMALS IN SOUTHERN CALIFORNIA
- 2:00 **Spaulding, M., Flynn, J. and Grande, L.** A NEW MAMMALIAN CARNIVORE FROM THE GREEN RIVER FORMATION, POSSIBLY POSSESSING A PREHENSILE TAIL
- 2:15 **Gishlick, A.** THE ONTOGENY OF THE AUDITORY BULLA IN MONGOUSES (HERPESTIDAE: MAMMALIA)
- 2:30 **Tseng, Z.** BONE-CRACKING CAPABILITY IN THE SKULL OF *DINOCROCUTA GIGANTEA* (CARNIVORA, MAMMALIA) REVEALS BIOMECHANICAL CONVERGENCE BETWEEN HYAENIDS AND PERCROCUTIDS
- 2:45 **Wheeler, H. T.** MACHAIRODONT FUNCTIONAL MORPHOLOGIC GROUPS: THE VARIED ROLE OF SABER SHAPE AND INCISORS IN KILLING BITE MODELS
- 3:00 **Meachen-Samuels, J.** PREY-KILLING ADAPTATIONS IN THE FORELIMBS OF SABER-TOOTHED CATS AND NIMRAVIDS

- 3:15 **Binder, W. and Meachen, J.** AGE DISTRIBUTION AND SEXUAL DIMORPHISM IN *PANTHERA ATROX* AND *SMILODON FATALIS* FROM RANCHO LA BREA
- 3:30 **Berg, L. and Pyenson, N.** OSTEOLOGICAL CORRELATES AND PHYLOGENETIC ANALYSIS OF DEEP DIVING IN LIVING AND EXTINCT PINNIPEDS: WHAT GOOD ARE BIG EYEBALLS?
- 3:45 **Finarelli, J. and Goswami, A.** INCREASED ENCEPHALIZATION AND ORBIT ORIENTATION IN CARNIVORA (MAMMALIA)
- 4:00 **Polly, P. D.** LOCOMOTION AND CLIMATE: COMMUNITY-LEVEL STRUCTURE OF DIGITIGRADY IN NORTH AMERICAN MAMMALIAN CARNIVORES

## POSTER SESSION I

**Authors must be present from 4:15 – 6:15 p.m.**

**Posters must be removed by 6:30 p.m.**

1. **Spears, S., Milner, A., Ferris-Rowley, D., Foss, S. and Kirkland, J.** THE NATION'S FIRST BLM PALEONTOLOGICAL SITE STEWARDSHIP PROGRAM ESTABLISHED IN WASHINGTON COUNTY, UTAH
2. **Breithaupt, B., Southwell, E. and Matthews, N.** CHARLES WHITNEY GILMORE AND HIS EARLY PALEONTOLOGICAL EXPERIENCES IN WYOMING
3. **Haist, B.** INSIGHTS INTO THE APPLICATION OF A GEOGRAPHIC INFORMATION SYSTEM TO THE TERAPA, SONORA, MEXICO PALEONTOLOGICAL SITE
4. **Ciampaglio, C., James, J. and Riege, B.** AN UNDESCRIBED MIDDLE DEVONIAN BONE BED WITHIN THE BOYLE FORMATION
5. **Szrek, P.** VERTEBRATES FROM THE UPPER KELLWASSER LIMESTONE, FRASNIAN-FAMENNIAN BOUNDARY BEDS (UPPER DEVONIAN) OF THE HOLY CROSS MOUNTAINS (POLAND)
6. **MacKenzie, L. and Wilson, M.** TOOTH WHORLS OF EARLY DEVONIAN ACANTHODIANS AND CHONDRICHTHYANS FROM THE MOTH LOCALITY, NORTHWEST TERRITORIES, CANADA
7. **Derycke, C.** COMPARISONS BETWEEN OLDEST CHONDRICHTHYAN CRUSHING-TOOTH AND TOOTH WITH CUSPS
8. **Ginter, M.** CTENACANTH SHARKS FROM THE UPPER DEVONIAN CLEVELAND SHALE OF OHIO
9. **Storrs, G., Kampouris, G. and Carr, R.** NEW INSIGHTS INTO THE ANATOMY AND FUNCTION OF DUNKLEOSTEUS TERRELLI (NEWBERRY), A GIANT ARTHRODIRE FROM THE FAMENNIAN CLEVELAND SHALE OF OHIO
10. **Hawthorn, J.** PORASPIDINE HETEROSTRACANS (CYATHASPIDIDAE: PORASPIDINAE) FROM THE DEVONIAN OF THE MACKENZIE MOUNTAINS OF CANADA
11. **Callahan, W. and Mehling, C.** A SMALL COELACANTH (SARCOPTERYGII: ACTINISTIA) FROM THE UPPER CRETACEOUS OF MONMOUTH COUNTY, NEW JERSEY
12. **Béchar, I. and Cloutier, R.** UNAMBIGUOUS, LARVAL AND JUVENILE DEVONIAN DIPNOANS
13. **Matsumoto, R. and Evans, S.** SKULL FUNCTION AND SUTURE MORPHOLOGY IN CHORISTODERA
14. **Konishi, T.** SYSTEMATICS OF PLIOPATECARPINE MOSASAURS (MOSASAURIDAE: PLIOPATECARPINI)
15. **DeMar, D., Head, J., Caldwell, M., Breithaupt, B. and Rage, J.** ANATOMY AND TAXONOMIC RELATIONSHIPS OF TWO SNAKE FRONTALS FROM THE MESAVERDE FORMATION, WYOMING: IMPLICATIONS FOR NORTH AMERICAN SNAKE EVOLUTION
16. **Schumacher, B.** WILL THE REAL POLYCOTYLUS PLEASE SWIM UP
17. **Hutson, J. and Hutson, K.** A FUNCTIONAL INVESTIGATION OF THE EVOLUTION OF CHAMELEON NARROW SURFACE LOCOMOTION VIA A MORPHOLOGICAL COMPARISON OF ARBOREAL TETRAPOD FORELIMB RANGES-OF-MOTION
18. **Nydam, R. and Lofgren, D.** PRELIMINARY REPORT ON LIZARDS FROM THE GOLER FORMATION (PALEOCENE) OF CALIFORNIA

19. **Curtis, N., Fagan, M., Shi, J., Evans, S. and Jones, M.** PREDICTING MUSCLE FORCES AND ACTIVATION PATTERNS DURING MASTICATION: A MULTI-BODY COMPUTER MODELLING STUDY OF SPHENODON PUNCTATUS (LEPIDOSAURIA: RHYNCHOCEPHALIA)
20. **Denton Jr, R. and O'Neill, R.** A REVISION OF THE SQUAMATE FAUNA OF THE ELLISDALE DINOSAUR SITE, UPPER CRETACEOUS (CAMPANIAN) OF NEW JERSEY
21. **Ikeda, T., Otsuka, H. and Ota, H.** THE LATE PLEISTOCENE SNAKE FAUNA (REPTILIA: SQUAMATA) OF THE RYUKYU ARCHIPELAGO, SOUTHWEST JAPAN, WITH SPECIAL REFERENCE TO THE FORMATION PROCESS OF THE EXTANT SNAKE FAUNA OF THIS REGION
22. **Hirayama, R.** TRIONYCHID TURTLES (TRIONYCHOIDEA; TESTUDINES) FROM THE EARLY CRETACEOUS OF CENTRAL JAPAN
23. **Oliveira, G., Kellner, A. and Campos, D.** THE FIRST PODOCNEMIDIDAE TURTLE FROM THE SÃO JOSÉ DE ITABORAÍ BASIN (PALEOCENE), RIO DE JANEIRO, BRAZIL
24. **Bourque, J., Hutchison, J., Holroyd, P. and Bloch, J.** A NEW KINOSTERNOID (TESTUDINES: DERMATEMYDIDAE) FROM THE PALEOCENE-EOCENE BOUNDARY OF THE BIGHORN BASIN, WYOMING, AND ITS PALEOCLIMATOLOGICAL IMPLICATIONS
25. **Sertich, J., Khosla, A., Prasad, G. and Verma, O.** DYROSAURID (CROCODYLOMORPHA: MESOEUCROCODYLIA) REMAINS FROM THE MAASTRICHTIAN INTERTRAPPEAN BEDS OF INDIA AND THE DISTRIBUTION OF THE DYROSAURIDAE
26. **Oliveira, C., Santucci, R., Andrade, M., Fulfaro, V. and Benton, M.** CROCODYLOMORPH EGGS AND EGGSHELLS FROM THE BAURU GROUP, UPPER CRETACEOUS OF BRAZIL
27. **Schneider, V., Clarke, J., Nesbitt, S. and Brinkman, P.** A NEW BASAL CROCODYLOMORPH FROM THE LATE TRIASSIC OF NORTH CAROLINA
28. **Rothschild, B.** REPRODUCIBILITY BETWEEN PATHOLOGIES IN RECENT AND FOSSIL CROCODILIANS AND CROCODILIAN ECOMORPHS
29. **Thompson, W. and Moses, R.** BIRDS, REPTILES, AND AMPHIBIANS: ADDITIONS TO THE RICHMOND HILLS LOCAL FAUNA (BLANCAN), BLACK HILLS, SOUTH DAKOTA
30. **Chapman, R., Sadleir, R., Dodson, P. and Makovicky, P.** HANDLING MISSING DATA IN PALEONTOLOGICAL MATRICES: APPROACHES FOR EXPLORATORY MULTIVARIATE ANALYSES IN MORPHOMETRICS
31. **Ergas, E. and Self, C.** GETTING TO THE ROOT OF TEETH AND BITE FORCE: A COMPARATIVE STUDY USING FINITE ELEMENT ANALYSIS
32. **Wallace, S. and Bredehoeft, K.** USING MORPHOMETRICS FOR THE DESIGNATION OF ENIGMATIC HOLOTYPES: AN ISOLATED TOOTH AS A TEST CASE
33. **MacPhee, R., Reguero, M., Strganac, C., Nishida, Y. and Jacobs, L.** OUT OF ANTARCTICA: PALEONTOLOGICAL RECONNAISSANCE OF LIVINGSTON ISLAND (SOUTH SHETLANDS) AND SEYMOUR ISLAND (JAMES ROSS GROUP)
34. **Camburn, J., Camburn, S., Pappas, J., O'Grady, B. and Parris, D.** THE TATMAN FORMATION (PALEOGENE OF WYOMING): NEW FAUNAL INFORMATION
35. **Imhof, M., Knauss, G., Murphey, P. and Browne, L.** VERTEBRATE PALEONTOLOGY AND STRATIGRAPHY OF THE UINTA FORMATION (MIDDLE EOCENE) IN THE LELAND BENCH-UTELAND BUTTE AREA, UINTAH COUNTY, UTAH: AN UPDATE
36. **Pagnac, D.** A REEXAMINATION OF THE SHOTWELL METHOD OF FOSSIL COMMUNITY RECONSTRUCTION FOR USE IN TAPHONOMIC AND PALEOECOLOGICAL INTERPRETATIONS
37. **Grandpre, R., Fastovsky, D., Sheehan, P. and Isbell, J.** WHAT IF THE EFFECTS OF A MASS EXTINCTION ARE SO PERVASIVE THAT THEY CAN BE RECOGNIZED IN THE DEPOSITIONAL ENVIRONMENTS?
38. **Schein, J., Lacovara, K., Gallagher, W. and Poole, J.** TRANSGRESSIVE LAG OR CONDENSED SECTION?: TAPHONOMIC EVIDENCE FROM THE LATEST CRETACEOUS-EARLIEST TERTIARY BASAL HORNERSTOWN FORMATION (NEW JERSEY, USA)
39. **Zook, E. and Behrensmeyer, A.** ROOT DAMAGE TO UNFOSSILIZED, BURIED BONES: RESULTS OF A PILOT STUDY

40. **Werning, S., Spector, P. and Lee, A.** HOW DOES SAMPLING METHOD INFLUENCE OUR INTERPRETATION OF BONE GROWTH?
41. **Raymond, K. and Prothero, D.** DEVELOPMENTAL CONSTRAINTS AND COMPARATIVE VARIABILITY OF DERMAL VS ENDOCHONDRAL BONES IN PLEISTOCENE MAMMALS
42. **Riedel, J. and Wilson, G.** SECOND OCCURENCE OF NANOCURIS (THERIA: NANOCURIDAE) FROM THE LATEST CRETACEOUS LANCE FORMATION OF WYOMING, USA
43. **Chester, S., Sargis, E., Szalay, F., Archibald, J. and Averianov, A.** THERIAN FEMORA FROM THE LATE CRETACEOUS OF UZBEKISTAN
44. **Davis, B.** EVOLUTION OF LOWER MOLAR MORPHOLOGY IN EARLY MAMMALS
45. **Wood, C., Rougier, G., Chen, J., Jin, L. and Zan, S.** AN UNEXPECTEDLY LARGE, MID-CRETACEOUS STEM EUTHERIAN MAMMAL FROM NORTHEASTERN CHINA (JILIN PROVINCE)
46. **Gordon, C., Wells, J. and Cifelli, R.** ENAMEL MICROSTRUCTURE OF MULTITUBERCULATE MAMMALS FROM THE EARLY-MID CRETACEOUS OF NORTH AMERICA
47. **Shoup, B. and Cavigelli, J.** A RARE LARGE MAMMAL DISCOVERY FROM THE WASATCH FORMATION (EOCENE) RESULTING FROM PROPOSED COAL BED METHANE DEVELOPMENT IN THE POWDER RIVER BASIN OF NORTHEASTERN WYOMING
48. **Baker, C., Davis, B. and Cifelli, R.** ADDITIONS TO THE MEDICINE ROCKS MAMMALIAN FAUNA (PALEOCENE: LATE TORREJONIAN) OF SOUTHEASTERN MONTANA
49. **Van Regenmorter, J. and Anemone, R.** BIOSTRATIGRAPHY OF THE FREIGHTER GAP AND PINNACLES AREAS, GREAT DIVIDE BASIN, SOUTHWESTERN WYOMING
50. **Westgate, J., Townsend, B., Cope, D. and Frischia, A.** SNAPSHOT FROM THE PAST: A UINTAN VERTEBRATE ASSEMBLAGE PRESERVING COMMUNITY STRUCTURE
51. **Semprebon, G. and Drewniak, P.** A PALEODIETARY ANALYSIS OF LATE EOCENE TO MIDDLE MIOCENE MERYCOIDODONTIDAE USING THREE TECHNIQUES OF MOLAR ANALYSIS
52. **Tsukui, K. and Clyde, W.** ECOLOGICAL STABILITY AMONG EARLY EOCENE MAMMALIAN FAUNAS FROM THE BIGHORN BASIN, WY
53. **Borths, M. and Hunter, J.** GIMME SHELTER?: LOCOMOTOR TRENDS AND MAMMALIAN SURVIVORSHIP AT THE K-PG BOUNDARY
54. **Egi, N., Tsubamoto, T., Nakaya, H., Kunimatsu, Y. and Takai, M.** CARNIVORANS FROM THE PONDAUNG (MYANMAR) AND KRABI (THAILAND) FAUNAS: CHANGE OF TAXONOMIC DIVERSITY IN THE MIDDLE TO LATE EOCENE OF SOUTHEAST ASIA
55. **Rankin, B. and Fox, R.** EARLY LATE PALEOCENE CARNIVORANS FROM THE ROCHE PERCEE LOCAL FAUNA, SOUTHEASTERN SASKATCHEWAN, CANADA
56. **St Clair, E., Boyer, D., Bloch, J. and Krause, D.** NEW RECORDS OF GONIACODON LEVISANUS (MAMMALIA, TRIISODONTINAE) FROM THE LATE PALEOCENE OF THE CRAZY MOUNTAINS BASIN, MONTANA
57. **Frischia, A. and Kirk, E.** NEW MIDDLE EOCENE (UINTAN) CARNIVOROUS MAMMALS FROM THE DEVIL'S GRAVEYARD FORMATION OF TRANS-PECOS TEXAS
58. **Schubert, B.** DENTAL EVOLUTION IN NORTH AMERICAN SHORT-FACED BEARS
59. **Jones, K. and Goswami, A.** MORPHOMETRIC ANALYSIS OF CRANIAL MORPHOLOGY IN PINNIPEDS (MAMMALIA, CARNIVORA): DISPARITY, DIMORPHISM, ECOLOGY AND ONTOGENY
60. **Naples, V. and Spearing, K.** RECONSTRUCTION OF THE FORELIMB MUSCULATURE AND FUNCTION IN XENOSMILUS HODSONAE: AN ATYPICAL SCIMITAR-TOOTHED FELID
61. **Tovar, D. and Dundas, R.** IRVINGTONIAN OCCURRENCES OF HOMOTHERIUM FROM IRVINGTON AND FAIRMEAD LANDFILL IN CALIFORNIA
62. **Ruez, Jr., D.** ALABAMA AS A DISPERSAL PATHWAY IN THE PLEISTOCENE
63. **Campbell, T., Degrate, J., Williams, J. and Lewis, P.** PALEOENVIRONMENTAL RECONSTRUCTION OF THE KOANAKA HILLS UTILIZING GEOGRAPHIC INFORMATION SYSTEMS (GIS)

64. **Montellano, M., Carbot-Chanona, G., Dominguez-Vazquez, G. and Islebe, G.** LATE PLEISTOCENE VERTEBRATE FAUNA FROM THE DEPRESSION CENTRAL OF CHIAPAS, MEXICO
65. **Froehlich, D., Froehlich, L., Toomey, R. and Veni, G.** A REVIEW OF LATE PLEISTOCENE TO HISTORIC VERTEBRATE FAUNAS RECOVERED FROM CAVES AND KARST FEATURES AT CAMP BULLIS, TEXAS
66. **Czaplewski, N. and Mead, J.** LATE PLEISTOCENE VERTEBRATE FAUNA OF PYEATT CAVE, SOUTHEASTERN ARIZONA, USA
67. **Phillips, G. and Feranec, R.** RESOURCE PARTITIONING AMONG LATE PLEISTOCENE UNGULATES IN THE BLACK PRAIRIE OF MISSISSIPPI AND ALABAMA
68. **Liggett, G. and Bever, G.** THE FORGOTTEN MAMMOTH SITE: THE STERNBERG ELEPHANT QUARRY IN LANE COUNTY, KANSAS
69. **Smith, K. and Fisher, D.** TUSK GROWTH RECORD OF A FEMALE AMERICAN MASTODON (*MAMMUT AMERICANUM*) FROM SOUTHEASTERN NEW YORK STATE
70. **LaDuke, T., Hill, M., May, D., Semken, H. and Theler, J.** EARLY HOLOCENE ENVIRONMENT ON THE CLARY RANCH, ASH HOLLOW, WESTERN NEBRASKA: A MULTIPROXY INTERPRETATION USING SEDIMENTS, MICROFAUNA, AND GASTROPODS

## THURSDAY MORNING, OCTOBER 16, 2008

### SYMPOSIUM: NEW DIRECTIONS IN THE STUDY OF FOSSIL ENDOCASTS: A SYMPOSIUM IN HONOUR OF HARRY J. JERISON

#### AMBASSADOR BALLROOM

#### MODERATORS: GRANT HURLBURT AND MARY SILCOX

- 8:00 **Goujet, D.** THE ENDOCRANIUM AND ENDOCAST OF PLACODERM FISHES
- 8:15 **Sanders, R. and Wedel, M.** THE ENDOCRANIAL ANATOMY OF THE DOMED-SKULL CHALICOTHERE *TYLOCEPHALONYX* UCMP 115867 WITH EMPHASIS ON THE PARANASAL SINUSES AND TURBINATES
- 8:30 **Evans, D., Witmer, L., Ridgely, R. and Horner, J.** ENDOCRANIAL ANATOMY OF LAMBEOSAURINE DINOSAURS: IMPLICATIONS FOR CRANIAL CREST FUNCTION AND EVOLUTION
- 8:45 **Dufeu, D. and Witmer, L.** MORPHOLOGICAL PATTERNS AND PHYLOGENETIC TRENDS IN THEROPOD BRAINCASE PNEUMATICITY.
- 9:00 **Tsuihiji, T., Witmer, L., Watabe, M., Barsbold, R. and Tsogtbaatar, K.** NEW INFORMATION ON THE CRANIAL ANATOMY OF *AVIMIMUS PORTENTOSUS* (DINOSAURIA: THEROPODA) INCLUDING VIRTUAL ENDOCASTS OF THE BRAIN AND INNER EAR
- 9:15 **Ridgely, R. and Witmer, L.** GROSS ANATOMICAL BRAIN REGION APPROXIMATION (GABRA): A NEW TECHNIQUE FOR ASSESSING BRAIN STRUCTURE IN DINOSAURS AND OTHER FOSSIL ARCHOSAURS
- 9:30 **Hurlburt, G.** RELATIVE FOREBRAIN SIZE IN THEROPOD DINOSAURS, NON-AVIAN REPTILES, AND BIRDS
- 9:45 **Macrini, T. and Luo, Z.** DIGITAL CRANIAL ENDOCAST OF *HADROCODIUM WUI* (MAMMALIAFORMES) AND ITS BEARING ON MAMMALIAN BRAIN EVOLUTION
- 10:00 **BREAK**
- 10:15 **Rodgers, J.** THE PETROSAL LOBES, SUBARCUATE FOSSA AND SEMICIRCULAR CANALS IN *MONODELPHIS DOMESTICA*: IMPLICATIONS FOR EXTINCT METATHERIANS
- 10:30 **Ekdale, E.** VARIATION AMONG ENDOCASTS OF THE BONY LABYRINTH OF ZHELESTIDS (MAMMALIA: EUTHERIA)
- 10:45 **Walsh, S., Milner, A., Barrett, P., Manley, G. and Witmer, L.** CAN HEARING AND VOCALIZATION CAPACITIES BE ESTIMATED FROM COCHLEAR DUCT ENDOCASTS?



- 11:00 **Dozo, M.** ENDOCASTS OF NOTOUNGULATES AND BRAIN EVOLUTION IN EXTINCT SOUTH AMERICAN UNGULATES
- 11:15 **Silcox, M., Dalmyn, C. and Bloch, J.** THE ENDOCAST OF *IGNACIUS GRAYBULLIANUS* AND BRAIN EVOLUTION IN EARLY PRIMATES
- 11:30 **Kay, R., Kirk, E. and Malinzak, M.** NEW DATA ON ENCEPHALIZATION IN MIOCENE NEW WORLD MONKEYS: IMPLICATIONS FOR ANTHROPOID BRAIN EVOLUTION
- 11:45 **Gingerich, P.** ENCEPHALIZATION RESIDUALS IN TERRESTRIAL AND AQUATIC MAMMALS, LIVING AND FOSSIL: BASELINE FOR COMPARISON
- 12:00 **Jerison, H.** FOSSILS, BRAINS, AND BEHAVIOR: ENDOCASTS AS BRAINS

### **ROMER PRIZE SESSION**

#### **GRAND BALLROOM A&B**

**MODERATORS: PAUL BARRETT AND DAVID FOX**

- 8:00 **Schmitz, L.** INFERENCE OF DIEL ACTIVITY PATTERN SUGGESTS COMPLEX TEMPORAL RESOURCE AND HABITAT PARTITIONING AMONG MESOZOIC ARCHOSAURS
- 8:15 **Corfe, I.** ASSESSING THE STATISTICAL SIGNIFICANCE OF CONFLICT IN MORPHOLOGICAL PHYLOGENETICS
- 8:30 **Clifford, A.** BIOMECHANICS AND EVOLUTION OF UNGULIGRADY IN CETARTIODACTYLA
- 8:45 **Burger, B.** EXTINCTION, MIGRATION, AND THE EFFECTS OF GLOBAL WARMING ON FOSSIL MAMMALS ACROSS THE PALEOCENE-EOCENE BOUNDARY IN WESTERN COLORADO, USA
- 9:00 **Tomita, T.** A NEW METHOD TO INFER FEEDING STRATEGIES OF EXTINCT LAMNIFORM SHARKS BASED ON TOOTH ROOT MORPHOLOGY.
- 9:15 **Pyenson, N.** CARCASSES ON THE COAST AND A BONEBED IN THE VALLEY: INTEGRATING TAPHONOMY AND ECOLOGY TO MEASURE CETACEAN DIVERSITY IN THE FOSSIL RECORD
- 9:30 **Brazeau, M.** EARLY JAW AND BRAINCASE MORPHOLOGIES WITH UNORTHODOX IMPLICATIONS FOR BASAL GNATHOSTOME INTERRELATIONSHIPS
- 9:45 **Georgi, J.** SEMICIRCULAR CANAL MORPHOLOGY AS EVIDENCE OF LOCOMOTOR ENVIRONMENT IN AMNIOTES
- 10:00 **BREAK**
- 10:15 **Farke, A.** EVOLUTION AND FUNCTION OF THE SUPRACRANIAL SINUSES IN CERATOPSID DINOSAURS AND THE FRONTAL SINUSES IN BOVID MAMMALS
- 10:30 **Prieto-Marquez, A.** PHYLOGENY AND HISTORICAL BIOGEOGRAPHY OF HADROSAURID DINOSAURS
- 10:45 **Turner, A.** PHYLOGENETIC HISTORY AND BODY SIZE EVOLUTION IN COELUROSAUR THEROPODS
- 11:00 **DeSilva, J.** ANKLE MORPHOLOGY IN EARLY HOMININS
- 11:15 **Samuels, J.** PALEOECOLOGY AND MORPHOLOGICAL EVOLUTION OF BEAVERS (FAMILY CASTORIDAE)
- 11:30 **Longrich, N.** AERODYNAMIC FUNCTION OF THE HIND LIMB FEATHERS OF *ARCHAEOPTERYX LITHOGRAPHICA*: A WIND TUNNEL STUDY
- 11:45 **Miller, J.** TESTING THE ECOLOGICAL FIDELITY OF YELLOWSTONE NATIONAL PARK'S LARGE-MAMMAL DEATH ASSEMBLAGE: PALEOECOLOGICAL IMPLICATIONS AND CONSERVATION APPLICATIONS
- 12:00 **Zanno, L.** THE PHYLOGENY OF THERIZINOSAURIA (THEROPODA: MANIRAPTORA): IMPLICATIONS FOR THE EVOLUTION OF COELUROSAURS

**PREPARATORS' SESSION**  
**GOLD BALLROOM**  
**MODERATORS: MATT SMITH AND WILLIAM SANDERS**

- 8:00 **Temme IV, T., Masters, S. and Sandau, S.** A SMALL SCALE, LOW-BUDGET, HYDRO-EFFICIENT SCREEN WASHING METHOD: THE "MINI-SCREENER"
- 8:15 **Fitzgerald, E.** DELICATE FOSSIL SKULLS FROM A RICH HOLOCENE SITE: WHICH TECHNIQUES WORKED BEST FOR PREPARATION, DISPLAY, AND TRANSPORTATION
- 8:30 **Fox, M., Bibi, F. and Hill, A.** JACKETING THE DESERT SANDS
- 8:45 **Cavigelli, J.** ON THE USE OF PLASTIC AIR CONDITIONER FILTER MEDIA IN PLASTER JACKETS FOR FOSSIL COLLECTING
- 9:00 **Keillor, T.** CHALLENGE: HOW TO EXCAVATE, PREPARE, DISPLAY AND TRANSPORT DELICATE ARTICULATED FOSSILS FOUND IN UNCONSOLIDATED SAND?
- 9:15 **Smith, M.** A RELATIONAL DATABASE DEVELOPED AT JOHN DAY FOSSIL BEDS NATIONAL MONUMENT FOR THE PURPOSE OF MANAGING AND STANDARDIZING PREPARATION DOCUMENTATION
- 9:30 **Nixon, D. and Vineyard, D.** UTILIZATION OF CYCLODODECAN AS A STABILIZER DURING PREPARATION OF CRANIATA
- 9:45 **Holland, M.** FAMILY REUNION: A COMPOSITE RECONSTRUCTION OF THE *TYRANNOSAURUS REX* HOLOTYPE SKULL
- 10:00 **BREAK**
- 10:15 **Brown, G.** WHEN THE CRADLE ROCKS: SIMPLE STRATEGIES FOR STABLE STORAGE AND SAFE USE OF PALEONTOLOGICAL COLLECTIONS
- 10:30 **Sanders, W., Graf, J., Zalmout, I., Ul-Haq, M. and Gingerich, P.** RESTORATION AND THREE-DIMENSIONAL ASSEMBLY OF A NEARLY COMPLETE, ARTICULATED EOCENE PROTOCETID WHALE SKELETON FROM PAKISTAN
- 10:45 **Crawford, B., Fair, M. and Krudwig, K.** AN EXPLANATION OF THE CHALLENGES AND TECHNIQUES FOR THE EXTRACTION AND TRANSFER OF LARGE WALL PLAQUES.
- 11:00 **Burnham, D., Miao, D., Martin, L. and Alexander, D.** THE FLIGHT OF THE *MICRORAPTOR*
- 11:15 **Nelsen, T., Madsen, S. and Gray, D.** A NEW "STREAMLINED CRADLE MAKING OPERATION" FOR MAXIMUM PROTECTION OF FOSSILS WHILE ALLOWING FOR EASY ACCESS FOR RESEARCH NEEDS
- 11:30 **Mason, J.** TINY TEETH: CRETACEOUS MAMMAL TEETH MOLDED AND CAST WITH STORAGE IN MIND
- 11:45 **Brown, M., Parker, W. and Sumida, S.** LEARNING THE BASICS: A LOOK AT AN ADAPTABLE LAB BASED FOSSIL PREPARATION TEACHING EXPERIENCE
- 12:00 **Finlayson, H., Sroka, S. and Nelsen, T.** HEALTH AND SAFETY IN THE PREP LAB: A STEP-BY-STEP GUIDE TO INSTALLING AN EFFICIENT AND COST EFFECTIVE DUST COLLECTING AND VENTILATION SYSTEM

**THURSDAY AFTERNOON, OCTOBER 16, 2008**

**TECHNICAL SESSION VI**  
**AMBASSADOR BALLROOM**  
**MODERATORS: PATRICIA HOLROYD AND SAMANTHA HOPKINS**

- 1:30 **Hopkins, S.** IS THERE A SCALE MISMATCH BETWEEN CHANGING DIET AND CHANGING DENTAL MORPHOLOGY?

- 1:45 **Evans, A., Zohdy, S., Wright, P. and Jernvall, J.** ROUGHING IT: DENTAL COMPLEXITY IN BAMBOO FEEDERS AND THE INFERENCE OF MESIC ENVIRONMENTS
- 2:00 **Holroyd, P.** NEW DATA ON DENTAL ERUPTION PATTERNS IN CONDYLRTHS AND AFROTHERES
- 2:15 **Barrow, E., MacLeod, N. and Krieger, J.** THE QUANTITATIVE COMPARISON OF HYRACOID TOOTH GEOMETRY
- 2:30 **Holbrook, L.** TOOTH REPLACEMENT IN HYRACOIDEA (MAMMALIA): EVIDENCE FOR FIVE PREMOLARS IN AN EXTANT PLACENTAL MAMMAL?
- 2:45 **Teaford, M., Grine, F., Kay, R., Schubert, B. and Ungar, P.** LOW MAGNIFICATION DENTAL MICROWEAR: THE PROBLEM OF POSTMORTEM ARTEFACTS
- 3:00 **Scott, R., Schubert, B., Grine, F. and Teaford, M.** LOW MAGNIFICATION MICROWEAR: QUESTIONS OF PRECISION AND REPEATABILITY
- 3:15 **Hoffman, J. and Clementz, M.** THE EFFECTS OF EXOGENOUS GRIT ON THE MICROWEAR OF EXTANT UNGULATES AND THE IMPLICATIONS FOR PALEODIET INTERPRETATIONS
- 3:30 **Uno, H., Yoneda, M., Taru, H. and Kohno, N.** DIETARY PREFERENCES OF DESMOSTYLIANS BASED ON ISOTOPE, MICROWEAR AND CRANIAL MORPHOLOGY
- 3:45 **Beatty, B.** CRANIODENTAL ONTOGENY IN THE DESMOSTYLIA

## TECHNICAL SESSION VII

### GRAND BALLROOM A

MODERATORS: NANCY STEVENS AND IYAD ZALMOUT

- 1:30 **Kraatz, B., Meng, J. and Li, C.** A HOMOLOGY-BASED NOMENCLATURE FOR DUPLICIDENTATE TOOTH CUSPS DERIVED FROM THE TRIBOSPHEMIC CONDITION
- 1:45 **Martin, R. and Marcolini, F.** MOSAIC EVOLUTION IN THE DENTITION OF THE ARCHAIC PLIOCENE VOLE *OGMODONTOMYS* FROM THE MEADE BASIN OF SOUTHWESTERN KANSAS
- 2:00 **Rinaldi, C., Martin, L., Timm, R. and Cole, T.** RIDGED ENAMEL ON THE TEETH OF GIANT BEAVERS: FUNCTION OR PHYLOGENY?
- 2:15 **McGuire, J., Blois, J., Tomiya, S., Sherrod, B. and Barnosky, A.** QUANTIFYING THE EXTENT OF TIME-AVERAGING INTRODUCED BY RODENT BIOTURBATION IN MAMMAL-BEARING CENOZOIC SEDIMENTS
- 2:30 **Stevens, N.** AN EMERGING LATE OLIGOCENE RODENT FAUNA FROM THE NSUNGWE FORMATION, RUKWA RIFT BASIN, TANZANIA
- 2:45 **Buchholtz, E. and Stepien, C.** BREAKING THE CERVICAL CONSTANT IN MAMMALS: DEVELOPMENTAL ORIGIN OF ABERRANT VERTEBRAL ANATOMY IN TREE SLOTHS
- 3:00 **Wolf, D.** OSTEODERM HISTOLOGY OF THE CINGULATA (XENARTHRA, MAMMALIA): IMPLICATIONS FOR SYSTEMATICS
- 3:15 **Gaudin, T. and Bramblett, J.** PHYLOGENETIC ANALYSIS OF CINGULATA (XENARTHRA) BASED ON POSTCRANIAL DATA
- 3:30 **Kalthoff, D.** TOOTH MICROSTRUCTURE IN FOSSIL AND RECENT SLOTH (MAMMALIA, FOLIVORA)
- 3:45 **Zalmout, I. and Gingerich, P.** SEXUAL DIMORPHISM IN THE BONY PELVIS OF SEA COWS FROM THE EOCENE OF EGYPT (MAMMALIA, SIRENIA)

## TECHNICAL SESSION VIII

### GOLD BALLROOM

MODERATORS: ALEXANDER HASTINGS AND WALTER JOYCE

- 1:30 **Lyson, T. and Joyce, W.** HOW DID THE TURTLE GET ITS SHOULDER GIRDLE INSIDE ITS RIBCAGE, OR DID IT?

- 1:45 **Jackson, F., Jin, X. and Cripps, C.** A LOWER CRETACEOUS TURTLE EGG CLUTCH FROM CHINA CONTAINING THE OLDEST *PENICILLIUM*
- 2:00 **Joyce, W. and Lyson, T.** THE RESPONSE OF TURTLES TO THE BREAKUP OF PANGAEA: VICARIANCE VERSUS DISPERSAL
- 2:15 **Hastings, A. and Bloch, J.** NEW LONG-SNOUDED DYROSAURID (CROCODYLIFORMES, MESOEUCROCODYLIA) FROM THE PALEOCENE OF NORTHEASTERN COLOMBIA
- 2:30 **Kellner, A., Barbosa, J., Viana, M., Silva, J. and Silva, H.** NEW INFORMATION ON *GUARINISUCHUS MUNIZI* (CROCODYLIFORMES, DYROSAURIDAE) FROM THE MARIA FARINHA FORMATION (EARLY PALEOCENE), BRAZIL
- 2:45 **O'Connor, P., Sertich, J., Stevens, N., Gottfried, M. and Roberts, E.** THE EVOLUTION OF MAMMAL-LIKE CROCODYLIFORMES (CROCODYLIFORMES: NOTOSUCHIA) IN GONDWANA: NEW EVIDENCE FROM THE MIDDLE CRETACEOUS GALULA FORMATION, RUKWA RIFT BASIN, SOUTHWESTERN TANZANIA
- 3:00 **Therrien, F., Zelenitsky, D. and Langston, Jr., W.** FEEDING BEHAVIOR AND BITE FORCE OF THE GIANT CROCODYLIAN *DEINOSUCHUS*
- 3:15 **Sadleir, R.** PHENOTYPIC PLASTICITY IN THE EVOLUTION OF ALLIGATORINAE
- 3:30 **Brochu, C., Njau, J., Blumenschine, R. and Densmore, L.** GIANT HORNED CROCODILES FROM THE LATE CENOZOIC OF AFRICA: STEALTH DIVERSITY REVISITED
- 3:45 **Wheatley, P., Head, J. and Koch, P.** PALEOECOLOGY OF SIWALIK GROUP *GAVIALIS* (CROCODYLIA) AND CARBON FLUX IN AN ANCIENT RIVER SYSTEM

## TECHNICAL SESSION IX

### GRAND BALLROOM B

MODERATORS: GARETH DYKE AND THOMAS STIDHAM

- 1:30 **Rega, E.** WHAT ARE APPROPRIATE EXTANT MODEL ORGANISMS FOR DINOSAUR DISEASE?
- 1:45 **Dececchi, T. and Larsson, H.** CRITICAL ANALYSIS OF ARBOREALITY IN MANIRAPTORAN THEROPODS
- 2:00 **de Boef, M.** SIGNATURES OF FLIGHT AND RUNNING IN BONE MICROSTRUCTURE: AN EXPERIMENTAL STUDY IN HELMETED GUINEA FOWL (*NUMIDA MELEAGRIS*) AND APPLICATIONS IN THE STUDY OF THE DINOSAUR-BIRD TRANSITION
- 2:15 **Jingmai, O. and Chiappe, L.** SKULL MORPHOLOGY OF ENANTIORNITHES (AVES: ORNITHOTHORACES)
- 2:30 **Wilson, L. and Chin, K.** BONE HISTOLOGY OF HESPERORNITHIFORMES (AVES) FROM LATE CRETACEOUS GREENHOUSE HIGH-LATITUDE ENVIRONMENTS
- 2:45 **Stidham, T.** EXTINCTION OF BIRDS AT THE END OF THE CRETACEOUS: CHRONOSTRATIGRAPHIC DATA
- 3:00 **Dyke, G., Archibald, B. and Mathewes, R.** LOWER EOCENE FOSSIL BIRDS FROM THE OKANAGAN HIGHLANDS (PACIFIC NORTHWEST OF NORTH AMERICA)
- 3:15 **Ksepka, D.** INSIGHT INTO THE TEMPO OF GALLIFORM EVOLUTION FROM COMBINED PHYLOGENETIC ANALYSES AND A NEW MIOCENE REPRESENTATIVE OF PHASIANIDAE
- 3:30 **Ohashi, T., Manabe, M., Yoshida, A., Rasoamiamanana, A. and Suwa, G.** ENDOCRANIAL ANATOMY OF AEPYORNITHIDAE BIRDS
- 3:45 **Prassack, K. and Blumenschine, R.** LANDSCAPE TAPHONOMY OF BIRD BONE AND ITS UTILITY AS A PALEOENVIRONMENTAL INDICATOR

## POSTER SESSION II

Authors must be present from 4:00 – 6:00 p.m.

Posters must be removed by 6:15 p.m.

1. **Colbert, M. and Racicot, R.** THE CRANIAL ENDOCAST OF A NEW FOSSIL PORPOISE (ODONTOCETI: PHOCOENIDAE) FROM THE PLIOCENE OF SAN DIEGO, CALIFORNIA
2. **Smith, D., Dufeu, D., Sanders, R., Ridgely, R. and Witmer, L.** THE CRANIAL ENDOCAST OF *EUTRETAURANOSUCHUS DELFSI* (CROCODYLIFORMES, GONIOPHOLIDIDAE) AND ITS RELATIONSHIP TO OTHER CEPHALIC SPACES
3. **Hodgetts, D., Bates, K., Rarity, F. and Phillip, M.** A *LIGHT* IN THE MUSEUM. APPLICATIONS OF LIGHT DETECTION AND RANGE (LIDAR) IMAGING IN PALAEOONTOLOGY
4. **Deck, L.** ENSURING SUCCESS FOR ALL IN EXHIBITIONS AND INFORMAL SCIENCE PROGRAMS
5. **Fitzgerald, V.** PLASTER
6. **Potapova, O.** THE METHODS AND DATA COLLECTION IN FOSSIL BONE PREPARATION PROCESS: TURNING SCRAP MATERIAL INTO PREMIUM SCIENTIFIC, EDUCATIONAL, AND EXHIBIT RESOURCES
7. **Norton, J., Rinehart, L. and Morgan, G.** THE USE OF URETHANE RESIN AS A NOVEL APPROACH TO THE STABILIZATION OF A LARGE NEARLY INTACT LAND TORTOISE FROM THE LATE PLIOCENE OF NEW MEXICO
8. **Sroka, S. and Finlayson, H.** THE TRIALS AND TRIBULATIONS OF EXCAVATION: TECHNIQUES FOR REMOVING LARGE, HEAVY FIELD JACKETS
9. **Hanks, H. and Haire, S.** STABILIZATION AND REPAIR OF LARGE CRACKS IN SIDERITE ROCK
10. **Starck, E., Weiler, M., Hoffnagle, E., Olinger, D. and Dopheide, A.** CHALLENGES OF A NATIONAL PARK PALEONTOLOGICAL QUARRY: THE BIG PIG DIG
11. **Haugrud, S. and Compton, B.** REVERSIBLE FILLER: A FRESH LOOK AT BUTVAR-76
12. **Davidson, A.** REMOVING FOSSIL RIBS: THE THREAD TECHNIQUE
13. **Mitchell, J., Heckert, A. and Schneider, V.** QUANTIFYING THE BENEFITS OF A HEAVY LIQUID (SODIUM POLYTUNGSTATE) SEPARATION TECHNIQUE ON MICROVERTEBRATE FOSSIL RECOVERY
14. **Bykowski, R.** MORPHOMETRIC ANALYSIS OF SPECIES RESPONSE TO CHANGING ECOLOGY IN *PEROMYSCUS* FROM LATE PREHISTORIC ARCHAEOLOGICAL SITES ON THE NORTHERN PLAINS, USA

### EDWIN H. AND MARGARET M. COLBERT POSTER COMPETITION

15. **Claeson, K.** ANGEL SHARK FETUSES REVEAL NEW INFORMATION ABOUT FOSSIL JUVENILE RELATIVES
16. **Burns, M.** A TIME-AVERAGED HARD AND SOFT TISSUE HISTOLOGY OF CROCODYLIAN OSTEODERMS AND IMPLICATIONS FOR THE STUDY OF DERMAL ARMOUR IN THE FOSSIL RECORD
17. **Mathis, J.** QUANTIFICATION OF EVOLUTION OF *LEPTOMERYX* ENAMEL ACROSS EOCENE-OLIGOCENE TRANSITION
18. **Hirasawa, T.** THE EVOLUTION OF RIBCAGES IN MESOZOIC THEROPODS: AN ANALYSIS OF SKELETAL ELEMENTS USING PARSIMONY
19. **Hamm, S.** SKELETAL ANATOMY OF THE LATE CRETACEOUS SHARK *PTYCHODUS MORTONI* FROM THE SMOKY HILL CHALK MEMBER OF THE NIOBRARA FORMATION IN WESTERN KANSAS
20. **Badamkhatan, Z.** DINOSAURS FROM THE LATE CRETACEOUS MONGOLIAN LOCALITY OF KHAICHIN I
21. **Watanabe, A.** *STEGOSAURUS*: HANDS, FEET, AND FOOTPRINTS

22. **Baasanjav, U.** NEW EVIDENCE FOR THREE SPECIES OF TSAGANOMYID RODENTS FROM THE VALLEY OF THE LAKES REGION, MONGOLIA
23. **Nakajima, Y.** GROWTH STRATEGY IN EARLY ICHTHYOSAURS: AN OSTEOHISTOLOGICAL STUDY
24. **Stiegler, J.** A FUNCTIONAL ANALYSIS OF THE FORELIMB IN THE MACROPODIDAE
25. **Reichel, M.** A CUTTING ANALYSIS: TOOTH SERRATIONS IN THEROPOD DINOSAURS AND THEIR BIOMECHANICAL IMPLICATIONS
26. **Varriale, F.** DENTAL MICROWEAR AND JAW MECHANICS IN BASAL NEOCERATOPSIANS
27. **Green, J.** BONE HISTOLOGY AND GROWTH IN *PLACERIAS HESTERNUS* (THERAPSIDA: DICYNODONTIA) FROM THE *PLACERIAS* QUARRY (LATE TRIASSIC), ARIZONA, USA
28. **Pino-Olivares, A.** *VARANUS GIGANTEUS* SKULL MECHANICAL BEHAVIOR REVEALS A CLOSE RESEMBLANCE TO CERATOSAURID DINOSAURS
29. **D'Amore, D.** KOMODO MONITOR (*VARANUS KOMODOENSIS*) TOOTH MARKS ON BONE AND IMPLICATIONS FOR MESOZOIC ZIPHODONT ARCHOSAUR BEHAVIORAL TAPHONOMY.
30. **Nesbitt, S.** THE EVOLUTION OF THE SACRUM: IDENTIFYING HOMOLOGOUS SACRAL VERTEBRAE ACROSS AMNIOTA
31. **Weiler, M.** PALEONTOLOGY AND GEOLOGY OF THE FORT RANDALL FORMATION AT FEYEREISEN GAP, GREGORY COUNTY, SOUTH DAKOTA
32. **Fahlke, J.** MAMMALIAN MIGRATION PATTERNS IN TIMES OF GLOBAL WARMING - IMMIGRATION AND LOCAL EXTINCTION IN CENTRAL EUROPE AT THE END OF THE LAST GLACIAL
33. **Pardi, M.** DON'S GOOSEBERRY PIT, BLACK HILLS, SOUTH DAKOTA: A SITE BASED TAPHONOMIC STUDY OF NON-ANALOG FAUNAL ASSEMBLAGES ACROSS THE PLEISTOCENE-HOLOCENE BOUNDARY
34. **Campione, N.** A NEW SPECIMEN OF *VARANOPS BREVIROSTRIS* WITH IMPLICATIONS FOR VARANOPIID ANATOMY AND EVOLUTIONARY HISTORY
35. **Mannion, P.** ENVIRONMENTAL ASSOCIATIONS OF SAUROPOD DINOSAURS AND THEIR BEARING ON THE EARLY LATE CRETACEOUS "SAUROPOD HIATUS"
36. **Romano, P.** AN UNUSUAL SPECIMEN OF *BAURUEMYS ELEGANS* AND ITS IMPLICATIONS FOR THE TAXONOMY OF THE SIDE-NECKED TURTLES FROM BAURU BASIN (UPPER CRETACEOUS OF BRAZIL)
37. **Keenan, S.** TAPHONOMY OF A *TRICERATOPS* BONEBED FROM THE UPPER HELL CREEK FORMATION, GARFIELD COUNTY, MONTANA
38. **Weinstein, D.** PRELIMINARY PHYLOGENY OF TAENIODONTA, AN ENIGMATIC ORDER OF EUTHERIAN MAMMALS (PALEOGENE, NORTH AMERICA)
39. **Carney, R.** ARCOSAUR: ARCGIS OPERATIONS FOR SURFACE ANALYSIS USING RASTERS
40. **Murakami, M.** THE MOST PRIMITIVE PORPOISE (CETACEA: DELPHINOIDEA) FROM THE UPPER MIOCENE WAKKANAI FORMATION, HOKKAIDO, JAPAN
41. **Lawrence, J.** A TOTAL EVIDENCE ANALYSIS OF THE EVOLUTIONARY HISTORY OF THE THUNNOSAUR ICHTHYOSAURS
42. **Bell, P.** A MEDLEY OF MALADIES: MULTIPLE PALEOPATHOLOGIES IN A SPECIMEN OF *GORGOSAURUS LIBRATUS* (TYRANNOSAURIDAE)
43. **Heywood, J.** PALAEODIETARY RECONSTRUCTION AND FUNCTIONAL MORPHOLOGY OF BOVID MOLARS
44. **Larson, D.** FAUNAL SHIFTS AS INDICATED BY MICROVERTEBRATE FOSSILS OF THE LATEST SANTONIAN UPPER MILK RIVER FORMATION, ALBERTA, CANADA
45. **Famoso, N.** A REPORT ON THE DISCOVERIES MADE AT THE GOLTER RANCH LOCALITY (HEMPHILLIAN) IN ANTELOPE COUNTY, NEBRASKA
46. **Parent, S.** A DECONSTRUCTION OF THE ARTIODACTYL ASTRAGALUS AND ITS IMPLICATIONS FOR RECONSTRUCTING PHYLOGENY

47. **George, C.** GEOGRAPHIC AND TEMPORAL CONSTRAINTS ON THE DISTRIBUTION OF QUATERNARY FAUNAS IN TEXAS
48. **Smith, N.** A NEW SPECIES OF AUK FROM THE MIOCENE OF CALIFORNIA REVEALS MORPHOLOGICAL TRENDS RELATED TO FLIGHTLESSNESS WITHIN ALCIDAE
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49. **Pajor, N., Breuer, T. and Perry, S.** HOW DID SAUROPODS BREATHE? RIB DIMENSIONS AND HISTOLOGY IN *CAMARASAURUS*
50. **Allen, V., Hutchinson, J. and Hertel, J.** EVOLUTION AND SENSITIVITY ANALYSIS OF WHOLE-BODY MASS DISTRIBUTION IN THEROPOD DINOSAURS
51. **Lamm, K., Ksepka, D., Stone, E. and Clarke, J.** IDENTIFYING DIFFERENTIAL SIZE TRENDS IN MESOZOIC BIRDS USING NEW DATA AND A NOVEL METHOD
52. **Bell, A., Tseng, Z. and Chiappe, L.** DIVING MECHANICS OF THE EXTINCT HESPERORNITHIFORMES: COMPARISON TO MODERN DIVING BIRDS
53. **Hall, M. and Iwaniuk, A.** ACTIVITY PATTERN AND COMPARATIVE OPTIC FORAMEN SIZE IN AVIANS
54. **Sculley, J., Johnson, E. and Lewis, P.** PRELIMINARY SYSTEMATIC AND PALEOENVIRONMENTAL ANALYSIS OF THE AVIFAUNA FROM ROLAND SPRINGS RANCH, WEST TEXAS
55. **Zaim, Y., Yan, R., Gunnell, G., Stidham, T. and Ciochon, R.** FIRST EVIDENCE OF MIOCENE TERRESTRIAL VERTEBRATES FROM SUMATRA (INDONESIA)
56. **Nestler, J. and Steadman, D.** ADDITIONAL MATERIAL OF THE MIOCENE CHACHALACA *BOREORTALIS LAESSLEI* (NEORNITHES, CRACIDAE) AND ITS IMPLICATIONS FOR THE THOMAS FARM FOSSIL LOCALITY AND THE EVOLUTION AND BIOGEOGRAPHY OF CRACIDS
57. **Rensberger, J.** ALTERATION OF BONE MICROSTRUCTURE RELATED TO GROWTH RATE IN THE GIANT RATITE *DINORNIS*
58. **Perry, M. and Foster, J.** BIRD SKULL FROM THE GREEN RIVER FORMATION (MIDDLE EOCENE) OF GARFIELD COUNTY, COLORADO
59. **Degrange, F., Moreno, K., Wroe, S., Tambussi, C. and Witmer, L.** A COMPUTATIONAL BIOMECHANICAL APPROACH TO THE RECONSTRUCTION OF PREDATORY BEHAVIOR IN THE TERROR BIRD *ANDALGALORNIS STEULLETI*
60. **Syverson, V. and Prothero, D.** EVOLUTIONARY PATTERNS IN PLEISTOCENE TO RECENT CALIFORNIA CONDORS
61. **Molina, S. and Prothero, D.** EVOLUTIONARY STASIS OF GOLDEN EAGLES OVER THE LAST GLACIAL-INTERGLACIAL CYCLE (35 KA TO PRESENT)
62. **Fraser, D., Furr, R. and Theodor, J.** IMPROVING LOW-MAGNIFICATION MICROWEAR TECHNIQUES USING HIGH DYNAMIC RANGE IMAGING
63. **Schwartz, L., Griffith, J. and Flanagan, C.** THE LAST SUPPER: MOLAR MICROWEAR FEATURES OF *PHASCOLARCTUS CINERUS* AND THE EFFECTS OF AGE, SEX AND SEASON
64. **Lewis, P., Brink, J., Kennedy, A. and Campbell, T.** PRELIMINARY ANALYSIS OF THE FLORISBAD SMALL ANIMAL ASSEMBLAGE
65. **Smith, K. and Czaplewski, N.** A PRELIMINARY ANALYSIS OF PHYLOGENETIC RELATIONSHIPS WITHIN THE GENUS *COPEMYS* (RODENTIA: CRICETIDAE) WITH EMPHASIS ON BARSTOVIAN SPECIES
66. **Tomida, Y. and Jin, C.** CAN MORPHOLOGICAL DIFFERENCES AMONG EXTINCT SPECIES BE EXPLAINED BY MEANS OF GENETICS? AN EXAMPLE FROM FOSSIL RABBITS
67. **Anderson, D. and Keil, K.** EVOLUTIONARY CHANGE IN *THISBEMYS* (RODENTIA; ISCHYROMYIDAE) RECOVERED FROM THE BRIDGER FORMATION, GREEN RIVER BASIN, WYOMING
68. **López Antoñanzas, R., Álvarez Sierra, M., García Paredes, I., Morales, J. and Peláez-Campomanes, P.** ON THE PRESENCE OF *HISPANOMYS PERALENSIS* (RODENTIA, CRICETINAE) AT BATALLONES (MADRID, SPAIN)
69. **Tabrum, A. and Fostowicz-Frelik, L.** LAGOMORPHS FROM THE LATE DUCHESNEAN (LATE MIDDLE EOCENE) DIAMOND O RANCH LOCAL FAUNA OF SOUTHWESTERN MONTANA

70. **Jass, C.** PLEISTOCENE LAGOMORPHS FROM CATHEDRAL CAVE, NEVADA
71. **Fostowicz-Frelik, L. and Kowalewska, M.** THE NORTHERNMOST RECORD OF *EUROLAGUS FONTANNESI* (MAMMALIA, LAGOMORPHA) FROM THE LATE MIOCENE (MN 9) LIGNITE DEPOSITS IN BELCHATÓW (POLAND)
72. **Meyer, T., Bell, S. and Bryant, H.** *PSEUDALLOMYS* (RODENTIA, APLODONTIDAE) FROM THE CYPRESS HILLS FORMATION, SASKATCHEWAN, DEMONSTRATES THAT *PSEUDALLOMYS* IS NOT A JUNIOR SYNONYM OF *ANSOMYS*
73. **Chick, J., Croft, D. and Anaya, F.** MIDDLE MIOCENE RODENTS FROM QUEBRADA HONDA, BOLIVIA
74. **Hulbert Jr., R., Poyer, A. and Bloch, J.** LATE BLANCAN RODENTS AND LAGOMORPHS FROM THE HAILE 7G LOCAL FAUNA, NORTH-CENTRAL FLORIDA
75. **Muldoon, K. and Burney, D.** MICROMAMMAL REMAINS FROM THE *PLESIORYCTEROPUS* ULNA SITE, ANJOHIBE CAVE, NW MADAGASCAR
76. **Calede, J. and Hopkins, S.** SKELETAL MORPHOLOGY AND ONTOGENY OF *ALPHAGAULUS PRISTINUS* (MAMMALIA: RODENTIA: MYLAGAULIDAE), AN EARLY BURROWER FROM THE BARSTOVIAN
77. **Masters, S., Sandau, S. and Temme IV, T.** A BRIDGERIAN RODENT (*SCIURAVIDAE*) FROM THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION IN THE PICEANCE CREEK BASIN, NORTHWESTERN COLORADO
78. **McAfee, R.** ASTRAGALUS MORPHOLOGY AND EVIDENCE OF SPECIATION IN THE GROUND SLOTH *MYLODON* (MAMMALIA: XENARTHRA: MYLODONTIDAE)
79. **Cruz, M. and Henriques, D.** DOCUMENTATION OF PATHOLOGICAL VERTEBRAE IN THE PLEISTOCENIC GIANT SLOTH *EREMOTHERIUM LAURILLARDI* FROM THE STATE OF PERNAMBUCO, BRAZIL
80. **Salles, L., Perini, F. and Moraes Neto, C.** A NEW COMPLETE SKELETON OF *NOTHROTHERIUM MAQUINENSE* FOUND IN AN UNDERWATER LIMESTONE CAVE FROM BAHIA (BRAZIL)
81. **Zurita, A., Carlini, A. and Gillette, D.** *GLYPTOTHERIUM-GLYPTODON* (XENARTHRA, GLYPTODONTIDAE, GLYPTODONTINAE): ANATOMY AND PALAEOBIOGEOGRAPHY
82. **Carlini, A., Zurita, A. and Gillette, D.** GLYPTODONTINES (XENARTHRA, GLYPTODONTIDAE) AND THE GREAT AMERICAN BIOTIC INTERCHANGE: A NEW INTERPRETATION
83. **Kearney, K. and Shockey, B.** OLDEST CRANIUM OF A HORNED ARMADILLO (PELTEPHILIDAE, LATE OLIGOCENE, BOLIVIA): CLUES REGARDING BASAL CINGULATE MORPHOLOGY
84. **Porpino, K., Fernicola, J. and Bergqvist, L.** A NEW SPECIES OF *PACHYARMATHERIUM* (XENARTHRA: CINGULATA) FROM THE LATE PLEISTOCENE OF NORTHEASTERN BRAZIL AND ITS PHYLOGENETIC AFFINITIES
85. **Redmond, B. and McDonald, H.** EVIDENCE OF HUMAN PREDATION ON JEFFERSON'S GROUND SLOTH (*MEGALONYX JEFFERSONII*) FROM EASTERN NORTH AMERICA
86. **Van Orden, T. and Godfrey, S.** UNUSUAL BONE PRESERVATION AND TAPHONOMY IN *METAXYTHERIUM CRATAEGENSE* (SIRENIA: DUGONGIDAE) FROM CALVERT CLIFFS, MARYLAND, USA (MIOCENE, CHESAPEAKE GROUP)

## **FRIDAY MORNING, OCTOBER 17, 2008**

### **SYMPOSIUM: EARLY HOMINID EVOLUTIONARY TEMPO AND MODE BETWEEN 3 MA AND 4.5 MA**

**AMBASSADOR BALLROOM**

**MODERATORS: YOHANNES HAILE-SELASSIE AND SCOTT SIMPSON**

- 8:00 **Plavcan, J. and Lockwood, C.** MODELING EARLY HOMINID BEHAVIORAL EVOLUTION
- 8:15 **Jablonski, N. and Frost, S.** THE EVOLUTION OF AFRICAN OLD WORLD MONKEYS FROM 4.5 TO 3.0 MA



- 8:30 **Simpson, S., Quade, J., Levin, N. and Semaw, S.** THE EARLY PLIOCENE HOMINID *ARDIPITHECUS RAMIDUS*: COMPARATIVE DENTAL ANATOMY AND ECOLOGICAL CONTEXT
- 8:45 **Levin, N., Simpson, S., Quade, J., Cerling, T. and Frost, S.** CARBON ISOTOPIC EVIDENCE FOR *ARDIPITHECUS* HABITAT AT GONA, ETHIOPIA
- 9:00 **Ward, C. and Manthi, F.** NEW FOSSILS OF *AUSTRALOPITHECUS ANAMENSIS* FROM KANAPOI, KENYA, AND EVOLUTION WITHIN THE *A. ANAMENSIS-AFARENSIS* LINEAGE
- 9:15 **Viola, R., Kullmer, O., Sandrock, O., Hujer, W. and Seidler, H.** AN EARLY AUSTRALOPITHECINE FEMUR FROM GALILI, ETHIOPIA
- 9:30 **Haile-Selassie, Y.** NEW EARLY PLIOCENE HOMINID FOSSILS FROM THE WORANSO-MILLE (CENTRAL AFAR, ETHIOPIA) AND THE QUESTION OF PHYLETIC EVOLUTION IN EARLY *AUSTRALOPITHECUS*
- 9:45 **Su, D. and Harrison, T.** THE LAETOLI PALEOENVIRONMENT: RECONSIDERATIONS AND IMPLICATIONS FOR HOMININ EVOLUTION

### TECHNICAL SESSION X

#### GRAND BALLROOM A&B

MODERATORS: RICHARD BUTLER AND ANUSUYA CHINSAMY-TURAN

- 8:15 **Sereno, P.** A COMPARATIVE FUTURE FOR MORPHOLOGY-BASED CLADISTICS
- 8:30 **Brusatte, S., Benton, M., Ruta, M. and Lloyd, G.** THE EVOLUTIONARY HISTORY AND HIGHER-LEVEL PHYLOGENY OF ARCHOSAURIA (TETRAPODA: DIAPSIDA)
- 8:45 **Claessens, L. and Vickaryous, M.** A REEVALUATION OF PREPUBIC SKELETAL ELEMENTS IN ARCHOSAURS
- 9:00 **Padian, K. and Li, C.** THE EARLY EVOLUTION OF ARCHOSAUR STANCE AND GAIT
- 9:15 **Zhou, C.** A NEW PTERODACTYLOID FROM THE EARLY CRETACEOUS YIXIAN FORMATION OF WESTERN LIAONING, CHINA
- 9:30 **Chinsamy-Turan, A., Codorniu, L. and Chiappe, L.** DEVELOPMENTAL GROWTH PATTERNS OF THE FILTER-FEEDING PTEROSAUR, *PTERODAUSTRO GUINAZUI*
- 9:45 **Unwin, D., Wilkinson, M. and Lü, J.** NEW FOSSIL EVIDENCE FOR A BROAD FOREWING IN PTEROSAURS
- 10:00 **BREAK**
- 10:15 **Butler, R., Barrett, P., Nowbath, S. and Upchurch, P.** ESTIMATING THE EFFECTS OF THE ROCK RECORD ON PTEROSAUR DIVERSITY PATTERNS: IMPLICATIONS FOR HYPOTHESES OF BIRD/PTEROSAUR COMPETITIVE REPLACEMENT
- 10:30 **Barrett, P., Butler, R., Kenrick, P. and Penn, M.** COEVOLUTION OVER GEOLOGIC TIMESCALES: TESTING INTERACTIONS BETWEEN NONAVIAN DINOSAURS AND CYCADS
- 10:45 **Upchurch, P., Maidment, S., Butler, R. and Benson, R.** RECONSTRUCTING THE BIOGEOGRAPHIC HISTORY OF MIDDLE AND LATE JURASSIC DINOSAURS USING EVENT-BASED PARSIMONY TREEFITTING
- 11:00 **Benton, M.** HOW TO FIND A DINOSAUR, AND THE ROLE OF SYNONYMY IN BIODIVERSITY STUDIES
- 11:15 **Carrano, M.** PATTERNS OF DIVERSITY AMONG LATEST CRETACEOUS DINOSAURS IN NORTH AMERICA
- 11:30 **Lloyd, G., Ruta, M., Tarver, J. and Benton, M.** DINOSAURS AND THE CRETACEOUS TERRESTRIAL REVOLUTION
- 11:45 **Porro, L.** ACCURACY IN FINITE ELEMENT MODELING OF EXTINCT TAXA: SENSITIVITY ANALYSES IN *HETERODONTOSAURUS TUCKI*
- 12:00 **Pei, R. and Boyd, C.** HISTOLOGY, TAXONOMY, AND SYSTEMATIC POSITION OF BASAL NEORNITHISCHIANS FROM THE LOWER CRETACEOUS YIXIAN FORMATION, WESTERN LIAONING, CHINA

## TECHNICAL SESSION XI

### GOLD BALLROOM

**MODERATORS: KENNETH ANGIELCZYK AND JÖRG FRÖBISCH**

- 8:00 **Pardo, J., Huttenlocker, A., Small, B. and Milner, A.** BIOTIC RESPONSES TO CLIMATE CHANGE IN THE PERMO-CARBONIFEROUS TRANSITION, PART I: VERTEBRATE FAUNAL DISTRIBUTIONS AND REGIONAL PROVINCIALISM
- 8:15 **Huttenlocker, A., Pardo, J., Small, B. and Milner, A.** BIOTIC RESPONSES TO CLIMATE CHANGE IN THE PERMO-CARBONIFEROUS TRANSITION, PART II: BETA DIVERSITY, REGIONAL EVOLUTIONARY RESPONSES, AND VAUGHN'S FAUNAL CLINE
- 8:30 **Modesto, S. and Reisz, R.** A NEW PARAREPTILE FROM THE MIDDLE PERMIAN *TAPINOCEPHALUS* ASSEMBLAGE ZONE, KAROO BASIN OF SOUTH AFRICA
- 8:45 **Tsuji, L., Müller, J. and Reisz, R.** A ENIGMATIC NEW PARAREPTILE (AMNIOTA: REPTILIA) FROM THE EARLY PERMIAN FORT SILL FISSURE FILL DEPOSITS IN OKLAHOMA
- 9:00 **Bickelmann, C., Müller, J. and Reisz, R.** *ACEROSODONTOSAURUS* AND THE MONOPHYLY OF YOUNGINIFORM REPTILES
- 9:15 **Reisz, R. and Modesto, S.** THE ANATOMY AND RELATIONSHIPS OF THE ENIGMATIC DIAPSID REPTILE *LANTHANOLANIA IVAKHNENKOI* FROM THE MIDDLE PERMIAN OF NORTHERN RUSSIA
- 9:30 **Fröbisch, J. and Reisz, R.** POSTCRANIAL ANATOMY OF THE PERMIAN THERAPSID *SUMINIA GETMANOVI*, THE OLDEST KNOWN ARBOREAL TETRAPOD
- 9:45 **Kammerer, C.** A NEW THEROCEPHALIAN FROM THE *CISTECEPHALUS* ASSEMBLAGE ZONE OF SOUTH AFRICA AND NEW INFORMATION ON THEROCEPHALIAN SYSTEMATICS
- 10:00 **BREAK**
- 10:15 **Ruta, M., Benton, M. and Surkov, M.** ANOMODONT DIVERSITY AND DISPARITY AND THE END PERMIAN EXTINCTION
- 10:30 **Sidor, C., Angielczyk, K., Hopson, J., Nesbitt, S. and Smith, R.** NEW VERTEBRATE FOSSILS FROM THE PERMO-TRIASSIC RUHUHU BASIN OF TANZANIA
- 10:45 **Angielczyk, K., Sidor, C., Tsuji, L., Nesbitt, S. and Smith, R.** THE PERMO-TRIASSIC DICYNODONT FAUNA OF THE RUHUHU BASIN, TANZANIA: NEW DISCOVERIES AND THEIR IMPLICATIONS
- 11:00 **Gao, K., Fox, R., Zhou, C. and Li, D.** A NEW NON-MAMMALIAN EUCYNODONT (SYNAPSIDA: THERAPSIDA) FROM THE LOWER TRIASSIC OF CHINA, AND ITS BIOSTRATIGRAPHIC IMPLICATIONS
- 11:15 **Sues, H. and Hopson, J.** TRAVERSODONT CYNODONTS FROM THE UPPER TRIASSIC OF EASTERN NORTH AMERICA
- 11:30 **Beck, A. and Sears, K.** TRENDS IN THE EVOLUTION OF BODY SIZE IN NON-MAMMALIAN SYNAPSIDS
- 11:45 **Sears, K., Doroba, C. and Beck, A.** DECOUPLED TRENDS IN THE EVOLUTION OF UPRIGHT STANCE IN NON-MAMMALIAN SYNAPSIDS
- 12:00 **Kilbourne, B. and Makovicky, P.** THE ONTOGENETIC ALLOMETRY OF LIMB BONES IN MAMMALS AND DINOSAURS AND THE USE OF ONTOGENETIC ALLOMETRY AS A PREDICTOR OF LIFE HISTORY TRAITS

## TECHNICAL SESSION XII

### AMBASSADOR BALLROOM

**MODERATOR: IRINA RUF**

- 10:15 **Ruf, I., Gingerich, P. and Koenigswald, W.** DO INTERNAL CRANIAL FEATURES REFLECT ADAPTATIONS IN "WOODPECKING" MAMMALS?
- 10:30 **Coleman, M. and Boyer, D.** A STIRRUP IN THE PALEO-SCENE. A NEW LINE OF EVIDENCE FOR INVESTIGATING CEREBRAL CIRCULATION PATTERNS IN FOSSILS

- 10:45 **Boyer, D.** A COMPARISON OF *PLESIADAPIS COOKEI* TO *P. TRICUSPIDENS* (MAMMALIA, PLESIADAPIFORMES): EVIDENCE FOR ECOLOGICAL DIFFERENCES
- 11:00 **Williams, B., Kay, R., Bajpai, S., Kapur, V. and Das, D.** NEW INDIAN EOSIMIIDS: THE OLDEST ASIAN RECORD OF ANTHROPOIDS
- 11:15 **Seiffert, E., Perry, J. and Simons, E.** DENTAL MORPHOLOGY AND DIET OF A LARGE ADAPIFORM PRIMATE FROM THE EOCENE BIRKET QARUN FORMATION, EGYPT
- 11:30 **Smith, A., Kupzik, K., Fagan, M., Rook, L. and O'Higgins, P.** GEOMETRIC MORPHOMETRICS AND FUNCTIONAL MORPHOLOGY OF A SARDINIAN FOSSIL MACAQUE: WARPING AND FINITE ELEMENTS ANALYSIS OF CRANIOFACIAL FEATURES IN *MACACA MAJORI*
- 11:45 **Shi, J., Curtis, N., Fitton, L., O'Higgins, P. and Fagan, M.** MUSCULOSKELETAL MODELLING OF A MACAQUE SKULL - SENSITIVITY STUDIES
- 12:00 **MacLachy, L., Cote, S., Orliac, M., Sanders, W. and Winkler, A.** THE FAUNAL AGE OF MOROTO I AND II, UGANDA

## FRIDAY AFTERNOON, OCTOBER 17, 2008

### TECHNICAL SESSION XIII

#### AMBASSADOR BALLROOM

**MODERATORS: LAWRENCE FLYNN AND BRUCE MACFADDEN**

- 1:30 **Bibi, F., Hill, A., Beech, M. and Yasin, W.** A RIVER FAUNA FROM THE ARABIAN DESERT: LATE MIOCENE FOSSILS FROM THE UNITED ARAB EMIRATES
- 1:45 **Croft, D. and Anaya, F.** A NEW EARLY/MIDDLE MIOCENE FAUNA FROM SOUTHERN BOLIVIA
- 2:00 **Flynn, L.** PALEOBIOGEOGRAPHIC AFFINITY ACROSS SOUTHERN ASIA DURING THE MIOCENE: SMALL MAMMALS REFLECT THE ORIENTAL REALM
- 2:15 **Orcutt, J.** MIOCENE CLIMATE CHANGE AND MAMMAL BODY SIZE EVOLUTION IN THE NORTHWESTERN UNITED STATES
- 2:30 **Solounias, N., Rivals, F. and Semprebon, G.** HERBIVORE DIETARY INTERPRETATION AND PALEOECOLOGY OF THE PIKERMIAN BIOME (LATE MIOCENE)
- 2:45 **Mörs, T.** FIRST TERTIARY LAND MAMMAL FROM SCANDINAVIA: PALEONTOLOGY AND ISOTOPE FINGERPRINTING
- 3:00 **DeSantis, L. and MacFadden, B.** STABLE ISOTOPES AND REES OF UNGULATES AND XENARTHANS FROM HAILE 7G: ELUCIDATING THE PALEOECOLOGY OF A LATE PLIOCENE FOSSIL SITE FROM FLORIDA
- 3:15 **MacFadden, B. and DeSantis, L.** PHYSICAL PROPERTIES, GEOCHEMISTRY, AND DIAGENESIS OF FOSSIL XENARTHAN TEETH: PROSPECTS FOR INTERPRETING STABLE ISOTOPE EVIDENCE
- 3:30 **Campbell, K.** THE LATE NEOGENE GEOLOGIC TRANSFORMATION OF THE AMAZON BASIN, SOUTH AMERICA
- 3:45 **Alroy, J.** CUT DOWN TO SIZE: BODY MASS, DIET, AND BACKGROUND EXTINCTION RATES IN FOSSIL MAMMALS

### TECHNICAL SESSION XIV

#### GOLD BALLROOM

**MODERATORS: MERRILEE GUENTHER AND MARY SCHWEITZER**

- 1:30 **Boyd, C., Cleland, T. and Novas, F.** HISTOLOGY, HOMOLOGY, AND FUNCTION OF INTERCOSTAL PLATES ON ORNITHISCHIAN DINOSAURS
- 1:45 **Hayashi, S., Kenneth, C., Watabe, M., Mateus, O. and Barsbold, R.** DEFENSIVE WEAPONS OF THYREOPHORAN DINOSAURS: HISTOLOGICAL COMPARISONS AND STRUCTURAL DIFFERENCES IN SPIKES AND CLUBS OF ANKYLOSAURS AND STEGOSAURUS

- 2:00 **Arbour, V., Snively, E. and Currie, P.** EVOLUTION AND FUNCTIONAL MORPHOLOGY OF THE TAIL CLUB IN ANKYLOSAURID DINOSAURS
- 2:15 **Leahey, L., Molnar, R. and Salisbury, S.** THE CRANIAL OSTEOLOGY OF *MINMI* SP., A BASAL ANKYLOSAUROMORPH (ORNITHISCHIA: DINOSAURIA) FROM THE EARLY CRETACEOUS (ALBIAN) ALLARU FORMATION OF RICHMOND, NORTH-WESTERN QUEENSLAND, AUSTRALIA
- 2:30 **Woodruff, D. and Varricchio, D.** MODELING AN *ORYCTODROMEUS CUBICULARIS* (DINOSAURIA) BURROW
- 2:45 **Hübner, T.** A JUVENILE SKULL OF THE ORNITHOPOD DINOSAUR *DRYOSAURUS LETTOWVORBECKI* - IMPLICATIONS FOR THE CRANIAL ONTOGENY IN ORNITHOPODS
- 3:00 **Guenther, M.** COMPARATIVE ONTOGENIES OF THE POSTCRANIA OF THREE HADROSAURID TAXA AND ONE BASAL IGUANODONTIAN TAXON
- 3:15 **Lee, A., Cooper, L., Taper, M. and Horner, J.** RAPID GROWTH OF THE HADROSAUR *HYPACROSAURUS* REFLECTS DIRECT AND INDIRECT EFFECTS OF PREDATION
- 3:30 **Scherzer, B. and Varricchio, D.** A DEBRIS FLOW-HOSTED BONEBED OF JUVENILE LAMBEOSAURINES IN THE TWO MEDICINE FORMATION OF MONTANA
- 3:45 **Schweitzer, M., Organ, C., Zheng, W., Asara, J. and Cleland, T.** EXCEPTIONAL PRESERVATION OF *BRACHYLOPHOSAURUS CANADENSIS* (CAMPANIAN, JUDITH RIVER FORMATION, USA)

### TECHNICAL SESSION XV

#### GRAND BALLROOM B

**MODERATORS: JASON ANDERSON AND NADIA FRÖBISCH**

- 1:30 **Maddin, H. and Anderson, J.** NEUROCRANIAL ANATOMY OF A MICROSAURIAN LEPOSPONDYL, *CARROLLA CRADDOCKI*, EXTRACTED VIA HIGH-RESOLUTION COMPUTED TOMOGRAPHY
- 1:45 **Olori, J.** POSTCRANIAL OSSIFICATION SEQUENCE AND MORPHOGENESIS OF *MICROBRACHIS PELIKANI* (LEPOSPONDYLI: TETRAPODA)
- 2:00 **Anderson, J., Reisz, R. and Maddin, H.** OSTODOLEPIDAE (LEPOSPONDYLI, RECUMBIROSTRA): PERMIAN BURROWING MICROSAURS
- 2:15 **Fröbisch, N. and Schoch, R.** TESTING THE IMPACT OF MINIATURIZATION ON THE PHYLOGENY OF PALEOZOIC DISSOROPHOID AMPHIBIANS
- 2:30 **Witzmann, F. and Soler-Gijon, R.** THE BONE HISTOLOGY OF OSTEODERMS IN TEMNOSPONDYLS
- 2:45 **Carroll, R. and Li, H.** REMARKABLE SOFT TISSUE PRESERVATION OF MIDDLE JURASSIC SALAMANDERS AND THE ANCESTRY OF MODERN FAMILIES
- 3:00 **Sigurdsen, T.** THE EVOLUTION OF THE AMPHIBIAN HUMERUS AND THE ORIGIN OF SALTATION IN FROGS
- 3:15 **Báez, A., Barbosa de Moura, G. and Gómez, R.** THE DIVERSE BATRACHOFAUNA FROM THE APTIAN CRATO FORMATION AND ITS BEARING ON THE MAIN RADIATION OF HYLOIDS FROGS
- 3:30 **Folie, A., Rana, R., Sahni, A., Rose, K. and Smith, T.** FROGS (ANURA) FROM THE EARLY EOCENE OF VASTAN LIGNITE MINE, GUJARAT, INDIA
- 3:45 **Marjanović, D. and Laurin, M.** DATING THE ORIGIN OF LISSAMPHIBIA BY THREE TECHNIQUES SUGGESTS A PERMIAN, MONOPHYLETIC ORIGIN

### POSTER SESSION III

**Authors must be present from 4:00 – 6:00 p.m.**

**Posters must be removed by 6:15 p.m.**

- Zhang, G., Wang, Y., Jones, M. and Evans, S.** A NEW CRETACEOUS SALAMANDER FROM HEBEI, CHINA
- Boardman, G., Schubert, B. and Mead, J.** SALAMANDERS OF THE MIO-PLIOCENE GRAY FOSSIL SITE

3. **Bredehoeft, K. and Schubert, B.** REVISED SPECIES STATUS OF THE EXTINCT HELLBENDER, *CRYPTOBRANCHUS GUILDAYI*
4. **Simons, V. and Stevens, N.** LIMB AND CONTACT STRUCTURE MORPHOMETRICS IN EXTANT ANURANS: IMPLICATIONS FOR INTERPRETING FOSSIL FROG LOCOMOTOR MORPHOLOGY
5. **Garcia, W.** CARBONIFEROUS VERTEBRATE PROVINCIALITY: DEFINING THE ILLINOIS BASIN VERTEBRATE FAUNA
6. **Fraser, N., Rieppel, O. and Mueller, B.** IS *MALERISAURUS* A PROTOROSAUR?
7. **Sobral, G. and Langer, M.** A SUPERTREE APPROACH TO PROLACERTIFORM PHYLOGENY
8. **Liebrecht, T., Müller, J. and Sumida, S.** THE SKULL OF A LARGE MULTIPLE TOOTH-ROWED CAPTORHINID (AMNIOTA: EUREPTILIA) FROM THE MIDDLE PERMIAN SAN ANGELO FORMATION OF KNOX COUNTY, TEXAS
9. **Egberts, S.** A MORPHOLOGICAL STUDY OF *CAPTORHINUS AGUTI* USING X-RAY COMPUTED TOMOGRAPHY: NEW INSIGHTS ON A WELL-STUDIED SPECIES
10. **Lucas, S., Spielmann, J. and Rinehart, L.** TIMING OF TETRAPOD EXTINCTIONS ACROSS THE PERMO-TRIASSIC BOUNDARY
11. **Pelletier, V. and Sumida, S.** A POSTCRANIAL DESCRIPTION OF THE BASAL EUPELYCOSAUR *AEROSAURUS WELLESI*
12. **Weide, D., Sidor, C., Angielczyk, K. and Smith, R.** A NEW RECORD OF PROCYNOSUCHUS DELAHARPEAE (THERAPSIDA: CYNODONTIA) FROM THE UPPER PERMIAN USILI FORMATION (RUHUHU BASIN), TANZANIA
13. **Felice, R. and Angielczyk, K.** DETERMINING LOCOMOTOR STYLE OF *OPHIACODON* (SYNAPSIDA) USING ANALYSIS OF AXIAL SKELETON MORPHOLOGY
14. **Fujiwara, S.** A BIOMECHANICAL MODEL FOR FORELIMB POSTURE IN EXTANT AND EXTINCT TETRAPODS
15. **Meyers, V., Breithaupt, B. and Matthews, N.** A CONUNDRUM OF PTEROSAUR ICHNOSPECIES IN WYOMING: *PTERAICHNUS STOKESI* OR *PTERAICHNUS SALTWASHENSIS*?
16. **Rodrigues, T. and Kellner, A.** HOW DO NEW DISCOVERIES AFFECT PTEROSAUR PHYLOGENY?
17. **Habib, M.** SKELETAL ARCHITECTURE AND LAUNCH MECHANICS OF PTEROSAURS
18. **Hill, R. and Norell, M.** *PINACOSAURUS GRANGERI* COMES OF AGE: ONTOGENETIC CHANGES IN THE ANKYLOSAURIAN SKULL
19. **Rivera-Sylva, H., Guzman-Gutierrez, J., Lopez-Espinosa, J., de la Peña-Oviedo, I. and Palomino-Sanchez, F.** FIRST REPORT OF THE GENUS *EDMONTONIA* (THYREOPHORA: NODOSAURIDAE) FROM MEXICO
20. **Parsons, W. and Parsons, K.** DIFFERENTIATING BETWEEN *SAUROPELTA EDWARDSORUM* (ORNITHISCHIA, THYREOPHORA) AND A NEW ANKYLOSAURID, BOTH FROM THE EARLY CRETACEOUS CLOVERLY FORMATION OF CENTRAL MONTANA
21. **Miyashita, T.** TWO PREVIOUSLY UNDESCRIBED SKELETONS OF *LEPTOCERATOPS* (ORNITHISCHIA, NEOCERATOPSIA) FROM THE LATEST CRETACEOUS OF SOUTHERN ALBERTA
22. **Ai, A., Evans, D. and Schott, R.** ONTOGENY OF CRANIAL BONE HISTOLOGY IN *ALLIGATOR*: IMPLICATIONS FOR AGING PACHYCEPHALOSAURID DINOSAURS
23. **Tanoue, K., You, H. and Dodson, P.** COMPARATIVE MORPHOLOGY OF BASAL CERATOPSID DENTITION
24. **Mallon, J., Holmes, R., Anderson, J., Farke, A. and Ryan, M.** NEW INFORMATION ON TWO CHASMOSAURINE CERATOPSIDS FROM THE HORSESHOE CANYON FORMATION (LATE CRETACEOUS) OF ALBERTA, CANADA
25. **Schott, R., Evans, D., Williamson, T., Carr, T. and Goodwin, M.** ANATOMY AND SYSTEMATICS OF *COLEPIOCEPHALE LAMBEI* (ORNITHISCHIA PACHYCEPHALOSAURIDAE) REVISED
26. **Tumarkin-Deratzian, A.** LONG BONE SURFACE TEXTURES AS ONTOGENETIC MARKERS IN CENTROSAURINE CERATOPSIDS

27. **Watabe, M. and Tsogtbaatar, K.** A NEW PACHYCEPHALOSAUR (MARGINOCEPHALIA, DINOSAURIA) FROM THE LOWER UPPER CRETACEOUS IN MONGOLIA-THE EARLIEST PACHYCEPHALID FORM
28. **Bavington, R. and Evans, D.** A NEW *PARASAUROLOPHUS* (HADROSAURIDAE) BRAINCASE FROM THE DINOSAUR PARK FORMATION, ALBERTA
29. **Shibata, M. and Pratueng, J.** NEW IGUANODONTID DINOSAUR MATERIAL FROM THE LATE EARLY CRETACEOUS IN THAILAND
30. **Knoll, F. and Dong, Z.** “*GONGBUSAURUS*” AND THE EARLY PHYLOGENY OF THE NEORNITHISCHIA
31. **Huh, M., Lee, D., Lim, J. and Norman, D.** THE PRELIMINARY STUDY ON A NEW HYPSEILOPHODONTID DINOSAURS FROM SOUTH KOREA
32. **Tsogtbaatar, K. and Watabe, M.** PHYLOGENETIC POSITION OF DERIVED ORNITHOPODS OF EARLY LATE CRETACEOUS (BAYNSHIRE AND DJADOKHTA AGE) IN MONGOLIA
33. **Gates, T., Tsogtbaatar, K. and Zanno, L.** A NEW IGUANODONTIAN (ORNITHOPODA) DINOSAUR SPECIES FROM THE LOWER CRETACEOUS OF MONGOLIA
34. **Hups, K., Lockley, M., Foster, J. and Gierlinski, G.** THE FIRST ANKYLOSAUR TRACK FROM THE JURASSIC
35. **Brown, C., Boyd, C. and Russell, A.** NEW SPECIMENS OF *THESCÉLOSAURUS* AND THEIR IMPLICATIONS FOR TAXONOMY AND PHYLOGENY OF BASAL NEORNITHISCHIANS
36. **Brink, K., Zelenitsky, D., Evans, D. and Horner, J.** NEW SUBADULT *HYPACROSAURUS STEBINGERI* SKULLS AND A COMPARATIVE ANALYSIS OF ALLOMETRIC CREST GROWTH IN LAMBEOSAURINES
37. **Pereda-Suberbiola, X., Canudo, J., Company, J., Cruzado-Caballero, P. and Ruiz-Omeñaca, J.** LATEST CRETACEOUS IBERIAN HADROSAUROIDS (DINOSAURIA)
38. **Dean-Carpentier, M.** NEW INFORMATION ON THE TEETH AND JAW BONES OF THE RARE HADROSAURIFORM *OURANOSAURUS NIGERIENSIS*
39. **Schachner, E. and Manning, P.** THREE DIMENSIONAL TRAUMA ANALYSIS USING X-RAY MICROTOMOGRAPHY IN *TENONTOSAURUS TILLETI*, CLOVERLY FORMATION (MONTANA, USA).
40. **Baziak, B.** COMPARATIVE OSTEOHISTOLOGY OF *MAIASAURA PEEBLESORUM* (HADROSAURIDAE) FROM THE TWO MEDICINE FORMATION (CAMPANIAN) CAMP-O-SAUR BONEBED OF MONTANA
41. **Hwang, S.** THE UTILITY OF TOOTH ENAMEL MICROSTRUCTURE IN IDENTIFYING ISOLATED DINOSAUR TEETH
42. **Holliday, C.** NEW INSIGHTS INTO JAW MUSCLE ANATOMY IN DINOSAURS
43. **DeBlieux, D., Kirkland, J., Hunt, G., Madsen, S. and Zeigler, K.** STRATIGRAPHY, TAPHONOMY, AND PALEONTOLOGY OF NEWLY DISCOVERED DINOSAUR SITES IN THE BASAL YELLOW CAT MEMBER OF THE CEDAR MOUNTAIN FORMATION (EARLY CRETACEOUS) OF UTAH
44. **Tanaka, K., Lü, J., Kobayashi, Y. and Zelenitsky, D.** STATISTICAL APPROACHES TO CLASSIFY DINOSAUR EGGS FROM THE HEYUAN BASIN, NORTHEASTERN GUANDONG PROVINCE, CHINA
45. **Lund, E., Loewen, M., Getty, M., Sampson, S. and Roberts, E.** PRESERVATION OF DINOSAUR INTEGUMENTARY IMPRESSIONS IN THE UPPER CRETACEOUS KAIPAROWITS FORMATION, GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, SOUTHERN UTAH
46. **Vavrek, M. and Larsson, H.** LARGE SCALE PATTERNS OF DINOSAUR DISTRIBUTION DURING THE CRETACEOUS
47. **Bolortsetseg, M., Jackson, F. and Chuluun, M.** DINOSAUR EGGS FROM THE OYU TOLGOI COPPER MINE, MONGOLIA
48. **Cleland, T. and Schweitzer, M.** PRELIMINARY INVESTIGATION OF MICROSCOPIC INTEGRITY AND MOLECULAR PRESERVATION IN NEWLY EXCAVATED DINOSAURS
49. **Kirkland, J., Barrick, R., Bartlett, J., Bird, J. and Burge, D.** TAPHONOMY OF THE GASTON QUARRY (EARLY CRETACEOUS, YELLOW CAT MEMBER, CEDAR MOUNTAIN FORMATION), EAST-CENTRAL UTAH: THE CASE FOR EXPANDING THE HYPODIGNM OF *UTAHRAPTOR* BEYOND THE SICKLE-CLAW

50. **Lee, Y., Barsbold, R., Jacobs, L. and Currie, P.** A SHORT REPORT OF KOREA-MONGOLIA INTERNATIONAL DINOSAUR PROJECT (1ST AND 2ND YEAR)
51. **Moratalla, J.** PORTILLA: A DINOSAUR NESTING SITE FROM THE UPPER CRETACEOUS OF THE CUENCA PROVINCE (SPAIN)
52. **Krumenacker, L., Jackson, F., Moore, J., Robison, S. and Varricchio, D.** PRELIMINARY PALEOECOLOGIC AND TAPHONOMIC OBSERVATIONS ON THE VERTEBRATE FAUNA OF THE WAYAN FORMATION (ALBIAN-CENOMANIAN) OF EAST IDAHO
53. **Lü, J., Kobayashi, Y., Lee, Y., Xu, L. and Zhang, X.** A NEW VERTEBRATE ASSEMBLAGE FROM THE LATE CRETACEOUS OF LUANCHUAN, HENAN PROVINCE, CHINA
54. **Christopher, S., Nishida, Y., Jacobs, L., Hooker, J. and Macphee, R.** CRETACEOUS CARBON ISOTOPE VALUES FROM THE CERRO NEGRO FORMATION, ANTARCTICA
55. **Matthews, N., Lockley, M., Breithaupt, B., Titus, A. and Noble, T.** THE MOCCASIN MOUNTAIN TRACKSITE, UTAH; WHERE SCIENCE, TECHNOLOGY, AND RECREATION MEET PALEONTOLOGICAL RESOURCE MANAGEMENT
56. **Lewis, C., Heckert, A. and Lucas, S.** A MIXED MARINE/NON-MARINE AND TERRESTRIAL MICROVERTEBRATE ASSEMBLAGE FROM THE LATE CRETACEOUS (LATE SANTONIAN-EARLY CAMPANIAN) MENESEE FORMATION OF NEW MEXICO: FAUNA, BIOSTRATIGRAPHY, AND PALEOECOLOGY
57. **Matson, C., Therrien, F., Zelenitsky, D. and Eberth, D.** PALEOENVIRONMENTS OF THE LATEST CRETACEOUS OLDMAN FORMATION OF SOUTHERN ALBERTA
58. **Kast, S., Rogers, R. and Curry Rogers, K.** RECONSTRUCTING LATE CRETACEOUS CLIMATE IN THE MAHAJANGA BASIN OF NORTHWESTERN MADAGASCAR
59. **Suarez, M., Gonzalez, L., Ludvigson, G. and You, H.** STABLE CARBON ISOTOPE CHEMOSTRATIGRAPHY OF THE FOSSIL BIRD-BEARING EARLY CRETACEOUS XIAGOU FORMATION IN CHANGMA BASIN, GANSU PROVINCE, CHINA
60. **Canavan, R., Rogers, R., Koenig, A., Brady, M. and Harwood, C.** A GEOCHEMICAL APPROACH TO DECIPHERING THE ORIGINS OF MICROFOSSIL BONEBEDS IN THE UPPER CRETACEOUS JUDITH RIVER FORMATION, MONTANA
61. **Malkani, M.** MESOZOIC CONTINENTAL VERTEBRATE COMMUNITY FROM PAKISTAN-AN OVERVIEW
62. **Freedman, E.** BAYESIAN MODELING OF VERTEBRATE PALEOCOMMUNITIES IN THE JUDITH RIVER FORMATION (UPPER CRETACEOUS: CAMPANIAN), NORTHCENTRAL MONTANA
63. **Morrison, K. and Dyke, G.** TAPHONOMY AND VERTEBRATE FAUNA OF THE CAMPANIAN NORTHUMBERLAND FORMATION, HORNBY ISLAND (BRITISH COLUMBIA)
64. **Lawing, A., Meik, J. and Polly, P.D.** USING ECOLOGICAL NICHE MODELS TO EXPLORE PALEOBIOGEOGRAPHIC PATTERNS
65. **Wilborn, B.** TESTING THE HOMOGENEITY OF THE MORRISON FORMATION FAUNA
66. **Poltenovage, M., Wilson, G. and Carter, G.** PALEOASYS: AN APPLICATION FOR HIGH-RESOLUTION TRACKING, REPORTING, AND ANALYZING PALEONTOLOGICAL RESEARCH ACTIVITIES WITHIN THE HELL CREEK STUDY SYSTEM
67. **Folinsbee, K. and Evans, D.** RECONSTRUCTING PALEOGEOGRAPHIC PATTERNS USING A TIME CALIBRATED AREA CLADOGRAM
68. **Ogino, S. and Otsuka, H.** THE FIRST DISCOVERY OF FOSSIL COLOBINE MONKEY FROM THE EARLY PLEISTOCENE OF TAIWAN.
69. **Haire, S., Hanks, H., Hoganson, J. and Lyson, T.** NEW MATERIAL OF *PLESIADAPIS* FROM THE LATE PALEOCENE BULLION CREEK FORMATION OF WESTERN NORTH DAKOTA
70. **Kirk, E. and Williams, B.** FIRST UINTAN SPECIMENS OF *MAHGARITA* (PRIMATES, ADAPIFORMES) FROM THE DEVIL'S GRAVEYARD FORMATION, TEXAS

71. **Perry, J., Kay, R., Vizcaíno, S. and Bargo, M.** FIRST CRANIAL MATERIAL OF A JUVENILE MONKEY FROM THE TERTIARY OF SOUTH AMERICA: CRANIAL ANATOMY AND DENTAL ERUPTION SEQUENCE
72. **Fleagle, J. and Shareef, O.** LIFE HISTORY AND TAPHONOMY: WHY FOSSIL APES SHOULD BE RARE
73. **Nakaya, H., Uno, K., Fukuchi, A., Kunimatsu, Y. and Nakatsukasa, M.** LATE MIOCENE PALEOENVIRONMENTAL CHANGE OF HOMINOID EVOLUTION IN SUB-SAHARAN AFRICA - MESOWEAR ANALYSIS OF *HIPPARION* (EQUIDAE, PERISSODACTYLA) CHEEK TEETH FROM KENYA
74. **Bernor, R., Eder, J., Kaufman, A., Mittmann, H. and Wolf, D.** MULTIDISCIPLINARY PALEOBIOLOGICAL RESEARCH AT THE LATE MIOCENE (MN9) LOCALITY OF HOEWENEGG, GERMANY
75. **Peek, S. and Clementz, M.** PALEODIET RECONSTRUCTION USING STARCH GRANULES FROM MARINE ANGIOSPERMS
76. **Atwood, T. and Schiebout, J.** INITIAL ISOTOPIC ANALYSIS OF MIOCENE MAMMALIAN FAUNA FROM FORK POLK IN WESTERN LOUISIANA
77. **Fremd, T. and Whistler, D.** A NEW MICROVERTEBRATE ASSEMBLAGE FROM THE ARIKAREEAN (EARLY MIOCENE) JOHN DAY STRATA, CENTRAL OREGON
78. **Tanaka, Y. and Kohno, N.** COMPARISONS OF SCAPULAE AND HUMERI OF THE ODOBENIDS (CARNIVORA: PINNIPEDIA) AMONG THE PINNIPEDS
79. **Uno, K., Cerling, T., Nakaya, H., Nakatsukasa, M. and Kunimatsu, Y.** STABLE CARBON AND OXYGEN ISOTOPE RATIOS OF FOSSIL TOOTH ENAMEL FROM THE NAKALI AND NAMURUNGULE FORMATIONS, KENYA: CAPTURING THE C<sub>3</sub>-C<sub>4</sub> TRANSITION IN EAST AFRICAN EQUID DIET AT ~9.6 MA

## **SATURDAY MORNING, OCTOBER 18, 2008**

### **SYMPOSIUM: FOSSILS AND THE EVOLUTIONARY PATTERS OF OSTARIOHYSANS ONE OF THE LARGEST VERTEBRATE CLADES**

**AMBASSADOR BALLROOM**

**MODERATORS: GLORIA ARRATIA AND TERRY GRANDE**

- 8:00 **Arratia, G.** THE OSTARIOPHYSAN FOSSIL RECORD: STATE OF THE ART
- 8:15 **Gottfried, M. and Ostrowski, S.** FOSSIL FISHING ONE PIECE AT A TIME, WITH A CATFISH EXAMPLE FROM THE LATE CRETACEOUS OF MADAGASCAR
- 8:30 **Reichenbacher, B., Schulz-Mirbach, T. and Klug, S.** OSTARIOPHYSAN OTOLITHS AND THEIR STRATIGRAPHIC AND SYSTEMATIC VALUE
- 8:45 **Coburn, M.** THE OTOPHYSAN WEBERIAN APPARATUS: FREEDOM FROM PRIOR RESTRAINT?
- 9:00 **Murray, A. and Wilson, M.** THE CENOZOIC FOSSIL RECORD OF OSTARIOPHYSANS IN AFRICA
- 9:15 **Grande, L. and Grande, T.** OSTARIOPHYSAN HISTORICAL BIOGEOGRAPHY AND DISTRIBUTION PATTERNS
- 9:30 **Orti, G. and Li, C.** MOLECULES AND PHYLOGENETIC RELATIONSHIPS OF OSTARIOPHYSANS
- 9:45 **Lopez, J., Broughton, R. and Mäkinen, T.** ESTIMATING THE TIMING OF THE OSTARIOPHYSAN RADIATION USING MOLECULAR CLOCKS: BENEFITS AND LIMITATIONS
- 10:00 **BREAK**
- 10:15 **Dahdul, W.** FOSSIL RECORD OF THE NEOTROPICAL SERRASALMIDAE (OSTARIOPHYSI, CHARACIFORMES)
- 10:30 **Malabarba, L. and Malabarba, M.** BIOGEOGRAPHY OF CHARACIFORMES: AN EVALUATION OF THE AVAILABLE INFORMATION OF FOSSIL AND EXTANT TAXA
- 10:45 **Davis, M., Arratia, G. and Kaiser, T.** THE EOCENE LAKE OF MAHENGE (TANZANIA) AND ITS FOSSIL FISHES



- 11:00 **Chang, M., Miao, D., Wang, X. and Liu, H.** DISCOVERY OF AN EXTRAORDINARY PLIOCENE SCHIZOTHORACIN (CYPRINIDAE) FISH FROM NORTHERN TIBETAN PLATEAU AND ITS PALEOECOLOGICAL IMPLICATIONS
- 11:15 **Hirt, M. and Simons, A.** DATING THE CYPRINIFORMES TREE OF LIFE
- 11:30 **Lundberg, J. and Sullivan, J.** FOSSILS, MOLECULES, AND THE AGE OF CATFISHES
- 11:45 **Albert, J., Bart, H., Reis, R. and Johnson, D.** NON-RANDOM DIVERSIFICATION IN NEOTROPICAL OSTARIOPHYSAN FISHES
- 12:00 **Grande, L.** FOSSILS, MORPHOLOGY AND PHYLOGENETIC RELATIONSHIPS OF OSTARIOPHYSANS

**TECHNICAL SESSION XVI**  
**GRAND BALLROOM A&B**  
**MODERATORS: RYOSUKE MOTANI AND XU XING**

- 8:00 **Polcyn, M.** BRAINCASE EVOLUTION IN PLIOPATECARPINE MOSASAURS
- 8:15 **Motani, R. and Jiang, D.** EVOLUTION OF U-SHAPED CLAVICLE COMPLEX AND EARLY RADIATION OF ICHTHYOPTERYGIA
- 8:30 **Schmeisser, R.** A NEW SPECIES OF POLYCOTYLID PLESIOSAUR FROM THE EARLY TURONIAN OF UTAH: EXTENDING THE STRATIGRAPHIC RANGE OF NORTH AMERICAN *DOLICHORHYNCHOPS*
- 8:45 **Sato, T., Cheng, Y., Wu, X. and Li, C.** OSTEOLOGY OF *YUNGUISAURUS* (SAUROPTERYGIA, PISTOSAUROIDEA)
- 9:00 **Jiang, D., Rieppel, O., Motani, R., Hao, W. and Sun, Y.** A SAUROPTERYGIAN OF SMALL HEAD WITH SPECIAL DENTITION (REPTILIA, SAUROPTERYGIA) FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA
- 9:15 **Scheyer, T.** BONE HISTOLOGICAL AND DEVELOPMENTAL ASPECTS OF THE TURTLE SHELL: COMPARISON WITH PLACODONT ARMOR AND AN ASSESSMENT OF *PRISCOCHELYS HEGNABRUNNENSIS* (MIDDLE TRIASSIC, SOUTHERN GERMANY)
- 9:30 **Flynn, J., Nesbitt, S., Parrish, M., Ranivoharimanana, L. and Wyss, A.** A NEW SPECIES OF BASAL ARCHOSAURMORPH FROM THE LATE TRIASSIC OF MADAGASCAR
- 9:45 **Stocker, M.** A REINTERPRETATION OF PHYTOSAURIAN DIVERSITY IN THE SONSELA MEMBER (CHINLE FORMATION) OF PETRIFIED FOREST NATIONAL PARK AND ITS INFLUENCES ON THE EVOLUTION OF AND PHYLOGENETIC RELATIONSHIPS WITHIN PHYTOSAURIA
- 10:00 **BREAK**
- 10:15 **Irmis, R. and Mundil, R.** NEW AGE CONSTRAINTS FROM THE CHINLE FORMATION REVISE GLOBAL COMPARISONS OF LATE TRIASSIC VERTEBRATE ASSEMBLAGES
- 10:30 **Witmer, L. and Ridgely, R.** AIR SPACES WITHIN THE HEADS OF DINOSAURS AND THEIR CONTRIBUTION TO CEPHALIC STRUCTURE
- 10:45 **Whitlock, J., Wilson, J. and Lamanna, M.** EVIDENCE FOR ONTOGENETIC SHAPE CHANGE IN A JUVENILE SKULL OF *DIPLODOCUS*
- 11:00 **Remes, K.** FUNCTIONAL ADAPTATIONS IN THE FORELIMB OF MAMENCHISAURID SAUROPODS
- 11:15 **Xu, X. and Clark, J.** HOMOLOGIES IN THE HAND OF THEROPODS
- 11:30 **Zhao, Q. and Xu, X.** A NEW THEROPOD FROM THE EARLY CRETACEOUS YIXIAN FORMATION OF WESTERN LIAONING, CHINA
- 11:45 **Burch, S. and Carrano, M.** ABELISAURID FORELIMB EVOLUTION: NEW EVIDENCE FROM *MAJUNGASAURUS CRENATISSIMUS* (ABELISAURIDAE: THEROPODA) FROM THE LATE CRETACEOUS OF MADAGASCAR
- 12:00 **Bates, K., Manning, P. and Sellers, W.** RECONSTRUCTING THE LOCOMOTOR BIOLOGY OF *ACROCANTHOSAURUS ATOKENSIS* (DINOSAURIA: THEROPODA)

**TECHNICAL SESSION XVII**  
**GOLD BALLROOM**  
**MODERATORS: KATHERINE BRAKORA AND AARON WOOD**

- 8:00 **Ladevèze, S., Missiaen, P. and Smith, T.** FIRST SKULL OF THE CONDYLARTH *ORTHASPIDOTHERIUM EDWARDI* FROM THE LATE PALEOCENE OF BERRU (FRANCE) AND AFFINITIES OF THE ENIGMATIC EUROPEAN FAMILY PLEURASPIDOTHERIDAE
- 8:15 **Penkrot, T.** DIETARY DIVERSITY AMONG PALEOCENE AND EOCENE NORTH AMERICAN CONDYLARTHRA (MAMMALIA: EUTHERIA)
- 8:30 **Hooker, J.** *HYRACOTHERIUM*, *EOHIPPIUS* AND DAWN HORSES
- 8:45 **Koenigswald, W., Rose, K. and Holbrook, L.** ENAMEL DIFFERENTIATION IN EARLY PERISSODACTYLS
- 9:00 **Wood, A., Bebej, R., Manz, C. and Gingerich, P.** NEW INSIGHTS INTO THE LOCOMOTORY CAPABILITIES OF THE EARLY EOCENE EQUID *HYRACOTHERIUM*
- 9:15 **Mihlbachler, M. and Holbrook, L.** THE EARLY EOCENE ASIAN PERISSODACTYL *DANJIANGIA PINGI* AND THE ORIGIN OF BRONTOTHERIIDAE
- 9:30 **Wang, X., Meng, J., Beard, K., Bai, B. and Ni, X.** EARLY EOCENE PERISSODACTYLS FROM THE UPPER NOMOGEN FORMATION OF THE ERLIAN BASIN, INNER MONGOLIA, CHINA
- 9:45 **Joomun, S., Hooker, J. and Collinson, M.** DIETARY CHANGE IN THE PERISSODACTYL *PLAGIOLOPHUS MINOR* ACROSS THE EOCENE/OLIGOCENE TRANSITION IN EUROPE
- 10:00 **BREAK**
- 10:15 **Shockey, B., Mihlbachler, M., Solounias, N. and Hayes, P.** FUNCTIONAL MORPHOLOGY OF THE KNEE IN RHINOS AND THE EVOLUTION OF KNEE LOCKING MECHANISMS AMONG RHINOCEROTOID PERISSODACTYLS
- 10:30 **Ludtke, J.** SYSTEMATICS AND BIOCHRONOLOGY OF AGRIOCHOERIDAE
- 10:45 **Cooper, L., Clementz, M., Thewissen, J., Bajpai, S. and Tiwari, B.** AQUATIC LIFESTYLES IN EOCENE RAOELLID ARTIODACTYLS AND ANTHRACOBUNID TETHYTERES
- 11:00 **Marcot, J.** A SAMPLE-STANDARDIZED MACROEVOLUTIONARY HISTORY OF THE UNGULATES OF WESTERN NORTH AMERICA
- 11:15 **Prothero, D.** THE EARLY EVOLUTION OF NORTH AMERICAN PECCARIES (TAYASSUIDAE)
- 11:30 **Kaiser, T. and Harrison, T.** FEEDING ECOLOGY AND NICHE PARTITIONING OF THE UNGULATE FAUNA FROM LAETOLI TANZANIA
- 11:45 **Wang, X., Xie, G. and Dong, W.** A NEW CROWN-ANTLERED DEER, *STEPHANOCEMAS*, FROM NORTHERN TIBETAN PLATEAU, CHINA, AND THE RELATIONSHIP OF EURASIAN FORMS
- 12:00 **Brakora, K.** THE USE OF CRANIAL TRAITS DISTINGUISHING FEMALE HORNED ANTELOPE FROM MALE CONSPECIFICS

**SATURDAY AFTERNOON, OCTOBER 18, 2008**

**TECHNICAL SESSION XVIII**  
**AMBASSADOR BALLROOM**  
**MODERATORS: DANA EHRET AND MARTHA RICHTER**

- 1:45 **Matton, O., Cloutier, R. and Stevenson, R.** RECOVERING PALEOENVIRONMENTAL DATA HIDDEN IN BIOAPATITES: GEOCHEMISTRY OF FISH REMAINS FROM THE UPPER DEVONIAN ESCUMINAC FORMATION (MIGUASHA, QUEBEC)
- 2:00 **Elliott, D. and Fiorillo, A.** TAPHONOMIC ANALYSIS OF EARLY VERTEBRATE OCCURRENCES FROM THE CANADIAN ARCTIC AND WESTERN USA
- 2:15 **Gess, R. and Coates, M.** VERTEBRATE DIVERSITY OF THE LATE DEVONIAN (FAMENNIAN) DEPOSIT NEAR GRAHAMSTOWN, SOUTH AFRICA

- 2:30 **Richter, M.** CTENACANTHID SHARK REMAINS (CHONDRICHTHYES) FROM THE LOWER PERMIAN PEDRA DO FOGO FORMATION, STATE OF TOCANTINS, BRAZIL
- 2:45 **Gonzalez-Barba, G.** RUPELIAN ELASMOBRANCH ASSEMBLAGE FROM THE EL CIEN AND SAN GREGORIO FORMATIONS FROM BAJA CALIFORNIA SUR, MEXICO
- 3:00 **Ehret, D., MacFadden, B. and Hubbell, G.** LIFE HISTORY OF AN EXTINCT WHITE SHARK (*CARCHARODON* SP.) FROM THE PLIOCENE, PISCO FORMATION OF PERU
- 3:15 **Xu, G. and Gao, K.** TAXONOMIC REVISION AND BIOSTRATIGRAPHIC SIGNIFICANCE OF *PLESIOFURO* (ACTINOPTERYGII: PERLEIDIFORMES) BASED ON NEW FOSSILS FROM THE LOWER TRIASSIC OF NORTHERN GANSU PROVINCE, CHINA
- 3:30 **López-Arbarello, A. and Rauhut, O.** FISH DIVERSITY AND FAUNAL COMPOSITION DURING THE JURASSIC
- 3:45 **Friedman, M.** EXTINCTION SELECTIVITY AMONG MARINE TELEOSTS AT THE CLOSE OF THE CRETACEOUS
- 4:00 **Newbrey, M., Murray, A., Wilson, M., Brinkman, D. and Neuman, A.** PALEOLATITUDINAL RESPONSE OF CHARACIFORMES (TELEOSTEI: OSTARIOPHYSI) TO CENOZOIC CLIMATE CHANGE

### TECHNICAL SESSION XIX

#### GRAND BALLROOM A&B

**MODERATORS: GABE BEVER AND OLIVER RAUHUT**

- 1:45 **Rauhut, O. and Milner, A.** CRANIAL ANATOMY AND SYSTEMATIC POSITION OF THE MIDDLE JURASSIC THEROPOD DINOSAUR *PROCERATOSAURUS* FROM ENGLAND
- 2:00 **Hieronymus, T. and Witmer, L.** THE FACIAL SKIN OF *MAJUNGASAURUS CRENATISSIMUS* (ABELISAUURIDAE: SAURISCHIA): PRONOUNCED DERMAL METAPLASIA AS THE CAUSE OF RUGOSITY IN ABELISAUURID SKULLS
- 2:15 **Eddy, D. and Clarke, J.** A RE-EVALUATION OF A WELL-PRESERVED SKULL OF *ACROCANTHOSAURUS ATOKENSIS* SUPPORTS ITS CARCHARODONTOSAURID AFFINITIES
- 2:30 **Kobayashi, Y., Lü, J., Lee, Y., Xu, L. and Zhang, X.** A NEW BASAL ORNITHOMIMID (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS IN HENAN PROVINCE OF CHINA
- 2:45 **Bever, G. and Norell, M.** NEONATE TROODONTID SKULLS FROM THE UPPER CRETACEOUS OF MONGOLIA WITH OBSERVATIONS ON THE CRANIAL ONTOGENY OF PARAVIAN THEROPODS
- 3:00 **Gignac, P., Makovicky, P., Erickson, G. and Walsh, R.** BITE FORCE ESTIMATES FOR *DEINONYCHUS ANTIRRHOPUS* USING TOOTH INDENTATION SIMULATIONS
- 3:15 **Currie, P., Longrich, N., Ryan, M., Eberth, D. and Demchig, B.** A BONEBED OF *AVIMIMUS* SP. (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS NEMEGT FORMATION, GOBI DESERT: INSIGHTS INTO SOCIAL BEHAVIOR AND DEVELOPMENT IN A MANIRAPTORAN THEROPOD
- 3:30 **Fiorillo, A., Hasiotis, S. and Kobayashi, Y.** A LATE CRETACEOUS HIGH LATITUDE, HIGH DIVERSITY DINOSAURIAN MEGATRACKSITE FROM DENALI NATIONAL PARK ALASKA
- 3:45 **Falkingham, P., Margetts, L. and Manning, P.** USING FINITE ELEMENT ANALYSIS TO AID INTERPRETATION OF DINOSAUR TRACKS.

### TECHNICAL SESSION XX

#### GOLD BALLROOM

**MODERATORS: MARK CLEMENTZ AND MARK UHEN**

- 1:45 **O'Leary, M., Spaulding, M., Parent, S. and Gatesy, J.** INSTABILITY OF PIVOTAL FOSSIL CLADES IN CETARTIODACTYLAN PHYLOGENY AND EVOLUTION OF THE EAR REGION AND ANKLE
- 2:00 **Boessenecker, R. and Geisler, J.** NEW MATERIAL OF THE BIZARRE WHALE *HERPETOCETUS BRAMBLEI* FROM THE LATEST MIOCENE PURISIMA FORMATION OF CENTRAL CALIFORNIA

- 2:15 **Clementz, M., Bajpai, S. and Thewissen, J.** GEOCHEMICAL RECONSTRUCTION OF THE FEEDING ECOLOGY AND HABITAT PREFERENCES OF REMINGTONOCETIDS
- 2:30 **Uhen, M., Pyenson, N., Thomas, D. and Mario, U.** THE OLDEST CETACEANS FROM THE SOUTHERN HEMISPHERE: NEW ARCHAEOCETES FROM THE PISCO BASIN OF SOUTHERN PERU
- 2:45 **Geisler, J. and Gatesy, J.** IMPACT OF MORPHOLOGY AND FOSSILS ON THE PHYLOGENY OF CETACEA
- 3:00 **Fitzgerald, E.** THE ORIGIN OF BALEEN WHALES
- 3:15 **Berta, A., Racicot, R. and Deméré, T.** THE COMPARATIVE ANATOMY AND EVOLUTION OF THE TYMPANOPERIOTIC COMPLEX IN BALAENOPTEROID MYSTICETES: ADAPTATIONS FOR LOW FREQUENCY HEARING
- 3:30 **Staley, M. and Barnes, L.** EARLY MIOCENE TOOTHED CETACEANS FROM THE VAQUEROS FORMATION, ORANGE COUNTY, CALIFORNIA
- 3:45 **Lambert, O., Bianucci, G., Post, K. and Urbina, M.** TUSK-BEARING BEAKED WHALES FROM THE MIOCENE OF PERU
- 4:00 **Fordyce, R. and Quilty, P.** NEW PLIOCENE *AUSTRALODELPHIS* (DELPHINIDAE) AND RIGHT WHALES (BALAENIDAE) FROM VESTFOLD HILLS, ANTARCTICA, IMPLY TAXONOMIC AND ECOLOGICAL TURNOVER IN THE SOUTHERN OCEAN SINCE 4 MA

#### POSTER SESSION IV

Authors must be present from 4:15 – 6:15 p.m.

Posters must be removed by 6:30 p.m.

1. **Brito, P. and Mayrinck, D.** OVERVIEW OF THE CRETACEOUS MARINE OTOPHYSI (TELEOSTEI-OSTARIOPHYSI)
2. **Klug, S., Kriwet, J. and Kiessling, W.** DIVERSIFICATION PATTERNS OF EARLY SHARKS AND RAYS (CHONDRICHTHYES, NEOSELACHII)
3. **Weiss, F., Malabarba, M. and Malabarba, L.** NEW CHARACIFORMS (TELEOSTEI: OSTARIOPHYSI) FROM THE EOCENE-OLIGOCENE OF EASTERN BRAZIL, SOUTH AMERICA
4. **Liu, J. and Chang, M.** A NEW CATOSTOMID FROM NORTHEASTERN CHINA
5. **Alvarado-Ortega, J. and Nuñez-Utrilla, M.** FOSSIL OSTARIOPHYSAN FROM MEXICO: A REVIEW
6. **Pamar, V., Arratia, G., Kriwet, J. and Prasad, G.** THE OSTARIOPHYSAN FOSSIL RECORD OF THE INDIAN SUBCONTINENT
7. **Stringer, G., Cicimurri, D., Knight, J., Campbell, L. and King, L.** FOSSILS FROM THE EAGLE POINT QUARRY PROVIDE INSIGHT INTO A PLIOCENE MARINE FISHES FAUNA FROM SOUTH CAROLINA
8. **Schulz-Mirbach, T.** MORPHOLOGICAL VARIATION IN OTOLITHS OF *CYPRINUS CARPIO* LINNAEUS, 1758
9. **Domingo, L., Grimes, S., Soler-Gijón, R. and López-Martínez, N.** APPLICATION AND INTERPRETATION OF BA/CA AND  $\delta^{18}\text{O}_{\text{PO}_4}$  PALAEOOTHERMOMETERS IN LEPISOSTEID SCALES
10. **Berrell, R., Alvarado-Ortega, J., Yabumoto, Y. and Salisbury, S.** A NEW ICHTHYODECTIFORM FISH FROM THE MID-CRETACEOUS OF AUSTRALIA
11. **Wu, F., Sun, Y., Hao, W., Jiang, D. and Tintori, A.** NEW FOSSILS AND MORPHO-ECOLOGIC DIVERSITY OF SAURICHTHIDAE (ACTINOPTERYGIAN) FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA
12. **Harrell, L.** A NEARLY COMPLETE SPECIMEN OF *STRATODUS APICALIS* (TELEOSTEI: DERCEITIDAE) FROM THE UPPER NIOBRARA FORMATION OF SOUTH DAKOTA, USA
13. **Sun, Z., Hao, W., Tintori, A., Lombardo, C. and Jiang, D.** A NEW MARINE ICHTHYOFAUNA FROM THE LATE ANISIAN (MIDDLE TRIASSIC) OF LUOPING, YUNNAN PROVINCE, SOUTH CHINA
14. **Zhang, J.** A LATE CRETACEOUS OSTEOGLOSSOMORPH FISH FROM NORTHEAST CHINA

15. **Milner, A., Spears, S. and Olsen, P.** NEW SPECIMENS OF *TANAOCROSSUS* (ACTINOPTERYGII, PERLEIDIFORMES) FROM THE LATE TRIASSIC CHINLE FORMATION OF THE WESTERN UNITED STATES
16. **Shimada, K.** A NEW ANACORACID SHARK FROM THE UPPER CRETACEOUS NIOBRARA CHALK OF WESTERN KANSAS, USA
17. **Janus, T. and Stidham, T.** VERTEBRATE FAUNA FROM THE PALEOGENE CALVERT BLUFF FORMATION, TEXAS
18. **Shin, J.** MORPHOLOGICAL VARIATION OF TOOTHPLATES AND CLADISTIC ANALYSIS OF GENUS *EDAPHODON* (CHONDRICHTHYES, HOLOCEPHALI, CHIMAEROIDEA) WITH A NEW SPECIES FROM THE LATE CRETACEOUS OF VANCOUVER ISLAND, BRITISH COLUMBIA, CANADA
19. **Padilla, A., Eberle, J., Cumbaa, S. and Hutchison, J.** DESCRIPTION AND PALEOBIOLOGY OF AN EOCENE SHARK FAUNA FROM BANKS ISLAND, ARCTIC CANADA
20. **Egerton, V., Lacovara, K., Schein, J., Gallagher, W. and Poole, J.** ARTICULATED AND ASSOCIATED SHARK VERTEBRAE FROM THE LATEST CRETACEOUS-EARLIEST PALEOGENE BASAL HORNERSTOWN FORMATION (NEW JERSEY)
21. **Bermúdez-Rochas, D.** NEW HYBODONT SHARK FROM THE CAMEROS BASIN (EARLY CRETACEOUS, SPAIN)
22. **Lane, J. and Maisey PhD, J.** PECTORAL MORPHOLOGY OF FOSSIL HYBODONT SHARKS: NEW INFORMATION AND BROADER IMPLICATIONS
23. **Kriwet, J. and Klug, S.** NEOSELACHIAN INTERRELATIONSHIPS, FOSSILS, AND THE ORIGIN OF MAJOR NEOSELACHIAN LINEAGES
24. **Cuthbertson, R. and Anderson, J.** A NEW ASSEMBLAGE OF EARLY TRIASSIC ICHTHYOPTERYGIANS FROM EAST-CENTRAL BRITISH COLUMBIA, CANADA
25. **Ji, C., Jiang, D., Motani, R., Hao, W. and Sun, Z.** TRUE TAILBEND OCCURRED IN TRIASSIC-- EVIDENCE FROM THE TRIASSIC ICHTHYOSAUR SKELETONS OF SOUTH CHINA
26. **Druckenmiller, P. and Russell, A.** AN EARLY NORTH AMERICAN OCCURRENCE OF POLYCOTYLIDAE (PLESIOSAURIA) FROM THE CLEARWATER FORMATION (EARLY CRETACEOUS; EARLY ALBIAN) OF NORTHERN ALBERTA, CANADA
27. **Massare, J. and Wahl, W.** AN ICHTHYOSAUR SKULL FROM THE SUNDANCE FORMATION (JURASSIC) OF CENTRAL WYOMING
28. **Yin, C., Jiang, D., Rieppel, O., Hao, W. and Sun, Z.** NEW INFORMATION FOR THE POSTCRANIAL OF TRIASSIC SAUROPTERYGIAN *NOTHOSAURUS* FROM THE GUIZHOU ANISIAN (MIDDLE TRIASSIC) MATERIAL
29. **Hao, W., Jiang, D., Sun, Y. and Sun, Z.** SEQUENCE OF TRIASSIC MARINE REPTILE FAUNAS IN SOUTHWESTERN CHINA AND ITS PALEO GEOGRAPHIC AFFILIATION
30. **Watts, A. and Heckert, A.** REEVALUATION OF SMALL VERTEBRATE FOSSILS FROM THE UPPER TRIASSIC CHINLE GROUP, SOUTHEASTERN UTAH
31. **Heckert, A., Mitchell, J., Schneider, V. and Olsen, P.** EXCEPTIONAL TAXONOMIC DIVERSITY FROM A SINGLE SITE: THE UPPER TRIASSIC MONCURE MICROVERTEBRATE LOCALITY, CUMNOCK FORMATION, SANFORD SUB-BASIN, NORTH CAROLINA, USA
32. **Parker, W.** HOW MANY VALID AETOSAUR SPECIES ARE THERE? REVIEWING THE ALPHA-TAXONOMY OF THE AETOSAURIA (ARCHOSAURIA: PSEUDOSUCHIA) AND ITS IMPLICATIONS FOR LATE TRIASSIC GLOBAL BIOSTRATIGRAPHY
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35. **Dilkes, D. and Sues, H.** ANATOMY AND RELATIONSHIPS OF THE LATE TRIASSIC ARCHOSAUROMORPH *DOSWELLIA KALTENBACHI*

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38. **Saegusa, H., Ikeda, T., Kusuhashi, N., Tanaka, S. and Matsubara, T.** A TITANOSAURIFORM SAUROPOD (DINOSAURIA: SAURISCHIA) AND MICROVERTEBRATES FROM THE LOWER CRETACEOUS OF HYOGO PREFECTURE, SW JAPAN
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42. **Hohn, B., Witzel, U. and Preuschoft, H.** 3-D FINITE ELEMENT STRUCTURE SYNTHESIS OF THE SHOULDER GIRDLE IN *DIPLODOCUS LONGUS*
43. **D’Emic, M. and Britt, B.** REEVALUATION OF THE PHYLOGENETIC AFFINITIES AND AGE OF A BASAL TITANOSAURIFORM (SAUROPODA: DINOSAURIA) FROM THE EARLY CRETACEOUS CLOVERLY FORMATION OF NORTH AMERICA
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73. **Maguire, K. and Stigall, A.** PREDICTED DISTRIBUTIONS OF EQUINES IN THE GREAT PLAINS DURING THE MIOCENE BASED ON ENVIRONMENTAL VARIABLES
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75. **Viner, T., Heckert, A. and Carrano, M.** MULTIPLE PATHOLOGICAL ELEMENTS IN A PHYTOSAUR (DIAPSIDA: ARCHOSAURIA) SKELETON FROM THE UPPER TRIASSIC OF ARIZONA, USA: EVIDENCE OF EXTREME OSTEOMYELITIS

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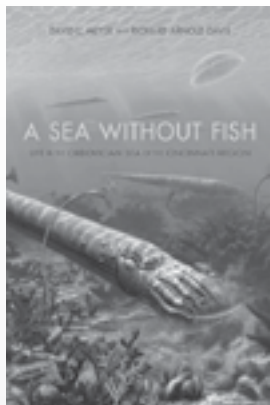
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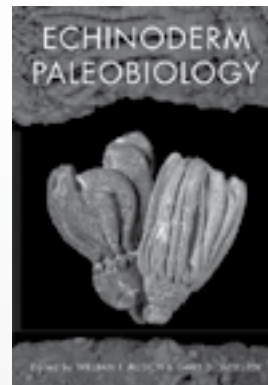
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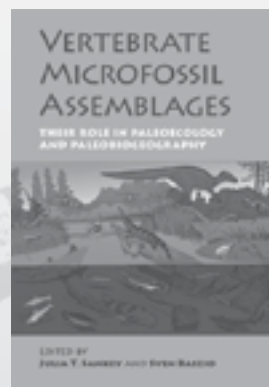
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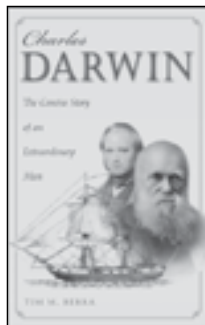
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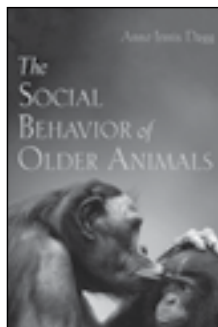


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Poster Session III (Friday)

**ONTOGENY OF CRANIAL BONE HISTOLOGY IN ALLIGATOR: IMPLICATIONS FOR AGING PACHYCEPHALOSAURID DINOSAURS**

AI, Angel, University of Toronto at Mississauga, Toronto, ON, Canada; EVANS, David, Royal Ontario Museum & University of Toronto, Toronto, ON, Canada; SCHOTT, Ryan, University of Toronto, Toronto, ON, Canada

The relative proportion of neurovascular space in isolated frontoparietal domes has been used to estimate the relative age of pachycephalosaurid dinosaur specimens. However, little is known of postnatal ontogenetic patterns of bone histology in the dermal skull bones of living archosaurs. To better understand the significance of histological variation in the cranial domes of pachycephalosaurids, *Alligator mississippiensis* was used as a model to investigate the ontogenetic changes in skull-roof bone histology in an extant archosaur. Standardized thin sections (interorbital, longitudinal, and parietal) of frontoparietals from three females of different size were examined in order to document histological changes during ontogeny. The largest specimen in the sample had a total weight of 62 kg and a total length of 2.4 meters at the time of death. The other two specimens were 14% and 54% the weight of the largest individual. The porosity index was used to quantify the relative area of neurovascular canal space in each section, and secondary osteons were counted and their percent area calculated. The number of growth zones increased with increasing size and age. The two smallest skulls exhibit predominantly fibrolamellar bone, while the largest specimen exhibits lamellar bone peripherally and extensive secondary osteon development centrally. The number and area of secondary osteons increases throughout the size series. The smallest specimen had no secondary osteons in the interorbital section, whereas the largest specimen had over 250, which accounted for approximately 70% of the section's area. The youngest samples have higher porosity than the oldest sample (4%). However, the second largest specimen had slightly higher porosity (12%) than the smallest specimen, implying variation in relative porosity that is not directly related to age. This study suggests that a combination of bone tissue type, amount of remodeling, and relative vascularity may be a valid mean of aging pachycephalosaurid domes, and that this method will be an important tool in clarifying Late Cretaceous pachycephalosaurid diversity.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 11:45

**NON-RANDOM DIVERSIFICATION IN NEOTROPICAL OSTARIOPHYSAN FISHES**

ALBERT, James, University of Louisiana, Lafayette, LA, USA; BART, Henry, Tulane University, New Orleans, LA, USA; REIS, Roberto, Museu de Ciências e Tecnologia da PUCRS, Porto Alegre, Brazil; JOHNSON, Derek, University of Louisiana, Lafayette, LA, USA

Neotropical freshwaters contain more than half of the Earth's freshwater fishes (> 5,700 species) and perhaps 10% of all extant vertebrate species. Ostariophysan fishes dominate this diversity (c. 4,400 species, 77%); the eight clades of Neotropical ostariophysans are the principal ecosystem incumbents. As in most regional faunas the great majority of Neotropical fishes are members of a few highly diverse clades, while most clades are represented by few species. This sort of species-richness distribution with the shape of a hollow curve is well described by a power function. Power laws are widely used to explain the ecological mechanisms that constrain biodiversity. However, the relationships between species richness and cladal diversity remain poorly understood, and the mechanisms that promote differential net diversification at a regional level are almost entirely unknown. Here we use newly compiled datasets of freshwater fishes from the Americas to compare regional patterns of species and cladal diversity. We report data for 5,738 Amazon Superbasin species in 65 clades, and 954 Mississippi Superbasin species in 88 clades. Species-richness was assessed among clades with phylogenetically independent origins in freshwaters, regardless of Linnaean rank or phylogenetic age. Minimum clade ages were estimated from paleontological, molecular, and biogeographic data. Empirical patterns were compared with MCMC simulations using a diversification model varying probabilities of speciation and extinction and ecosystem space (finite v. not-finite). Species richness is correlated with two clade-level properties, phylogenetic age and geographic range, and with mean body size. The results suggest heterogeneity in diversification rates among clades in both faunas, and that the Amazon, but not the Mississippi, faunas are saturated. Simulations in which diversification rates were randomly assigned to taxa in a closed space produced sigmoid curves that match the empirical data. These results suggest that Neotropical ostariophysans retain a relatively intact Late Cretaceous-Paleogene greenhouse diversity, in comparison with the more depauperate North American ichthyofauna.

Poster Session II (Thursday)

**EVOLUTION AND SENSITIVITY ANALYSIS OF WHOLE-BODY MASS DISTRIBUTION IN THEROPOD DINOSAURS**

ALLEN, Vivian, Royal Veterinary College, London, United Kingdom; HUTCHINSON, John, Royal Veterinary College, London, United Kingdom; HERTEL, Janice, Toronto, ON, Canada

Digitised skeletal elements of representative taxa from bird-line Theropoda were used as a basis for computer reconstructions of soft-tissue body mass distribution. Extra-skeletal body segment dimensions and cross-sectional profiles could not be confidently inferred to

any specific value, and so were systematically varied within a plausible range to evaluate the sensitivity of the model to such unknowns. The extent and distribution of skeletal and body-cavity pneumaticity was estimated with reference to skeletal correlates and extant taxa, and the effects of unknown dimensions similarly evaluated. To validate the methodology 3D computer models of extant taxa were created, based on only their tomographically-acquired skeletal geometry and using the same methods and assumptions as for extinct taxa. The results were found to agree well with empirical data on mass and mass distribution from the same animals. Initial results of the study support the inference that the centre of mass of theropod dinosaurs underwent a more gradual cranial migration along the line to birds, rather than rapidly switching from a conserved position near to the hip to a more cranial one with the evolution of flight.

Technical Session XIII, Friday 3:45

**CUT DOWN TO SIZE: BODY MASS, DIET, AND BACKGROUND EXTINCTION RATES IN FOSSIL MAMMALS**

ALROY, John, University of California, Santa Barbara, CA, USA

In extant mammals, body mass and diet correlate strongly with such plausible determinants of extinction rates as population density, geographic range size, and the intrinsic rate of increase. Both properties can be estimated from cheek tooth length and width using new methods that have been ground-truthed with measurements of museum specimens representing 343 African, Asian, and European species. Mass is often estimated from such variables as lower first molar area using equations that are specific to orders, which is problematic when dealing with archaic Paleogene groups. Better precision is obtained by ignoring homology and estimating mass with an all-mammal multiple regression involving the length and width of the second largest lower tooth of any kind. Diet can be estimated with a simple index of tooth shape variability that compares lengths and widths for the three largest consecutive upper and matching lower teeth. Herbivores, insectivores/omnivores, and carnivores have increasingly variable shapes. Newly compiled data for the same extant species show that both mass and shape variability are strong negative predictors of population density, although the relationships vary across communities. Therefore, species with large and/or variably shaped teeth should have higher background extinction rates. Mass and shape estimates were obtained using published measurements for more than 1000 species of North American Cenozoic mammals. No patterns are seen using all available durations obtained by appearance event ordination. However, excluding short ranges (< 1 My) reveals a consistent decline in median duration with rising body mass that corresponds to a drop in expected extinction rates of about 20% as mass goes from 100 g to 10,000 kg. No similar pattern is seen in the shape variability data. Unless it is consistently harder to distinguish small mammal species, the balance of diversity across the size spectrum appears to be maintained by a tradeoff between selection and extinction: at the individual level selection favors large size (Cope's rule), but at the species level large size leads to low population density and therefore faster extinction.

Poster Session IV (Saturday)

**FOSSIL OSTARIOPHYSAN FROM MEXICO: A REVIEW**

ALVARADO-ORTEGA, Jesús, Universidad Nacional Autónoma de México, México, México; NUÑEZ-UTRILLA, María José Paulina, Universidad Nacional Autónoma de México, México, México

The age of fossil remains of ostariophysan fishes found in Mexico range between the Early Cretaceous and the Pleistocene. Fossil ostariophysans are represented by Gonorynchiformes, Cypriniformes, and Siluriformes. Two gonorynchiform taxa have been collected in the Albian limestones of the Tlayúa quarry, Puebla State, a marine deposit with temporal freshwater influences: one form reported in 1990 is represented by large specimens, about 60 cm of estimated total length; the second form, recently discovered, is represented for smaller specimens of about 10 cm total length. A third gonorynchiform, of moderate length, was recovered in the Albian-Cenomanian marine limestones of El Doctor Formation that outcrops in the Muhi quarry, Hidalgo State. A couple of Judeichthys-like fishes were collected in El Chango quarry (possibly Albian or Cenomanian) and represents an estuarine deposit near Tuxtla Gutiérrez, Chiapas State. The fossil record shows that gonorynchiforms, that represent potential new species, may provide additional data to understand the patterns and process of diversification of these fishes along the Tethys Sea domains during the Cretaceous. The Late Cretaceous gonorynchiforms are represented by extinct taxa in Mexico, whereas Miocene to Pleistocene cypriniforms and siluriforms are represented by extant taxa. Disarticulated remains of cypriniforms and siluriforms are always found together in Miocene, Pliocene and Pleistocene lacustrine deposits located in the states of Hidalgo, Tlaxcala, Jalisco, Guerrero, and México. Among these deposits, it is remarkable the occurrence of four Pliocene localities near Tula de Allende, Hidalgo State, in which three-dimensionally isolated bones described as *Ictiobus aguilerai* were collected. Other fossil catostomids have been found in Miocene deposits near Panotla, Tlaxcala State. Up to now, all recovered fossil siluriforms have been identified as *Ictalurus*. In the near future, Oligocene to Pleistocene deposits, possibly containing ostariophysans, in Chiapas, Durango, Zacatecas, and Oaxaca will be explored.

Poster Session II (Thursday)

**EVOLUTIONARY CHANGE IN *THISBEMYS* (RODENTIA; ISCHYROMYIDAE) RECOVERED FROM THE BRIDGER FORMATION, GREEN RIVER BASIN, WYOMING**

ANDERSON, Deborah, St. Norbert College, De Pere, WI, USA; KEIL, Kimberly, St. Norbert College, De Pere, WI, USA

One motivation in the study of ischyromyid rodents is the discovery of unique patterns of evolutionary change. We found species transitions for members of the genus *Thisbemys* occurring within recognized Bridger Formation stratigraphic levels, crossing the stratigraphic boundaries originally used for chronospecies recognition. We studied specimens of *Thisbemys* recovered from the Bridger Formation, whose stratigraphic range spans the entire Bridgerian (Late Early to Middle Eocene) NALMA. Our qualitative analysis included scoring each specimen for key taxonomic characters. Following this, each specimen was measured using the standard length/width metrics for ischyromyid lower cheek teeth. We used a new method for measuring the upper premolar and molars that provided more consistency than standard techniques. Teeth were positioned so that no roots were visible when viewed from the crown. Length was measured at the center of each molar, widths were measured along the protoloph and metaloph. Three distinct species were identified based on morphology: *T. perditus*, *T. plicatus*, and *T. corrugatus*. A coefficient-of-variation test and bivariate plots of log-transformed tooth area vs. biostratigraphic level and length vs. width metrics revealed more than one species in Br1 and Br2; *T. plicatus* is common to both. *Thisbemys corrugatus* occurs in Br2 and Br3, essentially replacing *T. plicatus* in upper Br2 and Br3. Features such as the amount and pattern of crenulations, incisor shape, mesoconid size, and the development of a P4 hypocone displayed a pattern of mosaic evolution. Previously, *T. perditus*, *T. plicatus*, and *T. corrugatus* were thought to represent one phyletic lineage. Evidence of at least two distinct lineages of the Bridgerian taxa, *Thisbemys*, with an apparent species transition occurring during Br2, is a fresh insight that will facilitate species identification when classifying ischyromyid rodents from the Bridger Formation.

Technical Session XV, Friday 2:00

**OSTODOLEPIDAE (LEPOSPONDYLI, RECUMBIROSTRA): PERMIAN BURROWING MICROSAURS**

ANDERSON, Jason, University of Calgary, Calgary, AB, Canada; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada; MADDIN, Hillary, University of Calgary, Calgary, AB, Canada

Recent phylogenetic analyses have supported an origin of caecilians (Lissamphibia, Gymnophiona) within recumbirostran lepospondyls (Pantylidae, Gymnarthridae, Brachystelechidae, Goniorhynchidae, and Ostodolepidae). This diphyletic origin of lissamphibians is in direct conflict with molecular studies, which support a monophyletic origin. Whereas amphibamid temnospondyls have received intensive investigation in recent years, our understanding of the detailed anatomy of lepospondyls has lagged. Motivated by the discovery of a new genus of a small ostodolepid, we are undertaking a revision of this elongate lepospondyl clade to see whether derived features shared with caecilians can be found or if natural selection has led to convergence between two fossorial groups. The new genus is complete and undistorted except for the high and gently posteriorly sloping occiput, which is crushed into the sinus which lies between the braincase and skull roof. The snout is strongly overturned, and the premaxillae form a broad plate. The entire skull is reinforced against rostrocaudal stresses through deeply interdigitating sutures and broadly expanded medial laminae of most superficial dermal bones. Seen in all ostodolepids, these features strongly suggest a burrowing mechanism similar to amphibiaenids. However, the presence of large orbits and retention of limbs suggests a less fully fossorial lifestyle than seen in amphibiaenids or caecilians. Additionally, the new genus has a unique second ossification in the sphenethmoid region superficially similar to those seen in caecilians and a brachystelechid also under study, although this could represent a ventral flange of the frontal. The new genus, *Pelodosotis*, and *Micraroter* share the presence of large foramina along the sutures between the septomaxilla and the maxilla and lacrimal. CT investigation suggests confluence between this opening and the highly developed nasolacrimal canal near the latter's entry into the septomaxilla (and thus the nasal capsule), suggestive of a sensory function similar to the caecilian tentacle.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 8:30

**MORPHOLOGICAL AND FUNCTIONAL DISPARITY IN LATE DEVONIAN ARTHRODIRES**

ANDERSON, Philip, University of Bristol, Bristol, United Kingdom

Studies of ecological structure and diversity in extinct faunas have always been challenged by the inability to directly observe the functional interactions of fossil taxa. The most common evidence for function is the morphological characteristics of the preserved fossils. Studies on modern groups have shown that superficial morphological analyses may give misleading results in terms of ecological pattern and functional diversity. An alternative approach is to use morphological metrics based on a paleobiomechanical paradigm. The purpose of this research is to examine lower jaw variation in Late Devonian arthrodire placoderms using both morphological data and biomechanical metrics. Landmark-based morphometric data were collected for 94 isolated arthrodire inferognathals from the Gogo Formation in Western Australia and the Cleveland Shale in Ohio. Nine functionally relevant morphological features were measured on the same set of jaws. This data set was analyzed using multivariate statistical

methods. Disparity metrics (average pairwise distances) were compared between the two faunas based on both shape and functional characters. Statistical analysis of the morphological and functional disparity of these Late Devonian taxa shows a disjoint between the two measures. Model I Regression analysis and Spearman rank correlation analysis of average pairwise morphological and functional distance measures indicate no significant relationship between morphological and functional disparity amongst the jaws used in this study. The diversity patterns observed both within and between faunas differ greatly depending on whether morphological or functional data is used. Results based on functional data show clusters of arthrodire taxa independent of either taxonomy or general morphology, possibly indicating taxa with similar feeding niches. Although function is derived from morphology, these results show that superficial morphological shape analyses are not necessarily good proxies for eco-functional diversity. Biomechanical analyses of morphology will provide greater insight into the ecological diversity of fossil faunas.

Poster Session IV (Saturday)

**NICHE PARTITION IN SOLNHOFEN THALATTOSUCHIANS**

ANDRADE, Marco, Department of Earth Sciences, University of Bristol, Bristol, United Kingdom; YOUNG, Mark, Department of Earth Sciences, University of Bristol, Bristol, United Kingdom

The Solnhofen limestones of the Mörnsheim Formation (uppermost *Hybonotum* zone, early Tithonian, Upper Jurassic) yield a rich fauna of thalattosuchian crocodylians. At least five species can be recognized: 1) *Geosaurus giganteus*, 2) *G. suevicus*, 3) *G. gracilis*, 4) *Dakosaurus maximus* and 6) *Steneosaurus priscus*. Niche partitioning is here proposed as the mechanism allowing the co-existence of so many species in the same paleoenvironment. Despite a general resemblance, these crocodylians differ in several aspects, mainly related to feeding mechanics (e.g. dentition, rostrum morphology). The large (~2.5-4m in length) brevirostrine metriorhynchids (*G. giganteus*, *Dakosaurus*) are here hypothesized to be the top predators of the Mörnsheim environment. Both had laterally compressed non-procumbent serrated teeth, complemented with strong adductor musculature. Competition between these species is unlikely however, as *Dakosaurus* was an oreinrostral form possessing large, robust chopping/crushing teeth. In contrast, *G. giganteus* had blade-like dentition, which occluded in a slicing scissor-like pattern, unique among thalattosuchians. The small (~2m) longirostrine metriorhynchids (*G. suevicus*, *G. gracilis*), and the large (~3-4m) longirostrine teleosaurid *Steneosaurus* had procumbent dentition with piercing uncompressible and non-carinate teeth, indicating a primarily piscivorous diet. *Steneosaurus*, having extensive body armor and lacking paddles/caudal fin of the metriorhynchids would have been a poorer swimmer, restricted to ambush predation. The exceptionally delicate teeth of *G. gracilis* suggest specialization towards smaller and softer prey, including small crustaceans/soft-bodied mollusks. *Geosaurus suevicus*, being slightly larger and more robust than *G. gracilis*, would have been a more generalist feeder. The diverse morphology of teeth, skull and post-cranium in Mörnsheim thalattosuchians support the specialization towards particular diets, with little niche overlap. Differences in size probably allowed further partitioning amongst the piscivorous forms.

Technical Session I, Wednesday 11:45

**GEOLOGY AND VERTEBRATE PALEONTOLOGY OF PALEOCENE AND EOCENE DEPOSITS IN THE GREAT DIVIDE BASIN OF SOUTHWESTERN WYOMING**

ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA; DIRKS, Wendy, Newcastle University, Newcastle-Upon-Tyne, United Kingdom; WATKINS, Ron, Curtin University, Perth, Australia; NACHMAN, Brett, University of Texas at Austin, Austin, TX, USA; VAN REGENMORTER, John, Western Michigan University, Kalamazoo, MI, USA

The results of ten field seasons of geological and paleontological work in the Great Divide Basin (GDB) in southwestern Wyoming are summarized with respect to the taxonomic, biostratigraphic, and geological nature of its sedimentary deposits and their included fossils. As a result of this work, and after a long history of being considered of lesser importance than many other sedimentary basins in the Rocky Mountain West, the Great Divide Basin should now be recognized as a significant source of knowledge concerning the paleobiology of the early Paleogene. Following on the earlier, but rather limited, work in the GDB by USGS geologists (e.g., G Pipiringos) and Smithsonian Institution paleontologists (e.g., CL Gazin), our fieldwork has focused on determining the extent of late Paleocene and early Eocene mammal-bearing deposits in previously unexplored areas, as well as finding and re-collecting at the few fossil localities identified decades ago by previous workers. In addition, we have been utilizing innovative approaches from the Geographical Sciences (including GIS, GPS, and remote sensing) in our fieldwork and laboratory analysis of fossil distribution throughout the basin. Results indicate that fossil-bearing deposits in the GDB span the Paleocene-Eocene boundary, and that a particularly rich concentration of fossil mammals of late Wasatchian age (Wa6-7) are preserved in the northern part of the basin in the Freighters Gap-Pinnacles area. We have also thoroughly documented the presence of a Clarkforkian fauna with a decidedly "anachronistic" aspect in deposits north and east of Bitter Creek in the southern part of the basin. In a previously unexplored area in the eastern part of the basin known as Salt Sage Draw, an extensive middle to late Wasatchian fauna has been documented. Finally, the Tipton Buttes area has yielded another late Wasatchian (Wa6) fauna in an area first worked by Pipiringos, Gazin, and others in the 1950s. With over 7000 catalogued fossil mammals from 75 localities extending across the Paleocene-Eocene boundary, the Great Divide Basin can no longer be considered of little interest to the vertebrate paleontology of the American West.

Technical Session XI, Friday 10:45

**THE PERMO-TRIASSIC DICYNODONT FAUNA OF THE RUHUU BASIN, TANZANIA: NEW DISCOVERIES AND THEIR IMPLICATIONS**

ANGIELCZYK, Kenneth, The Field Museum, Chicago, IL, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA; TSUJI, Linda, Museum für Naturkunde, Berlin, Germany; NESBITT, Sterling, American Museum of Natural History, New York, NY, USA; SMITH, Roger, Iziko South African Museum, Cape Town, South Africa

Dicynodont therapsids were first discovered in the Ruhuhu Basin in 1930. Subsequently, the Upper Permian Usili Formation has produced a unique dicynodont fauna that includes a mix of taxa lacking concurrent stratigraphic ranges elsewhere, as well as endemic taxa such as *Kawingasaurus* and *Katumbia*. The Middle Triassic Lifua Member of the overlying Manda Beds have also yielded endemic dicynodonts (*Tetragonias*, *Angonisaurus*) as well as more cosmopolitan genera (*Kannemeyeria*, *Sangusaurus*). Recent fieldwork in the Ruhuhu Basin has led to the discovery of several specimens that offer new insights into dicynodont diversity, biostratigraphy, and biogeography. In the Usili Formation, we discovered two probable new species, emphasizing the endemic nature of the Ruhuhu fauna. One shows similarities to taxa such as *Oudenodon* and *Tropidostoma*, whereas the other may be close to the base of the Triassic radiation of kannemeyeriiform dicynodonts. A new specimen of *Kingoria* includes the first well-preserved humeri available for this taxon. These humeri display a generalized morphology which contrasts strongly with the highly derived nature of *Kingoria*'s pelvis and hindlimb. Finally, our field observations are congruent with previous assertions that a single assemblage is present in the Usili Formation. Combined with the unusual composition of the fauna, this fact implies that biostratigraphic correlations between the Ruhuhu and other basins likely will remain imprecise. Dicynodont remains are rarer in the Lifua Member, but two newly discovered specimens are of note. The first is a fragmentary specimen of *Angonisaurus* that includes the first humerus and ankle material reported for this genus. The second specimen is a partial skull and pelvis that appears to represent *Sangusaurus*. The specimen is well preserved, and offers much potential for elucidating the morphology and systematics of this poorly known taxon. Although Ruhuhu Basin strata have been studied for nearly a century, the abundance of fossils we encountered, as well as their fine preservation, strongly suggest that the potential of this area has not been fully exploited and additional discoveries remain to be made.

Technical Session XIV, Friday 2:00

**EVOLUTION AND FUNCTIONAL MORPHOLOGY OF THE TAIL CLUB IN ANKYLOSAURID DINOSAURS**

ARBOUR, Victoria, University of Alberta Laboratory for Vertebrate Paleontology, Edmonton, AB, Canada; SNIVELY, Eric, University of Alberta Laboratory for Vertebrate Paleontology, Edmonton, AB, Canada; CURRIE, Philip, University of Alberta Laboratory for Vertebrate Paleontology, Edmonton, AB, Canada

Ankylosaurid tail clubs are characterized by modified distal caudal vertebrae (the handle) and large terminal osteoderms (the knob). It has previously been assumed that these tail clubs were used as weapons. Descriptions of more than 25 tail club specimens from five taxa, supplemented with data from computed tomography scans of several *Euoplocephalus* specimens, provide new insight on tail club morphology. The keeled lateral knob osteoderms may be homologous with the wedge-shaped lateral caudal osteoderms of basal ankylosaurids like *Gastonia*. Results from finite element analyses show that the compact bone of the robust neural and haemal arches reduced stresses within the cancellous centra, under simulated clubbing forces. Centra are variably fused along the handles in different specimens. Ossified tendons are found alongside the handle vertebrae, and extend underneath the knob osteoderms. This suggests that knob osteoderms grew over the preexisting ossified tendons, which may indicate a relatively late development of the knob. Ridges found on the lateral edges of *Euoplocephalus* ilia appear to correspond to origins of large *M. longissimus caudae*, which would have extended down the length of the tail. Well-preserved ossified tendons in several specimens, and comparisons with modern crocodylians, also suggest that *M. iliocaudalis* and *M. caudofemoralis longus* were important muscles in ankylosaurid tails. Surprisingly, ankylosaurid caudal vertebrae are more lightly built than nodosaurid vertebrae, even though nodosaurids lack tail clubs. ImageJ was used to measure areas of varying density in CT slices of tail clubs. Multiplying areas by slice thickness, and then by bone densities for extant vertebrates, provides estimates of mass for tail clubs of various sizes. Tail club osteoderms are low-density cancellous bone, resulting in surprisingly small tail masses and rotational inertias, and possibly making the club easier to wield as a weapon.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 8:00

**THE OSTARIOPHYSAN FOSSIL RECORD: STATE OF THE ART**

ARRATIA, Gloria, Biodiversity Research Center, University of Kansas, Lawrence, KS, USA

The Ostariophysi--a clade comprising the (Gonorynchiformes or milkfishes + (Cypriniformes or carps + (Characiformes or characins + (Siluriformes or catfishes + Gymnotiformes or knifefishes)))--are represented today by about 8,000 species belonging to 68 families. Most modern ostariophysans live in freshwaters with the exception of some gonorynchiforms and catfishes. Currently, controversial molecular data have questioned the monophyly of ostariophysans and the phylogenetic relationships among and within subgroups. Up to now, most phylogenetic studies of ostariophysans have not included fossils.

The fossil record of the ostariophysan orders has been investigated and evaluated based on a review of the literature as well as of selected fossils. Results show (1) that part of the record is represented by an incomplete knowledge of hundreds of remains or isolated elements, e.g. the pharyngeal tooth bone and its teeth in cypriniforms; isolated jaw teeth in characiforms; and pectoral and dorsal spines in siluriforms; (2) the presence of ostariophysans in continents where they are absent today. For instance, in the past, gonorynchiforms were present in Europe, South America, and North America, continents where they are absent today and fossil characiforms have been recovered in Europe, whereas catfishes have been recovered in Antarctica, continents where they do not live today. Present and past distributions of each ostariophysan subgroup open major questions about possible connections and migration routes in the past; (3) the oldest record is an ostariophysan incertae sedis from the Upper Jurassic of Germany; the oldest gonorynchiforms, and supposedly the oldest characiform, are from Lower Cretaceous deposits of Europe and South America. In contrast, the oldest records of cypriniforms are Paleocene in age. Thus, the age of the oldest members versus the current phylogenetic hypothesis (if it is correct) reveal that important information still remains to be recovered from the fossil record.

Technical Session I, Wednesday 9:00

**MORPHOLOGICAL FEATURES OF A "MOLECULAR" CLADE: DEVELOPMENT IN AFROTHERIAN MAMMALS**

ASHER, Robert, University of Cambridge, Cambridge, United Kingdom

Living afrotherian mammals include elephants, sea cows, hyraxes, aardvarks, sengis, tenrecs and golden moles. Up until recently, evidence for their common ancestry was based almost entirely on molecular data. Anatomical features held in common by most or all afrotherians are not obvious, but are nevertheless apparent with consideration of their development. At least two of their shared, derived characteristics--non-descent of the male gonads and late eruption of the permanent dentition--result from an ontogenetic pattern that appears "slower" than those of other placental mammals. In this presentation I investigate new data on the absolute timing of dental eruption in macroscelidids and ask whether or not small afrotherians resemble living elephants, hyraxes, and manatees in the late eruption of their permanent dentition, delayed until well after sexual maturity. In addition, I optimize afrotherian features on recent hypotheses of the mammalian Tree of Life to ask if the ontogenetic distinctiveness of Afrotheria is derived or primitive relative to other placental mammals. Finally, I apply data from geographically relevant extinct mammals to infer the extent to which they share morphology characteristic of afrotherians.

Poster Session III (Friday)

**INITIAL ISOTOPIC ANALYSIS OF A MIOCENE MAMMALIAN FAUNA FROM FORK POLK IN WESTERN LOUISIANA**

ATWOOD, Travis, LSU Geology and Geophysics, Baton Rouge, LA, USA; SCHIEBOUT, Judith, LSU Geology and Geophysics, Baton Rouge, LA, USA

Terrestrial Miocene mammals have been recovered for the last fourteen years from outcrops of the Castor Creek Member of the Fleming Formation on Fort Polk in western Louisiana. Over the years, specimens of Carnivora, Artiodactyla, Perissodactyla and Proboscidea have been recovered, mainly through surface search and quarrying, although a few have been recovered in screening. Through screening a plethora of smaller vertebrate fossils have been found, dominated mainly by rodent teeth. Paleomagnetic data has been obtained that suggest that the stratigraphically highest site, Discovery (DISC), correlates to about 13.75 Ma. Stable isotope data has been obtained for some of the larger taxa from Fort Polk with focus on the DISC site. Fort Polk faunas represent a time period before the expansion of C4 grasslands (~7 Ma) and are therefore hard to analyze for resource partitioning. Recent studies indicate that it is possible to distinguish resource partitioning even in fossil C3 dominated environments. Of particular interest are the fossil equids that were analyzed, *Merychippus gunteri* and *Cormohipparion goorisi*.  $\delta^{13}C$  and  $\delta^{18}O$  values of *Merychippus gunteri* are more negative and indicate a more closed, forested environment. The other large fauna that were analyzed also fall in the same  $\delta^{13}C$  and  $\delta^{18}O$  range as *Merychippus gunteri*. However, *Cormohipparion goorisi* isotopic values are more positive and indicate a more open, drier habitat. The distribution of rodents at different Fort Polk sites has been compared to modern-day rodent distributions to estimate the type of environment at each site. The rodent data from the DISC site also supports the existence of an open environment that *Cormohipparion goorisi* could have inhabited, and palynological data obtained at Fort Polk also supports the existence of relatively open habitat along with a more closed, forested environment.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**NEW EVIDENCE FOR THREE SPECIES OF TSAGANOMYID RODENTS FROM THE VALLEY OF THE LAKES REGION, MONGOLIA**

BAASANJAV, Ugtbayar, Museum of the Rockies, Bozeman, MT, USA

In late 1990's and early 2000's, Mongolian and Austrian paleontological expeditions collected 29 skulls, 80 jaws, and 48 teeth of tsaganomyid rodents from 15 different localities in the Valley of the Lakes region of Mongolia. Although the most recent study suggests that Tsaganomyidae includes 3 genera: *Tsaganomys* (type genus), *Cyclomytus*, and *Coelodontomys*, it has been suggested that *Cyclomytus* is a junior synonym of *Tsaganomys* and that specimens called *Cyclomytus* are just small-sized *Tsaganomys*. In the present study,



specimens referred to *Tsaganomys altaicus* and *Cyclomytus lohensis* were studied in detail to determine if these are in fact different taxa. One interesting observation is that *Cyclomytus* is limited to the lower Oligocene while *Tsaganomys* is distributed in both the lower and upper Oligocene. This alone suggests these are different species. The number of specimens studied here exceeds previous studies, and detailed morphological comparisons and measurements suggest that these two species are in fact different from each other. The tips of the molar roots in *Tsaganomys altaicus* are lingually directed, and although the root in  $P_4$  of *Cyclomytus lohensis* is also directed lingually, those of the molars in *Cyclomytus* are directed buccally. In *Tsaganomys altaicus* the anterior border of the masseteric fossa is below  $M_1$ , while that same fossa terminates below  $M_2$  in *Cyclomytus lohensis*. In addition, when paleosols in the Valley of the Lakes region were compared to present-day soils, it appears that *Tsaganomys altaicus* and *Cyclomytus lohensis* possibly burrowed to different depths.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)  
**DINOSAURS FROM THE LATE CRETACEOUS MONGOLIAN LOCALITY OF KHAICHIN I**  
BADAMKHATAN, Zorigt, Museum of the Rockies, Bozeman, MT, USA

Khaichin I is a small Mongolian locality situated in the Omnogovi province of southwest Mongolia. It is situated just southwest of a better-known locality, Bugin Tsav, which has very fossiliferous exposures of the Late Cretaceous Nemegt Formation. Khaichin I is situated geographically between Bugin Tsav to the north and Paleogene exposures to the south, thus it is typically considered to be latest Cretaceous in age. Previously, *Buginbaatar*, a multituberculate mammal, and *Macroolithus rugustus* eggshells fragments have been described from this locality. Fragments of indeterminate turtle and dinosaur bones were also reported. In 2005 joint expedition between Georgia Southern University and the Mongolian University of Science and Technology found additional dinosaur fossils from Khaichin I, including theropod teeth, limb bones, and vertebrae. Although no dinosaur fossils were found in association, the concentration of weathered bones in the scree of certain slopes suggests that most of the bones collected belong to just a few individuals. The three isolated teeth are referred to Dromaeosauridae. As in dromaeosaurids, the tooth is recurved, has serrations on its distal margin, and has a base that is pinched in the middle indicating the close approximation of other teeth. Of the six vertebrae found, three are caudal and the rest are dorsal vertebrae. These vertebrae have features that resemble those of oviraptorids, including wide dorsal centra, pneumatic presacrals, and dorsal transverse processes that are short, wide, and slightly inclined. A right proximal end of a theropod femur was also collected, and it is tentatively identified as an ornithomimid, possibly *Gallimimus*. The dinosaur fauna from the Khaichin I is similar to those of the Djadochta and Nemegt Formations in having dromaeosaurids and oviraptorids; however, it is surprising that all the taxa identified so far are theropods, not ornithischians. Additional fieldwork is needed at this locality to increase the known dinosaur diversity and determine if this observed bias is not an artifact of small sample size.

Technical Session XV, Friday 3:15  
**THE DIVERSE BATRACHOFAUNA FROM THE APTIAN CRATO FORMATION AND ITS BEARING ON THE MAIN RADIATION OF HYLOIDS FROGS**  
BÁEZ, Ana, Universidad de Buenos Aires, CONICET, Buenos Aires, Argentina; BARBOSA DE MOURA, Geraldo, Universidade Federal de Pernambuco, Recife, Brazil; GÓMEZ, Raúl, Universidad de Buenos Aires, Buenos Aires, Argentina

The lacustrine limestones of the Crato Formation of northeastern Brazil have yielded one of Gondwana's most important Cretaceous Konservat Lagerstätten, which includes the remains of a few anurans. Several of these specimens have been considered to represent a single taxon, *Arariphrynus placidoi*, which has also been regarded as the earliest record of the Neobatrachia, the largest clade among extant anurans. Reexamination of this material shows that it belongs to more than one anuran taxon. Moreover, among the specimens assigned to *A. placidoi*, non-neobatrachian as well as neobatrachian frogs are represented. Three specimens, including the holotype of *A. placidoi*, preserve features consistent with neobatrachian affinity; however, they differ from one another in characters such as body proportions, scapular morphology, and shape of terminal phalanges, indicating that they represent separate taxa. Although the monophyly of neobatrachians can be considered a well-corroborated hypothesis, neobatrachian interrelationships are still far from being satisfactorily resolved. To evaluate the taxonomic placement of these specimens, we conducted a phylogenetic analysis of a matrix of 44 taxa, including extant representatives of most of the higher groups of neobatrachians as well as non-neobatrachians, and 71 osteological characters in TNT 1.0 under implied weights with different values of the concavity constant (k). As in other analyses based on morphological data, within Neobatrachia we recovered a monophyletic Ranoides but hyloid taxa appear as stem-ranoids. Our results consistently place the three fossil taxa in nested positions among hyloid taxa, although the topology of the tree varies. Recent studies based on molecular data have estimated divergence times for several anuran clades and proposed the main radiation of hyloid neobatrachians, excluding the australobatrachians, as a Late Cretaceous-Paleogene event. Our results are not consistent with this hypothesis as they imply that several hyloid lineages had already diverged around 115 my ago and, thus, the early history of hyloids is as yet not documented in the fossil record.

Poster Session I (Wednesday)  
**ADDITIONS TO THE MEDICINE ROCKS MAMMALIAN FAUNA (PALEOCENE: LATE TORREJONIAN) OF SOUTHEASTERN MONTANA**  
BAKER, Charles, University of Oklahoma, Norman, OK, USA; DAVIS, Brian, University of Oklahoma, Norman, OK, USA; CIFELLI, Richard, University of Oklahoma, Norman, OK, USA

We describe a rich and diverse assemblage of characteristic late Torrejonian (To3) taxa from a small sample collected from a site in the Tongue River Member of the Fort Union Formation. This locality, one of several sites around Medicine Rocks State Park in southeastern Montana, was last sampled over 30 years ago. While some limited portions of this fauna have been previously described, this is the first attempt to treat the mammalian fauna in its entirety. Though mammalian remains are so far restricted to isolated teeth, at least thirteen taxa are represented. Three orders and seven families of Eutheria are present, plus three families of multituberculates and the marsupial *Peradectes*. The taxonomic diversity is significant given a sample of only 500 pounds. This sample does not appear to be dominated by primates, unlike other northern latitude faunas; in fact, no single taxon or group is numerically superior. The species-level contents of this fauna may help better place the Medicine Rocks localities in a biostratigraphic context with more thoroughly sampled and roughly contemporaneous sites, such as the Gidley and Silberling quarries. Control of the relative placement of this fauna will also provide a biogeographic dimension to our knowledge of mammalian evolution through the middle Paleocene of North America.

Poster Session IV (Saturday)  
**THE ENDOCRANIAL MORPHOLOGY OF OVIPTOROSAURS AND A REINTERPRETATION OF THEIR ENCEPHALIZATION QUOTIENTS**  
BALANOFF, Amy, American Museum of Natural History, New York, NY, USA; BEVER, Gabe, American Museum of Natural History, New York, NY, USA; ROWE, Tim, The University of Texas at Austin, Austin, TX, USA

Oviraptorosaurs possess one of the most complex and bizarre cranial morphologies of any theropods, and their endocranial anatomy is no exception. Some analyses of the endocranium of derived oviraptorosaurs reveal that, similar to the rest of their body plan, they share a convergent morphology with birds. The relatively large volume of the endocranial space is also shared between derived oviraptorosaurs and birds, which may offer support for a close phylogenetic relationship. Such observations provide the impetus to reanalyze the volumetric relationships between these groups. Previous analyses of plots of encephalization quotients that included derived oviraptorosaurs, birds, as well as non-dinosaurian diapsids suggested that these unusual theropods were more closely associated with derived avians. These analyses, however, did not have a sufficient sampling of non-avian theropod dinosaurs, especially those postulated to be closely related to oviraptorosaurs. Recent fossil discoveries as well as the use of computed tomography fill out this missing portion of previous analyses. Additionally, we take a different approach in that we partition the volume data based on endocranial landmarks, which allows recognition of volumetric transformations with increased anatomical refinement. The addition of taxa, especially among non-avian maniraptoran theropods alters the distribution of volumetric data by largely eliminating the perceived volumetric gap between 'reptiles' and 'birds'. The encephalization quotient of oviraptorosaurs falls out closely with deinonychosaurs, further eroding support for oviraptorosaurs as avialans.

Poster Session IV (Saturday)  
**NORTH AMERICAN BRONTOTHERIID SUBFAMILIAL SYSTEMATICS: DO OSBORN'S CRANIOMETRIC DATA SUPPORT ANY TAXONOMIES?**  
BALES, Gerald, Western University of Health Sciences, Pomona, CA, USA

Osborn's comprehensive monograph on the then-called "titanotheres" was the result of 19 years work. Included are tables of craniometrical and postcranial measurements. While the horn length metrics have been analyzed for allometry, little to no analyses have been done on the other data. The monograph describes some 12 subfamilies and 35 genera, putting Osborn historically in the taxonomic "splitter" camp. Subsequent taxonomies have reduced the number of subfamilies and genera assigned within the Brontotheriidae (Perissodactyla: Ceratomorpha). This study undertook to observe clustering or other patterns in the craniometric data, and to correlate observed patterns with the taxonomies of Osborn and later workers. Missing data precludes traditional multivariate techniques, so the data are observed in a scatter plot matrix of pairwise 2-D morphospaces. Metrics used from Osborn are basilar length (condyle-premaxilla), horn length, zygomatic breadth, nasal breadth, occipital vertex to nasal tip distance, upper P1-M3 length, and cephalic index (width/length). The taxa, which most often cluster individually or together, separate from other genera, are three genera within Osborn's Dolichorhininae (*Mesatrinhinus*, *Metatrinhinus*, and *Dolichorhininus*) and *Manteoceras* within his Manteocerotinae. This supports the continued retention of Dolichorhininae. Later workers synonymized or subsumed *Dolichorhininus* within *Sphenocoelus*. Unfortunately, Osborn did not provide measurements for his *Sphenocoelus*. A consistent feature across the plots is much overlap of *Brontops*, *Allops*, *Menodus*, *Megacerops*, and *Brontotherium*. Simpson subsumed *Allops* into *Menodus* early. Later, *Brontotherium* was subsumed into *Megacerops*. The data supports this reasonably. However, *Brontotherium* consistently shows an overlapping part and a non-overlapping part suggesting that it may be two groups. There seems to be little unique subfamilial or generic morphology in the measurements supporting taxonomic groupings, except perhaps for dolichorhinine and brontotheriine groups.

Technical Session II, Wednesday 10:00

#### **QUATERNARY EXTINCTIONS AND THE GLOBAL TRADEOFF IN MEGAFAUNA BIOMASS**

BARNOSKY, Anthony, UC Museum of Paleontology, Berkeley, CA, USA

It is now widely recognized that between 50,000 and 10,000 years ago, the Earth's last great extinction event claimed two-thirds of all the largest mammal genera, and that one of the precipitating causes was the immigration of humans onto various continents and islands. Among the human impacts thought to lead to megafaunal extinction are direct hunting (overkill), habitat disruption and fragmentation (for example, by setting fires), and introducing diseases. Little appreciated has been the potential ecological effects of increasing human population sizes to critical levels in a zero-sum global ecosystem. To explore this I used population models constrained by archaeological and ecological observations to estimate human biomass and non-human megafauna biomass on Earth from human origins to the present. These estimates suggest that initially, growth of human biomass approximately matched the loss of non-human megafauna biomass. Then ~12 thousand years ago, as human biomass began its rapid rise, total megafauna biomass (counting humans as a megafauna species) crashed dramatically. Recovery of megafauna biomass to pre-crash levels proceeded primarily by continued growth of human population, converting the global ecosystem to a new state where one species--humans--made up an inordinate amount of the world's megafauna biomass. Interestingly, pre-crash biomass levels were not attained until just prior to the Industrial Revolution, then they shot above the pre-crash baseline. Exceeding the pre-crash baseline corresponded with adding energy to the global ecosystem by mining and using fossil fuels. Implications include (1) a global ecological threshold event occurred with the megafaunal extinctions, after which humans became the dominant megafauna in a worldwide context; and (2) in the absence of developing alternative energy sources as fossil fuels are depleted, a near-future biomass crash that will unfavorably impact humans is inevitable.

Technical Session X, Friday 10:30

#### **COEVOLUTION OVER GEOLOGIC TIMESCALES: TESTING INTERACTIONS BETWEEN NONAVIAN DINOSAURS AND CYCADS**

BARRETT, Paul, The Natural History Museum, London, United Kingdom; BUTLER, Richard, The Natural History Museum, London, United Kingdom; KENRICK, Paul, The Natural History Museum, London, United Kingdom; PENN, Malcolm, The Natural History Museum, London, United Kingdom

Coevolution is an important process driving biological diversity over ecological time, but it is unclear to what extent such processes contribute to the large scale evolutionary and ecological patterns observed in deep time. Some of the most pervasive long-term coevolutionary hypotheses relate to proposed interactions between herbivorous nonavian dinosaurs and Mesozoic plants, including cycads. It has been suggested that dinosaurs were key dispersers of cycad seeds and temporal variation in cycad diversity and abundance has been linked to changes in herbivorous dinosaur faunas. Here, we assess the evidence for hypotheses of trophic and evolutionary interactions between these two groups using diversity analyses, a database of Cretaceous dinosaur and plant cooccurrence data, and a geographical information system (GIS). Phylogenetic evidence suggests that several key biological properties of cycads (e.g., toxins, bright-coloured seeds) appeared prior to the origin of dinosaurs. Direct evidence of dinosaur-cycad interactions is not available, but evidence from extant analogues suggests that dinosaurs were plausible seed dispersers for cycads, although other vertebrate groups (e.g., birds, early mammals) might also have filled this role. While the Late Triassic radiations of dinosaurs and cycads appear to have been approximately contemporaneous, few significant changes in herbivorous dinosaur faunas coincide with the decline of cycads in the late Early Cretaceous, with the possible exception of stegosaurs. Statistically significant spatiotemporal associations between particular dinosaur clades and cycads are essentially absent and GIS visualisation reveals disparities between the spatiotemporal distributions of some dinosaur groups (e.g., sauropodomorphs) and cycads that are inconsistent with coevolutionary hypotheses. Available data provides little support for proposed coevolutionary interactions between cycads and herbivorous dinosaurs. Although it is possible that diffuse coevolutionary scenarios can operate over geologic timescales, such hypotheses need to be firmly grounded on direct evidence of interaction and may be difficult to support due to the patchiness of the fossil record.

Technical Session VI, Thursday 2:15

#### **THE QUANTITATIVE COMPARISON OF HYRACOID TOOTH GEOMETRY**

BARROW, Eugenie, University of Oxford, Oxford, United Kingdom; MACLEOD, Norman, Natural History Museum, London, United Kingdom; KRIEGER, Jonathan, Natural History Museum, London, United Kingdom

During the late Eocene and Oligocene hyracoids were the dominant terrestrial herbivores of Afro-Arabia. A Paleogene radiation gave rise to diverse forms, represented by up to 30 species assigned to 14 genera. The qualitative study of fossil dentitions has contributed much of what is known about the extent of taxonomic and ecological diversity among hyracoids. Early hyracoid teeth ranged from being bunodont to selenodont and lophoselenodont. By the Miocene more specialised, hypsodont forms arose. The three small-bodied genera exist today all with relatively lophodont teeth. No detailed morphometric analysis has been performed on hyracoid teeth. Although the arrangement of cusps provide suitably

corresponding structures to use in a landmark-based analysis, the morphology of the surfaces that make up the cusps, and the crests and spurs that run between them, are also taxonomically and functionally important. Eigensurface analysis has overcome previous problems associated with analysing data collected from 3D surfaces and provides a suitable method for examining the surface morphology of hyracoid teeth. Once a 3-D point cloud has been obtained (e.g. using 3D laser scanning) a user-specified grid is defined by interpolated points along the object outline, a 'backbone' and grid 'ribs'. The 3D grids can then be aligned using Procrustes (GLS) superimposition and a covariation-based SVD can be performed in order to examine shape variation across a sample. In order to compare and contrast the taxonomic and ecological information included in different parts of the hyrax molar a suite of Late Eocene and Early Oligocene specimens were subjected to relative warps (landmark), eigenshape (outline) and eigensurface (surface) analysis. The specimen ordinations obtained were then used to optimize the dimensionality of the data, and serve as input into canonical variates and partial least squares analysis in order to test taxonomic hypotheses and extract ecological trends. Results suggest that, while each approach has its appropriate domain of utility, the greater information content of eigensurface analysis has clear advantages for exploratory morphological investigations.

Poster Session IV (Saturday)

#### **THE PRICE RIVER 2 QUARRY: TAXONOMY AND TAPHONOMY TOGETHER TELL THE TANTALIZING TALE OF A TITANOSAURMORPH-THYREOPHORAN THANATOCOENOSIS**

BARTON, Bronson, Utah State University, Logan, UT, USA; BARRICK, Reese, College of Eastern Utah Prehistoric Museum, Price, UT, USA; BARTLETT, Jeffrey, College of Eastern Utah Prehistoric Museum, Price, UT, USA; BIRD, John, College of Eastern Utah Prehistoric Museum, Price, UT, USA

The Price River 2 (PR2) quarry, located in the uppermost Ruby Ranch Member of the Cedar Mountain Formation on the northern flank of the San Rafael Swell in central eastern Utah, preserves a macrovertebrate fauna dominated by three strange bedfellows: a large unnamed brachiosaurid titanosauro-morph, and two giant ankylosaurs, the large ankylosaurid *Cedarpelta bilbeyhallorum* and an even larger, unnamed nodosaurid. The combination of these three taxa – an ankylosaurid, a nodosaurid, and a brachiosaurid – together in the same fauna, let alone at the same site, is thus far unique in the fossil record. While most of the material recovered from PR2 pertains to the brachiosaurid, this study concentrates on the ankylosaurs, which are well represented by several specimens. A preliminary phylogenetic study of the ankylosaurs reveals that *Cedarpelta* is indeed an ankylosaurid and the nodosaurid closely aligned with *Sauropelta*. Hydrodynamic grading of skeletal elements is present at PR2: the lowermost part of the quarry primarily consists of current aligned limb bones; the upper parts of the quarry are more jumbled and are dominated by vertebrae and metapodials. Specimens from all three taxa are found throughout the bonebed, and all show similar taphonomic signatures (breakage, abrasion, weathering, etc.). This suggests that specimens belonging to the three taxa preserved at PR2 traveled approximately the same distance and were exposed to similar environmental conditions prior to deposition and were likely part of the same biocoenosis (living assemblage) as well as thanatocoenosis (death assemblage).

Technical Session XVI, Saturday 12:00

#### **RECONSTRUCTING THE LOCOMOTOR BIOLOGY OF ACROANTHOSAURUS ATOKENSIS (DINOSAURIA: THEROPODA)**

BATES, Karl, University of Manchester, Manchester, United Kingdom; MANNING, Phillip, University of Manchester, Manchester, United Kingdom; SELLERS, William, University of Manchester, Manchester, United Kingdom

Constructing musculoskeletal models of extinct taxa requires subjective assumptions about soft tissue morphologies rarely preserved in the fossil record. Sensitivity analysis of dynamic simulations of dinosaur running have confirmed that numerical values chosen for poorly understood mass and soft tissue properties have a significant effect on the predicted locomotor ability of these animals, emphasizing the need to better constrain plausible 'bio-realistic' ranges for individual species. In this study we have used laser scanning technology combined with computer modeling to create a 3D musculoskeletal model of *Acroanthosaurus atokensis* (Dinosauria: Theropoda). The most complete specimen of *A. atokensis* has been digitized, providing a high resolution skeletal framework around which body cavities and internal organs have been reconstructed, allowing calculation of body segment masses, centres of mass and moments of inertia for this animal. An extensive sensitivity analysis has subsequently been carried out, in which the volumes of body segments and respiratory structures were varied in an attempt to constrain the likely maximum bio-realistic range of mass parameters. Major pelvic and hind limb muscles have been reconstructed on the basis of homologous osteological correlates of muscle-tendon insertions in extant archosaurs. Combining the mass and muscle-tendon reconstructions we have conducted a 3D dynamic simulation of locomotion in *A. atokensis* using evolutionary robotics. To create stable locomotion, an appropriate muscle activation pattern has been developed by a distributed, parallel Genetic Algorithm (GA) optimization system. The GA control system searches for muscle activation patterns that maximize performance according to specific fitness criteria (e.g. maximum running speed) thereby producing explicit quantitative predictions of gait. This system alleviates the need to subjectively infer joint kinematics or rely on extant taxa as dubious locomotor analogues. Future work will use sensitivity analysis to quantify the effects of soft tissue and mass inputs on predicted gaits, using the bio-realistic ranges identified in this study.

Poster Session III (Friday)

**A NEW *PARASAUROLOPHUS* (HADROSAURIDAE) BRAINCASE FROM THE DINOSAUR PARK FORMATION, ALBERTA**

BAVINGTON, Rebecca, University of Toronto, Mississauga, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

The lambeosaurine hadrosaurid *Parasauroplophus* is known only from rare occurrences in Campanian deposits of the Dinosaur Park Formation, Alberta, Canada. An undescribed large hadrosaurid braincase collected in 1955 by W. Langston Jr. is recognized here as pertaining to the genus *Parasauroplophus* on the basis of several derived characters associated with the frontal-nasal articulation at the base of the crest. The specimen is generally poorly preserved, but it consists of complete frontals, the parietal, both orbitosphenoids, and the lateral wall of the braincase on both sides. When included in a phylogenetic analysis of lambeosaurines, the specimen forms a polytomy with all other species of *Parasauroplophus*. It can be identified as this genus on the basis of two unambiguous synapomorphies: 1) the massive thickness and steep, posterodorsal inclination of the frontal platform that overhangs the parietal, and 2) the greatly shortened ectocranial surface of the frontal. This specimen represents the third and largest cranial specimen of *Parasauroplophus* from the Alberta. Although it cannot be positively assigned to the species level, it occurs in the same deposits as the holotype specimen of *P. walkeri*, and may represent a late ontogenetic stage of this taxon. Re-examination of the holotype of *P. walkeri* suggests that the frontals form a large portion of the ventral base of the crest, an area that has historically been difficult to interpret. In the new braincase, the region of the frontal dome is completely overgrown by the posterodorsal expansion of the frontal platform, where as a distinct frontal dome is present in the holotype of *P. walkeri*. This suggests that the crest had not reached its full development in the holotype of *P. walkeri*. A particularly important aspect of the specimen is that the field notes allow it to be tightly constrained stratigraphically, and its stratigraphic position supports the notion that *Parasauroplophus* occurs only in the lower part of the Dinosaur Park Formation.

Poster Session III (Friday)

**COMPARATIVE OSTEOHISTOLOGY OF *MAIASAURA PEBBLESORUM* (HADROSAURIDAE) FROM THE TWO MEDICINE FORMATION (CAMPANIAN) CAMP-O-SAUR BONEBED OF MONTANA**

BAZIAK, Brian, Museum of the Rockies, Bozeman, MT, USA

A good use of osteohistology is to study the growth history of a single individual, since this is at best difficult to study from the external surface. By comparing the growth histories of multiple individuals of a species, we can arrive at a more complete understanding of the growth of that species than we would from studying the history of a single individual. A wide range of factors can affect bone growth, such as physiology, the environment, and individual variation. By examining bones representing a single species from a deposit interpreted as resulting from a single death assemblage, we can minimize physiological and environmental factors, and evaluate individual variation. A lack of understanding of how much individual variation there is has led some researchers to rely too heavily on data that may not be reliable. To better understand the expected amount of individual variation, full cross-sections cut from the mid-diaphysis of the tibia from nine individuals of *Maiasaura pebblesorum* collected from the Camp-o-saur bonebed were examined. ANOVA statistical tests were run on the data collected, analyzing both the variation in growth within single bones, and between different bones. The results show statistically significant (0.1 and higher confidence levels) variation within a single bone, demonstrating the importance of making multiple measurements from several areas around the cross-section of the bone. Comparing the same area of different bones gave mixed results; most areas show statistically significant variation between the bones, except in the anterior and posterior areas. This suggests that if only a limited area can be studied, these two areas are best. This study demonstrates that there is enough variation that researchers must be cautious when interpreting osteohistologic data.

Technical Session VI, Thursday 3:45

**CRANIODENTAL ONTOGENY IN THE DESMOSTYLIA**

BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA

In recent years, many new specimens of desmostylians have been found and await description. Complete adult specimens of desmostylians are rare, and any hopes of understanding intraspecific variation are mostly limited to isolated dentitions. To complicate matters, many specimens, including holotypes, are those of juvenile or subadult individuals. As more specimens are found and described, it is important that we find some way to recognize what characteristics vary within species and change during ontogeny. In order to address the role of ontogeny in the differences between specimens, I examined cranial and mandibular specimens from a number of collections in the US, Canada, and Japan. Specimen ontogenetic stage was determined by coupling dental eruption status with sutural fusion. The delayed eruption of postcanine teeth is most extreme in the Desmostyliidae, as is the loss of incisors and enlargement of tusks. The presence and size of the sagittal crest also depends on ontogenetic stage, like in many mammals. Being one of the characters that differentiate the Paleoparadoxiidae and Desmostyliidae, it is important that ontogenetic stage of individuals be considered before character states are designated in phylogenetic analyses. In a broader perspective, delayed dental eruption, tusk development, and craniofacial elongation are characteristics that appear to be shared among many crown tethytheres, even though basal

members of the Sirenia, Proboscidea, and Desmostylia appear to lack it. Whether these features are convergent or are homologous shared developmental potentials is still uncertain.

Poster Session IV (Saturday)

**LUMBAR SPINE OF *REMINGTONOCETUS* (MAMMALIA, CETACEA, ARCHAEOCETI) AND IMPLICATIONS FOR AQUATIC LOCOMOTION**  
BEBEJ, Ryan, University of Michigan, Ann Arbor, MI, USA

Remingtonocetids are semiaquatic archaeocetes endemic to India and Pakistan that are known for their long, narrow skulls. Fragmentary vertebrae and partial hind limb elements are among the post-cranial remains known for these whales. A recently collected specimen of *Remingtonocetus* (GSP-UM 3552) from the upper Domanda Formation (late Lutetian; early middle Eocene) of Pakistan includes a partial innominate and the most complete pre-caudal vertebral column of any remingtonocetid described to date, offering insights into the swimming capabilities of the group. The specimen preserves 7 cervical, 8 of a probable 13 thoracic, 6 lumbar, and 3 of 4 sacral vertebrae. Posterior thoracic, lumbar, and sacral vertebrae were preserved in articulation, showing definitively that remingtonocetids possessed 6 lumbar vertebrae like their protocetid contemporaries. Lumbar centra are broad and only moderately long, with reniform endplates. Short, robust transverse processes project laterally from lumbar vertebral bodies. These processes angle increasingly more cranially and ventrally from L4-L6. Prezygapophyses are convexly curved and face medially, which would have allowed some dorsoventral movement while restricting lateral and axial rotation. Neural spines are relatively short dorsoventrally, but are over two-thirds of the centrum length anteroposteriorly, limiting dorsiflexion. Posteriorly flaring apices of neural spines and excavations in the laminae dorsal to the neural canals accommodated robust supra- and interspinous ligaments that would have resisted ventral flexion. *Remingtonocetus* had a stable lumbar region with a small degree of dorsoventral flexibility. Taken together with a fused 4-vertebrae sacrum, large innominates, and robust femora, the morphology of the lumbar vertebrae is consistent with an animal that swam primarily by powerful movements of the hind limbs rather than dorsoventral undulation.

Poster Session I (Wednesday)

**UNAMBIGUOUS, LARVAL AND JUVENILE DEVONIAN DIPNOANS**

BÉCHARD, Isabelle, Chaire de recherche en paléontologie et biologie évolutive, Université du Québec à Rimouski, Rimouski, QB, Canada; CLOUTIER, Richard, Chaire de recherche en paléontologie et biologie évolutive, Université du Québec à Rimouski, Rimouski, QB, Canada

The dipnoan fossil record is fairly abundant, although unambiguous larval forms have not been described yet. The adult morphology of the Late Devonian *Scaumenacia curta* from the Escuminac Formation (Miguasha, Québec, Canada) is one of the best known among extinct dipnoans. Recently, abundant material of well-preserved larval-juvenile specimens of *S. curta* were found in a juvenile effective habitat or nursery. Size and shape changes as well as sequences of ossification are evaluated based on more than 200 specimens ranging in size from 18.5 to 50.0 mm. In the smallest specimen, squamation, fin rays, pectoral girdle, cranial ossification and tooth plates are well developed and the second dorsal, anal, and caudal fins are barely distinguishable from one another. Larval-juvenile specimens differ from larger specimens (adults) in terms of body proportions, number of fin rays, number of ossified elements, and caudal curvature of the notochord. Reconstructed patterns of ossification for serial bony elements include: (1) pleural ribs ossify from anterior to posterior, whereas (2) supraneurals ossify from posterior to anterior; (3) caudal and anal proximal radials ossify from anterior to posterior, whereas (4) dorsal proximal radials ossify bidirectionally. All these characteristics are consistent with larval-juvenile stages of growth and suggest that *S. curta* was going through metamorphosis. Ontogenetic patterns of *S. curta* are compared with those of living dipnoans and extinct sarcopterygians.

Technical Session XI, Friday 11:30

**TRENDS IN THE EVOLUTION OF BODY SIZE IN NON-MAMMALIAN SYNAPSIDS**

BECK, Allison, Augustana College, Moline, IL, USA; SEARS, Karen, University of Illinois at Urbana-Champaign, Urbana, IL, USA

As the earliest non-mammalian synapsids (e.g., pelycosaurs) were relatively large (~20 to 100 kg), and the first mammals relatively small (~ 5 to 15 g), there is an apparent trend of decreasing body size in the evolution of non-mammalian synapsids. Several authors have suggested that small body size was either a prerequisite for, or a direct result of the evolution of a mammal-like way of life characterized by a relatively high metabolic rate, active foraging, endothermy, and an upright stance. Despite the importance of body size in the origin and evolution of mammals, the apparent trend toward decreased body size in the evolution of non-mammalian synapsids has never been quantitatively examined within a phylogenetic context. Using this approach, we address two questions: (1) is the trend toward decreased body size active or passive, and (2) what is the mechanism behind the trend (e.g., biased morphologic evolution, constrained morphologic evolution, or differential extinction or speciation)? We approximated body size (using limb bone lengths as a proxy) on a composite cladogram of 75 genera, then estimated and compared (using a likelihood-ratio test) the numbers and magnitudes of evolutionary increases and decreases in body

size. To test if the apparent trend was influenced by the biased extinction of larger genera or origination of smaller genera, we compared the body size distribution of genera with first and last appearances in each interval to the overall distribution for that interval. We found that non-mammalian synapsids as a whole exhibit a passive trend toward decreased body size, suggesting that small body size was not persistently selectively advantageous across the entire clade. However, the lineage leading to mammals (e.g., the “backbone” of the tree) and the clade Probainognathia, which contains the Mammalia and their immediate ancestors, both display an active trend toward decreased body size. These active trends were driven by the occurrence of more reductions than increases in size. This pattern suggests that small body size was selectively advantageous in the lineage leading to mammals, and in the earliest mammals and their immediate ancestors.

Technical Session I, Wednesday 9:45

**A WINDOW INTO EARLY MAMMALIAN PALEOECOLOGY: PALEOENVIRONMENTAL AND TAPHONOMIC INVESTIGATION OF THE GOLD SPRING QUARRY “BLUE LAYER,” KAYENTA FM., ARIZONA**

BEHRENSMEYER, Anna, National Museum of Natural History, Smithsonian Institution, Washington, DC, DC, USA; WHATLEY, Robin, Columbia College Chicago, Chicago, IL, USA

As part of a global-scale research project on the paleoecology and taphonomy of early mammal diversification, we investigated the Harvard University Gold Spring Quarry (GSQ) locality, Kayenta Formation, Navajo Nation, Coconino Co., Arizona. The GSQ is the only mammaliaform-bearing assemblage of Early Jurassic age (~200 Ma) in North America and is one of the most diverse small vertebrate assemblages worldwide for that time interval. Lateral tracing and stratigraphic sections integrated with a standardized surface survey (bonewalk) were used to document lithofacies and surface fossils over ~1.5 km of the upper GSQ Blue Layer. This provides evidence for the paleoenvironmental context and taphonomy of the mammaliaform-bearing stratum within the “Silty Facies” of the Kayenta Fm. The GSQ BL is associated with a gleyed paleosol at the top of a fining-upward sequence above an extensive channel deposit. Interfingering beds of eolian Navajo Sandstone suggest interaction of an active fluvial system and dune fields at the time of the GSQ BL. Ostracods are commonly associated with the GSQ BL, indicating periodic aquatic conditions. Based on this evidence, we interpret the GSQ BL as forming in an extensive seasonal wetlands environment. Four days of standardized surface survey resulted in 56 records representing ~seven identifiable taxa including *Oligokyphus*, *Dinnebitodon*, and a possible mammaliaform. Surface surveys documented mainly fragmentary, isolated specimens, in contrast to the Gold Spring Quarry where excavated remains are commonly articulated or associated. All of the fossils recorded along the GSQ BL are from relatively small-bodied taxa, with the upper size limit represented by *Scutellosaurus*, a turkey-sized ornithischian dinosaur. *Scutellosaurus* and turtle, the most abundant taxa in the surface surveys, are absent from the Gold Spring Quarry. This research provides a unique snapshot of the paleoecology of Early Jurassic mammals in the context of a vertebrate community that included diverse synapsids (mammaliaforms and traversodontids), turtles, caecilians, lepidosauromorphs, and dinosaurs associated with an extensive, low relief, seasonally wet land surface.

Poster Session II (Thursday)

**DIVING MECHANICS OF THE EXTINCT HESPERORNITHIFORMES: COMPARISON TO MODERN DIVING BIRDS**

BELL, Alyssa, The Dinosaur Institute, Natural History Museum, LA County, Los Angeles, CA, USA; TSENG, Zhijie Jack, Dept of Paleontology, Natural History Museum of LA County, Los Angeles, CA, USA; CHIAPPE, Luis, The Dinosaur Institute, Natural History Museum of LA County, Los Angeles, CA, USA

The Hesperornithiformes of the Late Cretaceous represent a diverse lineage of pre-modern birds that were highly specialized for foot-propelled diving. Like modern loons and grebes, hesperornithiforms had an extreme rotation of the hindlimb such that it was directed behind the body. This adaptation presumably increased efficiency in force generation during swimming, as is the case with modern foot-propelled diving birds. This study presents a detailed comparison of the skeletal morphology of hesperornithiforms, loons, and grebes in order to examine specializations that may increase diving efficiency. Furthermore, the relative potential of the hindlimb of *Hesperornis regalis* and a grebe to produce force through a single foot stroke is compared using finite-element models built from three-dimensional CT scan data. Through this study, the diving capabilities of the unusual hesperornithiforms can be closely evaluated in light of modern diving birds in order to address questions regarding the optimality of hesperornithiform hindlimb structure as well as stress and strain distribution within the limb. Furthermore, this study can be used to highlight skeletal specializations that differ among diving birds and may therefore provide phylogenetically informative traits regarding the evolutionary radiation of hesperornithiform birds.

Technical Session IV, Wednesday 1:45

**HOW THE STICKLEBACK LOST ITS PELVIS: GENES, NATURAL SELECTION, AND A MICROSTRATIGRAPHIC SEQUENCE**

BELL, Michael, Stony Brook University, Stony Brook, NY, USA; TRAVIS, Matthew, Rowan University, Glassboro, NJ, USA

The genetics of adaptation during speciation is poorly understood because it is difficult to combine the necessary genetic and ecological information with long-term observations. We report evolution of reduced pelvic structures during 17,000 years, within which a new threespine stickleback species evolved. In extant threespine stickleback, the *Pitx1* gene has a large effect on pelvic structure, and full expression is partially dominant over reduction. Other genes have minor effects on pelvic expression. Silencing *Pitx1* during pelvic development also causes the left pelvic vestige to be larger than the right one. The left pelvic vestige is larger in about 75% of fossil stickleback with vestigial pelvic phenotypes. Vestigial pelvic phenotypes also have a largely bimodal frequency distribution, indicating the action of a major gene with dominance. Thus, *Pitx1* is implicated in pelvic reduction in the fossil stickleback. Although there was a delay of 2750 years between the onset of directional natural selection for armor reduction and the evolution of pelvic reduction in this lineage, the lengths of the pelvis and pelvic spine begin to decline immediately, implicating other genes with minor effects on the size of the pelvis and pelvic spine. Partially recessive *Pitx1* alleles for pelvic reduction were apparently too rare initially to respond to natural selection immediately. The complex temporal pattern of pelvic evolution in this fossil lineage conforms to expectations for the response to directional selection on a phenotype that depends on a major locus with dominance plus minor loci, as is found in extant stickleback populations.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**A MEDLEY OF MALADIES: MULTIPLE PALEOPATHOLOGIES IN A SPECIMEN OF *GORGOSAURUS LIBRATUS* (TYRANNOSAURIDAE)**

BELL, Phil, University of Alberta, Edmonton, AB, Canada

Paleopathology provides unique insights into the lifestyle and behavior of extinct animals. A well-preserved, partial skeleton of *Gorgosaurus libratus* (UALVP10) from the Dinosaur Park Formation (Campanian) in Dinosaur Provincial Park, Alberta consists of a nearly complete skull and jaws, cervical vertebrae C5-C8, at least six dorsal vertebrae including numerous ribs and gastralia, a partial right forelimb, and parts of both hindlimbs. Close examination of the bones reveals several abnormalities in four consecutive cervical vertebrae, the right humerus, right metatarsal IV, and right pedal phalanx III-1. These are attributed to infection, ligament avulsion, and idiopathic (unknown) causes. Two cervical vertebrae (C7 and C8) are fused by ligamentous ossification of the ventral longitudinal ligament. CT imaging suggests a close resemblance to diffuse idiopathic skeletal hyperostosis (DISH) in mammals. Abnormalities on two other vertebrae (C5 and C6) and the right humerus are diagnosed as osteomyelitis. The avulsive injury and osteomyelitis on metatarsal IV and phalanx III-1, respectively, on the right pes may be related. Infection or trauma at either of these locations would have promoted lameness and a tendency toward further injury. Despite these injuries UALVP10 survived for a considerable time based on their extent and longevity of these conditions. Furthermore, extensive trauma in *Gorgosaurus*, *Tyrannosaurus*, and *Allosaurus* suggests large theropods were remarkably resilient when compromised by injury and were not easily dethroned from their position as top predators in the terrestrial ecosystem.

Technical Session II, Wednesday 9:30

**ANALYSIS OF UNGULATE DIET DURING THE LAST GLACIAL (MIS 5-2) IN THE LEVANT: EVIDENCE FOR LONG-TERM STABILITY IN A MEDITERRANEAN ECOSYSTEM**

BELMAKER, Miriam, Harvard University, Cambridge, MA, USA

The last glacial in Europe is known for extreme climatic fluctuations, with floral and faunal turnover. In the Levant, the amplitude of climate change may not have been great enough to cause an appreciable shift in either vegetation or faunal communities. If climate change in Levantine ecosystems had an appreciable effect on vegetation, ungulates would increase the proportion of graze in their diet in response to changes from woodland to scrubland within the Mediterranean biome. Mesowear measures the height and relief of upper molar paracones on selenodont ungulates and can be used to distinguish between the diet of browsers, grazers and mixed feeders. Novel prediction equations for percent graze, browse and fruit in ungulate diet were developed using a stepwise least square regression analysis for each of the dietary categories based on mesowear data of selenodont ungulates and used to reconstruct the diet of ungulate species throughout the last glacial in the Levant. Mesowear was recorded on populations of *Dama mesopotamica* and *Gazella gazella* obtained from sites dating to the last glacial MIS 5-2 (c. 110-12 ky) from Israel and applied to the prediction equations. Results indicate no significant shift in diet for *D. mesopotamica* (c. 80% browse) or *G. gazella* (c. 45% browse) during the early and middle pleniglacial in the Southern Levant. A significant decrease of browse in diet (c. 55% browse) was found at the height of the last glacial maximum (c. 23 kya) for *D. mesopotamica* populations, although this shift was not observed in the diet of *G. gazella* which remained similar to earlier periods. This suggests that during most of the last glacial, the relative distribution between woodland and scrubland in the Levant was stable. The environmental shift observed during the last glacial maximum stands in contrast to the long period of environmental stability that preceded it. This study provides insight into temporal and spatial patterns of persistence and change through time and the response of biota to different amplitudes of climatic change.

Poster Session IV (Saturday)

#### **A NEW THEROPOD PHYLOGENY FOCUSSED ON BASAL TETANURANS, AND ITS IMPLICATIONS FOR EUROPEAN 'MEGALOSAURS' AND MIDDLE JURASSIC DINOSAUR ENDEMISM**

BENSON, Roger, Department of Earth Sciences, University of Cambridge, Cambridge, United Kingdom

Theropod dinosaur phylogeny has been tested by numerous cladistic analyses. However, areas of uncertainty remain, such as the interrelationships of basal, non-coelurosaurian tetanurans. A new phylogenetic dataset constructed to resolve basal tetanuran relationships includes 41 operational taxonomic units (OTUs), including 37 basal tetanurans, more than any previous analysis. 213 characters (22 new) were compiled based on thorough reassessment of previous phylogenetic datasets and direct examination of specimens representing 85% of the OTUs. Scorings also drew on recently published and unpublished results of taxonomic reviews of the European Jurassic theropod record. Analysis of the new dataset recovers a monophyletic Tetanurae. Spinosauroida is the most basal tetanuran clade and forms the sister taxon of Neotetanurae, comprising Allosauroida and Coelurosauria. Spinosauroida was previously conceived as including Spinosauridae and its sister taxon, Megalosauridae (or Torvosauridae). The present analysis finds *Afrovenator*, *Torvosaurus*, and the European Middle Jurassic theropods *Dubreuillosaurus*, *Eustreptospondylus*, *Magnosaurus*, *Megalosaurus*, '*Megalosaurus*' *hesperis*, and *Piveteausaurus* as megalosaurids. Previously unrecognized spinosauroid clades are recovered as successive outgroups to Megalosauridae + Spinosauridae: *Chuanlongocoelurus* + *Monolophosaurus* (Middle Jurassic, China), and; *Xuanhanosaurus* (Middle Jurassic, China) + (*Marshosaurus* (Late Jurassic, North America) + (*Condorraptor* + *Piatnitzkysaurus*; Middle Jurassic, Argentina)). This result demonstrates the monophyly of most European Middle Jurassic 'megalosaurs', although *Poekilopleuron* is an allosauroid. Megalosaurids are not known from outside Europe during the Middle Jurassic, although global sampling is poor and some Chinese taxa of undetermined affinities were not included in the new analysis due to brief published descriptions. Middle Jurassic spinosauroids dominated the role of apex predator in taxonomic and numerical abundance and show limited endemism across Pangaea. Most spinosauroid lineages went extinct at the end of the Middle Jurassic and were ecologically replaced by allosauroids.

Technical Session X, Friday 11:00

#### **HOW TO FIND A DINOSAUR, AND THE ROLE OF SYNONYMY IN BIODIVERSITY STUDIES**

BENTON, Michael, University of Bristol, Bristol, United Kingdom

Taxon discovery underlies many studies in evolutionary biology, including biodiversity and conservation biology. Synonymy has been recognised as an issue, and as many as 30-60% of named species later turn out to be invalid as a result of synonymy or other errors in taxonomic practice. This error level cannot be ignored because users of taxon lists do not know whether their data sets are clean or riddled with erroneous taxa. A year-by-year study of a large clade, Dinosauria, comprising some 1000 taxa, reveals how systematists have worked. The group has been subject to heavy review and revision over the decades, and the error rate is about 40% at generic level and 50% at species level. The naming of new species and genera of dinosaurs is proportional to the number of people at work in the field. But the number of valid new dinosaurian taxa depends on the discovery of new territory (sedimentary basins/ countries). Error rates are highest (> 50%) for dinosaurs from Europe; less well-studied continents show lower totals of taxa, exponential discovery curves, and lower synonymy rates. Plots of valid genera (i.e. total genera minus synonyms and other errors) may be concave-up, straight lines, or concave-down. Further, from any observation point (e.g., 2008), it is possible to determine a 'half life', the time to naming of the first 50% of valid species within a clade. In comparisons with other studies, 50% of the current total was achieved as follows: mammals (1940s), basal tetrapods (1950s), trilobites (1960s), dinosaurs (1980s), and birds (1990s). Reasons for these differences will be explored, and the use of such data in developing measures of 'confidence' in data sets will be presented. The most prolific namer of dinosaurs was Othniel Marsh who named 80 species, closely followed by Friedrich von Huene (71) and Edward Cope (64), but the 'hit rate' (proportion of dinosaurs named that are still regarded as valid) was low (0.14-0.29) for these earlier authors, and it appears to improve through time. If 50% of species are invalid, evolutionary biologists and conservationists must exercise care in their use of unrevised taxon lists.

Technical Session V, Wednesday 3:30

#### **OSTEOLOGICAL CORRELATES AND PHYLOGENETIC ANALYSIS OF DEEP DIVING IN LIVING AND EXTINCT PINNIPEDS: WHAT GOOD ARE BIG EYEBALLS?**

BERG, Lauren, Department of Integrative Biology, University of California, Berkeley, Berkeley, CA, USA; PYENSON, Nicholas, Department of Integrative Biology, University of California, Berkeley, Berkeley, CA, USA

Marine tetrapods have independently evolved multiple solutions to deal with the challenges of feeding at depth below the photic zone. Odontocetes, for example, evolved a biosonar system. Some ichthyosaurs evolved the largest eyeballs known in any vertebrate, likely for use in such low light settings. Some authors have proposed that deep-diving pinniped lineages evolved large eyeballs relative to their skull size for similar reasons. Here, we test this hypothesis in a phylogenetic context using morphological and diving data from living pinniped species. We

examined the crania of 20 pinniped species that possess associated natural history data. This extant sample of 95 mature, adult specimens includes *Odobenus*, a predominantly Northern Hemisphere sample of phocids and otariids, and select arctoid carnivorans as outgroup taxa. Specifically, we measured bony orbit size as a proxy for eyeball size, and also recorded multiple associated skull measurements to control for changes in orbit size relative to skull size. For diving depth, we used average deepest dive depth reported in the literature. We used a molecular phylogeny of crown pinnipeds to analyze correlations between the independent contrasts of relative orbit size and diving depth. Although absolute orbit size is positively correlated with diving depth using species values, regression analyses using independent contrasts show no correlation between these two traits, which indicates that the correlation between orbit size and diving depth is not affected by phylogeny. Because fossil pinnipedimorphs are disproportionately represented by isolated cranial remains, we will outline how these methods can be applied to infer likely diving ability in extinct pinnipeds with well preserved crania.

Poster Session IV (Saturday)

#### **A TALE OF TWO MANDIBLES: PROBLEMS CONCERNING SPECIMENS ASSIGNED TO *CARODNIA VIEIRAI* (MAMMALIA: XENUNGULATA) FROM ITABORAÍ BASIN, BRAZIL**

BERGQVIST, Lillian, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; ABRANCHES, Carla, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; MORATO, Leonardo, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; ÁVILLA, Leonardo, Universidade do Rio de Janeiro, Rio de Janeiro, Brazil

*Carodnia vieirai* is the best-known species so far recovered from Itaboraí Basin, late Paleocene of the state of Rio de Janeiro. It was described on the basis of postcranial and cranial materials of two individuals, both including almost complete, but clearly distinct, lower jaws. The holotype mandible (DGM 333M) is a little larger but its body is proportionally higher than that of the paratype (DGM 334M). The angular process is almost straight and little projected in DGM 333M, while in DGM 334M it is well projected posteriorly, beyond the mandibular condyle. The teeth of both specimens are quite similar, with minor distinctions in the premolar series, mainly on p2, but they are different in size - smaller in the holotype. However, the most remarkable difference is the forward projection of the rami in DGM 334M, like in extant manatees, whereas in DGM 333M, the rami are projected upwards, as in most mammals. Some hypotheses can be raised in the attempt to explain the distinct morphology between specimens: 1) each belongs to a different species - nonetheless, no significant distinctions are observed in the well-preserved postcranial skeleton and teeth morphology. Moreover, all material of *C. vieirai* was recovered from a single fissure fill deposit in Itaboraí Basin. 2) Sexual dimorphism - although possible, such a difference in the lower jaw is not seen in any extant mammals, and would imply distinct patterns of mastication and biomechanical forces between individual represented by the specimens. 3) Taphonomic processes - also possible, as the cranial material is fragmented and slightly distorted, but the morphology of DGM 334M would have to be explained by heterogeneous strain, affecting mainly the posterior portion of the dentary; however, in this region the stresses would have to act in similar manners in both rami, as the distortions are equivalent. 4) Malformation - as with the taphonomy hypothesis, it is unlikely that pathology would be bilaterally symmetrical; further, no clear signs of inflammatory tissues are observed. Ontogenetic variation was discharged because both specimens belong to adult individuals.

Poster Session IV (Saturday)

#### **NEW HYBODONT SHARK FROM THE CAMEROS BASIN (EARLY CRETACEOUS, SPAIN)**

BERMÚDEZ-ROCHAS, David, Área de Investigación en Patrimonio Geológico-Minero, Departamento de Investigación en Recursos Geológicos, Instituto Geológico y Minero de España, Madrid, Spain

Recent field works in Early Cretaceous sediments of the Cameros Basin (Northwest of the Iberian Chain) have yielded abundant Hybodontiformes remains (Elasmobranchii, Chondrichthyes). The Cameros Basin is situated between three Spanish provinces (La Rioja, Soria, and Burgos). All fossiliferous sites with hybodontiform remains are located in La Rioja province, in the Enciso Group sediments. The Enciso Group deposits are interpreted as lacustrine paleoenvironment. The hybodont assemblages from Cameros Basin show general similarities with the hybodont faunas previously known from the Early Cretaceous of Spain, as the ones found in Galve (Teruel, Maestrazgo Basin) and Vega de Pas (Cantabria, Basque-Cantabrian Basin). In addition to hybodont taxa previously known from other Early Cretaceous sites, an endemic hybodont species with high-crown multicuspid teeth has been found. Elements of this new taxon have been registered in two different outcrops inside the Enciso Group (Aptian in age). In Badornera site (Rincón de Olivedo), only one isolated tooth of this new taxon has been found. In Las Navas 1 site (Igea) (part of the material currently under preparation), three teeth have been recovered, together with finspine fragments, one placoid scale, and remains of calcified cartilage, which have been interpreted as belonging to the same individual. The teeth found are very similar to *Egertonodus basanus* teeth from the Early Cretaceous of England. The new species teeth can be discriminated from *E. basanus* and all other high-crowned hybodont taxa by the presence of accessory cusplets in the labial side of some of them, a dental character unique among this selachian group. Teeth preservation is very good in the new taxon, and the root (extremely difficult to get preserved) is present in all of them. This root shows a hybodontoid type (anaulacorhize stage), and it is linguo-basally directed. The new species presents a tearing-type dentition, and a probable combination of monognathic and dignathic heterodonty is inferred from the studied material.

Poster Session III (Friday)

**MULTIDISCIPLINARY PALEOBIOLOGICAL RESEARCH AT THE LATE MIOCENE (MN9) LOCALITY OF HOEWENEGG, GERMANY**

BERNOR, Raymond, Howard University, Washington, DC, USA; EDER, Johanna, Staatliches Museum für Naturkunde, Stuttgart, Germany; KAUFMAN, Alan, University of Maryland, College Park, MD, USA; MITTMANN, Hans-Walter, Staatliches Museum für Naturkunde, Karlsruhe, Germany; WOLF, Dominik, Howard University, Washington, DC, USA

Höwenegg (Hegau, N' Lake Constance area) is a late Miocene locality (MN 9, 10.3 Ma) exceptional for the completeness of its paleobiological record. The original research was undertaken by Tobien and Jörg over several field seasons in the 1950s and 1960s. Trenching and collection of datable volcanics were undertaken by Karlsruhe scientists between 1985 and 1992 yielding a secure single crystal argon age of 10.3 Ma. Our current research excavations, led by W. Munk (Karlsruhe), commenced in 2001 and have continued through 2007. Our project's aims include: a complete retrieval of all biotic elements within a precise stratigraphic context; undertaking geochemical and taphonomic studies to better understand the site's depositional history; integrating the current excavations with those of Tobien and Jörg's; continued study of the vertebrate skeletons systematics, functional anatomy and ecomorphology (in collaboration with E. Heizmann, Stuttgart). Given the prevalence of Late Miocene volcanism in the region and the presence of volcanic bombs within the sediments, we hypothesize that the sudden release of CO<sub>2</sub>, either by overturn or direct volcanic injection, resulted in the sudden demise of animals in the lake vicinity. The 2007 field season reestablished the principal bone-bearing bed of Tobien and Jörg, retrieving several new partial and complete skeletons of *Hippotherium*, *Miotragocerus* and *Dorcatotherium*. Since 2001, the project has expanded the inventory of fossil plant material including pollen, seeds, fruits and whole leaves, limnic and terrestrial gastropods (M. Rasser, Stuttgart), skeletons of reptiles (E. Frey, Karlsruhe) and the dominant ungulates. New species of turtle and cervid have also been discovered. The principal bone bed, Unit 11 also has the most diverse biotic elements, which include rarely occurring fresh-water crabs and terrestrial click-beetles (Elateridae). This international multidisciplinary project is currently funded by the National Science Foundation (BCS-0321893 and EAR0125009), LSB Leakey Foundation and the Karlsruhe and Stuttgart Museums of Natural History.

Poster Session IV (Saturday)

**A NEW ICHTHYODECTIFORM FISH FROM THE MID-CRETACEOUS OF AUSTRALIA**

BERRELL, Rodney, School for Integrative Biology, The University of Queensland, Brisbane, Australia; ALVARADO-ORTEGA, Jesus, Instituto de Geología, Universidad Nacional Autónoma de México, Coyoacan, Mexico; YABUMOTO, Yoshitaka, Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan; SALISBURY, Steven, School for Integrative Biology, The University of Queensland, Brisbane, Australia

Ichthyodectiformes or 'bulldog fishes' constitute a nominal order of extinct, mackerel-like basal teleostean fishes. Their fossils are exclusively known from Middle Jurassic to Late Cretaceous deposits, many associated with the Tethys Sea. Most members of this group are marine, but some fossils are found in brackish or even freshwater deposits. In 2005, an ichthyodectiform fish was collected near the town of Isisford, central-western Queensland, Australia, in sediments of the mid-Cretaceous (late Albian-early Cenomanian) Winton Formation of the Rolling Downs Group. The discovery increases the diversity of the fossil vertebrate assemblage from the Winton Formation, which thus far has yielded body and trace fossils of various types of dinosaurs, and isolated tooth plates of various dipnoan species, including the ceratodont lungfishes *Ceratodus* sp., *Metaceratodus wollastoni*, and *Metaceratodus ellioti*. The new Isisford ichthyodectiform is from the same locality that produced the paratype skull of the basal eusuchian crocodyliform *Isisfordia duncani*. The partial, articulated skeleton displays diagnostic characters that support its inclusion in Ichthyodectiformes, and the suborder Ichthyodectoidei. This new fish shares many characteristics with the Brazilian ichthyodectiform, *Cladocyclus gardneri*, and is identified as *Cladocyclus* sp. based on the morphology of the cleithrum and composition of the articular facet of the lower jaw. This is the first time that a freshwater fish with unquestionable affinities to a taxon from another Gondwanan landmasses has been recognized in the Australian Cretaceous, supporting recent arguments for faunal interchange between eastern and western Gondwana during this time.

Technical Session XX, Saturday 3:15

**THE COMPARATIVE ANATOMY AND EVOLUTION OF THE TYMPANOPERIOTIC COMPLEX IN BALAENOPTEROID MYSTICETES: ADAPTATIONS FOR LOW FREQUENCY HEARING**

BERTA, Annalisa, San Diego State University, San Diego, CA, USA; RACICOT, Rachel, University of Texas, Austin, TX, USA; DEMÉRE, Tom, San Diego Natural History Museum, San Diego, CA, USA

We report preliminary results of a detailed study of the ear anatomy of 20 extant and better preserved fossil balaenopteroid mysticetes (11 extinct and 9 extant). New material in SDMNH collections includes: *Parietobalaena securis*, Round Mountain Silt, Sharktooth Hill (15 mya), basal balaenopteroid, Monterey Formation (11 mya), and "*Megaptera*" cf. "*M.*" *miocaena*, cf. *Parabalaenoptera*, *Balaenoptera* new sp. and eschrichtiid new genus,

San Diego Formation (3.5 mya). Eleven new characters are evaluated in addition to nine characters of the tympanoperiotic used in a recent analysis of molecular and morphologic data. Mesquite 2.0 was used to map ancestral state character reconstructions (parsimony and maximum likelihood) and explore different tree topologies ("cetotheres" and *Balaenoptera* new sp.). We also show that ontogenetic variation makes some characters previously employed unreliable (e.g. length of posterior process) or potentially problematic unless adults are evaluated (e.g. widely separate openings for the internal acoustic meatus and CN VII in neonates and juveniles become a single opening in adult individuals of all balaenopteroids). Mysticete ears are adapted for hearing low frequency sounds. Digital endocasts isolated from the inner ears of neonate and adult specimens allowed visualizations and accurate measurements of the bony labyrinths, laminar gap widths, and other features known to be associated with hearing frequency and vestibular function. *Balaenoptera acutorostrata* (minke whale) had relatively thin semicircular canals with high arcs (3-4 mm), unlike *Eschrichtius robustus* (gray whale) with thicker semicircular canals and lower arc heights (3-4 mm) more similar to those observed in odontocetes. Laminar gap measurements in the cochlea follow the same patterns seen in other mammals of increasing width from basal to apical ends. Data collected in this study confirm previous observations that mysticetes differ from odontocetes in having longer laminar gap widths and an increased number of cochlear turns. Bony characteristics associated with the evolution of low frequency hearing emerged at least 15 mya.

Technical Session XIX, Saturday 2:45

**NEONATE TROODONTID SKULLS FROM THE UPPER CRETACEOUS OF MONGOLIA WITH OBSERVATIONS ON THE CRANIAL ONTOGENY OF PARAVIAN THEROPODS**

BEVER, Gabe, American Museum of Natural History, New York, NY, USA; NORELL, Mark, American Museum of Natural History, New York, NY, USA

The remains of embryonic and juvenile vertebrates are emerging from the fossil record with increasing frequency. This trend is less obvious within paravian Theropoda, where the number of specimens representing early stages of skeletal ontogeny is extremely restricted. Establishing the nature and pattern of skeletal development, and the phylogenetic distribution of features defining it, is necessary to understand the characters through which we interpret the evolutionary history of this, or any, group. Our understanding of skeletal development and its phylogenetic pattern in extinct Paraves, a clade that includes the origin of birds, therefore remains limited. The skulls of two neonate paravians from Ukhaa Tolgod, Mongolia are nearly unique in their combination of ontogenetic age and preservational quality. These specimens provide us with the first look at the three-dimensional morphology of such important anatomical regions as the rostrum, palate, and braincase at or near the onset of postnatal development in a non-avian paravian coelurosaur. Based on a number of derived characters, the skulls are allocated to a derived position within Troodontidae. A single synapomorphy, presence of a lateral maxillary groove, supports the Ukhaa neonates as *Byronosaurus*. The comparative morphology of the Ukhaa neonates indicates a number of significant postnatal transformations (e.g., elongation and flattening of the rostrum, increase in the number of maxillary and dentary teeth, restructuring of the occipital plate and paroccipital process). These comparisons demonstrate that many characters historically considered important for phylogenetic and taxonomic assessments of adult maniraptorans are present at a relatively early stage of ontogeny. Differences in the developmental timing of various cranial characters, including the bony signatures of cranial pneumaticity, have important implications for interpreting the fossil record as well as for understanding the role heterochrony has played in the evolution of derived coelurosaurs.

Technical Session III, Wednesday 3:45

**A NEARLY COMPLETE MACROSTOMATAN SNAKE FROM THE EOCENE OF TEXAS**

BHULLAR, Bhart-Anjan, Harvard University, Cambridge, MA, USA; SCANFERLA, Agustin, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina; BEVER, Gabe, American Museum of Natural History, New York, NY, USA; SMITH, Krister, Museum und Forschungsinstitut Senckenberg, Frankfurt-am-Main, Germany

The Chadronian faunas of western Texas, collected largely in the middle of the last century by J.A. Wilson of UT Austin and his field crews, represent a unique slice of biotic time and space. Only the mammal faunas, which contain many unique and evolutionary significant taxa, have been carefully examined. We report the existence of a nearly complete snake skeleton from the West Texas Eocene. Articulated snake material including the cranium is extremely rare in the fossil record; the only other comparable specimens from North America are two incompletely described skeletons of an erycine-like taxon from the White River Oligocene and one flattened specimen, now lost, of the taxon *Boovus* from the Green River Eocene. The Texas macrostomatan lies in a natural position, its body loosely coiled. Nearly the entire postcranium is preserved, and the head is complete save for the anteriormost bones of the snout, the suspensorium, and the basioccipital, supraoccipital, and otooccipitals of the braincase. However, the indurated sandstone matrix is difficult to prepare without specimen damage, and we utilize CT scans for anatomical description. The Texas macrostomatan does not appear to show erycine affinities as suggested for the White River skeletons, nor tropidophiid affinities as suggested for various other Tertiary macrostomatans. Cranially, the abbreviated and expanded parietal, the narrow maxilla, and features of the sphenoid show synapomorphies with various groups of 'boid' snakes, but a

precise phylogenetic hypothesis is hindered by the lack of consensus regarding the topology of this part of the snake tree. The neural arches of the mid-trunk vertebrae are unusually tall compared to the centra, a feature shared with taxa assigned to *Boavus*. If the Texas macrostomatan is nested within a monophyletic *Boavus*, it would be the first well-preserved specimen of that taxon since the loss of the Green River specimen. Regardless, it represents an opportunity to apply fossil evidence to the problematic question of the phylogeny of small non-colubroid macrostomatan snakes.

Technical Session XIII, Friday 1:30

#### **A RIVER FAUNA FROM THE ARABIAN DESERT: LATE MIOCENE FOSSILS FROM THE UNITED ARAB EMIRATES**

BIBI, Faysal, Yale University, New Haven, CT, USA; HILL, Andrew, Yale University, New Haven, CT, USA; BEECH, Mark, Abu Dhabi Authority for Culture and Heritage, Abu Dhabi, United Arab Emirates; YASIN, Walid, Abu Dhabi Authority for Culture and Heritage, Abu Dhabi, United Arab Emirates

Renewed fieldwork efforts since 2003 have produced new fossil specimens from the Baynunah Formation, exposed in the Western Region of Abu Dhabi Emirate, United Arab Emirates. Previous work had established that the Baynunah fossils are between 8 to 6 Ma in age, comprising Asiatic, European, and African elements including bovids, hippopotamids, carnivores, proboscideans, equids, turtles, fish, and a cercopithecoid primate. Among these were described a new genus and species of gerbil, *Abudhabia baynunensis*, and a new species of equid, *Hipparion abudhabiense*, the latter of which may also be present among the Chad late Miocene hominid fauna. Some of the more significant recent discoveries from the Baynunah Formation include additional and abundant remains of fossil proboscideans such as the primitive elephantid *Stegotabelodon syrticus*, a partial skeleton of the giraffid *Palaeotragus germaini*, a giant synsacrum belonging to a previously undescribed ratite, and large exposures of mud-cracked carbonate beds preserving footprints of proboscideans. Additionally, the Baynunah Formation is rich in fossil eggshell of the ratite *Diamantornis laini*, which, by way of correlation to the Nawata Formation at Lothagam, Kenya, suggests the age of the Baynunah fauna may be no younger than 6.5Ma. Renewed work on the Baynunah Formation, including paleomagnetostratigraphic and palynological analyses, is expected to provide increased chronostratigraphic resolution while continuing to expand the faunal list.

Technical Session XI, Friday 9:00

#### **ACEROSODONTOSAURUS AND THE MONOPHYLY OF YOUNGINIFORM REPTILES**

BICKELMANN, Constanze, Museum für Naturkunde, Humboldt-Universität zu Berlin, Berlin, Germany; MÜLLER, Johannes, Museum für Naturkunde, Humboldt-Universität zu Berlin, Berlin, Germany; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada

Phylogenetic relationships of Carboniferous and Permian basal diapsid reptiles are still poorly known. In particular, many hypotheses on the monophyly of certain taxa are based on claims that precede modern phylogenetic methodology. This applies to the so-called younginiform reptiles, whose suggested monophyly has never been tested. In the present study, the enigmatic aquatic reptile *Acerosodontosaurus piveteaui* from the Upper Permian of Madagascar was reexamined in the light of our increased understanding of diapsid phylogeny. The reinvestigation revealed that several anatomical features were previously misinterpreted: for example, what was originally described as the quadratojugal is in fact the epipterygoid, and also the articulation between squamosal and quadrate is different than previously described, which has significant implications for a proper understanding of the temporal region of this taxon. In order to investigate if younginiform reptiles, which include both marine and terrestrial taxa, indeed form a monophyletic group, a phylogenetic analysis based on a morphological character matrix including 184 characters was conducted. The results show that *Acerosodontosaurus*, *Tangasaurus*, *Hovasaurus*, *Kenyasaurus*, and *Youngina* form a clade, and fall as the sister taxon of the contemporaneous *Claudiosaurus* and the more derived diapsids. Within the clade, *Youngina* is sister to the node consisting of *Acerosodontosaurus*, *Tangasaurus*, *Hovasaurus*, and *Kenyasaurus*. Our results therefore provide the first phylogenetic evidence for monophyly of Younginiformes, and also indicate that an aquatic lifestyle evolved several times among Permian diapsids.

Technical Session V, Wednesday 3:15

#### **AGE DISTRIBUTION AND SEXUAL DIMORPHISM IN *PANTHERA ATROX* AND *SMILODON FATALIS* FROM RANCHO LA BREA**

BINDER, Wendy, Loyola Marymount University, Los Angeles, CA, USA; MEACHEN, Julie, University of California, Los Angeles, Los Angeles, CA, USA

The Rancho La Brea tar seeps are well known for their unusual preservation of more carnivores than herbivores. The tar seeps may have attracted a random distribution of carnivores, or a more limited segment of the population, such as the old or young, or even a biased sex ratio. Here, we use a radiographic technique to assess the age distribution in combination with a statistical analysis of linear measurements of the mandible to determine the sex of American lions (*Panthera atrox*) and sabertoothed cats (*Smilodon fatalis*) preserved at Rancho La Brea. *P. atrox* and *S. fatalis* are related to the African lion, *Panthera*

*leo*, but cranial and dental features that traditionally have been used to age them may have different growth and wear rates. Previous studies used tooth wear to age individuals, but this can be confounded by diet. More recently, carnivores have been aged using the pulp cavity width of the canine from radiographs. Dental pulp cavity closure may be a more reliable method of aging and is unlikely to be affected by functional differences. The diameter of the pulp cavity shrinks as dentine is laid down, thus a smaller pulp cavity correlates with increased age. Radiographs of dentaries were taken and the lower canine pulp cavity diameter measured. Here, we compare the relative age of individual *P. atrox* and *S. fatalis* at Rancho La Brea with a sample of African lion mandibles from museum collections. Given the relative age, mandibular length allows for a more accurate morphological comparison by which to determine sex in animals that tend to show sexual dimorphism, such as the large cats. By combining age, linear morphological measures and using the known sex of a sample of African lions for comparison, we are likely to have increased accuracy in assigning the sex of individuals, and thus determining sex distributions of the sample. We found different degrees of sexual dimorphism in *S. fatalis* and the other species, and differing age distributions as well. *P. atrox* and *P. leo* had more similar patterns of sexual dimorphism and age distributions, which may reflect their close relatedness to one another.

Technical Session I, Wednesday 11:00

#### **VERTEBRATE FAUNAS FROM THE PALEOCENE BOGOTA FORMATION OF NORTHERN COLOMBIA**

BLOCH, Jonathan, University of Florida, Florida Museum of Natural History, Gainesville, FL, USA; CADENA, Edwin, University of Florida, Florida Museum of Natural History, Gainesville, FL, USA; HASTINGS, Alexander, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; RINCON, Aldo, Smithsonian Tropical Research Institute, Panama City, Panama; JARAMILLO, Carlos, Smithsonian Tropical Research Institute, Panama City, Panama

The terrestrial Paleocene of South America is poorly sampled, especially from the northern tropics. Carlos Villarroel described a new primitive xenungulate *Etayoa bacatensis* based on a single left dentary from the Bogotá Formation outcropping along Mochuelo Creek in the southern part of Bogotá City. Studies of preserved pollen indicate a middle-late Paleocene age (58-60 Ma), similar to that of the fossiliferous Cerrejón Formation from the Guajira Peninsula. Several recent expeditions jointly led by the Florida Museum of Natural History and the Smithsonian Tropical Research Institute to Mochuelo Creek and other newly discovered vertebrate-bearing localities south of Bogotá, near the town of Nemocón, have resulted in recovery of many additional vertebrate fossils including reptiles, amphibians, and mammals. The Bogotá Formation consists of fluvial sandstones and mudstones with well-developed paleosols, and vertebrate fossils concentrated in conglomeratic channel-lags. In contrast, the coeval Cerrejón Formation was likely deposited in lowland tidal-flat plains incised by large-scale river systems with vertebrate fossils concentrated in the clay-stone underlying major economic coal seams. Faunas from both formations include a diversity of pleurodire turtles, dyrosaurid mesoeucrocodylians, boid snakes, and dipnoan fishes. However, in each case they are notably larger in the more transitional Cerrejón Formation. The Bogotá faunas have a number of groups not present in those of the Cerrejón including frogs, lizards, sebecid crocodylians, and mammals, indicating a more terrestrial environment consistent with the depositional setting. Mammals are potentially important for correlation to other terrestrial fossil-bearing localities from the Paleocene of South America. Mammal specimens recovered to date include a dentary with 3 teeth of a new very small xenungulate likely related to *Etayoa* from Mochuelo Creek. Additionally, multiple specimens of at least two new marsupials have also been recovered. While identifiable mammals from the Bogotá Formation are rare (n= 11), they indicate a potential for higher diversity with increased sampling.

Technical Session II, Wednesday 11:15

#### **SMALL MAMMAL RESPONSE TO THE PLEISTOCENE-HOLOCENE TRANSITION IN NORTHERN CALIFORNIA**

BLOIS, Jessica, Stanford University, Stanford, CA, USA; HADLY, Elizabeth, Stanford University, Stanford, CA, USA; MCGUIRE, Jenny, UC Berkeley, Berkeley, CA, USA; BARNOSKY, Anthony, UC Berkeley, Berkeley, CA, USA

Understanding how species and communities have responded and will continue to respond to environmental change is a primary goal of both paleoecology and modern ecology. The transition from the Last Glacial Maximum to the Holocene provides a good model for understanding biological response to climatic warming and other types of environmental change. We excavated and dated a new fossil deposit from Samwel Cave in the Shasta-Trinity National Forest in northern California. The deposit, a woodrat midden and sometime carnivore den, contained thousands of bones, primarily from small mammals. Ten AMS-radiocarbon dates show that the deposit can be provisionally divided into three sections spanning the last 21,000 years: late Pleistocene (>10300 <sup>14</sup>C years before present [ybp]), early-mid Holocene (10300-4500 <sup>14</sup>C ybp), and mid-late Holocene (4500-0 <sup>14</sup>C ybp). Together with two previous excavations in the region, these deposits provide a rich glimpse into the faunal dynamics since the late Pleistocene. Our preliminary results indicate the small mammal community experienced significant changes in relative abundance through time, particularly across the Pleistocene to Holocene transition and throughout the early Holocene. Pocket gophers (*Thomomys*), for example, recorded a replacement event near the Pleistocene-Holocene boundary, with the subgenus *Thomomys* giving way to the subgenus *Megascapheus*. This

replacement corresponds with other changes in the small mammal fauna, including an increase in species characteristic of more open landscapes, such as *Peromyscus* and *Spermophilus*. Significantly, the mountain beaver (*Aplodontia rufa*) dropped out of the record in the late Pleistocene/early Holocene, suggesting enhanced warming and drying conditions in the region. We discuss the small mammal community with respect to climatic records and megafaunal extinctions in the region and its implications for future environmental change.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny,  
Wednesday 9:30

#### **ANASPID MORPHOLOGY AND THE SHAPING OF THE GNATHOSTOME BODY PLAN**

BLOM, Henning, Subdepartment of Evolutionary Organismal Biology, Department of Physiology and Developmental Biology, Uppsala University, Uppsala, Sweden

Our understanding of the origin and early evolution of jawed vertebrates relies heavily on data from various fossil groups on the gnathostome stem. Among them stand the anaspids, a heterogeneous group that superficially resemble extant lamprey, to which they often have been associated. However, anaspids also possess characteristics such as paired fins and bone that today only occur in gnathostomes. These are characters which have supported a consensus that anaspids, together with other "ostracoderms" such as heterostracans and osteostracans, are closer to gnathostomes than to either lampreys or hagfishes, and are therefore members of the gnathostome stem group. Although rare, anaspids have been of particular interest partly because their suggested sister group relationship to lampreys. This was based on the overall body shape, organization of the gill openings and an inferred dorsal nasohypophysial opening. More importantly, anaspids have been frequently discussed in the context of the origin of paired fins, since their elongated paired fins, inferred from some specimens, have featured in discussions around the lateral fin-fold theory. Recent discoveries of new material of anaspids and their relatives have revealed new anatomical information on, for example, the branchial apparatus, endoskeletal mineralization and the nature of paired fins. This stresses the importance of exploring and revising anaspid morphology and its relevance to understanding the origin of the gnathostome body plan.

Poster Session III (Friday)

#### **SALAMANDERS OF THE MIO-PLIOCENE GRAY FOSSIL SITE**

BOARDMAN, Grant, Department of Biological Sciences and the Don Sundquist Center of Excellence in Paleontology, East Tennessee State University, Johnson City, TN, USA; SCHUBERT, Blaine, Department of Geosciences and the Don Sundquist Center of Excellence in Paleontology, East Tennessee State University, Johnson City, TN, USA; MEAD, Jim, Department of Geosciences and the Don Sundquist Center of Excellence in Paleontology, East Tennessee State University, Johnson City, TN, USA

Previous studies of fossil salamander vertebrae from the Gray Fossil Site (GFS), northeastern Tennessee, have identified two groups to the family level: Plethodontidae and Ambystomatidae. Here we further characterize specimens from these groups and identify one additional family, Salamandridae. The represented ambystomatids (genus *Ambystoma*) are here assigned as medium-sized terrestrial adults based on vertebral characters and degree of ossification. The plethodontid specimens were not previously identified below the family level due to concerns with overlapping characters in the literature and a lack of modern specimens for comparison. More detailed analysis of the GFS plethodontids has now taken place and at least three forms are recognized; with the most distinct being an opisthocleous desmognathine. The represented salamandrid is referred to genus level (*Notophthalmus* sp.) based on the presence of alar processes and the relative position of the parapophyses to diapophyses. While we are still in the early stages of work at the GFS, the site clearly represents a unique opportunity to better understand Mio-Pliocene (Hemphillian) salamander paleoecology and evolution in the southern Appalachians.

Technical Session XX, Saturday 2:00

#### **NEW MATERIAL OF THE BIZARRE WHALE *HERPETOCETUS BRAMBLEI* FROM THE LATEST MIOCENE PURISIMA FORMATION OF CENTRAL CALIFORNIA**

BOESSENECKER, Robert, Montana State University, Bozeman, MT, USA; GEISLER, Jonathan, Georgia Southern University, Statesboro, GA, USA

Fossils of the bizarre baleen whale *Herpetocetus* are known from Mio-Pliocene rocks at temperate latitudes throughout the Northern Hemisphere. Most crania of *Herpetocetus* are either very partial or fragmentary in nature; however, we describe a recently collected and nearly complete cranium of *Herpetocetus bramblei* from the latest Miocene Purisima Formation of central California. This new specimen includes petrosals, tympanic, and all middle ear ossicles, and additional petrosals, tympanics, and dentaries from the Purisima Formation are also referable to *H. bramblei*. *Herpetocetus* exhibits a combination of primitive and highly derived features and does not bear particular resemblance to any of the extant mysticete species. Primitive features of *H. bramblei* include a narrow rostrum, anteriorly directed zygomatic processes, an acutely triangular supraorbital shield, and a long postorbital process. In contrast, *H. bramblei* exhibits highly derived features such as a highly telescoped cranium, maxillae meet posterior to the nasals, enlarged maxillary foramina reminiscent of but not homologous to those in odontocetes, distinct fossa on the lateral side of petrosal, an enlarged and club-like posterior process of petrosal, and

a wide, elongate angular process of the dentary. Previous phylogenetic analyses have placed *Herpetocetus* with *Piscobalaena*, *Cetotherium*, *Mixocetus*, and *Metopocetus* in a monophyletic Cetotheriidae *sensu stricto*. However, some of these analyses differ in having cetotheriids inside or outside the mysticete crown group. Incorporation of morphological data from the new skull of *Herpetocetus bramblei* into published data sets will allow the placement of this family among mysticetes and the placement of *Herpetocetus* within it to be tested. In addition, incorporation of multiple species of *Herpetocetus* into phylogenetic analyses will likely resolve relationships among species within this genus and reveal biogeographic or temporal patterns in their distribution.

Poster Session III (Friday)

**DINOSAUR EGGS FROM THE OYU TOLGOI COPPER MINE, MONGOLIA**  
BOLORTSETSEG, Minjin, Museum of the Rockies, Bozeman, MT, USA; JACKSON, Frankie, Montana State University, Bozeman, MT, USA; CHULUUN, Minjin, Mongolian University of Science and Technology, Ulaanbaatar, Mongolia

Twenty-three, 11 cm-diameter, dinosaur eggs were discovered in 2005 at the Oyu Tolgoi copper mine in the southern Gobi Desert of Mongolia. The orientations and numbers of eggs in each clutch are unknown because the eggs were recovered from the mine tailings of the Upper Cretaceous Baruun-Goyot Formation. Eggshell removed from two of the eggs is abnormal (Eggshells ES 1 and ES 3) and eggshell from the third is normal. Normal eggshell morphology displays a single layer of calcite that was originally 2 mm thick, but in places diagenetic dissolution has reduced it to 1.0 mm in thickness. The single layer of calcite consists of radiating spherulites that emanate from closely spaced nucleation centers to form narrow shell units. These units exhibit sweeping extinction under crossed nicols; pores are straight and narrow. Although these eggs are tentatively assigned to the oogenus *Shixingoolithus*, one egg displays rows of widely spaced, 0.4–0.9 mm-wide surficial nodes, a feature previously unreported in this oospecies. Abnormal eggs consist of two superimposed eggshell layers. The inner and outer layers of the abnormal eggs are about 1.5 and 0.3 mm. Additional abnormal nuclei are abundant and clustered or randomly distributed throughout ES 3, but are rare in ES 1. In eggs of extant taxa, abnormal eggshell morphology is caused by egg retention, which is a response to physiological stress. Similar eggshell abnormalities are relatively common in the oogenus *Megaloolithus* but have been only occasionally reported in other oospecies. This abstract is the first report of *Shixingoolithus* from Baruun-Goyot Formation.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny,  
Wednesday 12:15

#### **PALATE AND BRAINCASE OF THE MISSISSIPPIAN STEM-TETRAPOD *WHATCHEERIA DELTAE***

BOLT, John, Field Museum, Chicago, IL, USA; LOMBARD, Eric, University of Chicago, Chicago, IL, USA

Availability of numerous specimens permits reasonably complete reconstruction of palate and braincase of *Whatcheeria* despite preservation problems. The palate is primitive, with small interpterygoid vacuities and fangs and tooth rows on all paired lateral palatal bones. The anteroposteriorly elongate choanae are bounded by the maxilla laterally and vomer medially, with the premaxilla and palatine forming only minor contributions anteriorly and posteriorly respectively. The premaxilla has an extensive palatal shelf, with very shallow depressions that may/may not represent anterior palatal vacuities; there is no anterior palatal fenestra. The pterygoid has a bifaceted basal joint surface as well as a "tympanic excavation." These are likely borne by the epipterygoid, the position of whose junction with the pterygoid is uncertain in all specimens. The pterygoid quadrate ramus is a ribbon-like strip of bone. In one large specimen the entire epipterygoid is ossified at least from the basal joint posteriorly, and forms most of the medial wall of the adductor fossa. In the braincase, the sphenethmoid is unossified within the available specimen-size range. The short parasphenoidal base is shaped like an inverted Y, with the junction of the arms likely marking the position of a remnant of the ventral cranial fissure. The basisphenoid shows a prominent dorsum sellae and a "crista sellaris" which preserves well-developed, paired fossae on its anterior surface. These are usually interpreted as insertion areas for extrinsic eye muscles, although they show no obvious muscle scars. Neither the basisphenoid nor parasphenoid indicates an attachment site for ventral cranial muscles. The otic capsules appear to be ossified dorsally only, and a joint between prootic and opisthotic cannot be determined. The basioccipital is present in only two specimens, indicating a weak integration with other elements of the braincase. The occipital condyle is apparently unossified. Despite a considerable increase in our knowledge of the *Whatcheeria* palate, there are no derived features that strongly indicate a relationship to any of the recognized early-tetrapod groups.

Poster Session I (Wednesday)

#### **GIMME SHELTER?: LOCOMOTOR TRENDS AND MAMMALIAN SURVIVORSHIP AT THE K-PG BOUNDARY**

BORTHS, Matthew, The Ohio State University, Columbus, OH, USA; HUNTER, John, The Ohio State University, Columbus, OH, USA

Sixty-five million years ago a bolide approximately 10 km in diameter collided with the Earth triggering the Cretaceous-Paleogene (K-Pg) extinction. Robertson et al. proposed immediate extinction was driven by infrared radiation (IR) from falling impact ejecta. They suggested terrestrial survivors of the impact event buffered the resulting 10 kW-m<sup>-2</sup> power



flux by sheltering below ground or underwater, insulating from the radiation. The Sheltering Hypothesis suggests the survivors of the impact event were morphologically equipped for fossorial or semi-aquatic locomotion. To test the hypothesis we utilized the mammalian fossil record at the K-Pg. Other groups exhibit differential survival patterns, but poor sampling and conservative morphologies make it difficult to test the scenario. No previous examination of differential survival has utilized the K-Pg post-cranial record. One of the most reliable indicators of fossorial behavior is the relative length of the olecranon process of the ulna. We demonstrate extant mammals can be grouped into locomotor guilds based on this ulnar feature using linear measurements and linear regression. However, complete fossil ulnae are not readily preserved, so a novel proxy based on the length of the semi-lunar notch is described. This proxy is based on correlations to ulnar length. This proxy allows the examination of mammalian ecomorphology in fragmentary samples. Using UCMP and PTRM fossil specimens we compare the locomotor diversity of mammals before and after the impact event. Preliminary results refute the Robertson hypothesis. Mammalian survivorship was more closely related to body size than locomotor guild. Derived adaptations for fossorial or semi-aquatic locomotion are apparent before the boundary including the likely swimmer *Didelphodon vorax* but the survivors are locomotor generalists. Ongoing research is incorporating other post-cranial structures and material into the sample in order to corroborate this conclusion and the rejection of the Sheltering Hypothesis.

Poster Session I (Wednesday)

**A NEW KINOSTERNOID (TESTUDINES: DERMATEMYDIDAE) FROM THE PALEOCENE-EOCENE BOUNDARY OF THE BIGHORN BASIN, WYOMING, AND ITS PALEOCLIMATOLOGICAL IMPLICATIONS**

BOURQUE, Jason, University of Florida, Florida Museum of Natural History, Gainesville, FL, USA; HUTCHISON, J, University of California Museum of Paleontology, Berkeley, CA, USA; HOLROYD, Patricia, University of California Museum of Paleontology, Berkeley, CA, USA; BLOCH, Jonathan, University of Florida, Florida Museum of Natural History, Gainesville, FL, USA

Turtles of the family Dermatemydidae are endemic to North and Central America with a fossil record that extends into the Tiffanian NALMA (~57 Ma). The genus *Baptemys* was first known to occur from the late Wasatchian (~54.1 Ma) exemplified by the taxon *Baptemys garmanii*. Recent fieldwork in the southern Bighorn Basin, Wyoming, has led to the discovery of a new species of *Baptemys* from the earliest Wasatchian (zone Wa-0; ~55.7 Ma). It is represented by a nearly complete adult carapace and plastron as well as isolated peripherals from at least three other individuals. Scant material from the latest Paleocene (Clarkforkian; Cf-3) of the southern Bighorn Basin may also represent the new taxon. *Baptemys* sp. nov. differs from congeners most notably in attaining a smaller adult body-size; being relatively thick-shelled; having more reduced plastral lobes; a reduced entoplastron with the gular-humeral sulcus positioned along and just posterior to the ento-hyoplastral suture; a smooth carapace with three pronounced lateral keels that run the length of the shell with the medial keel not extending to the pygal; relatively straight, thick, and shortened peripherals; and a trench-like pelvic concavity on the xiphiplastron just posterior to the hypo/xiphiplastral suture in visceral aspect. Based on morphology, the new species is the most basal member of the genus and placed phylogenetically between the kinosternoid *Hoplochelys* and dermatemydid *Baptemys garmanii*. Morphological characters suggest adaptations for bottom-walking foraging behavior similar to the Central American kinosternid *Staurotypus*. The new species is significant in that it is the oldest known occurrence of *Baptemys* by at least 1.6 million years as well as the only known dermatemydid from the Paleocene-Eocene boundary. The presence of a dermatemydid (a tropically distributed clade) during the Paleocene-Eocene Thermal Maximum (PETM) provides further support that this interval experienced a rapid warming event with associated geographic range changes in both plants and animals.

Technical Session XIV, Friday 1:30

**HISTOLOGY, HOMOLOGY, AND FUNCTION OF INTERCOSTAL PLATES ON ORNITHISCHIAN DINOSAURS**

BOYD, Clint, North Carolina State University, Raleigh, NC, USA; CLELAND, Timothy, North Carolina State University, Raleigh, NC, USA; NOVAS, Fernando, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina

Homology and function of accessory ossifications in dinosaurian taxa remains a subject of significant debate. Intercostal plates, known from six ornithischian taxa, are overlapping ossifications on the lateral side of the rib cage in close proximity, but unattached to the posterior margin of the dorsal ribs. Previous authors proposed these plates may be modified dermal armor or functional analogs to uncinat processes of extant maniraptorans, hypothesized to facilitate breathing. Plates from two specimens of the basal neornithischian *Thescelosaurus* and a specimen of the basal iguanodontian *Talenkauen* were histologically sampled to investigate their development, structure, and possible function. In *Thescelosaurus*, a continuous layer of calcified cartilage forms the outer edges of each plate, surrounding an inner layer of lamellar bone. In *Talenkauen*, the plates are composed entirely of lamellar bone. These differences may indicate that distinct developmental pathways evolved in these species, or, as we hypothesize, the plates from *Talenkauen* may represent the developmentally mature condition. The presence of calcified cartilage in the plates from *Thescelosaurus* indicates that intercostal plates formed via an endochondral pathway, refuting previous claims that these plates represent modified dermal armor, as the latter ossify via an intermembranous pathway. These plates appear to have ossified relatively late in ontogeny, as they are absent from articulated specimens of smaller, immature individuals. Dense packets of obliquely oriented Sharpey's fibers present on the lateral margin of the plates in *Talenkauen* signify they served as a site of origin and/or insertion for muscles and

were not passively embedded in the surrounding tissue. The parallel distribution of intercostal plates and ossified sternal ribs within Ornithischia suggests they may have worked together to stiffen the thoracic region in these taxa. Based on their phylogenetic distribution, these structures are not homologous with uncinat processes of other diapsids (e.g., maniraptorans), but it is uncertain if ossification of these plates has a single or multiple origins within Ornithischia.

Technical Session XII, Friday 10:45

**A COMPARISON OF PLESIADAPIS COOKEI TO P. TRICUSPIDENS (MAMMALIA, PLESIADAPIFORMES): EVIDENCE FOR ECOLOGICAL DIFFERENCES**

BOYER, Doug, Stony Brook University Medical Center, Stony Brook, NY, USA

Paleogene Plesiadapidae is a diverse family of stem-primates known from North America and Europe. In the late Paleocene several large (~2-3 kg) species evolved on both continents. Among these larger taxa, a comparison of three dimensional digital images of lower second molar crowns, generated from microCT data, reveals that those of *Plesiadapis cookei* from North America have significantly greater relief than European *P. tricuspidens*, suggesting greater folivory in the former. It has been suggested that *P. cookei* was larger than *P. tricuspidens* because samples of molar teeth of the former are 15-30% larger than those of the latter. Paradoxically, the skull associated with a skeleton of *P. cookei* (UM 87990) is apparently about 20% shorter than two well-preserved skulls of *P. tricuspidens*, even though the teeth are larger in the former specimen. However, all specimens exhibit substantial brittle deformation, and thirty-seven caliper measurements on cranial bones reveal that the skull of UM 87990 was probably about the same size as the *P. tricuspidens* specimens during life. Additionally, some measurements of postcrania (e.g., femoral diameter and humeral distal end width) are of similar size. These data suggest that the two species were of similar body mass despite differences in molar size. In fact, this result is predicted from the observation that among modern primate species of similar body mass, more folivorous ones tend to have larger teeth. Further differences between the two taxa include greater long bone lengths in *P. cookei* and greater humerus diameters in *P. tricuspidens*. It has been proposed that *P. cookei* was a sloth-like suspensory mammal. In this context, the more robust and absolutely shorter limbs (especially forelimbs) in *P. tricuspidens* suggest that it was a more generalized arboreal quadruped. *P. cookei* was apparently more specialized in both its dietary and locomotor habits. Ecological differences between these species may correspond to inferred community and environmental differences between late Paleocene North American and European localities, and/or environmental changes through the late Paleocene.

Technical Session XVII, Saturday 12:00

**THE USE OF CRANIAL TRAITS DISTINGUISHING FEMALE HORNED ANTELOPE FROM MALE CONSPECIFICS**

BRAKORA, Katherine, UC Berkeley, Berkeley, CA, USA

Identification of the sexes is a critical step towards understanding the basic biology of the taxon under study. Morphological similarity can hamper our ability to distinguish between the sexes of a species and prevent us from understanding many aspects of their biology and natural history. Even more critical are concerns that the sexes may be mistaken for different taxa, which confounds the reconstruction of phylogenies and identification of evolutionary patterns. Among antelopes, correlations in size, morphology, sexual dimorphism and ecology, coupled with rapid divergences in the mid-Miocene, have made it challenging to identify basal relationships and test hypotheses about their evolution. Patterns of differences between the sexes in species with horned females, and patterns of sexual differences above the species level, have not been systematically reported in antelopes. Having a reliable set of heuristics for distinguishing between males and females among fossil taxa, as well as unidentified extant specimens, would be useful for descriptive, experimental, and evolutionary studies in this clade. I measured skulls of adult male and females for fifteen antelope species, sampling all the major extant clades with horned females, including tragelaphins, hippotragins, acelaphins, cephalophins, and gazelle-like antelopes (and excluding cattle, sheep and goats). Measurements applicable to fragmentary specimens were emphasized, including horncores, horn bases, frontlets, maxillary and mandibular toothrows and upper first molars. The sexes of most species can be separated on the basis of 1-3 traits, although there was no single best indicator for all taxa. Posterior head width, breadth between the horn bases, horn/horncore circumference, and horn length are the measurements that differ most frequently and most significantly between the sexes. Considerable variation between subspecies and relatively similar species was found, despite broadly similar ecologies and morphologies.

Poster Session IV (Saturday)

**CRANIAL VARIATION IN THE LATE JURASSIC THEROPOD DINOSAUR ALLOSAURUS**

BRANDAU, Deanna, Utah Museum of Natural History, Salt Lake City, UT, USA; LOEWEN, Mark, Utah Museum of Natural History, Salt Lake City, UT, USA; FARKE, Andrew, Raymond M. Alf Museum of Paleontology, Claremont, CA, USA; BAZIAK, Brian, Museum of the Rockies, Bozeman, MT, USA

Assessing variation in the craniofacial skeleton of theropod dinosaurs has been limited by a paucity of taxa known from reasonably large sample sizes. A key exception is the Late Jurassic *Allosaurus*, known from the Morrison Formation of North America. In addition to multiple associated and articulated specimens recovered as isolated finds, this genus is known

from large samples of elements recovered from two bonebeds: the Dry Mesa Quarry and the Cleveland-Lloyd Dinosaur Quarry. Each of these quarries preserves multiple size classes of a distinct species of *Allosaurus*—*A. n. sp.* and *A. fragilis*, respectively. Several elements were selected for a study focusing on intraspecific variation within the skull of *Allosaurus*, focusing in particular on ontogenetic changes. The study sample was subjected to quantitative analysis, with multiple parameters measured for each element. These measurements formed the basis of bivariate comparisons, principle component analysis, and shape analyses, which were used to provide a picture of growth changes in these elements. Ultimately, these results, together with observations of additional skull elements, were used to reconstruct overall skull morphology at different size and relative age classes for both *A. n. sp.* and *A. fragilis*. Ontogenetic changes in all of the elements suggest that skull height experienced significant positive allometry, increasing more rapidly than skull length in both *Allosaurus* species. The caudal portion of the skull in *A. fragilis* exhibits positive allometry, increasing in breadth much more than the rostral portion, which actually narrowed in breadth. These modifications, and others such as proportional changes in the orbit and lateral temporal fenestra, suggest relative strengthening of the skull during ontogeny. Many of the changes exhibited by *A. fragilis* are not reflected in *A. n. sp.*, further illustrating the utility of taxonomic characters related to these changes. Significant changes in the height and breadth of the skull, as well as an overall increase in robustness, are thought to be associated with increased stresses and loading associated with adult predation and feeding.

Romer Prize Session, Thursday 9:30

**EARLY JAW AND BRAINCASE MORPHOLOGIES WITH UNORTHODOX IMPLICATIONS FOR BASAL GNATHOSTOME INTERRELATIONSHIPS**  
BRAZEAU, Martin, Uppsala University, Uppsala, Sweden

New morphological data from a variety of Paleozoic gnathostomes have provided unexpected challenges to classical views on the early evolution of this group. One of these challenges has been the complex picture of neurocranial evolution emerging from discoveries of basal chondrichthyans and osteichthyans. For example, the discovery of a basal articulation and ventral cranial fissure in a Paleozoic chondrichthyan has forced a re-evaluation of characters that unite each of the Chondrichthyes, Osteichthyes, and Crown-Gnathostomata respectively. Homologizing the key morphological landmarks that are the neurocranial jaw articulations of basal gnathostomes is a problem of comparative morphology that extends even to modern lineages. Recent evidence suggests that the orbital articulation of some Paleozoic chondrichthyans may correspond to the basiptyergoid articulation of other gnathostomes. I present the only known neurocranium of a Devonian acanthodian, *Ptomacanthus anglicus*, along with a re-description of its articulated jaws. The specimen bears a palatoquadrate-braincase articulation that is intermediate between the conditions seen in chondrichthyans and osteichthyans and supports the view that the basiptyergoid and orbital articulations are indeed homologous. Furthermore, the neurocranium of *Ptomacanthus* is radically unlike that of the Permian and only other known acanthodian braincase, *Acanthodes*. It compares more closely with chondrichthyans but also lacks some derived features of the gnathostome crown group, suggesting acanthodian paraphyly. The comparative morphology of early gnathostome braincases is reviewed in light of this, leading to novel interpretations of other taxa. These new data and interpretations are incorporated into a phylogenetic analysis testing generic-level gnathostome interrelationships. The results call into question the assumption made by many previous works on early gnathostomes that have presupposed the monophyly of classical taxonomic categories. It also carries with it implications for the comparative morphology of modern gnathostome braincases.

Poster Session III (Friday)

**REVISED SPECIES STATUS OF THE EXTINCT HELLBENDER, CRYPTOBRANCHUS GUILDAYI**

BREDEHOEFT, Keila, East Tennessee State University, Johnson City, TN, USA;  
SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, USA

*Cryptobranchus guildayi* is a large cryptobranchid salamander known from two Pleistocene cave deposits; Cumberland Cave, Maryland and New Trout Cave, West Virginia. Of the diagnostic differences cited between *C. guildayi* and the modern *C. alleganiensis*, only one, an articular process on the epiphyal, exists as a discrete character state. The others form a suite of characteristics that vary by differences of degrees. Since a limited number of modern comparative specimens (no more than four) were used in naming *C. guildayi*, we posit that the intraspecific variation of the modern hellbender was underestimated, and indeed have found that each of the characters diagnostic to *C. guildayi* may be observed in modern *C. alleganiensis* specimens. Furthermore, the skeletal element identified as an epiphyal was misdiagnosed. This element is not part of the hyoid apparatus at all, but a sacral rib, and the articular process supposedly unique to *C. guildayi* is also found on the sacral ribs of *C. alleganiensis*. For these reasons, we consider the Pleistocene salamander *C. guildayi* conspecific with the modern hellbender, *C. alleganiensis*.

Poster Session I (Wednesday)

**CHARLES WHITNEY GILMORE AND HIS EARLY PALEONTOLOGICAL EXPERIENCES IN WYOMING**

BREITHAUPT, Brent, Geological Museum, Laramie, WY, USA; SOUTHWELL, Elizabeth, Geological Museum, Laramie, WY, USA; MATTHEWS, Neffra, Geological Museum, Laramie, WY, USA

Charles Whitney Gilmore was born on March 11, 1874 in Pavilion, New York. At age 6, his interests in paleontology and museology were entrenched after a visit to Ward's Natural Science Establishment in Rochester. Shortly after this trip, collections of fossil shells, rocks, bird's eggs and insects appeared in the Gilmore household, along with various attempts at taxidermy on Charles's stuffed animals. Gilmore's fondness of outdoor activities, enthusiasm for natural science, adventurous spirit, thirst for knowledge, and lust for independence spurred him to the Rocky Mountain West. A visit to the frontier town of Laramie in April of 1896 led him to enroll at the University of Wyoming. During this spring visit, he traveled onto the windswept prairie of the Laramie Plains with versatile Wyoming geologist Wilbur C. Knight. Gilmore was shown an impressive array of immense fossil reptile bones in the ground and determined that these were the kinds of specimens that he would like to study. Soon after beginning his studies, he accepted the position as Student Assistant for Knight and devoted much of his time to the collection and preparation of fossils. While at the University of Wyoming, he resolved to make the study and collection of vertebrate fossils (especially dinosaurs) his life's work. Under the tutelage of Knight and his premier assistant William H. Reed, Gilmore helped amass one of the best collections of American Jurassic vertebrate fossils in the world. Knight and Reed strove to use the abundant paleontological resources of southeastern Wyoming to establish a museum of world renown. Between 1896 and 1899 almost 10,000 specimens, including over 70 tons of Jurassic plant (e.g., cycads) and giant reptile (e.g., dinosaurs, ichthyosaurs, plesiosaurs) fossils were collected. Gilmore received his Bachelor of Science degree from the University of Wyoming in 1901. Later that same year, his experiences in the West garnered him the appointment of Collector of Vertebrate Fossils at the Carnegie Museum in Pittsburgh. In 1903 he began a long and faithful career at the U.S. National Museum in Washington, D.C. He remained at the National Museum until his death in 1945.

Poster Session III (Friday)

**NEW SUBADULT HYPACROSAURUS STEBINGERI SKULLS AND A COMPARATIVE ANALYSIS OF ALLOMETRIC CREST GROWTH IN LAMBEOSAURINES**

BRINK, Kirstin, University of Calgary, Calgary, AB, Canada; ZELENITSKY, Darla, University of Calgary, Calgary, AB, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; HORNER, John, Montana State University, Bozeman, MT, USA

The lambeosaurine *Hypacrosaurus stebingeri* (Ornithischia: Hadrosauridae) is represented by a remarkable growth series that includes complete, articulated skulls from embryonic to adult stages. Here we describe several skulls of a previously unknown sub-adult growth stage for *H. stebingeri* that have a skull length approximately half that of the largest known skull. The crest forms a low, rounded dome and the posterior and dorsal fan of the nasal is not developed. Unlike similarly sized specimens of *H. altispinus*, the premaxilla-nasal fontanelle is present, although it is relatively smaller than in the equivalent ontogenetic stage of *Corythosaurus*. In order to compare cranial growth of *H. stebingeri* (n=10) to that of other closely related lambeosaurines (n=45), we performed an allometric analysis based on 15 linear measurements each regressed against skull length as a proxy for size. Six variables relate to the snout and temporal region, and nine relate to growth of the crest. Our analysis indicates a generally conservative pattern of allometric growth among corythosaurian lambeosaurines. It confirms that, exclusive of the crest, lambeosaurines follow an undifferentiated general pattern of facial growth. Differences in crest growth are typically the source of significant variation in the clade; however, *Lambeosaurus*, *Corythosaurus*, and *Hypacrosaurus* share a similar ontogenetic trajectory in terms overall crest height and crest area, both of which are positively allometric. *Lambeosaurus* differs from the latter taxa in the allometry of the angle between the crest and the snout, and relative position of the crest apex. *H. stebingeri* shares a number of growth features with *H. altispinus* to the exclusion of all other lambeosaurines, including *Corythosaurus*. These include a reduced crest snout-angle and a shortened upper temporal region of the skull through ontogeny. The similarity of their cranial growth trajectories supports a close evolutionary relationship between *H. stebingeri* and *H. altispinus*.

Poster Session IV (Saturday)

**OVERVIEW OF THE CRETACEOUS MARINE OTOPHYSI (TELEOSTEIOSTARIOPHYSI)**

BRITO, Paulo, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil;  
MAYRINCK, Diogo, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

Numerous early ostariophysans have been recovered in marine deposits. Among them, a number of taxa, always found in marine or brackish environments from the Lower Cretaceous of South America such as *Santanichthys diasii* and "*Clupavus*" *brasilensis* and from the Upper Cretaceous of Europe like *Sorbinicharax verreaesi*, *Salminops ibericus*, and *Lusitanichthys characiformes* are considered as stem-characiforms among otophysans. In the present study, we reviewed these controversial Mesozoic stem-characiforms, testing their phylogenetic position

on the light of the latest phylogenies proposed for the extant otophyan. Our phylogenetic hypothesis suggests that the Mesozoic forms, found in marine environments, may be interpreted as stem-otophyan. According to our results the older unambiguous Characiformes are the forms represented by isolated teeth found in typical continental paleoenvironments, in the Upper Cretaceous of South America, which points to a Gondwanan origin of this order.

Technical Session VIII, Thursday 3:30

**GIANT HORNED CROCODILES FROM THE LATE CENOZOIC OF AFRICA: STEALTH DIVERSITY REVISITED**

BROCHU, Christopher, University of Iowa, Iowa City, IA, USA; NJAU, Jackson, National Natural History Museum, Arusha, Tanzania; BLUMENSCHINE, Robert, Rutgers University, New Brunswick, NJ, USA; DENSMORE, Llewellyn, Texas Tech University, Lubbock, TX, USA

A Pleistocene crocodile from Olduvai Gorge, Tanzania, represents a new extinct crocodylid with prominent “horns” on the posterolateral margins of the skull table. Though its horns resemble those of the extinct Holocene Malagasy crocodile *Voay robustus*, the new species is closely related to the modern Nile crocodile (*Crocodylus niloticus*). Contemporaneous hominin fossils from two nearby localities preserve features interpreted as crocodile tooth marks. Fossils historically referred to *Rimasuchus lloydi* from the Mio-Pliocene Koobi Fora and Lothagam sequences of Kenya are actually another new species closely related to the Olduvai form. Some of these reached 7 m in length, and depending on how relationships are resolved, the lineage including the Nile crocodile (one of the largest living crocodylians) may actually reflect a reduction in body size over time. This lineage includes neither “*Crocodylus*” *garipeensis* from the Early Miocene of Namibia nor “*Crocodylus*” *pigotti* from the Early Miocene of Kenya, both of which are allied with the living dwarf crocodiles (*Osteolaemus*), sawfish-shaped *Euthecodon*, *Voay*, and *Rimasuchus* (which is currently known with certainty only from the Early Miocene of Egypt) in phylogenetic analyses. Crocodiles from Koobi Fora previously referred to *C. niloticus* are actually from the extinct species *C. chechchiai*, otherwise known from North Africa, which shares derived states with New World *Crocodylus*. These analyses reinforce a close relationship between African and Neotropical *Crocodylus* and a single dispersal event across the Atlantic. Oldest known African *Crocodylus* (~7 Ma) constrain the age of this divergence (though not necessarily the dispersal) to the Late Miocene or earlier. As the largest predators faced by (and eating) human ancestors, these crocodylids may have had a major influence on hominin land use.

Poster Session III (Friday)

**NEW SPECIMENS OF *THESCÉLOSÁURUS* AND THEIR IMPLICATIONS FOR TAXONOMY AND PHYLOGENY OF BASAL NEORNITHISCHIAN**

BROWN, Caleb, University of Calgary, Calgary, AB, Canada; BOYD, Clint, North Carolina State University, Raleigh, NC, USA; RUSSELL, Anthony, University of Calgary, Calgary, AB, Canada

The postcranial anatomy of the basal neornithischian taxon *Thescelosaurus* is well known from several articulated specimens (USNM 7757; CMN 8537). However, the absence of cranial material from the holotype of *T. neglectus* (USNM 7757), the name bearing species, combined with the small number of postcranial autapomorphies previously identified for *Thescelosaurus*, impedes the evaluation of specimen referrals to this taxon. Additionally, most cranial material referred to this taxon is non-overlapping, hindering comparison to the holotype and other referred specimens. These circumstances have resulted in: (1) a poor understanding of the cranial anatomy of this taxon; (2) difficulty assessing the referral of specimens to this taxon and the taxonomic validity of closely related taxa (e.g., *Bugenasaura infernalis*); and (3) a lack of clarity in the systematic position of *Thescelosaurus*. Resolving the phylogenetic position of *Thescelosaurus* is essential for establishing character state expression and polarity within the Neornithischia. Recent discovery of multiple articulated specimens that preserve partial postcranial skeletons and nearly complete skulls (MOR 979; NCSM 15728; TLM unnumbered) facilitates a reevaluation of all articulated and associated specimens previously referred to this taxon that preserve portions of the cranium. Here we document these recent finds and outline current research incorporating newly emergent data into a reanalysis of the relationships within the Neornithischia using both parsimony and Bayesian methods. This analysis, which included these new specimens as terminals, supports the referral of these specimens to a *Thescelosaurus* clade and allows for the recognition of a set of unambiguously optimized cranial autapomorphies that diagnose this clade. Future research on this topic will include: (1) identification of postcranial autapomorphies of *Thescelosaurus* via reanalysis of this dataset after the inclusion of new postcranial characters and all specimens previously referred to this taxon; and (2) a thorough redescription of the anatomy of *Thescelosaurus* using only specimens referred to this taxon based on shared autapomorphies.

Preparators' Session, Thursday 10:15

**WHEN THE CRADLE ROCKS: SIMPLE STRATEGIES FOR STABLE STORAGE AND SAFE USE OF PALEONTOLOGICAL COLLECTIONS**

BROWN, Gregory, University of Nebraska State Museum, Lincoln, NE, USA

Limiting the potential for damage to any museum object involves addressing all of the “agents of deterioration” recognized by conservators, but the vast majority of damage to paleontological collection objects can be attributed to a single agent: direct physical forces

(gravity and applied forces) related to improper storage and handling. An irregular object placed on a flat surface exerts all of its mass on three points, imparting considerable stress to the object. If the majority of mass is born on only two of these points, the object will be both under stress and unstable (prone to motion). It is a mistake to assume that seemingly sound and robust specimens do not require proper support. For larger objects, traditional form-fitting cradles of reinforced plaster or resin relieve stress by distributing an object's mass over an infinite number of points, however the irregular cradle itself may not assume a preferred orientation or stable resting position in storage. Addition of a cradle support system composed of blocks of expanded polyethylene foam on a rigid base of high-density Masonite provides cradle stability and isolation from vibration. Smaller objects benefit from simple polyethylene foam cradles. Proper orientation and compartmentalization in cabinet drawers limits destructive motion. It is also a mistake to assume that those who utilize our collections have the requisite skill or common sense to handle specimens safely. Formal written protocols should be provided that detail both basic and specialized handling guidelines and requirements. In addition, wise choice of primary storage orientation and use of “clam-shell” cradles can significantly lessen the need for direct handling of specimens. Well-designed storage can be both aesthetically and functionally elegant and, when combined with enforced handling protocols, can greatly reduce the forces that commonly damage our collections.

Preparators' Session, Thursday 11:45

**LEARNING THE BASICS: A LOOK AT AN ADAPTABLE LAB BASED FOSSIL PREPARATION TEACHING EXPERIENCE**

BROWN, Matthew, Petrified Forest National Park, Petrified Forest, AZ, USA; PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA; SUMIDA, Stuart, California State University, San Bernardino, CA, USA

In the absence of a widely accepted professional fossil preparation training program in North America, paleontology departments rely on a variety of informal or less formal methods of staffing laboratories. Many new employees come from volunteer or amateur communities, while others are recent graduates with little or no experience at the work bench. In order to partially address this experience gap, Petrified Forest National Park recently partnered with California State University, San Bernardino, to provide an internship for students with an interest in paleontology to receive basic training in preparation methods. One student spends ten weeks (one quarter) in the Petrified Forest preparation lab and is provided with an extensive list of required reading from the preparation and conservation literature in addition to hands on experience and guidance preparing Triassic archosaurs. These specimens represent a wide variety of preservation and requiring several different methods of chemical and mechanical preparation. The students also receive experience in field work, collections work, and molding and casting. The candidates are evaluated on technical ability, and are tested on knowledge of methods, anatomy, and materials. Experience with three students has shown positive results for the candidate, as well as the park paleontology program. Additionally, this process has provided insight into forming curricular and training models for longer term professional programs, and volunteer or new employee training. The program could possibly be expanded and developed in conjunction with an existing university graduate or undergraduate curriculum, or a large institution could develop a model for a regional training facility.

Technical Session I, Wednesday 8:30

**TESTING CHARACTERS IN THE DEVELOPMENT OF HYPOTHESES OF RELATIONSHIP AMONG BASAL MAMMALIA**

BROWNE, Ian, Oklahoma State University Center for Health Sciences, Tulsa, OK, USA; WEIL, Anne, Oklahoma State University Center for Health Sciences, Tulsa, OK, USA

In recent years, researchers working on the phylogenetic relationships of early mammals have increasingly used the “supermatrix” first introduced by Luo and its subsequent iterations as a starting point. Cladistic analysis of this matrix yields a relatively robust phylogeny that has been used to make bold claims about the evolution of key mammalian features. Detailed examination of the matrix reveals that many of its characters represent either different aspects of what are best described as a single character or various portions of a single structural unit that have been coded as multiple characters. The first of these in effect weights characters by duplicating them. For example, the presence of a post-dentary trough and presence of an overhanging medial ridge above the post-dentary trough were originally coded as separate characters. Recoding these into a single character with three states (absent; present, with overhanging medial ridge; present, without an overhanging medial ridge) eliminates the additional weight. Preliminary reanalyses of the most recent iteration of the “supermatrix” run with the most homoplastic and a small proportion of duplicate characters deactivated (21 of 436 total) produce a strict consensus tree with a different topology from that supported by the original matrix. The reanalysis consensus includes significant unresolved polytomies, suggesting that the consensus tree of the original analysis derives much of its structure from problematic characters. Some phylogenetic relationships derived from analysis of the “supermatrix” and related statements regarding character evolution should be viewed with caution, as the original tree is not robust to condensation of a few characters.

Technical Session X, Friday 8:30

**THE EVOLUTIONARY HISTORY AND HIGHER-LEVEL PHYLOGENY OF ARCHOSAURIA (TETRAPODA: DIAPSIDA)**

BRUSATTE, Stephen, University of Bristol, Bristol, United Kingdom; BENTON, Michael, University of Bristol, Bristol, United Kingdom; RUTA, Marcello, University of Bristol, Bristol, United Kingdom; LLOYD, Graeme, University of Bristol, Bristol, United Kingdom

Crown group Archosauria is a primary division of the vertebrate tree of life, and includes major groups such as birds, dinosaurs, and crocodylomorphs, along with several extinct Mesozoic clades. However, despite years of study, the higher-level phylogeny of Archosauria is poorly-resolved, hampering attempts to study the evolutionary history of the group. The phylogeny of crocodile-line archosaurs (Crurotarsi) is particularly contentious, and has been plagued by problematic character and taxon sampling, especially related to the representation of supraspecific ingroup clades. Recent discoveries and renewed focus on archosaur anatomy enable the compilation of a new dataset, which assimilates and standardizes character data pertinent to higher-level archosaur phylogeny. This character list is scored across the largest group of taxa yet analyzed and produces a well-resolved phylogeny. The analysis recovers mostly traditional relationships within Avemetatarsalia, places Phytosauria as the basal-most crurotarsan clade, finds a close relationship between Aetosauria and Crocodylomorpha, and divides "rauisuchian" taxa into three disparate clades (a basal clade, a group of "poposauroids," and a cluster of prestosuchids/rauisuchids). Support values are low, suggesting widespread homoplasy within Archosauria, but the phylogeny is highly congruent with stratigraphy. Comparison with alternative analyses identifies numerous scoring differences, but indicates that character sampling is the primary source of incongruence. The phylogeny implies extensive missing lineages in the Early Triassic, suggests that Triassic archosaur clades were cosmopolitan, and may support a Carnian-Norian extinction event. The dataset is used to investigate the tempo and pattern of dinosaur origins, through the calculation of disparity metrics and rates of character change. Crurotarsans occupied a significantly larger area of morphospace than dinosaurs during the Triassic, but evolutionary rates did not significantly differ between the groups. These results are consistent with a two-phased model for dinosaur diversification during the Norian and Early Jurassic.

Technical Session VII, Thursday 2:45

**BREAKING THE CERVICAL CONSTANT IN MAMMALS: DEVELOPMENTAL ORIGIN OF ABERRANT VERTEBRAL ANATOMY IN TREE SLOTHS**

BUCHHOLTZ, Emily, Wellesley College, Wellesley, MA, USA; STEPIEN, Courtney, Wellesley College, Wellesley, MA, USA

Cervical count in mammals has been fixed at seven for more than 200 million years. Both the evolutionary constraint and its three exceptions (*Bradypus*, *Choloepus*, *Trichechus*) have intrigued anatomists since the late eighteenth century. The role of *Hox* genes in patterning the axial skeleton and the independence of primaxial and abaxial patterning have been established by developmental biologists using molecular tools. These insights are critical to the reexamination of the cervical constant because the freely articulating ribs with sternal junctions that define the first thoracic vertebra have both primaxial and abaxial components. We documented vertebral anatomy in 113 specimens of the tree sloths *Bradypus* and *Choloepus* to test three competing hypotheses for the developmental origin of their aberrant cervical counts: local cervicothoracic homeotic transformations, meristic increases or decreases, and global mismatch between primaxial and abaxial patterning domains. Almost all individuals of both genera display transitional instead of discrete cervicothoracic boundaries. Miniature partial ribs on cervical vertebrae, sternal malformations, and left / right asymmetry are common, and presacral counts vary with cervical counts. Surprisingly, disrupted vertebral anatomy also occurs frequently at thoracolumbar, lumbosacral, and sacrocaudal series boundaries. Lumbosacral disruption is the most marked: "lumbar" vertebrae are variably fused to the anterior sacrum in *Bradypus* and inset "sacral" vertebrae lack complete ilial fusion in *Choloepus*. These observations are consistent only with the hypothesis of a mismatch between primaxial and abaxial patterning domains. The inferred repatterning can be determined to be the result of abaxial, as opposed to primaxial, repatterning by the polarity of the traits in transitional vertebrae, the patterns of series count, and the posterior (*Bradypus*) or anterior (*Choloepus*) displacement of the abaxially patterned brachial plexus. Unexpectedly, these results indicate that *Bradypus* and *Choloepus* retain traditional cervical counts primaxially, and that the "rule of seven" is even more invariant than previously recognized.

Technical Session XVI, Saturday 11:45

**ABELISAURID FORELIMB EVOLUTION: NEW EVIDENCE FROM MAJUNGASAUROUS CRENATISSIMUS (ABELISAURIDAE: THEROPODA) FROM THE LATE CRETACEOUS OF MADAGASCAR**

BURCH, Sara, Stony Brook University, Stony Brook, NY, USA; CARRANO, Matthew, Smithsonian Institution, Washington, DC, USA

The Upper Cretaceous (Maastrichtian) Maevarano Formation of northwestern Madagascar is known for its exquisite preservation of fossil vertebrates. Recent discoveries include an articulated skeleton of the abelisaurid theropod *Majungasaurus crenatissimus* that preserves a virtually complete pectoral girdle and forelimbs. Isolated forelimb elements have also been recovered. The bizarre, highly reduced forelimb morphology of abelisaurids was known previously only from two specimens, one each of *Carnotaurus* and *Aucasaurus*,

both recovered from Upper Cretaceous deposits in Argentina. Thus, the discovery of this third specimen, especially in light of its relative completeness and preservation, adds important further knowledge about the unusual forelimb morphology of abelisaurids. As in other abelisaurids, the scapular blade of *Majungasaurus* is wide and has parallel margins throughout its length. The coracoid is large and fused to the scapula, with a rounded anteromedial margin and a prominent ventral process anterior to the glenoid fossa. The humerus is small relative to the size of the scapulo-coracoid (roughly one-third the length); it is robust and curved mediolaterally, possessing a large, hemispherical head and flat distal articular surface. The radius and ulna are approximately one-third the length of the humerus and both have expanded proximal and distal articular surfaces relative to their narrow diaphyses. The manus consists of four digits, each comprised of a short metacarpal and one (digits I and IV) or two (digits II and III) phalanges. The phalanx and metacarpal of digit IV are fused, as are the two phalanges of digit III. No ossified carpals are present. The proportions of the brachium and antebrachium are stout, more similar to the condition in *Carnotaurus* than *Aucasaurus*. The completeness and preservation of this specimen allows a detailed reconstruction of the musculature of the forelimb and pectoral girdle. This is the first step toward a detailed functional analysis of the pectoral limb of *Majungasaurus* specifically, and abelisaurids in general. Finally, we assess trends in forelimb reduction in Ceratosauria, a non-tetanuran clade.

Romer Prize Session, Thursday 8:45

**EXTINCTION, MIGRATION, AND THE EFFECTS OF GLOBAL WARMING ON FOSSIL MAMMALS ACROSS THE PALEOCENE-EOCENE BOUNDARY IN WESTERN COLORADO, U.S.A.**

BURGER, Benjamin, University of Colorado at Boulder, Boulder, CO, USA

As scientists, we strive for a coherent understanding of what occurs during periods of rapid global warming, specifically the effects on biodiversity. The Paleocene-Eocene boundary and the corresponding Paleocene-Eocene Thermal Maximum (PETM) represent one such event in Earth's history. Intense paleontological research has focused on the Paleocene-Eocene boundary in the Bighorn Basin of northern Wyoming, yet little is known from other geographic areas. Discovery of the Paleocene-Eocene boundary defining Carbon Isotope Excursion (CIE) in the Piceance Creek Basin, 788 kilometers to the south in Colorado, facilitates comparison of contemporaneous mammalian faunas between the two basins. My research in the Piceance Creek Basin includes over 300 localities representing an interval of time from the late Paleocene (middle Tiffanian) through the early Eocene (late Wasatchian) time. Over 140 mammalian species occur in the Piceance Creek Basin during this six-million-year interval. A significant shift in lithology occurs at the Paleocene-Eocene boundary, wherein sandstones replace coals and carbonaceous shales, and red beds with cyclic paleosols predominate the Eocene strata. The observed lithologic change is consistent with an abrupt increase in aridity and desertification during the PETM. Furthermore, the level of mammalian extinction across the Paleocene-Eocene boundary supports a more cataclysmic PETM event than observed in the Bighorn Basin. Only 4 of the 50 Paleocene species survive the PETM event in Colorado. The PETM seemed most detrimental to the arboreal mammalian species, none of the Paleocene species survived, which is consistent with loss of forest habitat, due to desertification. Furthermore, most large terrestrial mammals (6) went extinct including *Barylambda*, *Titanoides*, and *Probathyopsis*. Northward migration of smaller Paleocene species of *Ectocion* and *Haplomyllus* occurred during the PETM. That the PETM in Colorado coincided with increased aridity, extinction, and northward migration contrasts significantly with the effects of the PETM in northern Wyoming, and highlights regional biotic impacts that can occur during abrupt warming events.

Preparators' Session, Thursday 11:00

**THE FLIGHT OF THE MICRORAPTOR**

BURNHAM, David, University of Kansas Natural History Museum and BRC, Lawrence, KS, USA; MIAO, Desui, University of Kansas Natural History Museum and BRC, Lawrence, KS, USA; MARTIN, Larry, University of Kansas Natural History Museum and BRC, Lawrence, KS, USA; ALEXANDER, David, University of Kansas, Lawrence, KS, USA

Discovery of a small, four-winged fossil from China—*Microraptor*, has led to a debate concerning its posture. If truly a dinosaurian as described, it would be a biped; however, the initial description indicated a sprawling posture to accommodate the hindlimb wings. In order to test the posture and offer comment concerning the possible life habits of *Microraptor*, a life-size model was made from an actual specimen. The process began with transfer preparation that allowed the fossil specimen to be cast on both sides. These casts were used to reconstruct a skeleton using original morphology and bone details such as articular surfaces. More importantly, the fossil preserved enough evidence to examine the range of motion needed to determine its posture. The reconstructed skeleton was used as a template to build a life model. Feather pattern was based on the nearly completely preserved wing feathers of the holotype, *Microraptor gui*. Airfoils of the wings were generated from modern avian wing and feather shapes. Afterwards the model was modified so it could be flown. Improvements were made only if they were scientifically justified. For example, the sprawling version improved significantly with proper airfoil alignment of the hindlimb wings and the addition of a delta wing tail. This resulted in more stable and repeatable glides with the longest flight covering nearly 25 meters. This successful gliding experiment strongly suggests the sprawling posture is accurate and conforms to the skeletal morphology of *Microraptor*.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)  
**A TIME-AVERAGED HARD AND SOFT TISSUE HISTOLOGY OF CROCODYLIAN OSTEODERMS AND IMPLICATIONS FOR THE STUDY OF DERMAL ARMOUR IN THE FOSSIL RECORD**  
BURNS, Michael, University of Alberta, Edmonton, AB, Canada

The dermal armor skeleton (composed of individual osteoderms) is an important, but relatively understudied, morphological feature of vertebrates. All osteoderms form in the dermis and include contributions from this integumentary layer, in both mineralized and unmineralized regions. Consequently, any study of these elements should include a soft tissue component whenever possible. Osteoderms are rarely sectioned in more than one plane, and histological and petrographic studies are generally not performed as part of a comprehensive investigation of fossil specimens. These factors may introduce bias into the interpretation of the three-dimensional histology of osteoderms in the fossil record. Ideally, paleohistological interpretations should be tested against modern organisms. In order to compare fossil and extant material among closely related taxa, this study examines osteoderms within the Brevirostres (Crocodylia), including fossil material from the Cretaceous to the recent. Specimens were petrographically sectioned in three planes and one modern osteoderm was histologically sectioned. This method allows for an assessment of the effects of sampling and preparation techniques on histological interpretations in modern and fossil osteoderms. Soft tissue histology on complete specimens of *Alligator mississippiensis* was obtained from previous work. Crocodylian osteoderms exhibit a thick cortex of fibrolamellar bone. Internally, they possess a region of cancellous bone and sometimes age-dependent woven bone. Evident in the fossil and modern material, lines of arrested growth span the basal cortex and margins of the osteoderms. Sharpey's fiber bone is also readily identifiable in these regions, more prominently in the margins. These crocodylians are relatively conservative with respect to histological evolution over the ~77 million years represented by the specimens studied. This research has implications for the examination of fossil forms such as early crocodylians, squamates, and some dinosaurs, like ankylosaurs, the osteoderms of which display a histology most similar to those of crocodylians. Some soft tissue anatomy may be inferred from osteological/histological structures of osteoderms.

Technical Session X, Friday 10:15

**ESTIMATING THE EFFECTS OF THE ROCK RECORD ON PTEROSAUR DIVERSITY PATTERNS: IMPLICATIONS FOR HYPOTHESES OF BIRD/PTEROSAUR COMPETITIVE REPLACEMENT**

BUTLER, Richard, Department of Palaeontology, The Natural History Museum, London, United Kingdom; BARRETT, Paul, Department of Palaeontology, The Natural History Museum, London, United Kingdom; NOWBATH, Stephen, Department of Earth Sciences, University College London, London, United Kingdom; UPCHURCH, Paul, Department of Earth Sciences, University College London, London, United Kingdom

Pterosaurs formed an important component of terrestrial and marginal marine ecosystems during the Mesozoic, and were the first flying vertebrates. The fossil record appears to indicate a decline in pterosaur taxic diversity in the Late Cretaceous, followed by extinction at the Cretaceous/Paleogene boundary. This reduction in species-richness has been linked to the ecological radiation of birds in the Early Cretaceous – it has been proposed that early birds competitively excluded pterosaurs from many key niches. Hypotheses of competitive replacement are frequently posited based on the fossil record, but few have been tested in detail. Here we present a detailed examination of pterosaur diversity through time based upon a new comprehensive database of the spatial and temporal distribution of pterosaurs. We use this database to calculate taxic and phylogenetically corrected diversity estimates, and compare these estimates with a model describing temporal variation in rock availability. We use numbers of pterosaur-bearing formations (PBFs) as a proxy for rock availability; temporal variation in the number of PBFs is then used to generate a model in which rock availability is a perfect predictor of diversity. Both taxic and phylogenetic diversity curves are strongly correlated with numbers of PBFs, suggesting that a significant part of the signal contained within pterosaur diversity patterns may be controlled by geological and taphonomic megabiases rather than macroevolutionary processes. Moreover, significant differences between observed diversity and the diversity predicted by the rock availability model coincide with the occurrence of sites of exceptional preservation (Lagerstätten), again indicating major biases in the pterosaur fossil record. There is no evidence for a long-term decline in pterosaur diversity during the Cretaceous, although a reduction in species-richness might have occurred in the Late Cretaceous. Available data provide little support for the long-term competitive replacement of pterosaurs by birds.

Poster Session II (Thursday)

**MORPHOMETRIC ANALYSIS OF SPECIES RESPONSE TO CHANGING ECOLOGY IN PEROMYSCUS FROM LATE PREHISTORIC ARCHAEOLOGICAL SITES ON THE NORTHERN PLAINS, USA**

BYKOWSKI, Richard, University of Iowa, Iowa City, IA, USA

Remains of *Peromyscus* (Order: Rodentia) are common among many archaeological sites and Native American village sites on the Northern Plains. Extant members of the genus are very polytypic, having a wide distribution over a range of habitats. Specimens of *Peromyscus* recovered from three archaeological sites in South Dakota have been attributed to *P. maniculatus*, but could also contain specimens of *P. leucopus* as well. Specimens were recovered in abundance from refuse-filled storage pits from the lodges at each of the three

localities. The three archaeological sites were occupied circa 1000 AD, 1300 AD and 1500 AD. They span a 500-year interval and represent an ecosystem that experienced distinct climatic and human-induced changes. But do morphotypes represent variation within species and is the variation correlated with changing environmental conditions? Eleven mandibular landmarks were identified, photographs taken and digitized using NIH-Image software. Canonical Variance Analysis was conducted using the program CVAgen6 to discriminate among the three samples; Bookstein coordinates were obtained utilizing the program CoordGen. One-way ANOVA tests were performed to assess variance in centroid size and the first two canonical variables. Non-parametric tests were also performed on the first two canonical variables (Kruskal-Wallis and Mann-Whitney) to assess difference in population means utilizing the statistical software SPSS. The preliminary research to date reveals at least three different morphotypes of the species *Peromyscus maniculatus*. This may potentially indicate adaptation of the species to differing environmental conditions.

Poster Session II (Thursday)

**SKELETAL MORPHOLOGY AND ONTOGENY OF ALPHAGAULUS PRISTINUS (MAMMALIA: RODENTIA: MYLAGAULIDAE), AN EARLY BURROWER FROM THE BARSTOVIAN**

CALEDE, Jonathan, University of Oregon, Eugene, OR, USA; HOPKINS, Samantha, University of Oregon, Eugene, OR, USA

Recent studies of living rodents have shown ontogenetic changes in burrowing behavior among fossorial mammals. This finding emphasizes the importance of understanding ontogeny when studying the morphology of fossorial mammals. *Alphagaulus pristinus* is an extinct member of Mylagaulidae from the early Barstovian of Montana. Mylagaulids are fossorial rodents known mostly from the northwest of the United States although specimens from Florida, New Mexico and possibly China have been reported. First described in 1903 on the basis of a single juvenile lower jaw, *A. pristinus* is only known from partial dentaries and isolated teeth. The later members of Mylagaulidae have extensive morphological adaptations for burrowing. Previously undescribed material from the Burke Museum of the University of Washington includes three fairly well preserved skulls showing different stages of the ontogeny from juveniles to an individual showing late stage of wear of the cheek teeth. The description of these three specimens of succeeding stages of wear and thus of the growth and maturation of *A. pristinus* leads to a better understanding of the ontogeny of these burrowing mammals. This is particularly interesting because of the scarcity of juvenile osteological fossil remains in small mammal taxa. The description of these specimens in conjunction with the position of *A. pristinus* at the base of Mylagaulinae, also offers the opportunity to get an insight in the evolution of burrowing ecology in this group. In particular, it allows adding to the work already done on the evolution of fossoriality by studying the early history of head-lift and scratch digging through the morphology of the skull and preserved post-cranial elements, which exhibit distinct adaptations to a subterranean life habit even in these early to mid-Miocene species. In addition to a better understanding of the evolution of fossoriality, a life habit common to numerous extant rodents (i.e. Geomyidae, *Cynomys*, Chrysochloridae, Bathyergidae), the specimens examined here illuminate ontogeny and phylogeny of the genus *Alphagaulus* and the subfamily Mylagaulinae.

Poster Session I (Wednesday)

**A SMALL COELACANTH (SARCOPTERYGII: ACTINISTIA) FROM THE UPPER CRETACEOUS OF MONMOUTH COUNTY, NEW JERSEY**

CALLAHAN, Wayne, New Jersey State Museum, Trenton, NJ, USA; MEHLING, Carl, American Museum of Natural History, New York, NY, USA

The Late Cretaceous vertebrate scrap faunas of the New Jersey coastal plain have been the source of many major paleontological discoveries since the early 19<sup>th</sup> century. Even today, in spite of urban sprawl and the steady loss of classic collecting localities, new discoveries are made with relative frequency. Recently a partial quadrate of a small coelacanth was collected in situ at a site along a small tributary at the headwaters of Ramanessin Brook in Holmdel, NJ. This site exposes a transgressive lag deposit from the Late Campanian, basal Navesink Formation. This is the second coelacanth fossil ever reported from the Cretaceous of New Jersey and, since it was collected directly from matrix, is the only New Jersey Cretaceous coelacanth that can be confidently dated. The specimen, though not complete, is well preserved with moderately ornamented bone above and on the sides of the condyles. The condyles themselves are approximately one quarter the size of those from the smallest quadrate assigned to *Megalocoelacanthus dobiei*. Since the newly found quadrate is quite robust in cross-section it does not appear to be from a juvenile and so does not likely belong to *M. dobiei*. The new specimen is from younger strata than the freshwater Cretaceous Gondwanan forms *Mawsonia* and *Axelrodichthys* and is considerably smaller than *Mawsonia*. We compare the new fossil quadrate to fragments of several small unidentified coelacanth specimens from the Late Cretaceous of Kansas and speculate as to the relationship of the new specimen to the European Cretaceous coelacanth *Macropoma*. Until additional material is found the exact status of the new fossil coelacanth is equivocal, however it does appear to represent a new small coelacanth in the Late Campanian of the Atlantic Coastal Plain.

Poster Session I (Wednesday)

**THE TATMAN FORMATION (PALEOGENE OF WYOMING): NEW FAUNAL INFORMATION**

CAMBURN, Joseph, New Jersey State Museum, Trenton, NJ, USA; CAMBURN, Sandra, New Jersey State Museum, Trenton, NJ, USA; PAPPAS, John, South Dakota School of Mines and Technology, Rapid City, SD, USA; O'GRADY, Bevin, South Dakota School of Mines and Technology, Rapid City, SD, USA; PARRIS, David, New Jersey State Museum, Trenton, NJ, USA

Renewed field investigations of the Tatman Formation have yielded refined biostratigraphic determinations and additional paleoenvironmental interpretations. Although traditionally correlated with the late Wasatchian, mammalian evidence has been sparse. Previously, *Microsypops* and *Paramys cf. copei* had been reported. The addition of *Pelycodus* and *Phenacodus* to the fauna is consistent with a late Wasatchian correlation. Although generally yielding a typical lacustrine fauna of invertebrates, fish, amphibians, and aquatic reptiles, some well preserved baenoid turtles have been found at one locality. A bentonitic stratum is associated with the turtles, suggesting a mass mortality.

Technical Session XIII, Friday 3:30

**THE LATE NEOGENE GEOLOGIC TRANSFORMATION OF THE AMAZON BASIN, SOUTH AMERICA**

CAMPBELL, KEN, Natural History Museum, LOS ANGELES, CA, USA

The late Neogene of the Amazon Basin of South America was a period of dramatic change for the region's biota as geologic events dramatically rewrote the landscape and mammalian immigrants from North America began dispersing into the continent. A long period of stasis within Amazonia ended at ~9.5 – 9.0 mya as a flood of sediment poured into the basin from the rapidly rising Andes Mountains to the west. The flood of sediment buried what had been a low-lying peneplain and brought about the extinction, through extreme habitat alteration, of numerous vertebrates, especially those that had achieved gigantic size under the pre-existing ideal tropical conditions. The uplift of the Andes, which various studies suggest might have been as much as 2.5 – 3.5 km over the period from ~10 mya to ~7 mya, not only initiated a flood of sediment into the low-lying basin, it brought about dramatic climate change as well. Drainage from the Amazon Basin prior to the rapid uplift of the Andes was presumably both westward through a Pacific portal in the Ecuadorian Andes and northward toward the Caribbean through a proto-Orinoco drainage. The Andean uplift closed the Pacific portal and pushed the proto-Orinoco drainage eastward onto the Guiana Shield, which provided a base level resistant to erosion. Sediment deposition continued within the basin until the modern Amazon River was formed ~2.5 mya, either by westward erosion of the proto-Amazon River, a breaching of the eastern rim of the basin as it finally filled with sediment, or both. Once drainage toward the east began, rapid incision formed what we now recognize as the modern Amazon River drainage system, once again dramatically altering the geologic underpinning of the basin. The basin was converted from a region of vast swamps, deltas, and giant, shallow lakes to a region of narrow valleys with deeply incised rivers, some of which gradually widened to provide the large floodplains seen today. Fossil vertebrates, radiometric dates on volcanic ashes, and new stratigraphic data all provide support for the timing of the major events that dramatically changed the landscape and biota of the Neogene Amazon Basin.

Poster Session I (Wednesday)

**PALEOENVIRONMENTAL RECONSTRUCTION OF THE KOANAKA HILLS UTILIZING GEOGRAPHIC INFORMATION SYSTEMS (GIS)**

CAMPBELL, Timothy, Sam Houston State University, Huntsville, TX, USA; DEGRATE, Justin, Sam Houston State University, Huntsville, TX, USA; WILLIAMS, Justin, Sam Houston State University, Huntsville, TX, USA; LEWIS, Patrick, Sam Houston State University, Huntsville, TX, USA

Many methods for reconstructing paleoenvironments from small mammal fossils are presently used including the analysis of isotopic ratios, dental micro-wear patterns, dental morphology and faunal turnover. Geographic Information Systems (GIS) based analyses are currently emerging as another powerful tool in paleoenvironmental reconstructions. GIS models, for example, allow for the prediction of past environments by analyzing the tolerances of modern taxa that have persisted relatively unchanged throughout the Plio-Pleistocene. These tolerance ranges are then applied to areas where these taxa are known to have occurred in the past. In order to better understand the past environment of the Koanaka Hills locality in northwestern Botswana, our analysis focuses on the modern distributions of southern African gerbils of the genus *Tatera* (Rodentia: Gerbillinae). The Koanaka Hills locality is a Plio-Pleistocene cave site with a large and diverse small mammal assemblage. Excavations at the site have produced at least two different members of the genus *Tatera*. Multiple taxa are still found in southern Africa today and are geo-referenced here along with their associated substrate type, mean annual precipitation and the annual temperature ranges. While their presence is often cited as evidence for an arid, savanna environment, these taxa show environmental tolerances that range from xeric to mesic and from desert to woodland habitats. The results of our analysis suggest that the Koanaka Hills environment of the Plio-Pleistocene could have differed greatly from the dry savanna environment known there today and which has been suggested as occurring during the late Pliocene. The environmental tolerances of the modern representatives of *Tatera* provide a baseline to which data from other taxa can be added to further refine our interpretations of this site's past environment.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**A NEW SPECIMEN OF VARANOPS BREVIROSTRIS WITH IMPLICATIONS FOR VARANOPIID ANATOMY AND EVOLUTIONARY HISTORY**

CAMPIONE, Nicolas, University of Toronto, Mississauga, ON, Canada

Varanopidae, a long-lived clade of non-therapsid synapsids, includes small to medium sized species, 30 cm to 2 m in length. Their fossil record is known from various part of the world, including Russia, Europe and South Africa; however, the largest members, the varanodontines, are known only from the Early Permian of North America. Varanodontines (*Varanops*, *Aerosaurus*, *Watongia* and *Varanodon*) are distinct from contemporaneous large, robust sphenacodontids in that they exhibit a more gracile morphology, with slender skulls and strongly recurved teeth. However, previous studies of this clade have suffered from a paucity of specimens that result in a poor understanding of their cranial anatomy. Of the four taxa, only *Varanops brevirostris* is known from multiple individuals, although details of the cranial anatomy have been difficult to discern due to poor preservation and preparation. Therefore, the discovery of a large, well-preserved skeleton of *V. brevirostris* from the Lower Permian of Texas allows the first comprehensive evaluation of its cranial morphology. Revision of *V. brevirostris* supports previous specific diagnoses, and provides additional autapomorphies including loss of the postorbital boss; a smooth transition between the dorsal and lateral surfaces of the postorbital; basiptyergoid processes with hypertrophied, mediolaterally elongate articular facets; deep and elongate neural spine excavations; posterior dorsal vertebrae with dorsally tapered neural spines; and a deep groove proximal to femoral fourth trochanter. Additionally, this specimen provides new information on the morphology of the lower jaw. They are unusually slender, and the angular bone is rounded ventrally, with a conspicuous surface. This likely represents the attachment for the *M. intermandibularis*, which was probably larger relative to skull size, compared to other basal synapsids. This arrangement is present in other large varanodontines and may represent a derived feeding mechanism for the clade. A revised phylogenetic analysis, and first stratocladistic analysis of any Palaeozoic vertebrate, places *V. brevirostris* as the sister-taxon to a *Varanodon agilis*-*Watongia meieri* clade.

Poster Session III (Friday)

**A GEOCHEMICAL APPROACH TO DECIPHERING THE ORIGINS OF MICROFOSSIL BONEBEDS IN THE UPPER CRETACEOUS JUDITH RIVER FORMATION, MONTANA**

CANAVAN, Robin, Geology Department, Macalester College, Saint Paul, MN, USA; ROGERS, Raymond, Geology Department, Macalester College, Saint Paul, MN, USA; KOENIG, Alan, Mineral Resources Team, USGS, Denver Federal Center, Denver, CO, USA; BRADY, Mara, Department of Geophysical Sciences, University of Chicago, Chicago, IL, USA; HARWOOD, Cara, Department of Geology, University of California, Davis, Davis, CA, USA

Geochemical and mineralogical markers in vertebrate bioclasts can be used to investigate hypotheses that relate to provenance and reworking of fossils. Rare earth elements (REE) incorporated into bone during diagenesis can provide critical information that pertains to early diagenetic conditions. Moreover, void spaces within bone provide sites for authigenic minerals that reflect the redox potential and pH of their formative environment. Over the past several years numerous microfossil bonebeds (n=8) in the Campanian Judith River Formation of north central Montana have been characterized with regard to REE signatures and authigenic cements. These bonebeds are preserved in three distinct facies contexts: channel-hosted sites that occur in fluvial sandstones, pond/lake sites that occur in fine-grained lacustrine beds, and shallow marine sites that occur in shoreface sediments. This study documented the diagenesis of 57 bones from five distinct sites (three channel-hosted, two lacustrine). Authigenic cements were studied using standard petrography and scanning electron microscopy. REE data were collected using laser ablation-inductively coupled plasma-mass spectrometry. Interestingly, the terrestrial sites show considerable overlap with regard to REE signatures and authigenic mineral content. This finding is consistent with stratigraphic and taphonomic data that suggest the channel-hosted microfossil bonebeds are likely reworked from preexisting pond/lake bonebeds. Two bonebeds in particular support this taphonomic reconstruction. Bonebed UC-8302 crops out in the basal 30 cm of a 7 m thick sandstone body. The sandstone hosting UC-8302 erodes down through several meters of fine-grained interchannel facies, and in its most fossiliferous expanse intersects another microfossil bonebed, UC-8302A, preserved in a lacustrine facies. These two bonebeds yield distinguishable geochemical signatures that show a slight enrichment in heavy REE, and this is consistent with the premise that the vertebrate fossils in UC-8302 were fossilized in the lacustrine facies prior to reworking and incorporation into the channel sandstone.

Poster Session IV (Saturday)

**ECOLOGICAL CORRELATES OF GHOST LINEAGES IN RUMINANTS**

CANTALAPIEDRA, Juan, Museo Nacional de Ciencias Naturales, Madrid, Spain; ALCALDE, Gema, Museo Nacional de Ciencias Naturales, Madrid, Spain; DEMIGUEL, Daniel, Universidad de Zaragoza, Zaragoza, Spain; AZANZA, Beatriz, Universidad de Zaragoza, Zaragoza, Spain; HERNANDEZ FERNANDEZ, Manuel, Universidad Complutense de Madrid, Madrid, Spain

Periods in evolutionary history of ruminants with no fossil evidence (ghost lineages) are identified and quantified by the integration between phylogenetic systematics and paleontological data. We explore whether certain correlations exist among duration of

ghost lineages and several ecomorphological variables (biometrical, biogeographical and ecological). For this innovative approach we codified variables for terminal taxa as double-state characters and used concentrated changes tests on the phylogeny of all extant species of this suborder of Artiodactyla (Mammalia). In order to test the robustness of the results obtained concerning the extant species, the analyses were repeated for each partial tree generated by cutting the complete tree at ages of 4, 8, 12, 16 and 20 Ma. Although this pruning process entails a significant change in tree length and a consequent shaking of ghost lineages percentages at the tips, it may show whether the trends observed in the previous analysis is maintained thought the evolutionary history of the Ruminants. Our results indicate that the proportion of known fossil record in ruminants appears to be influenced by the preservation potential of the bone remains in different environments. Furthermore, it seems that large geographical ranges of species increase the likelihood of preservation. Finally, body size is shown to be an important factor, increasing the representation of large size taxa in the fossil record, and reducing that of species with lower weight. Nevertheless, this latter variable might be probably important from the Plio-Pleistocene onwards, while it resulted statistically not significant in earlier periods.

Poster Session II (Thursday)

**GLYPTODONTINES (XENARTHRA, GLYPTODONTIDAE) AND THE GREAT AMERICAN BIOTIC INTERCHANGE: A NEW INTERPRETATION**

CARLINI, Alfredo, Paläontologisches Institut und Museum, Universität Zurich, and Departamento Científico Paleontología de Vertebrados, Museo de La Plata, La Plata, Argentina; ZURITA, Alfredo, Centro de Ecología Aplicada del Litoral (CECOAL-CONICET) and Universidad Nacional del Nordeste, Argentina, Corrientes, Argentina; GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ, USA

Until recently, the earliest records of Glyptodontidae Glyptodontinae (Xenarthra) were limited to late Miocene-Pliocene ("Araucanense", ~7 Ma) of southern South America (*Glyptodontidium tuberifer* Cabrera). The entrance of this group of glyptodonts to North America during the Great American Biotic Interchange was interpreted as a unidirectional faunal migration with the subsequent differentiation of a new genus (*Glyptotherium*), probably in the late Pliocene. A new comparative study of materials from the Mio-Pliocene of northernmost South America (Venezuela and Colombia) and traditionally included within Glyptodontidae Propalaeophlorinae (*Asterostemma* spp.), suggests these taxa are not Propalaeophlorinae but represent the first stages in the cladogenesis of Glyptodontinae Glyptodontidae; they are currently assigned to a recently established genus, *Boreostemma*. The first records of this clade in southernmost South America coincide with the acme of the "Age of Southern Plains", which probably extended from Venezuela to Argentinean Patagonia during the late Miocene-Pliocene. These great open extensions of savannah habitat may have favored the dispersal of the glyptodontines into more southern areas through "Andean biogeographical corridors." The discovery of *Glyptotherium* sp., cf. *G. cylindricum* (one of the most derived species of the genus and until recently, limited to the holotype, from central Mexico) in the latest Pleistocene (ca 15-12 ka) of Venezuela supports the bidirectional faunal migration during the GABI, probably associated with a biogeographical "corridor" that formed during one of the later glacial periods. The immigration from North America is a new case of re-entrance of a group that emigrated from South America and diversified in North America, as has already been proposed for other xenarthrans (e.g., Cingulata: Pampatheriidae and Phyllophaga: Megatheriinae). Recent reports that postulate the ingress of glyptodontines to North America ~3.9 Ma, prior to the establishment of the Isthmus of Panama as a continuous land bridge, require new interpretations concerning identification of the emigrant taxa and the derived genera in North America.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**ARCOSAUR: ARCGIS OPERATIONS FOR SURFACE ANALYSIS USING RASTERS**

CARNEY, Ryan, Yale University, New Haven, CT, USA

The paleontological "digital revolution" has fostered various exaptations of scanning and modeling software for the 3D visualization and animation of extinct organisms; however, such programs are often unsuitable for quantitative analysis. Recently, geographic information system (GIS) software has been used to characterize fossil topology, but this has been limited to relatively planar manifolds (occlusal surfaces of mammalian teeth) and Euclidean geometries (distance, slope, orientation). In order to conduct more comprehensive topographic analyses in ESRI's ArcGIS 9.2 software, I created a suite of automated processing tools called ARCOSAUR (ArcGIS Operations for Surface Analysis Using Rasters) by using the ArcToolbox ModelBuilder visual programming environment and scripting in the Python language. Using the ARCOSAUR toolbox, 3D data acquired via computed tomography (CT) or laser scanning can be converted from computer-aided design (CAD) formats to triangulated irregular networks (TIN) and then rasterized into digital elevation models (DEM). In addition to calculating surface relief and basic Euclidean measurements, the tools can be used to analyze surface convexity and concavity, identify and characterize topographic landmarks such as muscle scars and bone pathologies, and even create 3D "pseudofossils" from 2D digital photographs. Additionally, analyses need not be limited to planar surfaces such as dentition or fossils *in situ*; various trigonometric operations include the identification of centers and axes of rotation along curvilinear joint surfaces; in turn these markers can be exported for use as kinematic references in modeling software. To illustrate the utility of these processing tools, forelimb elements of theropod *Deinonychus antirrhopus*,

alligator *Alligator mississippiensis*, and pigeon *Columba livia* were digitized with a high-resolution laser surface scanner and reconstructed in Maya 5.0. ARCOSAUR was then used to import and process the data, analyze the topology of articular surfaces, and reconstruct cartilaginous tissue for *D. antirrhopus* within an extant phylogenetic bracketing paradigm.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 8:15

**THE CLEVELAND SHALE FAUNA REVISITED: IS THE FAUNA THE STANDARD FOR COMPARISON IN THE FAMENNIAN AND LATE DEVONIAN?**

CARR, Robert, Ohio University, Athens, OH, USA; JACKSON, Gary, Cleveland Museum of Natural History, Cleveland, OH, USA

The Late Devonian, punctuated by a number of orogenic events and global extinctions associated with the suturing of Pangaea, represents an important time in the evolution of early gnathostomes. Our understanding of the biotic changes at this time is based on a limited number of faunas. The Cleveland Shale fauna (Famennian) in northern Ohio represents one of the better-known faunas of the Late Devonian. This is based on a history of collecting since the late Nineteenth Century that is augmented by the diligent collecting of Peter A. Bungart in the 1920s to 1940s and finally by the salvage of numerous specimens during the 1966–1967 construction of Interstate-71 through the most fossiliferous horizons. Although 44 taxa are reported in the literature, a survey of the collections housed in the Cleveland Museum of Natural History and a review of unpublished museum documents indicates the presence of 66 taxa (33 chondrichthyans, 28 placoderms, and 5 osteichthyans). The past perception that placoderms dominated the fauna is based in part on the abundance of this group in the collection; however, this numerical dominance is overly represented by a single species, *Dunkleosteus terrelli*. The large size of *Dunkleosteus* with its thick dermal bone presents the potential collector with an obvious size bias. In the Famennian, the Cleveland Shale fauna with its 66 species represents the standard for comparison with the next most speciose locality (Tafilalt, Morocco) possessing 32 species. In the Late Devonian, the Cleveland Shale fauna is comparable in number to the Frasnian Bad Wildungen locality (Germany; 61 species). The implication of these disparities is not that these localities represent pockets of high diversity isolated from adjacent basins, but that the other basins have been under sampled. For example, recent collecting in the Michigan Basin has nearly quadrupled the known fauna suggesting the potential reward with renewed fieldwork. Although we can now consider the Cleveland Shale fauna as a standard to achieve, the fact that only 44 of the 66 taxa have previously been reported demonstrates that despite the history of work on the fauna much still needs to be done.

Technical Session X, Friday 11:15

**PATTERNS OF DIVERSITY AMONG LATEST CRETACEOUS DINOSAURS IN NORTH AMERICA**

CARRANO, PH.D. Matthew, Smithsonian Institution, National Museum of Natural History, Washington, DC, USA

Latest Cretaceous dinosaur diversity has been a contentious point in discussions of dinosaur extinction, resulting in widely divergent opinions of both the pattern and its relevance. At the local scale, intraformational sampling shows little evidence for a decline in dinosaur diversity immediately prior to the end of the Maastrichtian. Globally, diversity is much higher in the Campanian than in the Maastrichtian, leading to suggestions of longer-term decline. However, comparisons of global, stage-level diversity typically rely on temporal, rather than stratigraphic, correlations when determining how to separate and align samples. This has resulted in the tendency to lump taxa into a single "Campanian" bin, despite the fact that better resolution is frequently available regarding taxon contemporaneity. It is especially important to recognize that superposed formations (e.g. Oldman, Dinosaur Park, Horseshoe Canyon) can provide genuinely sequential diversity estimates. In addition, such comparisons must also account for variations in sampling method and density, paleoenvironment, and taxonomic ranges and resolution. When these factors are addressed, North American dinosaur diversity shows much less variation between formations and time intervals than is documented by raw, stage-level diversity counts. A significant component of diversity tracks changes in how often and how many paleoenvironments are being sampled. In North America, at least, latest Cretaceous dinosaur diversity appears to reflect more complex biotic and anthropogenic patterns, rather than a drawn-out, pre-extinction decline.

Technical Session II, Wednesday 10:45

**ASSESSING THE HUMAN IMPACT ON MAMMALIAN SPECIES DIVERSITY DURING THE END-PLEISTOCENE EXTINCTION: CLUES FROM THE LAST 30 MILLION YEARS**

CARRASCO, Marc, University of California, Berkeley, Berkeley, CA, USA; BARNOSKY, Anthony, University of California, Berkeley, Berkeley, CA, USA

The relative weight of human impacts versus climate change as a cause of the end-Pleistocene extinction in North America has long been debated. Part of the difficulty in assessing the importance of each purported cause has been establishing a natural biodiversity baseline that takes into account the fluctuations of diversity in the presence of climate change but in the absence of humans through deep time. Here we use the MIOMAP and FAUNMAP databases of mammalian occurrences to clarify this baseline, as assessed by species-area curves, for

the past 30 million years. We subject species-occurrence data to rarefaction and other sample standardization techniques and, in combination with the Berkeley Mapper software, derive species-area curves by geographic region for distinct time slices from the late Oligocene through the Holocene. Preliminary results indicate that mammalian species diversity, particularly in the northern Great Plains region, became severely depressed in the Holocene relative to every other time slice studied. These results suggest that the reduction in diversity across the Pleistocene-Holocene boundary was more excessive than had occurred for millions of years previously, lending support to ideas that invoke the presence of humans for the first time to explain the extinction. The case for coincident unusual events, such as out-of-the-ordinary glacial-interglacial warming or a purported comet impact, is less firm.

Technical Session XV, Friday 2:45

**REMARKABLE SOFT TISSUE PRESERVATION OF MIDDLE JURASSIC SALAMANDERS AND THE ANCESTRY OF MODERN FAMILIES**

CARROLL, Robert, Redpath Museum, McGill University, Montreal, QB, Canada; LI, Hong, Inner Mongolia Autonomous Region Museum, Huhehaote, China

Fully articulated skeletons of larval and adult salamanders with impressions of skin, musculature, eyes, external gills, ecto-parasites and gut contents from the Jehol Biota, northern China represent a diversity of taxa and excellence of preservation that exceeds that of all other deposits known from the later Mesozoic or Cenozoic. The Daohugou locality, near Ningcheng, Inner Mongolia includes putative antecedents of cryptobranchids, either hynobiids and/or salamandroids and a possible sirenid. The Middle Jurassic age of this horizon is approximately mid-way between the latest known Paleozoic antecedents of salamanders and the modern biota. All fossils show a mosaic of character states including some inherited from branchiosaurids, others unique to primitive urodeles, and a few shared with one or more of the modern families. The most common elements of this fauna are a putative cryptobranchid, *Chunerpeton*, and *Jeholotriton*, which combines a primitive sequence of ossification of the caudal vertebrae with a highly derived configuration of the skull. The palatal dentition somewhat resembles that of sirenids. A third genus represents a cryptobranchid differing from *Chunerpeton* in having double rather than single headed ribs and relatively shorter limbs. The most exciting specimen closely resembles modern hynobiids in the number and nature of pre- and postsacral vertebrae and ribs, the phalangeal count, and very high number of marginal teeth. It may also be close to the ancestry of salamandroids, including the primarily terrestrial ambystomatids, salamandrids, and plethodontids, but also the secondarily aquatic proteids and amphiumids. It's most striking feature, clearly demonstrating terrestrial adaptation, are well defined costal grooves throughout the trunk. These structures are common to nearly all modern terrestrial salamanders but have not previously been seen in fossils. They serve as tubes to draw up water from damp substrates by capillary action to maintain a damp surface of the body for cutaneous respiration. Together, these fossils document a very early radiation of the major salamander clades.

Technical Session I, Wednesday 10:45

**A PRE-NEOGENE PHALANGERID POSSUM FROM SOUTH AUSTRALIA**

CASE, Judd, Eastern Washington University, Cheney, WA, USA; MEREDITH, Robert, University of California, Riverside, Riverside, CA, USA; PERSON, Jeff, North Dakota Geological Survey, Bismarck, ND, USA

Phalangeridae is one of the most widely dispersed families of possums (Marsupialia, Diprotodontia) in the Australasian region extending from Tasmania in the southeast to Sulawesi of the Greater Sunda Islands of Indonesia in the northwest. Yet this one family of possums has generated the most morphological and biochemical phylogenetic uncertainties of any family within the Order Diprotodontia. The various phylogenetic relationships for the family have led to different biogeographic models in regard to the site of origin and directions of dispersal for taxa within the family. The recovery of a maxilla from faunal zone B of the Oligo-Miocene Etadonna Formation at Lake Palankarinna, South Australia (ca. 25 mya) results in the oldest known phalangerid to date, some ten million years older than the numerous mid-Miocene fossil phalangerids described from Riversleigh, Queensland. Whereas the Riversleigh phalangerids are similar enough to the modern taxa to have originally been included in modern genera, the Etadonna specimen has morphologies that are very plesiomorphic for the family, such as a bladed P3 with a central main cusp with denticles posteriorly but no ridges, the P3 is aligned with the tooth row, M1 with paraloph shear aligned with the blade of P3; M2 and M3 more square in occlusal outline, the infraorbital canal is anterior to the second premaxillary and the opening of the lacrimal canal is inside of the orbit. With substantial molecular time of divergence data now available, plus the addition of this new pre-Neogene phalangerid from South Australia, a new biogeographic model of site of origin and dispersal can be offered, where phalangerids originate in Australia, diversify and give rise to the cuscus subfamilies, which disperse to New Guinea and then onto Indonesia.

Preparators' Session, Thursday 8:45

**ON THE USE OF PLASTIC AIR CONDITIONER FILTER MEDIA IN PLASTER JACKETS FOR FOSSIL COLLECTING**

CAVIGELLI, Jean-Pierre, Tate Geological Museum, Casper, WY, USA

The use of plaster jackets has long been standard practice in the collection of fossil vertebrates. Since the nineteenth century burlap dipped into plaster has been used to make plaster jackets. These provide strength and rigidity to fragile specimens. Several creative

alternatives to plaster jackets have been used recently, most commonly pre-plastered medical bandages, and aluminum foil and duct tape. Several years ago, at the email urging of Russ McCarty, some collectors started using plastic air conditioning media instead of burlap in field jackets. Randomly oriented polyester strands make up these filters, leaving a lot of air space between them. Plaster easily takes the place of the air, while the plastic provides multidirectional strength. Using AC filter media instead of plaster is a quick and efficient way to make strong plaster jackets for fossils. These jackets are easier to open, thereby reducing the chances of accidentally scarring the fossils inside. The Tate Museum has tried this technique now for several field seasons with great success. Two of the plaster jackets were multi-ton dinosaur jackets, both of which suffered no ill effects when rolling them over. Air conditioner filter media can, of course, also be used in conjunction with burlap, depending on the situation. We encourage others to try this technique as it is quicker and easier than burlap strips. One drawback is that larger pieces of filter media saturated in plaster may tear when used due to the weight of the wet plaster. This technique may not be best for smaller specimens or for tightly packed fossils that will be jacketed individually. We have also developed a simple technique to aid in the initial opening of plaster jackets using foam swimming pool noodles.

Fossils and the Evolutionary Patterns of Ostariohysans, One of the Largest Vertebrate Clades, Saturday 11:00

**DISCOVERY OF AN EXTRAORDINARY PLIOCENE SCHIZOTHORACIN (CYPRINIDAE) FISH FROM NORTHERN TIBETAN PLATEAU AND ITS PALEOECOLOGICAL IMPLICATIONS**

CHANG, Mee-mann, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; MIAO, Desui, Natural History Museum and Biodiversity Research Center, University of Kansas, Lawrence, KS, USA; WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA, USA; LIU, Huangzhang, Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan, China

The India-Asia plate collision and associated uplift of the Tibetan Plateau created some of the highest inland basins in western China today. Among them is Qaidam Basin on the northern Tibetan Plateau, which has experienced continuing aridification since the beginning of the Late Cenozoic. The process of aridification of the basin is mainly recorded in its evaporite deposits and indicated by salinity-tolerant invertebrate fossils, particularly ostracods. Vertebrate fossils have been scarce until the recent discovery of abundant fossil fish from the Pliocene lacustrine deposits. Here we report an unusual schizothoracin fish, characterized by a unique combination of characters shared with "barbines" and primitive schizothoracines on one hand and specialized schizothoracines on the other: body elongated, nearly cylindrical; head relatively long; orbit small, situated anteriorly; anterior margin of lower jaw shovel-like; pharyngeal bone stout, triangle-shaped, with three rows of cylindrical teeth, new teeth with rounded top, worn teeth with truncated, flat grinding surface; distal end of transverse process of 4<sup>th</sup> vertebra blunt and slightly expanded; fork in pelvic bone shallow, both branches comparatively broad; dorsal fin with three unbranched and seven branched rays, the longest unbranched ray with robust serrations; proximal portion of epural expanded. A phylogenetic analysis using PAUP Version 4.0b 10 resolves the new fish among the early branching schizothoracines, in a position slightly more derived than *Schizothorax*. Thus, the new fish is not the most ancient member of the group but is somewhere between the primitive members of the group, e.g. the extant genus *Schizothorax*, and more derived members. The history of the group would go back to a time earlier than the Neogene. Our analysis also shows that schizothoracines form a monophyletic group within the Barbiniae (*sensu lato*), indicating that the Barbiniae *sensu stricto* is paraphyletic. Additionally, the most striking aspect of the fish is its extraordinarily thick skeleton that occupied almost the entire body, suggesting that they lived in water bodies with high mineral contents.

Poster Session I (Wednesday)

**HANDLING MISSING DATA IN PALEONTOLOGICAL MATRICES: APPROACHES FOR EXPLORATORY MULTIVARIATE ANALYSES IN MORPHOMETRICS**

CHAPMAN, Ralph, Eryops Consulting, Los Alamos, NM, USA; SADLEIR, Rudyard, University of Chicago and The Field Museum, Chicago, IL, USA; DODSON, Peter, University of Pennsylvania, Philadelphia, PA, USA; MAKOVICKY, Peter, The Field Museum, Chicago, IL, USA

Missing data is one of the greatest problems encountered with morphometric analyses in paleontology as specimens are often incomplete. The optimal approaches to dealing with this depend on the problems being studied and the stage of the research itself. Established procedures, such as replacing missing values with an average value, tend to homogenize the data and reduce the variability that may be of primary biological interest. This can have a devastating effect on exploratory analyses when the structure of the data is unknown: masking any taxonomic, dimorphic, or polymorphic trends. We present an alternative that works well regardless of whether the data come from a uniform or mixed population of individuals. The process starts with a comprehensive matrix of as many specimens and measurements as possible. The matrix will have holes that will need attention before any multivariate analyses can be performed. We suggest analyses on various subsets of the data in order to maximize matrix completeness and added experimentation with multiple matrices. Once a useful subsample of the comprehensive matrix is available, the approach then fills in the remaining holes using bivariate linear relationships. Values are projected



onto the line fit to the data using the residual optimized by the line-fitting method applied. A correlation-based method such as the reduced major axis is recommended. Finally, once the matrix is complete, the selected multivariate analyses can proceed. The relationships of unused specimens and variables can be examined afterwards using bivariate comparisons as well. Overall, dimorphism, polymorphism, and other data heterogeneity are maintained better with this method. The results of this approach are compared to more established procedures. We use classic data sets to demonstrate the method including those for the dinosaurs *Protoceratops* and *Stegoceras*, and include analyses using the experimental degradation of complete data sets.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 11:30

#### EVOLUTION OF MEDIAN FINS MODULARITY IN OSTEICHTHYANS

CHAREST, France, Chaire de recherche en paléontologie et biologie évolutive, Université du Québec à Rimouski et Parc national de Miguasha, Rimouski, QB, Canada; CLOUTIER, Richard, Chaire de recherche en paléontologie et biologie évolutive, Université du Québec à Rimouski, Rimouski, QB, Canada

Phenotypic developmental modularity is expressed by morphological similarities and recurrent developmental patterns among taxa. Such patterns have been recognized in dorsal and anal fins of living actinopterygians: (1) a developmental sequence of six events is identical for both fins (chondrification of radials, formation of lepidotrichia, segmentation of lepidotrichia, ossification of lepidotrichia, bifurcation of lepidotrichia and ossification of radials), (2) radials and lepidotrichia differentiate in the same direction (the exoskeleton and endoskeleton module), and (3) both fins differentiate in the same direction (dorsal and anal fins patterning module). The presence of these modular patterns are described for the first time from rare fossil taxa for which size series of well-preserved specimens are known. Eight size (ontogenetic) series of basal taxa from five osteichthyan groups (two actinopterygian, two actinistian, two porolepiform, one dipnoan and one osteolepiform species) were examined for recurrent phylogenetic patterns. Specimens came from three localities that allow such type of study: the estuarine paleoenvironment of Miguasha (Late Devonian; Québec, Canada), the deltaic paleoenvironment of Mazon Creek (Late Carboniferous; Illinois, USA) and the "lacustrine" paleoenvironment of Achanarras (Middle Devonian; Scotland). Inferred patterns include: (1) the developmental sequence is fairly conservative among groups, with homoplastic deletion of bifurcation of lepidotrichia, (2) within species, the number of radials and lepidotrichia is similar between dorsal and anal fins; except for dipnoans, (3) similarity of radial ossification pattern (mainly from anterior to posterior), and (4) same segmentation and bifurcation patterns for all species (excepted for species with unbifurcating lepidotrichia). Living actinopterygian modules are identified in basal actinopterygians and sarcopterygians; thus, the presence of dorsal-anal fins modules is not unique to actinopterygians but could be an apomorphic condition for osteichthyans. However, dissociations occur, causing the loss, or the alteration, of some modules along phylogeny.

Poster Session I (Wednesday)

#### THERIAN FEMORA FROM THE LATE CRETACEOUS OF UZBEKISTAN

CHESTER, Stephen, Yale University, New Haven, CT, USA; SARGIS, Eric, Yale University, New Haven, CT, USA; SZALAY, Frederick, University of New Mexico, Albuquerque, NM, USA; ARCHIBALD, J., San Diego State University, San Diego, CA, USA; AVERIANOV, Alexander, Russian Academy of Sciences, St Petersburg, Russia

Femora referable to metatherians and eutherians have been recovered from the Bissekty Formation, Dzharakuduk, Kyzylkum Desert, Uzbekistan (90 MYA). Fourteen of thirty-two isolated elements preserve enough relevant morphology to be assessed in a comparative and functional context. These specimens were sorted based primarily on size and overall morphology into groups that likely correspond to the species level or higher. Groups were then tentatively assigned to taxa known from teeth, petrosals, and/or other postcrania at these localities. The distal femur of a small arboreal metatherian lacks a patellar groove and has a marked asymmetry between the size of the condyles; the lateral condyle is much wider. It is similar in size to an unassociated metatherian humerus with features indicative of arboreality. The distal femora of the terrestrial eutherian taxa possess a patellar groove and subequal condyles. Most of these specimens probably represent zhelestids and/or zalmabdalestids. With the exception of one possible eutherian that may be a zalmabdalestid, all of the proximal femora that have been collected exhibit a metatherian-like morphology. These specimens possess a cylindrical femoral head and lateral and posterior extension of the articular surface onto the neck. They have a short greater trochanter that is lower than or even with the femoral head and a lesser trochanter that projects medially or posteromedially. The third trochanter is either absent or very small. The dental record currently suggests the presence of thirteen eutherian species and only one metatherian at Dzharakuduk, whereas the crurotarsal and humeral evidence supports the presence of at least three or four metatherian species. Given the sample size of the proximal femora (which were classified into six different groups), and the overwhelming presence of eutherians at these localities, including three distal femoral groups, it is highly unlikely that only metatherian proximal femora were preserved due to a sampling bias. Therefore, this sample seems to suggest that the metatherian proximal femoral condition is primitive for Theria and that some eutherian taxa retain this condition.

Poster Session II (Thursday)

#### MIDDLE MIOCENE RODENTS FROM QUEBRADA HONDA, BOLIVIA

CHICK, Jennifer, Case Western Reserve University, Cleveland, OH, USA; CROFT, Darin, Case School of Medicine, Cleveland, OH, USA; ANAYA, Federico, Universidad Autonoma Tomas Frias, Potosi, Bolivia

Despite South America's rich fossil mammal record, relatively little work has focused on middle-latitude faunas of Miocene age; most current understanding of South American mammals during the Miocene derives from the extremes of the continent: La Venta, Colombia (5° N) and southern Argentina (≥ 40° S). Quebrada Honda in southern Bolivia (21° S) is intermediate in latitude between these two regions, partly filling this large geographic gap. The fauna, temporally well-constrained to 12.7-13.0 Ma, is contemporaneous with the only other Laventan South American Land Mammal "Age" fauna known, La Venta, Colombia. Since Quebrada Honda is more than 3,000 km south of La Venta, comparing the two faunas will clarify patterns of mammal distributions during this interval. Previous Quebrada Honda studies focused on larger mammals, but the rodents have not been studied in detail. New collections from Quebrada Honda in 2007 make such an analysis possible, and preliminary results are provided here. More than half of the specimens collected at Quebrada Honda are rodents. Although absent from La Venta, chinchillids are the most common Quebrada Honda rodents (57% of rodent specimens). Based on molar laminae with relatively straight anterior and posterior margins, the specimens appear to pertain to the lagostomine *Pliolagostomus*, a genus known from Santacrucian through Chasicocoan faunas of Patagonia. The caviid *Orthomyctera* from Quebrada Honda represents the earliest and northernmost occurrence of the genus. It is common in Chasicocoan through Montehermosan faunas of northeastern and western Argentina. The Quebrada Honda species appears to be *O. rigens*; it is small with a slight elongation of the anterior p4 prism, anterior and posterior P4 lobes of equal size, and a broad M3 third prism. One echimyid is represented by a single specimen with trilophodont, high crowned teeth and m3 smaller than m2. It resembles some adelphomyines, such as *Prostichomys*, but the molars lack mesolophids. The other echimyid, a heteropsomyine, is brachydont and is represented by 13 specimens; it resembles *Pampamys*, but differs in wear patterns, with the posterior flexids becoming isolated first.

Technical Session X, Friday 9:30

#### DEVELOPMENTAL GROWTH PATTERNS OF THE FILTER-FEEDING

#### PTEROSAUR, *PTERODAUSTRO GUINAZUI*

CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, South Africa; CODORNIU, Laura, Universidad Nacional de San Luis, San Luis, Argentina; CHIAPPE, Luis, The Dinosaur Institute, Los Angeles, CA, USA

*Pterodaustro guinazui* from the Lower Cretaceous laminated shales of the Lagarcito Formation of Central Argentina (Sierra de Las Quijadas, San Luis Province) is a medium-sized, filter-feeding pterodactyloid. Since the first excavations in the 1960s, hundreds of individuals (with wingspans ranging from 0.3 to 2.5m) have been recovered from this locality – including an embryo inside an egg. Here, we report on a comprehensive osteohistological assessment of multiple skeletal elements of a range of ontogenetic sizes of *Pterodaustro*. Our findings suggest that upon hatching, *Pterodaustro* juveniles grew rapidly for about 2 years until they reached approximately 53% of their mature body size, whereupon they attained sexual maturity. Thereafter, growth continued for at least another 3-4 years at comparatively slower rates until larger adult body sizes were reached. Our analysis further provides definitive evidence that *Pterodaustro* had a determinate growth strategy. This investigation of the bone microstructure of *Pterodaustro* has led to an unparalleled assessment of the growth and life history strategy of this ctenochasmatid pterodactyloid from early ontogeny to adulthood.

Poster Session IV (Saturday)

#### A NEW BASAL COELUROSAUR FROM THE UPPER SHISHUGOU FORMATION (XINJIANG, PEOPLE'S REPUBLIC OF CHINA)

CHOINIERE, Jonah, George Washington University, Washington, DC, USA; CLARK, James, George Washington University, Washington, DC, USA; XING, Xu, IVPP, Beijing, China; FORSTER, Catherine, George Washington University, Washington, DC, USA

Basal coelurosaur fossils are uncommon and usually fragmentary. We report here on a new and relatively complete theropod specimen from the Upper Shishugou Formation, Xinjiang, People's Republic of China. The specimen, discovered in 2001 by the Sino-American Field Expedition at the Wucaiwan locality, offers further insight into the morphological characteristics of the earliest coelurosaurs, the theropod group that includes birds. Extensive radiometric dating of volcanic tuffs at Wucaiwan constrains the age of the specimen to between 158.7 ± 0.3 mya and 161.2 ± 0.2 mya, approximately at the beginning of the Late Jurassic. We present a comprehensive cladistic analysis of the Coelurosauria, based on the theropod working group matrix, including 65 ingroup taxa and 23 taxa in a multilayered outgroup. This analysis places the new taxon as the basalmost coelurosaur known from relatively complete material, sister to the very poorly known species *Tugulusaurus faciles* from the Early Cretaceous of Xinjiang. The new specimen adds considerably to our knowledge of the cranial and axial morphology of the earliest and most primitive coelurosaurs. It increases the diversity of the theropods recovered from deposits at Wucaiwan and confirms the prediction made from ghost lineage studies that coelurosaurs had started to diversify by the earliest Late Jurassic.

Poster Session III (Friday)

#### CRETACEOUS CARBON ISOTOPE VALUES FROM THE CERRO NEGRO FORMATION, ANTARCTICA

CHRISTOPHER, STRGANAC, Southern Methodist University, Dallas, TX, USA; NISHIDA, Yosuke, Southern Methodist University, Dallas, TX, USA; JACOBS, Louis, Southern Methodist University, Dallas, TX, USA; HOOKER, Jerry, Natural History Museum, London, United Kingdom; MACPHEE, Ross, American Museum of Natural History, New York, NY, USA

Dinosaurs and other terrestrial vertebrates inhabited high latitudes of both the northern and southern hemispheres during the Cretaceous Period. This vertebrate distribution was superimposed on abundant and widespread temperate forest vegetation, including forests preserved at high latitudes where none exists today, documenting a warmer global temperature for the Cretaceous. In addition, Cretaceous warmer temperatures manifested a shallower latitudinal temperature gradient than at present. The Cerro Negro Formation of Livingston Island, Antarctica, preserves a middle Aptian (119-120 Ma) floral assemblage, indicating a temperate forest at paleolatitude 59° S. No fossil vertebrates are yet known from the Cerro Negro Formation. Published  $\delta^{13}\text{C}$  values from Texas (in the middle latitudes of the Northern Hemisphere) and Australia (then joined to Antarctica) show a 2‰ offset, suggesting that there may be a gradient in organic carbon values as well as temperature. The cause of the putative carbon offset is unknown, but probably relates to the vegetation from which it derived, and therefore understanding the carbon isotopic variation may supply data concerning the environment of high latitude plants, and by extension, of vertebrates. Carbonized wood recently collected from the Cerro Negro Formation yields  $\delta^{13}\text{C}$  values between -25‰ and -24‰, similar to the values from Australia during the middle Aptian, which supports the validity of a latitudinal gradient in plant-derived  $\delta^{13}\text{C}$  and extends paleoenvironmental data for Cretaceous polar environments.

Poster Session I (Wednesday)

#### AN UNDESCRIBED MIDDLE DEVONIAN BONE BED WITHIN THE BOYLE FORMATION

CIAMPAGLIO, Charles, Wright State University, Dayton, OH, USA; JAMES, John, Wright State University, Dayton, OH, USA; RIEGE, Benjamin, Wright State University, Dayton, OH, USA

A paleontologically important, well preserved macro- and micro-vertebrate fauna was obtained from a previously undescribed site within the Middle Devonian (Givetian) Boyle Formation. The exposure consists of a series of road-cuts located on the west side of KY Rt. 89, approximately two miles south of the town of Mina. The outcrop exposes approximately 6 meters of the Boyle Formation, which is unconformably underlain by Late Ordovician Ashlock Formation, and overlain by 3 meters of the Late Devonian New Albany Shale. The previously undescribed bone-rich bed occurs within a distinct, 10 cm layer that spans portions of the exposure. The lithology of the layer consists of an olive-gray to brownish-gray, fine to medium-crystalline dolomitic limestone. Copious well preserved macro- and micro-vertebrate remains and phosphatic nodules are scattered primarily on the upper surface and within the upper two- to three centimeters of the layer. Macro-vertebrate remains include disarticulated arthrodiapophyses and isolated skeletal elements, as well as sarcopterygian tooth plates and teeth. Micro-vertebrate material consists of abundant conodont elements, acanthodian and paleonisciform actinopterygians scales, chondrichthyan dermal denticles and teeth. Chondrichthyan are represented by the cladoselachids *Stethacanthus* and *Symmorium*, by the phoebodontids *Phoebodus* and *Thrinacodus*, by members of the genus *Protacrodus*, as well as several undescribed species. Stratigraphically, the Mina bone bed layer occurs within the Kiddville Member of the Boyle Formation, yet does not appear to correspond to any bone beds described therein. Surprisingly, the vertebrate fauna appears to be similar to Late Devonian faunas described within the Ohio Shales of Central and Northeastern Ohio. Given this discrepancy, future work will focus on careful lithostratigraphic, sequence stratigraphic, and biostratigraphic analysis, as well as faunal correlation with other Late Devonian faunas in the Midwest.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

#### ANGEL SHARK FETUSES REVEAL NEW INFORMATION ABOUT FOSSIL JUVENILE RELATIVES

CLAESON, Kerin, Museum fuer Naturkunde, Berlin, Germany

Angel sharks (Elasmobranchii: Squatinidae) are a successful group of dorsoventrally flattened sharks with juvenile and adult fossil representatives preserved in lithographic limestones of southern Germany. Seven juveniles of *Squatina alifera* from the Late Jurassic of Solnhofen were examined and compared to fetal specimens of four extant species of *Squatina* (*S. dumeril*, *S. guggenheim*, *S. punctata*, and *S. squatina*) in an effort to identify potential growth-trajectory characters for phylogenetic study. Comparisons were based primarily on x-rays and CT scans. Results indicate several important morphological differences between fossil and extant species, supporting previous hypotheses that the Jurassic squatinids are justifiably assigned to a different genus, †*Pseudorhina*. †*Pseudorhina alifera* are of similar size to each other (TL = 143mm–149mm) and are preserved in both ventral and dorsal views. Extant fetuses measured 190mm–300mm. Notable similarities are basiventral processes, vertebral centra, and neural arch components that create a tight, though unfused, element at the anterior-most part of the vertebral column, and a rostrally

displaced anterior neurocranium in both fossil and extant specimens. Differences include, but are not limited to, the presence of small, tightly-packed, non-overlapping rounded-denticles with a short anchoring-neck. These denticles marginate the anterior border of the neurocranium and the paired fins of †*P. alifera*, but are absent in extant *Squatina*. The basiventrals of †*P. alifera* are less laterally expanded than those in *Squatina*, and vertebral hemicentra are larger proportionally in †*P. alifera* than they are in *Squatina*. A uniformly robust and markedly curved coracoid bar is present in †*P. alifera*, but *Squatina* has a straighter, gracile coracoid bar. Additionally a rectangular propterygium lacks an anterior lobe in †*P. alifera*. This study demonstrates that phylogenetic data are recoverable in the early life stages of these taxa. A preliminary phylogenetic analysis excluding adults indicates that †*P. alifera* is sister to a monophyletic *Squatina* in which *S. punctata* is the most basal extant taxon.

Technical Session X, Friday 8:45

#### A REEVALUATION OF PREPUBIC SKELETAL ELEMENTS IN ARCHOSAURS

CLAESSENS, Leon, College of the Holy Cross, Worcester, MA, USA; VICKARYOUS, Matthew, University of Guelph, Guelph, ON, Canada

Many historical descriptions of the archosaur pelvis recognized a fourth element located anterior to and in close contact with the pubis. This element, the prepubis (= praepubis, epipubis, os marsupiale), was well known to many 19<sup>th</sup> century anatomists but has received little attention since. To date, the identity and homology of prepubic skeletal elements remains unclear. Most of the confusion surrounding the validity and distinctiveness of the prepubis as a discrete element stems from a series of misinterpretations. Among crocodylians, previous developmental studies documented an additional proximal cartilage condensation contributing to the pelvis. Using embryonic *Alligator* material we demonstrate that this putative fourth element is instead an unmineralized portion of the ischium. We interpret the 'prepubis' in pterosaurs to represent either a distal segment of pubis, which articulated with the remainder of the pubis (or pubic portion of the puboischial plate) through a syndesmotical or synovial joint, or a neomorphic element. In ornithischians, the identification of a prepubis seems to be based on an early misidentification of sternal plates. Regrettably, some authors later transferred the term prepubis to the anterior pubic process of the ornithischian pubis, a practice that should be avoided. Among birds, the tuberculum preacetabulare (processus pectinealis) has also been referred to as a prepubis, despite its iliac origin in most neognaths. With the possible exception of pterosaurs, there are no data to support the presence of a prepubic element among archosaurs. The revised interpretation of pelvic structure in crocodylians and pterosaurs permits a reevaluation of pelvic evolution and function. Movement of the pubic bone in extant alligators and its role in lung ventilation is, in part, enabled by the loss of connection with the ilium. The evolution of the puboischial joint can be traced back to Early Jurassic crocodyliiforms. Considering the structural similarities between the crocodyliiform pubic and the pterosaur prepubic complex, pterosaurs appear to have independently evolved a comparable accessory lung ventilation mechanism.

Poster Session III (Friday)

#### PRELIMINARY INVESTIGATION OF MICROSCOPIC INTEGRITY AND MOLECULAR PRESERVATION IN NEWLY EXCAVATED DINOSAURS

CLELAND, Timothy, North Carolina State University, Raleigh, NC, USA; SCHWEITZER, Mary, North Carolina State University, Raleigh, NC, USA

Soft tissue has been recovered from late Cretaceous dinosaurs of Montana, indicating the presence of a depositional facies conducive to preserving organic material on the molecular level. The mode of preservation is unknown; however, iron-induced crosslinking has been proposed as a possible mechanism for preservation of these components. To test the hypothesis that iron is part of the chemical pathway of preservation of these tissues that may be responsible for the persistence of these soft tissues, additional dinosaur bony elements were collected without preservatives, using a field collection protocol designed to reduce chances of contamination or artifact. These specimens were demineralized within days of collection to verify the presence of soft tissues, and either embedded and sectioned, or chemically extracted, then subjected to multiple analyses to characterize these components. Histochemical and immunostaining were performed to detect and identify remnant endogenous organics preserved within the soft tissues. The sections were examined using analytical transmission electron microscopy (TEM) to determine the presence and elemental compositions of high-density minerals associated with the preserved tissues. The microstructures preserved within the dinosaur were then chemically compared to extant ostrich vessels derived from long bone elements. The vessels were incubated in a concentrated solution of hemoglobin, as a proxy for naturally occurring processes proposed to occur during death and degradation. Comparing the chemical changes in ostrich vessel, including resultant mineral precipitation in vessel walls, provides a model for early diagenetic chemical pathways that may have assisted in the preservation of dinosaur soft tissue structures. Developing testable models of rates and processes that may result in the preservation of cells and vessels is critical because current understanding of fossilization and/or degradation does not allow for the persistence of these soft tissue structures across geological time.

**GEOCHEMICAL RECONSTRUCTION OF THE FEEDING ECOLOGY AND HABITAT PREFERENCES OF REMINGTONOCETIDS**

CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA; BAJPAI, Sunil, Indian Institute of Technology, Roorkee, India; THEWISSEN, J.G.M., Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA

Remingtonocetids are an early group of archaeocetes whose fossils have been recovered from middle Eocene deposits in India and Pakistan. The skull morphology and sensory adaptations of this group are quite distinct from those of other archaeocetes and suggest unique habitat and/or dietary specializations. Along with a proportionately greater snout length, remingtonocetids differ from other archaeocetes in significantly reducing the size of the eye. When combined with enhancements in the size and structure of the ear, smaller eyes suggest that vision may have played a minor role to underwater hearing when these animals were locating prey. This de-emphasis on vision is also seen in living freshwater and estuarine cetaceans that spend a significant amount of time in murky or low visibility waters, and suggests that remingtonocetids may have had similar ecological preferences. To test this interpretation, we analyzed the stable isotope composition of fossilized tooth enamel from remingtonocetids and sediments associated with these fossils. Enamel  $\delta^{13}\text{C}$  values are related to diet and are labeled by the  $\delta^{13}\text{C}$  value of primary producers at the base of a food web. The carbon isotope composition of sedimentary organic matter and carbonates is also related to the types of primary producers present in an ecosystem, and can serve along with enamel  $\delta^{13}\text{C}$  values as a proxy for an animal's habitat and foraging preferences. Sediment samples were taken from archaeocete fossil localities in Kutch, western India. At each locality, sediments were collected from below, within, and above the sedimentary layers from which remingtonocetid fossil specimens had been previously collected. The carbonate and organic matter fraction was then separated from each sample and prepped for carbon isotope analysis. Enamel samples were taken from multiple specimens of the remingtonocetids *Remingtonocetus* (n = 10) and *Andrewsiphius* (n = 3) that are housed at the India Institute of Technology in Roorkee. Carbon isotope analyses of these specimens and associated sediments will provide further evidence as to whether this interesting group of early whales favored freshwater, estuarine or marine habitats.

Romer Prize Session, Thursday 8:30

**BIOMECHANICS AND EVOLUTION OF UNGULIGRADY IN CETARTIODACTYLA**

CLIFFORD, Andrew, Brown University, Providence, RI, USA

Unguligrady is a key innovation in ungulates, yet its biomechanical significance remains unknown. Digit loss and ligamentous replacement of interosseus muscles accompany the transition from digitigrady to unguligrady. Unguligrade cetartiodactyls have evolved a paraxonic foot emphasizing digits III and IV, but there is variation in digit number and degree of reduction. Interosseus ligaments (IL) reduce multi-functionality of the foot and maintain an elevated metacarpophalangeal (MCP) joint. During locomotion, the IL and digit flexors produce torque opposing the ground reaction force (GRF), which tends to extend (collapse) the (MCP) joint. I tested the hypothesis that the IL resists torque at the MCP through combining kinematic data with kinetic data collected *in vivo* and in a reduced *in vitro* preparation. Because extant suids serve as anatomical intermediates between ancestral digitigrade foot types and the didactyl limb of most extant terrestrial cetartiodactyls, I used mini-pigs run in a trackway to calculate torque at the MCP joint using inverse dynamics. *In vitro* preparations of the ligament and its attachment sites with simulated GRFs permit calculations of torque resisted by the IL alone. The ratio between the two yields the contribution of the IL to total joint torque. The IL produces >80% of the joint torque resisting the GRF at the MCP joint, indicating that the IL is a critical mechanical component of the MCP joint. The replacement of muscular interossei with ligaments permits unguligrade taxa to add leg length without increasing metabolic demand on muscles to resist torque in the MCP joint. Longer legs permit greater stride length and thus less expensive locomotion if cost per stride is kept constant, so unguligrade taxa experience energy savings compared to digitigrade ancestors. More derived taxa evolve relatively longer distal leg segments that permit yet cheaper locomotion and possibly emphasize elastic energy storage at the IL. The derived, highly cursorial limbs of most extant terrestrial cetartiodactyls are exaptations of limbs that first evolved a more efficient unguligrade stance.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 9:15

**TEGOLEPIS: SOMETHING UNUSUAL FROM THE EARLY RECORD OF ACTINOPTERYGIAN FISHES**

COATES, Michael, University of Chicago, Chicago, IL, USA; FRIEDMAN, Matt, University of Chicago, Chicago, IL, USA

The diversity of Devonian actinopterygian fishes falls far short of that known from the Mississippian. Devonian actinopterygian evolution tends to be presented as *Cheirolepis*, the traditional stand-in for acanthodian-like primitive osteichthyan conditions, giving rise to *Mimia* and *Moythomasia*, which then yield a radiation of similar forms grouped as 'palaeoniscids' scattered throughout the remainder of the Paleozoic. In contrast to our rudimentary knowledge of these earliest actinopterygians, far more research attention has focused on Devonian sarcopterygians, and as a result we have a much more detailed picture of diversity at the base of lungfishes, coelacanth and tetrapods. Better knowledge

of *Tegeolepis clarki* (Newberry), an actinopterygian from the Cleveland member of the Upper Devonian Ohio Shale, should help rectify this imbalance of information. *Tegeolepis* is extraordinary for several reasons: its large size, its peculiar skull shape with long pointed snout, and the incongruently advanced condition of several features in the cranial skeleton. When included in phylogenetic analyses, *Tegeolepis* has behaved as something of a wild card taxon, with little consistency apparent between alternative hypotheses of sister-group relationships. Our research is building upon the currently available outline description, and we will present new data on the condition of the jaws, dentition, braincase, hyoid arch and paired fins. In several respects, features of *Tegeolepis* resemble conditions described in recently reported sarcopterygians from the earliest Devonian. *Tegeolepis* is likely to add significantly to the emerging picture of morphological diversity among early crown-group osteichthyans.

Fossils and the Evolutionary Patterns of Ostariohysans, One of the Largest Vertebrate Clades, Saturday 8:45

**THE OTOPHYSAN WEBERIAN APPARATUS: FREEDOM FROM PRIOR RESTRAINT?**

COBURN, Miles, John Carroll University, University Heights, OH, USA

The Weberian apparatus, consisting of modified anterior vertebrae, is among the most important character complexes in the systematics of otophysan fishes. It is a unique synapomorphy for this clade and is also highly diversified in otophysan subgroups. Since some evolutionary transformations seen in adult otophysans are still unclear, a deeper understanding of how these anterior vertebrae become modified is essential for making homology statements. Using larval cleared and stained and sectioned specimens representing three otophysan lineages, a gonorynchiform, a clupeiform, and an osmeriform, the role of intermuscular myosepta in the formation of pleural ribs was examined. Typically, ribs form in the connective tissue junction of segmental myosepta with the peritoneum. While the anterior myosepta are present in otophysans, they are not well developed especially close to the vertebrae. During the formation of the otophysan tripus, a modified pleural rib and parapophysis of vertebra 3, and the modified parapophysis + rib of vertebra 4, cartilaginous basiventrals are enlarged and grow in a ventral orientation, freeing the basiventral tip from the myoseptum. Subsequently, membrane ossifications at the tips of the basiventrals diverge sharply from their respective myoseptae, forming the transformer process of the tripus and the os suspensorium of vertebra 4. In the former, the process grows in a ventroposterior direction and, in the latter, the os grows ventromedially. In both cases, these ossifications occur prior to pleural rib ossification in succeeding vertebrae. This study suggests that a key step in the evolution of these and other elements of the Weberian apparatus may have been freeing the developing vertebrae from the influence of the pre-existing myoseptal framework through a reduction of the anterior myoseptae and hypertrophy of some cartilages combined with the capability of otophysans to ossify connective tissues outside the myoseptae. Until the organization of these additional connective tissues is better understood, a full understanding of the homology of all elements of the apparatus will be difficult to realize.

Poster Session II (Thursday)

**THE CRANIAL ENDOCAST OF A NEW FOSSIL PORPOISE (ODONTOCETI: PHOCOENIDAE) FROM THE PLIOCENE OF SAN DIEGO, CALIFORNIA**

COLBERT, Matthew, University of Texas at Austin, Austin, TX, USA; RACICOT, Rachel, University of Texas at Austin, Austin, TX, USA

An undescribed species of fossil porpoise from the Pliocene San Diego Formation of San Diego, California possesses some of the most unusual cranial morphology thus far recorded within Phocoenidae. Most notably, it has an extremely elongated mandibular symphysis that extends well beyond the anterior maxillae. The phylogenetic relationships of this fossil to other phocoenids have not been determined, and relationships within Phocoenidae are generally not well resolved. Here we evaluate the potential of character data from endocasts based on CT data for phylogenetic analysis. Endocasts document not only the hydrostatic shape and size of the brain, but also circulatory and meningeal features recorded as impressions and canals on the cranial cavity walls. We analyzed endocasts from all six extant porpoise species, as well as the new fossil, and assessed patterns of intraspecific variation using a sample of six harbour porpoises (*Phocoena phocoena*). Characters varying between samples include the prominence of particular vascular channels (e.g., the fossil has branched anterior spinal meningeal canals unlike the unbranched condition seen in *Neophocoena* and others), the degree of flattening of the dorsal anterior telencephalon (e.g., the fossil's flattened telencephalon is comparable to *P. dioptrica* and *Ph. dalli*), and various other features related to size, shape and proportions (e.g., the volume of the fossil endocast is second only to *Ph. dalli*). The systematic consistency of these characters was evaluated by optimization onto existing molecular and morphological phylogenies. Preliminary analysis of intraspecific variation in the *P. phocoena* sample resulted in surprisingly low coefficients of variation (CV) in contrast to the CV of all phocoenid species. For example, the CV of endocast length was 1.6% for the *P. phocoena* sample, compared to a CV of 12.3% for all phocoenid species pooled. This suggests morphological constraint within phocoenid species that may have evolutionary significance, and that the inclusion of endocast characters may provide additional evidence to clarify the phylogenetic relationships of the undescribed fossil.

Technical Session XII, Friday 10:30

**A STIRRUP IN THE PALEO-SCENE. A NEW LINE OF EVIDENCE FOR INVESTIGATING CEREBRAL CIRCULATION PATTERNS IN FOSSILS**

COLEMAN, Mark, Midwestern University, Glendale, AZ, USA; BOYER, Doug, Stony Brook University Medical Center, Stony Brook, NY, USA

Cranial circulation patterns have proven useful for reconstructing phylogenetic relationships at various taxonomic levels. This is particularly true of the arteries of the brain. Extant primates are characterized by having one of three branches of the carotid arteries that provide the majority of blood to the cerebral hemispheres: anthropoids show dominance of the promontory artery, most lemuroids show dominance of the stapedia artery, and lorisooids show dominance of the ascending pharyngeal artery. Because these arteries leave various bony markers of their presence, these patterns can often be reconstructed in fossil taxa. This study documents a novel line of evidence for inferring the presence or absence of the stapedia artery in extant primates and closely related taxa and uses this data to explore the cerebral blood supply pattern in an extinct primate species. We assessed the relationship between the presence or absence of the stapedia artery and stapes morphology by comparing the area of the obturator (stapedia) foramen with the overall size of the stapes as measured by the long axis of the stapedia footplate in a sample of over 40 species of primates (>150 specimens), including individuals representing all three major cerebral blood supply patterns. Obturator foramen area and footplate length were measured by taking digital photographs under low magnification. It was found that taxa with stapedia artery dominance have a relatively larger obturator foramen than those with other blood supply patterns. This is the first study to document this relationship. Using these data, stapedia artery presence was investigated in *Plesiadapis tricuspidens*, a ~57 million year old extinct plesiadapiform. The actual specimen assayed is a previously undescribed stapes contained within an isolated petrosal bone. The fossil was imaged using high resolution x-ray computed tomography, and the stapes was digitally extracted. The specimen clearly groups with the extant taxa that do not have a functional stapedia artery, agreeing with previous suggestions about this species.

Technical Session III, Wednesday 3:15

**NEW DATA ON THE EVOLUTION OF VARANIDAE (SQUAMATA: GOANNASAURIA)**

CONRAD, Jack, AMNH, New York, NY, USA; GAO, KeQin, Peking Univ, Beijing, China; AST, Jennifer, Univ. of Michigan, Ann Arbor, MI, USA; RIEPPEL, Olivier, The Field Museum, Chicago, IL, USA; GRANDE, Lance, The Field Museum, Chicago, IL, USA

Varanidae (Monitor Lizards and their relatives) is a diverse clade of extant and fossil squamates known from four continents and spanning nearly eight orders of magnitude in adult mass. *Varanus* fossils are unknown before the Miocene, and now includes more than 60 extant species across Africa, southern Asia, and Australia. Although various fossil forms have been suggested as being close to the ancestry of this group, few phylogenetic analyses have addressed these fossils and with little consensus. A new taxon from the Cretaceous Gobi, *Ovoogurval*, is the smallest fossil varanid known. This tiny lizard may be close to the varanine-lanthanotine split. A new specimen of *Saniwa ensidens* reveals new data about the skeleton of this North American Eocene varanid. We incorporated data from these specimens into a phylogenetic analysis of Varanidae. Our preliminary analysis looked at global lepidosaur relationships to help identify outgroups and included 303 species and 509 morphological characters. We also performed a combined-evidence analysis for Anguimorpha, including 2033 molecular characters. Our analyses revealed that some taxa typically referred to Varanidae are non-varanid goannasaurids (e.g., *Proplatynotia*). Proximal outgroups to Varanidae (s.s.) include *Necrosaurus cayluxi* and *Saniwides mongoliensis*. We also ran a combined evidence analysis of anguimorph relationships. Varanid status for "*Saniwa feisti*" and *Telmasaurus grangeri* were variable between the analyses. The African Miocene taxon *Varanus rusingensis* was always nested within *Varanus*. Varanidae is primarily an Asian clade, probably originating in the Cretaceous. In contrast to the relatively large monstrosaurids with which they shared their environment (e.g., *Estesia mongoliensis*), Cretaceous Gobi varanids remained relatively small (>5cm skull length). However, varanid diversity and distribution greatly expanded in the Cenozoic, and may have accelerated in the Neogene.

Technical Session II, Wednesday 12:15

**GOOGLE EARTH, GIS, AND THE GREAT DIVIDE**

CONROY, Glenn, Washington University Medical School, St. Louis, MO, USA; ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA; VAN REGENMORTER, John, Western Michigan University, Kalamazoo, MI, USA; ADDISON, Aaron, Washington University, St. Louis, MO, USA

Geographic Information Systems (GIS) is a powerful tool for geospatial analyses. Here we show how paleontological data can be easily displayed and communicated by combining GIS and Google Earth™; specifically how GIS map layers and their associated attribute tables (e.g., field catalog data) can be transmitted as email attachments to anyone with access to Google Earth™, even to those having no knowledge of, or access to, GIS. These email attachments are then simply "dragged and dropped" by the recipient onto their own desktop Google Earth™ display where they immediately appear, correctly georeferenced, draped over the Google Earth™ landscape. All graphics and attributes of each map layer exported from GIS, as well as all Google Earth™ tools (e.g., adjustable map layer transparencies,

labeling, spatial coordinate determinations, linear distance measurements, tilting of landscapes for enhanced 3-D viewing) are functional and automatic. We demonstrate the power, and ease, of this method by using paleontological field data derived from Anemone's Great Divide Basin Project. The Great Divide basin, a large (ca. 4000 square miles) sedimentary basin in southwestern Wyoming, consists of well over a thousand meters of mostly flat-lying sedimentary rocks of the Paleocene Fort Union Formation and the Eocene Wasatch, Green River, and Bridger Formations. Google Earth™, as a powerful and freely downloadable geographic visualization tool, is accessed daily by thousands of users worldwide, thus opening up enormous possibilities for the free and easy dissemination of paleontological information in a visually meaningful and stimulating way to students, colleagues, and the interested general public, around the world.

Poster Session IV (Saturday)

**METASCHIZOTHERIUM FRAASI KOENIGSWALD (PERISSODACTYLA: CHALICOTHERIIDAE) FROM PETERSBUCH, SOUTHERN GERMANY: NEW INSIGHTS INTO SCHIZOTHERIINE MORPHOLOGY AND PHYLOGENY**  
COOMBS, Margery, University of Massachusetts, Amherst, MA, USA; FAHLKE, Julia, Bonn University, Bonn, Germany

The claw-bearing perissodactyl family Chalicotheriidae is represented by two subfamilies, Chalicotheriinae and Schizotheriinae, in middle Miocene faunas of Europe. Schizotheriinae from this time period have been poorly known, but recently new, more complete, mid-Miocene material of *Metaschizotherium* has been discovered. At least four karst fissure fillings in the quarry of Petersbuch, Franconian Alb, Southern Germany, have yielded new finds of *Metaschizotherium fraasi*, which are dated to MN 6 by means of biostratigraphic correlation of the accompanying mammalian fauna. Despite their widespread presence in Europe at this time, no remains of the Chalicotheriinae have been recovered from this locality. *M. fraasi* had previously only been known from its cheek teeth, co-ossified phalanges, and astragalus and calcaneum. Thus, previously unknown unique characters of the jaw, the almost complete manus and pes, and several long bones have now been identified and are presented for the first time. New information elucidates the morphology of most of the dentition, including well-developed lower incisors. A comprehensive morphological comparison with other derived schizotheriines is carried out. *M. fraasi* is clearly distinguishable from the slightly older species *M. bavaricum* from Häder and Sandelzhausen (MN 5), also Southern Germany, by its larger body size, the position of articular surfaces between the tarsals and metatarsals, and especially by the more derived P4. Yet there are many striking similarities between the two species. Referral of *Metaschizotherium* to the later Eurasian and African genus *Ancylotherium* is once more rejected due to different morphologies of almost all skeletal elements. *M. fraasi* shares many morphological characters, primarily involving the carpals, tarsals, and tibia, but also the jaws and teeth, with representatives of the North American schizotheriine genus *Moropus*. It especially resembles the early Barstovian species *Moropus merriami*. This resemblance may imply a close relationship between the European and the American Schizotheriinae and sheds new light on early to middle Miocene patterns of distribution and intercontinental migration.

Technical Session XVII, Saturday 10:45

**AQUATIC LIFESTYLES IN EOCENE RAOELLID ARTIODACTYLS AND ANTHRACOBUNID TETHYTERES**

COOPER, Lisa Noelle, NEOUCOM, Rootstown, OH, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA; THEWISSEN, J.G.M., NEOUCOM, Rootstown, OH, USA; BAJPAI, Sunil, Indian Institute of Technology, Roorkee, Roorkee, India; TIWARI, B.N., Wadia Institute of Himalayan Geology, Dehra Dun, India

Semi-aquatic taxa typically display thickened cortices of their long bones. This characteristic has evolved in several distantly related vertebrates, such as modern shallow diving birds, marine iguanas, *Hippopotamus*, some pinnipeds, and sea otters. An increased deposition of mineral in long bones provides ballast to counteract buoyancy and allows these taxa to expend little energy when wading and foraging at shallow depths. By integrating quantitative measures of bone thickness and isotopic values of tooth enamel, we tested the hypothesis that two lineages of extinct mammals, raoellid artiodactyls and anthracobunids, an extinct lineage of basal tethyteres, occupied a semi-aquatic niche. Based on micro-CT scans of appendicular bones, the ratio of medullary to total bone thickness was measured in the raoellid *Indohyus* (n=8), and two genera of Anthracobunidae (n=5) and compared with those of extant taxa. Results indicate that all appendicular bones of *Indohyus* displayed a medullary cavity that ranged from only 25-47% of the total bone width. This range of values falls well below the ratios calculated in the limbs of terrestrial vertebrates (60-75%). Oxygen isotopic values taken from dental enamel showed values well below those of terrestrial taxa, suggesting that *Indohyus* lived in water. Medullary cavity ratios display a broad range of values (50-76%). Bones of *Anthracobune* displayed only slightly thickened cortices compared to terrestrial taxa, however the cortex was filled with massive trabecular struts. These struts were present throughout the medullary cavity, and were much thicker than those of their terrestrial counterparts. This finding suggests that *Anthracobune* was weighting the skeleton by trabecular bone hyperostosis, rather than just thickening the bony cortex. Oxygen isotopic values indicated *Anthracobune* occupied an aquatic niche. Taken together, our results indicate that the raoellid *Indohyus* and the anthracobunid *Anthracobune* occupied a semi-aquatic niche, and that these genera evolved different means of weighting the skeleton.

Romer Prize Session, Thursday 8:15

**ASSESSING THE STATISTICAL SIGNIFICANCE OF CONFLICT IN MORPHOLOGICAL PHYLOGENETICS**

CORFE, Ian, University of Helsinki, Helsinki, Finland

Evolutionary analyses that include extinct taxa are frequently based on the phylogenetic results from parsimony analyses of morphological datasets. Differing phylogenetic results from separate datasets can lead to alternative, sometimes conflicting evolutionary hypotheses. This study aims to evaluate the properties of existing techniques for identifying statistically significant conflict (SSC) between competing phylogenetic hypotheses, and to develop new methods and metrics where required. By identifying factors that contribute towards SSC rather than perceived conflict, it becomes possible to focus research efforts more effectively to increase the accuracy of phylogenetic results and our confidence in evolutionary hypotheses generated from them. Parameters that may contribute towards SSC range from choice of taxa and characters, through character scoring differences, to the character coding and analytical methods used. Specific tests were applied to individually control for parameters affecting SCC. Two recent, comprehensive phylogenies of the Sauropoda were analysed as a case study, from which to draw both specific and more generally applicable conclusions. Results show that the effects of individual characters are highly context dependent. For example, characters scored identically for a single taxon in the two datasets may support conflicting phylogenetic relationships. Conversely, a character scored differently in the two datasets can support the same relationship. Furthermore, not all sauropod taxa previously conceived to be contributing towards conflict between competing phylogenies do so in a statistical sense. The use of phylogenetic hypothesis robustness methods for identifying conflict may not recover all SSC cases. Controlling for taxon choice does not eliminate overall SSC between the sauropod datasets, and given that analytical methods are the same, character choice, coding and scoring must be responsible for the SSC. Finally, a set of methodological recommendations is presented to enable the comparison of conflicting phylogenetic hypotheses, and guide the use of techniques for investigating them and identifying SSC causing parameters.

Preparators' Session, Thursday 10:45

**AN EXPLANATION OF THE CHALLENGES AND TECHNIQUES FOR THE EXTRACTION AND TRANSFER OF LARGE WALL PLAQUES**

CRAWFORD, Brett, Research Casting International, Trenton, ON, Canada; FAIR, Matt, Research Casting International, Trenton, ON, Canada; KRUDWIG, Kevin, Research Casting International, Trenton, ON, Canada

Many museums are faced with the inherent problem of re-furbishing their exhibit halls in order to present their visitors something new and exciting. There appears to be a current trend where many museums are finding themselves with exhibits that are well outdated, going back 60 or 70 years or even further. These exhibits were often created with a "last forever" approach in which they were constructed and installed in a more permanent manner. Though many of the smaller exhibits have been dealt with in house, museums are finding that they require a little more assistance with the larger exhibits, especially the large and weighty wall mounts or plaques. Most of these wall plaques are original composites of fossil discovered in situ and sculpted parts made of plaster. The entire plaque is often surrounded and reinforced by massive amounts of diamond lathe, hard wood, steel and especially plaster. A lot of these plaques are also in need of repair due to many factors. Gravity pulling on the tremendous weight of the materials and the effects of prolonged climate changes have created cracks, crumbling and unnecessary stresses on priceless fossils. Even though the plaques may measure 25 feet long and weigh thousands of pounds, it is still possible to extract the plaques from the wall as one unit. This is done by creating a specialized steel frame around the plaque which supports the weight of the plaque in an even manner and allows the plaque to be wheeled away to a new location or destination. This method has been used on numerous occasions. Whether the plaques needed to travel a lengthy distance within the museum or simply as a cosmetic repair within the exhibit hall, they have been removed and transferred all with the successful preservation of the specimen.

Technical Session XIII, Friday 1:45

**A NEW EARLY/MIDDLE MIOCENE FAUNA FROM SOUTHERN BOLIVIA**

CROFT, Darin, Case Western Reserve University, Cleveland, OH, USA; ANAYA, Federico, Universidad Autónoma Tomás Frías, Potosí, Bolivia

Nearly all Tertiary fossil localities in South America come from temperate latitudes. The few low latitude faunas presently known are scattered in space and time, providing only glimpses of Neotropical paleocommunities. A biased record such as this is inadequate for understanding the development of modern faunas, and discovery of additional Neotropical faunas therefore should be a top priority for paleontologists. We here provide a preliminary report of a new Neotropical mammal fauna from the "Estratos de Cerdas" near 21° S latitude, about 60 km southeast of Uyuni, Bolivia. A paleomagnetic section with associated radioisotopic dates constrains the fossiliferous horizons to ca. 16.5–15.3 Ma (late early to early middle Miocene). Fossils were first reported from the area in 1972, but no mammals other than mesotheriid notoungulates had been noted by investigators. Our team of geologists and paleontologists collected 72 new mammal specimens from Cerdas during a brief visit in 2007, increasing taxonomic representation to nine families and twelve species. The most common mammals at Cerdas are mesotheriid notoungulates; many partial dentitions and several skulls of "*Plesiotypotherium*" minus and/or

*Microtypotherium choquecotense* have been collected. Other Cerdas notoungulates include a very small hegetotheriine (75% the size of *Hegetotherium mirabile*), two interatheriines (one resembling *Prototypotherium attenuatum* but with more reduced premolar talonids, the other 25% smaller with a tiny middle lobe on M1), and a toxodontid (*Palyeiodon* sp.). A metatarsal and a partial mandible from a small macraucheniid litoptern may pertain to a new species. Osteoderms of at least three armadillos have been collected: a peltephilid (?*Epiplatelphillus*), a eutatin dasyopod (*Stenotatus* cf. *S. planus*), and a euphractin dasyopod (?*Prozaedyus* sp.). A partial mandible records the presence of the megatheroid sloth *Xyophorus villarroeli*. The only rodent collected thus far is a lagostomine chinchillid, likely *Prolagostomus*. These species represent a mix of Cerdas endemics, species present in contemporaneous Chilean and Argentine faunas, and species present in Bolivian faunas of different age.

Poster Session II (Thursday)

**DOCUMENTATION OF PATHOLOGICAL VERTEBRAE IN THE PLEISTOCENIC GIANT SLOTH *EREMOTHERIUM LAURILLARDI* FROM THE STATE OF PERNAMBUCO, BRAZIL**

CRUZ, Monalise, Museu Nacional, Rio de Janeiro, Brazil; HENRIQUES, Deise, Museu Nacional, Rio de Janeiro, Brazil

By the end of 1930s and the beginning of the 1940s, the Brazilian naturalist Ney Vidal, collected a spectacular amount of Pleistocene mammalian specimens in the municipality of Pesqueira, Pernambuco State, northeastern Brazil. A great part of the collected specimens was sent to the Museu Nacional, in Rio de Janeiro, and they are now housed in the Paleovertebrate Collection of this museum. During the last years, paleopathological analyses and taphonomic considerations have been done for the understanding of the behavior and paleoenvironmental conditions that those elements were submitted to. In regard to the study of the giant sloth *Eremotherium laurillardi*, 24 of the 25 vertebrae collected presented signals of lesions. The most striking one is a possible Schmorl's node, a lesion related more commonly to repetitive mechanical stress and degeneration of the vertebral column due to old age. It was observed in a caudal vertebra centrum, which still needs to be submitted to a tomographic study. In this element, the lesion is surrounded by reactive bone indicating that some weeks were necessary for the development of it, and the repetitive mechanical stress is here considered. Also, just one of all analyzed elements was considered as a juvenile indicating an old assemblage. Osteophyte formation is evident on some of the specimens. Signals of infection, deformations for overload and muscular stress, as well as healing processes could be noticed in some elements. Not healed traumas were observed. The pathological lesions related to the caudal vertebrae may be due to the bipedal posture that the individuals of this group can assume.

Technical Session XIX, Saturday 3:15

**A BONEBED OF *AVIMIMUS* SP. (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS NEMEGT FORMATION, GOBI DESERT: INSIGHTS INTO SOCIAL BEHAVIOR AND DEVELOPMENT IN A MANIRAPTORAN THEROPOD**

CURRIE, Philip, University of Alberta, Edmonton, AB, Canada; LONGRICH, Nicholas, University of Calgary, Calgary, AB, Canada; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA; EBERTH, David, Royal Tyrrell Museum, Drumheller, AB, Canada; DEMCHIG, Badamgarov, Institute of Geology, Academy of Natural Sciences, Ulaanbaatar, Mongolia

In 2006, fieldwork in Mongolia's Gobi Desert resulted in the discovery of a remarkably rich, monodominant bonebed of the bird-like theropod *Avimimus*. The bonebed is in the lower portion of the Upper Cretaceous Nemegt Formation, 10.5m above the Barun Goyot Formation, and is associated with silty, pebbly, fine- to medium-grained sandstone representing a migrating point bar in a meandering river channel. Sedimentary and taphonomic indicators suggest highly variable conditions at the locality, including stagnant water, and erosive flow that probably removed the smallest and lightest elements. The small (4 x 1.5m) quarry has produced parts of at least 10 individuals although its limit has not been reached. Over 90% of the recovered fossils represent *Avimimus*, but small elements from hadrosaurids, dromaeosaurids, ornithomimids and oviraptorids are also present. Although all parts of the skeleton are represented, including parts of the jaw and skull, there is a strong bias towards larger, thick-walled elements (e.g., femora and tibiae) suggesting reworking and selective transportation of some elements. Bonebeds are typically interpreted as reflecting natural associations of the preserved taxon and we hypothesize that the *Avimimus* assemblage resulted from gregarious behavior; this is the first evidence for such behavior in the Oviraptorosauria. Adults and subadult-sized elements are present, but curiously, small juveniles are absent. Adult material is recognized as being from the largest size class and exhibits extensive fusion of compound elements (e.g., tarsometatarsus and tibiotarsus), along with well developed muscle scars and articular surfaces, features missing from subadults. Adult elements exhibit little variation in size, suggesting determinate growth. The marked morphological differences between adults and subadults suggest that researchers must be cautious in using features such as fusion between elements and muscle scars to diagnose taxa, or to infer phylogeny, although some of these features may prove useful for assessing maturity in maniraptorans.

Poster Session I (Wednesday)

**PREDICTING MUSCLE FORCES AND ACTIVATION PATTERNS DURING MASTICATION: A MULTI-BODY COMPUTER MODELLING STUDY OF SPHENODON PUNCTATUS (LEPIDOSAURIA: RHYNCHOCEPHALIA)**

CURTIS, Neil, University of Hull, Hull, United Kingdom; FAGAN, Michael, University of Hull, Hull, United Kingdom; SHI, JunFen, University of Hull, Hull, United Kingdom; EVANS, Susan, University College London - UCL, London, United Kingdom; JONES, Marc, University Collage London - UCL, London, United Kingdom

The relationship between skull form and skull function can be evaluated through techniques such as finite element analysis, which predicts skull deformations in response external loading (e.g. muscle forces and bite forces). However, if the skull is optimised to withstand the average loading applied to it, as proposed by some, then being able to load the skull accurately is vital in detailed studies of skull form. Here we have performed a multi-body dynamics analysis of the skull in *Sphenodon* (Diapsida: Lepidosauria: Rhynchocephalia), which used rigid-body motion to predict muscle, joint and bite loading throughout mastication. Micro-computed tomography datasets of an adult *Sphenodon* skull were transformed into a three-dimensional multi-body model that included the neck, cranium and mandible. The depressor muscles that open the jaw, adductor muscles that close the jaw, and neck muscles that control the cranial motions were all represented. Unconstrained contact was modeled at the jaw joints which, along with the adductor muscle groups, were the only restraints placed on the jaw motions. The multi-body dynamics analysis predicted muscle activation patterns, bite forces and joint forces for several situations, including unilateral and bilateral biting. The simulations revealed that joint forces were extremely sensitive to muscle activation, particularly during unilateral biting. Measurement of *in vivo* joint forces is problematic and therefore working and balancing joint forces during unilateral biting remain uncertain. For equal activation of the working and balancing muscle groups, joint forces were approximately 50% larger on the balancing side of the skull; however, this is not something we would expect. A more reasonable scenario would be to have equal joint forces, or even a minimal balancing joint force. These scenarios produced a balancing side muscle activation rate of approximately 65% and 10% of the working side respectively. Bite point and gape both affected muscle activation rates and overall skull loading.

Poster Session IV (Saturday)

**A NEW ASSEMBLAGE OF EARLY TRIASSIC ICHTHYOPTERYGIANS FROM EAST-CENTRAL BRITISH COLUMBIA, CANADA**

CUTHBERTSON, Robin, University of Calgary, Calgary, AB, Canada; ANDERSON, Jason, University of Calgary, Calgary, AB, Canada

Ichthyopterygia is a diverse clade of Mesozoic marine reptiles. Basal members first appear in the Early Triassic already exhibiting a highly derived skeleton. However, fossil evidence for these critical early forms is incomplete and only a few locations worldwide have produced fossils. As a result, we have a poor understanding of the early evolution of this interesting clade. New Early Triassic fossil-bearing sites discovered along a series of mountain cirques in east-central British Columbia, Canada have yielded numerous fossil marine vertebrates, including fish, thalattosaurs, and a striking abundance of ichthyosaurs. Collection sites vary in their exact stratigraphic position, but all have been attributed to the basal-most 100 meters of the Sulphur Mountain Formation (SMF) of Lower Triassic deposits, suggesting the specimens originated from the Vega-Phroso Siltstone Member (VPSM) and tentatively assign them to an Induan-Olenekain (251-245 Ma) age. The VPSM outcrops of B.C. are known for their highly informative and rare thalattosaur and weigeltisaurid specimens, in addition to many basal ichthyosaurs. Unfortunately, because the new specimens were collected from scree slopes, their exact stratigraphic position within the SMF must be confirmed. The general stratigraphic position of the new specimens suggests they may be important basal members of Ichthyopterygia, possibly representing *Parvinator*, *Utatusaurus*, or *Grippia*, all of which have previously been collected from Early Triassic deposits of B.C., but they may be new taxa. One of several nearly complete skulls is preserved in dorsal aspect. It shows a long and very slender snout that is incompletely persevered on the dorsal surface of its right premaxilla, revealing at least ten alveoli. Four conical teeth are visible on the right maxilla and one on the left, providing an incomplete maxillary tooth count. Of these, one crown is fully preserved and terminates in a blunt point. Gentle striations can be observed on two of the better preserved crowns. These dental observations are similar to those provided for *Utatusaurus hataii* and *Utatusaurus* sp.

Poster Session I (Wednesday)

**LATE PLEISTOCENE VERTEBRATE FAUNA OF PYEATT CAVE, SOUTHEASTERN ARIZONA, USA**

CZAPLEWSKI, Nicholas, Oklahoma Museum of Natural History, Norman, OK, USA; MEAD, James, East Tennessee State University, Johnson City, TN, USA

Pyeatt Cave opens at 1654 m elevation near the northwestern end of the Huachuca Mountains, Cochise County, Arizona, about 25 km from the Mexico-USA border. The Huachuca Mountains are in the southern Basin and Range province and constitute one of the so-called "sky islands" or Madreaan mountains situated between the Sierra Madre Occidental and the southern edge of the Colorado Plateau. Just a few meters inside the present (and probably the Pleistocene) cave entrance in the dark zone is a vertical cliff that drops 24 m to a lower level, providing a pitfall that could potentially kill animals that walked over the edge. In the Basement room of the cave, partial skeletons of *Nothrotheriops shastensis* and *Arctodus simus* were excavated from two different

pits just 4 m apart, nearly below the drop-off and 45 m lower than the entrance datum. The skeletons occurred in reddish Pleistocene deposits that were overlain by grayish late Holocene sediments. The sloth remains (*N. shastensis*) proved to be from the same pit and specimens in the University of Arizona collection as were excavated in about 1961. A sloth vertebral centrum yielded an uncorrected AMS radiocarbon age of 22,480 +/- 490 rcybp. The Pleistocene sediments also contained the remains of several other vertebrates including amphibians (anurans and the salamander *Ambystoma*), squamates (snakes and few lizards), birds (turkey, *Meleagris*, and passeriforms), and additional mammals. At least 18 taxa of mammals include the sloth and bear already mentioned plus shrews (*Notiosorex* and *Sorex*), bats (*Myotis*), additional carnivorans (*Puma*, Mephitidae, *Urocyon*, and *Ursus*), rabbit (*Sylvilagus*), artiodactyl (Cervidae or Bovidae), and rodents (*Spermophilus*, Geomyidae, Heteromyidae, *Peromyscus*, *Reithrodontomys*, *Neotoma*, and *Microtus*). The *A. simus* is only the second Pleistocene record of a short-faced bear in Arizona. Except for the extinct species, the full-glacial mammals are similar to taxa found in the area today.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**KOMODO MONITOR (VARANUS KOMODOENSIS) TOOTH MARKS ON BONE AND IMPLICATIONS FOR MESOZOIC ZIPHODONT ARCHOSAUR BEHAVIORAL TAPHONOMY**

D'Amore, Domenic, Rutgers University, New Brunswick, NJ, USA

Tooth marks attributed to Mesozoic ziphodont archosaurs have prompted many behavioral and paleoecological reconstructions. Unfortunately, few of these interpretations have been based on controlled observations of modern dental analogues, of which *Varanus komodoensis*, the Komodo monitor, is the most suitable. We conducted controlled feedings of Australian goat partial carcasses to eleven captive individuals. *V. komodoensis* extensively modified bone surfaces of one third of all elements. The vast majority of tooth marks are scores. Pits are present but significantly less common. Tooth furrows and punctures are rare. 'Edge marks', a trace unique to *V. komodoensis*, are produced on flat elements and processes. Serrated tooth marks, or 'denticle drags', are evident on 25% of the modified elements, but represent less than 5% of all marks. The majority of marks maintain a limited width but variable lengths. Around half the marks display some degree of curvature. Over one-third of the marks occur within parallel clusters. Mark production is a by-product of flesh removal, and bone crushing was not observed. Scores are a consequence of apical dragging, resulting from the unique 'medial-caudal arc' defleshing technique utilized by *V. komodoensis*. Score and pit width is limited by apical width. Edge marks and denticle drags result from distal and mesial carinae contact respectively. Parallel clusters result from repetitive defleshing strokes, and/or simultaneous crown contact during strokes. The high frequency of linear, parallel scoring in Mesozoic assemblages is very similar to our controlled assemblage. Following the *V. komodoensis* model, the majority of Mesozoic marks primarily indicates defleshing behavior with little evidence of bone chewing or crushing. The parallel nature of scores indicates similar, repetitive, caudal defleshing strokes, but the lack of curvature implies less of a mesial 'arc'. Differences in tooth mark characters and frequency between these analogues may also be explained by diagenesis and inconsistency in evaluation procedures.

Poster Session IV (Saturday)

**REEVALUATION OF THE PHYLOGENETIC AFFINITIES AND AGE OF A BASAL TITANOSAURIFORM (SAUROPODA: DINOSAURIA) FROM THE EARLY CRETACEOUS CLOVERLY FORMATION OF NORTH AMERICA**

D'EMIC, Michael, Department of Geological Sciences, University of Michigan, Ann Arbor, MI, USA; BRITT, Brooks, Department of Geological Sciences, Brigham Young University, Provo, UT, USA

Most Early Cretaceous North American sauropod genera appear to be basal titanosauriforms, but a few are possibly titanosaurs. Sauropod remains from the Early Cretaceous Cloverly Formation in north-central Wyoming, briefly described by Ostrom, consist of adult dorsal and caudal vertebrae, appendicular bones, and teeth, as well as juvenile cervical, dorsal, and sacral centra. Based on Ostrom's field notes and maps, as well as the lack of duplication of elements at the site, it is likely that most of the adult bones belong to one individual. Anterior dorsal neural spines of the Cloverly Formation sauropod are anteroposteriorly thin and transversely wide with a rounded end, a possible autapomorphy of the taxon. Opisthocoeleous posterior dorsal vertebrae and camellate pneumaticity in presacral vertebrae indicate that Ostrom's Cloverly Formation sauropod is referable to Macronaria and Titanosauriformes, respectively. The presence of a hyposphene-hypantrum, non-procoelous caudal vertebrae, and an unexpanded distal tibia exclude this taxon from Titanosauria, relegating it to basal titanosauriforms. However, the presence of at least two morphs of sauropod teeth at the site and a humerus with a squared proximolateral corner from several dozen meters away in the Little Sheep Mudstone Member (Unit B/Unit V) suggest that a second sauropod taxon is present in the Cloverly Formation. To assess the age of the Himes Member (Unit C/Units VI & VII) of the Cloverly Formation, where most of the sauropod bones were found, sandstone samples were collected just below Ostrom's sauropod quarry, ~20 m below the overlying Sykes Mountain Formation. Laser ablation multi-collector inductively coupled plasma mass spectrometry of euhedral detrital zircons from these sandstones provides a U-Pb age of 103.49 Ma +/- 0.79 -1.17 Ma via the TuffZirc routine of IsoPlot from a coherent group of nine crystals. Thus the Cloverly Formation sauropods are no older than late Albian, making them some of the last known sauropods before the start of the "sauropod hiatus" of North America near the Early-Late Cretaceous boundary.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 10:15  
**FOSSIL RECORD OF THE NEOTROPICAL SERRASALMIDAE (OSTARIOPHYSI, CHARACIFORMES)**  
DAHDL, Wasila, Academy of Natural Sciences, Ichthyology Dept., Philadelphia, PA, USA

Serrasalminae is a prominent lineage of characiform fishes containing 16 genera and approximately 75 species distributed in the major lowland drainages of cis-Andean and northern South America. Serrasalminae are well known for their diversity of feeding habits, including the flesh- and fin-biting piranhas (*Serrasalmus*, *Pygocentrus*), scale-eating false piranhas (*Catoprion*, *Acnodon*), and fruit- and seed-eating pacus (*Mylossoma*, *Piaractus*, *Colossoma*). Isolated teeth and fragmentary jaw elements identified as serrasalminae are known from the fossil record of South America spanning most of the Cenozoic and Upper Cretaceous. The serrasalminae fossil record, including description of a new genus and species, is discussed in light of recent phylogenetic analyses of their relationships. The diversity of feeding behaviors in the family is reflected in taxonomically variable tooth and jaw morphologies, and the characters that are useful for fossil identification are outlined. The earliest fossils, from the Upper Cretaceous to Paleocene of Bolivia, belong to the pacu clade, and *Colossoma macropomum* is known from throughout the Neogene of South America. *Mylossoma* is known from the upper Miocene, and isolated teeth indistinguishable from modern true piranhas are known from the Miocene. My recent phylogenetic analyses based on morphological and molecular data recover a basal pacu clade that is sister to all other serrasalminae. This topology is consistent with the earlier appearance of pacus with respect to piranhas in the fossil record. The new genus and species of serrasalminae from the upper Miocene of Argentina based on a large, partially toothed premaxilla is described. The pattern of tooth placement exhibited by the new species is intermediate between the double-row condition of pacus and the single-row condition of piranhas, and is suggestive of how the double row of teeth may have been rearranged into a single row in the evolution of piranhas. Results from a new phylogenetic analysis including tooth and premaxillary characters aimed to determine the phylogenetic position of the new species are presented.

Technical Session IV, Wednesday 3:15  
**WHAT CAN SEDIMENT PATTERNS TELL US ABOUT SOFT TISSUE?: AN ACTUALISTIC TAPHONOMIC STUDY OF OSTRICH HEADS DURING AND POST-BURIAL**  
DANIEL, Joseph, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

CT scans of fossil skulls often show radiological density variations within the encasing rock. These variations may correspond to differential sediment sorting by soft tissue during burial. To test this hypothesis, we built two flumes to model deposition in (1) deep, slow-moving water (pools) and (2) shallow, fast-moving water (sand bars). Ostrich heads were buried in each flume under varying decompositional states (fresh, desiccated, rotten, clean skulls), then CT scanned and sectioned to obtain sediment samples for comparison with sediment maps created from the CT scans. Marked contrasts were seen between flow regimes and among decompositional states. Sediment drapes covered the heads retaining feathers in the shallow flume. No drapes appeared on the clean skulls nor on any head buried in the deep flume except after extensive decomposition dispersed organics into the surrounding water. Drapes may be a useful indicator of integumental coverings such as feathers or hair as well as water flow indicators. Only heads in the shallow flume showed any sediment sorting, as corroborated by grain-size analysis, filling the oral cavity and pharynx. The nasal cavity and large paranasal sinuses were extensively filled only in rotten specimens buried in the shallow flume. Nevertheless, in all cases the rostralmost nasal conchae were sufficiently covered, suggesting that evidence of conchae may be preserved in the sediment, even when not in the fossil itself. Over 30% of the initial air remained in all heads with soft tissue in the deep flume, whereas over 65% remained in fresh heads in the shallow flume, but decomposition rapidly let most air escape. Even in clean skulls, some air remained, suggesting that some fossil void spaces may be primary and were never sediment-filled. Continued decay after burial affects these patterns depending on the post-burial environment, most notably in the fresh heads, less so in the clean skulls. Such sediment patterns may provide additional anatomical information from CT scans of matrix-filled fossils, as well as identifying optimal preservational environments, allowing field workers to target promising rock units.

Poster Session II (Thursday)  
**REMOVING FOSSIL RIBS: THE THREAD TECHNIQUE**  
DAVIDSON, Amy, American Museum of Natural History, New York, NY, USA

Preparators often face the problem of extracting high priority pieces (e.g., cranial elements) from beneath ribs in jumbled vertebrate fossil skeletons. The thread technique was recently developed when faced with this situation in preparing two dinosaurs; one from Ghost Ranch (New Mexico) and one from the Gobi Desert of Mongolia. Both blocks contain skeletons preserved as dense assemblages of disarticulated bones that must be separated and prepared as individual elements. Especially problematic are areas where multiple, fragile, fractured ribs are interwoven and overlying skull elements. In order to untangle and lift each rib, a piece of sewing thread is first adhered to the surface with a thick, temporary coating of Acryloid/Paraloid B72 in acetone. The thread and thick coating span the fractures and gaps to hold them together but remain flexible. With this system the overlying end of one rib can be folded back to pull out an underlying rib. The rib is then lifted on the thread like a

beaded necklace preserving the order of the segments. The thread technique allows the ribs to be set aside indefinitely while higher priority elements are removed and prepared. The rib fragments are later removed from the thread one by one, the coating cleaned with a needle or acetone and the fragments reassembled with a thick (50%) solution of Acryloid/Paraloid B72 in acetone.

Poster Session I (Wednesday)  
**EVOLUTION OF LOWER MOLAR MORPHOLOGY IN EARLY MAMMALS**  
DAVIS, Brian, University of Oklahoma, Norman, OK, USA

Marsupial and placental mammals evolved from a stock of stem taxa that shared a combination of dental features allowing both shearing and crushing of food in one chewing stroke. This opened up a myriad of dietary niches, allowing modern groups to achieve far more morphological diversity than any previous mammalian clade. Mastication was improved by occlusion between a novel upper molar structure, the protocone, and a basining within the lower molar talonid. An examination of Middle Jurassic through Early Cretaceous material at the Natural History Museum in London reveals a morphological progression of lower molar evolution through early mammals, which correlates with the current phylogeny of pre-tribosphenic groups. The talonids of otherwise derived groups such as spalacotheriids and dryolestids do not differ appreciably from that of archaic taxa, such as *Kuehneotherium*, in the possession of a single cusp placed lingually on a short heel. However, talonid morphology deviates significantly from this pattern across early zatherian lineages, and this has led to some inconsistencies in determining homology with the multi-cusped talonids of more derived groups. As the talonid and cristid obliqua are elongated, the single talonid cusp migrated labially into a position consistent with the hypoconid. Under this interpretation, amphitheriids (including *Palaeoxonodon*) fit well between the plesiomorphic morphology, characterized by dryolestids, and more advanced single-cusped taxa such as the stem zatherian *Argiurus*. The hypoconulid was added posterolingually to the hypoconid, both to take over molar-to-molar interlocking, and to provide an additional shearing surface in correlation with lingual migration of the upper molar metacone (as demonstrated by the morphology exhibited by *Peramus*). The single talonid cusp of early mammals is therefore most likely homologous with the hypoconid of more modern groups. This has a bearing on consistent coding of molar morphology in early mammalian taxa, and on the interpretation of character evolution from phylogenetic analyses.

Poster Session IV (Saturday)  
**EVOLUTION OF DEVELOPMENT IN RUMINANT HEADGEAR: POTENTIAL FOR PHYLOGENETIC RESOLUTION**  
DAVIS, Edward, University of Oregon DoGS and MNCH, Eugene, OR, USA; LEE, Andrew, Ohio University College of Osteopathic Medicine, Athens, OH, USA; BRAKORA, Katherine, UC Berkeley Dept of IB, UCMP, Berkeley, CA, USA

A great deal of recent work has been devoted to understanding the phylogenetic position of Cetacea within the context of the larger artiodactyl phylogeny. While extremely productive with respect to understanding whale ancestry, this effort has resulted in novel topologies for the relationships within the ruminants. Building on this Cetartiodactyla work and other work focused on the Ruminantia, we have begun to address ruminant relationships through an exploration of the phylogenetic information recorded in the developmental processes of ruminant headgear (ossicones, horns, antlers, and pronghorns) and an initial assessment of how that information can be diagnosed in fossil taxa. One of the goals of this analysis is to understand whether or not headgear development is controlled by a deep developmental homology within ruminants. There is extensive evidence that headgear evolved two or more times within the ruminants, but the coincidence of this parallel evolution may reflect Gouldian canalization: the fostering of diversification through shared developmental constraints. Placing these characters in the context of existing molecular and combined analyses suggests novel character polarizations and/or convergences depending upon which topology is chosen. Future work will include more extensive histological studies of developmental series of extant ruminants and a more complete sampling of fossil taxa in a new combined analysis.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 10:45  
**THE EOCENE LAKE OF MAHENGE (TANZANIA) AND ITS FOSSIL FISHES**  
DAVIS, Matthew, University of Kansas Natural History Museum and Biodiversity Research Center, Lawrence, KS, USA; ARRATIA, Gloria, University of Kansas Natural History Museum and Biodiversity Research Center, Lawrence, KS, USA; KAISER, Thomas, University of Hamburg Biocentre Grindel and Zoological Museum, Hamburg, Germany

Recent excavations in the Eocene lake of Mahenge, Tanzania by a German/Tanzanian team recovered approximately 2,000 fossils including vertebrates, invertebrates (mainly arthropods), plants, and trace fossils, of which 51% are fishes and 36% are plants. Combined with the sedimentological data, the fossil flora indicates an overall dry climate with pronounced seasonality. Fishes that have been formally described from Mahenge include the following: two osteoglossomorphs, one clupeomorph, one characiform, one siluriform, and five species of cichlids (*Mahengechromis*) that have been interpreted as a species flock. In this contribution we report the first fossil kneriid gonorynchiform recovered in Africa or worldwide. The material is represented by complete specimens that provide the first

information on kneriid vertebral centra and ribs, as well as other postcranial and cranial elements. Extant Gonorynchiformes comprise four families (Chanidae, Gonorynchidae, Kneriidae, and Phractolaemidae) with the families Kneriidae and Phractolaemidae inhabiting freshwater systems of Africa. Extant African gonorynchiforms are currently interpreted as pedomorphic forms. The fossil kneriid specimens described in this study are slightly longer (51 to 76 mm total length) than the extant kneriids. With this new information the fossil record of gonorynchiforms is now known from the following three families; Chanidae (Early Cretaceous), Gonorynchidae (late Early Cretaceous), and the much younger Kneriidae (Eocene). Gonorynchiform distribution in the fossil record corresponds with the currently recognized phylogenetic position of Kneriidae as the most derived group of gonorynchiform fishes.

Technical Session IX, Thursday 2:00

**SIGNATURES OF FLIGHT AND RUNNING IN BONE MICROSTRUCTURE: AN EXPERIMENTAL STUDY IN HELMETED GUINEA FOWL (*NUMIDA MELEAGRIS*) AND APPLICATIONS IN THE STUDY OF THE DINOSAUR-BIRD TRANSITION**

DE BOEF, Maria, McGill University, Montreal, QB, Canada

The origin of aerial birds from terrestrial dinosaurs is a well accepted theory. However, understanding how this transition occurred requires knowledge of which intermediate forms were able to fly and how proficient that flight was. Such knowledge can be gleaned, to some extent, from gross morphological studies but, at times factors such as unpreserved feathers can lead to inconclusive results. In recent years compact bone microstructure was found to differ in bones that experienced consistently distinctive loads. Here we experimentally tested how differently fore- and hind-limbs are loaded during flight and running and if such loading leads to predictably differing bone microstructure. Groups of Helmeted Guinea Fowl (*Numida meleagris*) were subjected to flying or running exercise throughout growth while a third group had their movements restricted. Bone strain was measured in the fore- and hind-limbs of all three groups. Bone microstructure parameters such as vascular orientation, bone density, bone deposition rate, secondary remodeling rate and cross sectional geometry were compared between groups. Results indicate that bone microstructure does differ predictably between animals that are running and those that are flying. These results are compared to other bone microstructure studies that observe flying and running species. Commentary will be given on how best to apply these results to better understand the origin of flight in birds.

Poster Session III (Friday)

**NEW INFORMATION ON THE TEETH AND JAW BONES OF THE RARE HADROSAURIFORM *OURANOSAURUS NIGERIENSIS***

DEAN-CARPENTIER, Matthias, University of Chicago, Chicago, IL, USA

New specimens of *Ouranosaurus nigeriensis* were collected in the 1990s in the Elrhaz Formation of Niger (Aptian-Albian) by a University of Chicago expedition. These specimens include well preserved teeth and portions of the maxilla and dentary. Although *Ouranosaurus* was long thought to be a near outgroup to hadrosaurids, these specimens display a surprising number of primitive features in its dental and jaw morphology. The posterior portion of the left maxilla was recovered in a nearly complete state. This portion is characterized by being narrow dorsally and rectangular in shape. This section of maxilla bears 9 to 10 aveoli with 5 occupied by teeth. In addition, the anterior section of the dentary was recovered, bearing 9 open aveoli. Only maxillary teeth were recovered from these specimens. The maxillary crown is proportionally wider than those of *Iguanodon* and related species. Both sides of the crown bear enamel. However, the lingual side of the crown bears much thinner enamel, which only covers the distal one-half of the crown. The primary ridge is shifted slightly offset from the median in placement. There is at least one secondary ridge on each tooth that tapers distally from its widest point where the enamel contacts the root. The denticles of the maxillary crown are large and roughly tongue-shaped. However, each denticle bears subtle denticles. The roots of the maxillary teeth are long and strongly medially curved. Judging from the shallow depth of the dentary, large size of the teeth, and strong curvature of the root, it is likely that there existed only one replacement crown per tooth position. The primitive dental features displayed in these specimens suggest a complexity to the phylogenetic history of hadrosauriforms that has not previously been discussed. Only a broader analysis, including both cranial and post-cranial information from other hadrosauriforms will determine if these dental features are the product of a reversal, a parallelism or are simply reflective of a more basal placement for *Ouranosaurus* than has previously been thought.

Poster Session III (Friday)

**STRATIGRAPHY, TAPHONOMY, AND PALEONTOLOGY OF NEWLY DISCOVERED DINOSAUR SITES IN THE BASAL YELLOW CAT MEMBER OF THE CEDAR MOUNTAIN FORMATION (EARLY CRETACEOUS) OF UTAH**

DEBLIEUX, Donald, Utah Geological Survey, Salt Lake City, UT, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA; HUNT, Gary, Utah Geological Survey, Salt Lake City, UT, USA; MADSEN, Scott, Utah Geological Survey, Salt Lake City, UT, USA; ZEIGLER, Kate, University of New Mexico, Albuquerque, NM, USA

The Crystal Geyser Dinosaur Quarry (CGDQ), southeast of Green River, Utah, contains

abundant disarticulated remains of the basal therizinosauroid dinosaur *Falcarius utahensis* and rare bones of a giant polacanthine ankylosaur. These bones are found in a pebbly mudstone sequence that lie 1-2 m below a sandy, siliceous, limestone caprock that is a useful marker bed in the Early Cretaceous Yellow Cat Member of the Cedar Mountain Formation (YC) in this area. About 1 km west, the Suarez site also preserves a similar fauna immediately below the caprock. As neither taxon is known to occur elsewhere in the YC, we suspect that a distinct older fauna may occur below the caprock. To test this hypothesis, we began intensive prospecting and study of this basal interval, in addition to excavations at middle and upper YC sites. Our work has resulted in the discovery of a number of important new sites including several rich bone beds. At Don's Ridge, 2 km west of CGDQ, a number of bone-bearing strata are located in a relatively thick sequence (~10 m) of mudstone with floating cobbles and lenses of chert and quartzite below the caprock in what we interpret as a paleovalley. Near the middle of this section, associated iguanodontid and ankylosaur partial skeletons overlie bone beds containing numerous bones of brachiosauroid sauropods, ankylosaurs, and shed theropod teeth. The basal YC 40 km to the east of CGDQ at Doelling's Bowl has produced hundreds of bones of iguanodontids, ankylosaurs, sauropods, and dromaeosaurids (including associated skeletons), just above a distinctive silcrete interval and meters below a thick calcrete (= caprock?) that has been used to mark the contact between the Late Jurassic Morrison Formation and the YC. We now recognize a distinct lower YC based on an abundance of floating chert pebbles. Continued excavation and study of the several lineages of dinosaurs, such as iguanodontids and ankylosaurids, found at these sites will provide data needed to establish whether or not the lower YC preserves a distinct fauna as compared to the main body of the YC indicating whether or not the calcrete/caprock represents evolutionary time (millions of years).

Technical Session IX, Thursday 1:45

**CRITICAL ANALYSIS OF ARBOREALITY IN MANIRAPTORAN THEROPODS**  
DECECCHI, T, Redpath Museum, McGill University, Montreal, QB, Canada; LARSSON, Hans, Redpath Museum, McGill University, Montreal, QB, Canada

Arboreality is a commonly employed life history strategy among extant vertebrates and has appeared in almost all modern tetrapod groups. While the basic ability to climb is seen among a large number of organisms with little to no change in morphology, those organisms that habitually use tree branches and trunks show a diverse assemblage of adaptations that allow greater efficiency for accessing and exploiting these environments. Recently, attention has been focused regarding the extent to which small maniraptoran theropods were arboreal and whether this facilitated the origin of powered flight. We present a detailed qualitative and quantitative-based comparative assessment of osteological morphology of modern arboreal, scansorial, and non-arboreal tetrapods to determine what morphologies are likely associated with climbing and non-climbing regimes. Allometric and phylogenetic biases are removed. We compare generalized force vector analyses that include rotational moments during branch walking, friction and non-frictional grip mechanisms at the tree-manus and tree-pes contact points and reaction forces required to counter forces about the center of gravity on all limb joints when ascending and descending the trunk. It was found that maniraptoran theropod skeletons show little to no evidence of anatomical specializations currently associated with modern arboreal animals. These results lend support to the ground-up model for the origin of avian flight.

Poster Session II (Thursday)

**ENSURING SUCCESS FOR ALL IN EXHIBITIONS AND INFORMAL SCIENCE PROGRAMS**

DECK, Linda, Bradbury Science Museum, Los Alamos, NM, USA

Historically, exhibitions and informal science programs filled out an institution's expected portfolio of public offerings, guided often by an individual's work and vision. There was trust that this vision was appropriate and compelling, accurate and up-to-date, and would contribute to the institution's positive reputation. The institution's (or funder's) desire to be known for scholarly, engaging, and original public offerings still exists, but now also regularly includes a business model mentality requiring a demonstrably valuable result. These two motives can be combined, resulting in a successful project from all viewpoints. A robust approach to planning a successful exhibition or informal science education program begins with a clear idea of what the goals are for the project that directly relate to the mission of your institution or program; who the user is and their underlying capacities and needs; who the stakeholders are who contribute money, space, reputation, and/or resources and demand positive return on investment; and who are partners in the project that have their own agendas to meet and what these are. This leads to the ultimate outcomes; meaningful change in the user of the project relating back to their compelling needs which also has meaning for the stakeholders. Following this logic model enables the project planners to chart a course directed toward achieving measurable success for all invested. The plan should detail inputs of resources and the activities that will produce the project; activities lead to outputs that can be measured and show accomplishment and success while the project is still in progress. The ultimate measures of success are changes to the knowledge, attitudes, or behaviors of the users. Shifting the focus to the user, not the project, ensures the resources spent will add up to a meaningful investment. Examples of using this method for exhibitions, informal science programs, and to guide the work of entire informal science education institutions will be illustrated. Methods and examples of user needs and capabilities assessments, output and outcomes tracking, and producing and using this planning method will be shown.



Poster Session II (Thursday)

**A COMPUTATIONAL BIOMECHANICAL APPROACH TO THE RECONSTRUCTION OF PREDATORY BEHAVIOR IN THE TERROR BIRD *ANDALGALORNIS STEULLETI***

DEGRANGE, Federico, Museo de La Plata, La Plata, Argentina; MORENO, Karen, University of New South Wales, Sydney, Australia; WROE, Stephen, University of New South Wales, Sydney, Australia; TAMBUSSI, Claudia, Museo de La Plata, La Plata, Argentina; WITMER, Lawrence, Ohio University, Athens, OH, USA

The predominantly South American phorusrhacid radiation comprised a range of small to gigantic terrestrial predators for which there are no close functional analogues, making reconstruction of their feeding behavior particularly problematic. Here we have applied a Finite Element approach to a 3-D model of the cranium of the medium-sized (~40 kg) patagornithine phorusrhacid *Andalgalornis steulleti* (Upper Miocene-Lower Pliocene, Andalgalá Formation, Catamarca, Argentina), in order to assess its mechanical performance in a comparative context. We found that relative to a range of extant species, including one of its closest living relatives, the red-legged seriema, as well as eagles and vultures, the terror bird's cranium shows high stress under torsional and lateral loadings, but low stress where force is applied in dorso-ventral or in 'pullback' simulations. We conclude that if *A. steulleti* used its beak in the dispatch of relatively large prey, then it must have been applied with considerable precision.

Poster Session I (Wednesday)

**ANATOMY AND TAXONOMIC RELATIONSHIPS OF TWO SNAKE FRONTALS FROM THE MESAVERDE FORMATION, WYOMING: IMPLICATIONS FOR NORTH AMERICAN SNAKE EVOLUTION**

DEMAR, David, University of Wyoming Geological Museum, Laramie, WY, USA; HEAD, Jason, University of Toronto at Mississauga, Mississauga, ON, Canada; CALDWELL, Michael, University of Alberta, Edmonton, AB, Canada; BREITHAUPT, Brent, University of Wyoming Geological Museum, Laramie, WY, USA; RAGE, Jean-Claude, Museum National D'Histoire Naturelle, Paris, France

Snakes represent only a minor component in North American Cretaceous faunas and occur predominately as isolated vertebrae. The discoveries of two complete frontals from the Campanian Mesaverde Formation of Wyoming are the oldest known snake cranial elements from North America. These frontals were found in association with numerous fossil fishes, amphibians, reptiles, and mammals and were collected from friable, yellowish channel sandstones of the Barwin Quarry/Fales Rocks vertebrate microsite. Features of the frontals allying them with snakes include the well-developed and ventrally fused descensus frontali, and the likely presence of the anterior margin of the optic foramen on the posteroventral margin of the descensus frontalis. Conversely, these specimens are unique among snakes in possessing complete dorsomedial fusion of the frontals into a single element. In contrast to modern snakes, the anterior portion of the enclosed olfactory tracts is not separated by paired median flanges which is similar to the condition observed in the penecontemporaneous Gondwanan snake, *Dinilysia*. Absence of median frontal flanges suggests a basal position outside of Alethinophidia; however, an important characteristic that allies these frontal elements with modern anilioids, a basal group within the Anethinophedia, includes the anteriorly well-developed median flange/trabecular ridge on the ventral surface of the fused descensus frontali. This feature is shared between modern *Cylindrophis* and *Anilius* due to the configuration of the medial processes of the palatine bones which are 'braced' against this frontal ridge. The oldest North American fossil genus, *Coniophis* (a poorly constrained taxon tentatively assigned to the Aniliidae), is known only from isolated vertebrae; nevertheless, these records of *Coniophis* are consistent with other occurrences of this taxon and show no other generic forms throughout the North American Cretaceous. These specimens may be referable to *Coniophis* based on association with isolated preloacal vertebrae and while we do not here assign these frontals to *Coniophis*, we tentatively refer them as cf. *Coniophis* sp. pending further analysis.

Poster Session I (Wednesday)

**A REVISION OF THE SQUAMATE FAUNA OF THE ELLISDALE DINOSAUR SITE, UPPER CRETACEOUS (CAMPAIAN) OF NEW JERSEY**

DENTON JR, Robert, Potomac Environmental Services, Harpers Ferry, WV, USA; O'NEILL, Robert, New Jersey State Museum, Trenton, NJ, USA

Discovered in 1980, the Ellisdale "dinosaur" Site has produced the most diverse assemblage of terrestrial vertebrates yet known from the Upper Cretaceous of eastern North America. Unfortunately, the most commonly cited reference summarizing the Ellisdale fauna was published in 1992, and is sorely out of date. Most of the errors made in our early analysis of the site's fauna were a result of attempting to find direct comparisons of Ellisdale animals with known Judithian taxa, functioning under the premise that there was faunal interchange taking place between the Cordilleran and Appalachian subcontinents. This bias was particularly evident in the fossil lizard assemblage, and it was assumed that the characteristic Cordilleran genera *Chamops*, *Leptochamops*, *Contogenys* and *Peltosaurus* were present at Ellisdale. Careful restudy of the Ellisdale squamate fauna over the subsequent years has revealed that none of the known taxa share generic affinities with the lizards of the western interior. Specimens of what were assumed to have been *Chamops*, *Leptochamops*, and *Contogenys* are now understood to represent a single new taxon, *Prototeius stageri*.

Similarly, fragmentary remains putatively identified as *Peltosaurus* are now understood to be a previously unknown taxon of glyptosaurine lizard. In addition, indeterminate xenosaur, helodermatid and iguanid remains do not show any favorable comparisons to equivalent taxa from Judithian or Lancian assemblages. Although there are strong familial affinities between the Ellisdale fauna and those of equivalent age from western North America, the lack of any congeneric squamate taxa suggests that the eastern subcontinent was effectively isolated from western North America by the Epeiric Sea, and for a sufficient amount of time to produce the differences that are now recognized. These data may also be able to contribute to the understanding of the timing and rate of trans-continental distribution, vicariance and taxonomic diversification among other, non-squamate Cretaceous terrestrial taxa.

Poster Session I (Wednesday)

**COMPARISONS BETWEEN OLDEST CHONDRICHTHYAN CRUSHING-TOOTH AND TOOTH WITH CUSPS**

DERYCKE, Claire, University of Lille1, Villeneuve d'Ascq Cedex, France

Extant chondrichthyans give a dental lamina dentition pattern with a continuous replacement of shedding teeth. Usually crushing-teeth are considered to grow continuously (contrary to teeth with cusps) and are more subject to abrasion due to a slow replacement rate. A new Devonian crushing-tooth (*Melanodus*) from the Boulonnais (northern France) shows microscopic, oblique striae on its surface. These striae could be link to the diet, not necessary due to the prey but also to the nature of the substrate. We could consider that striae result of abrasion by sand grains usually on the shells because the hardness of apatite (5) for the predator teeth is higher than the calcite one (3) for the prey test. Differences exist between inorganic and organic materials (biomineralization, composite i.e. mineral and organic material). Furthermore, the combination of osteodentine, inner more soft tissue and the enameloid-like, outer hard tissue confers highest characteristic than separate characteristic of each tissue. An outer thin layer of hard tissue protects dentine against inward deformation. In fact teeth are made of composite material microscopically and macroscopically. A second crushing-tooth (*Thorolodus*) from the Devonian does not show so dense striae. The surface shows the emergence of tubules of orthotrabeculine regularly spaced with the long axis perpendicular to the mesio-distal length. A front of decalcification is clearly visible on the surface, hiding diet signs. The oldest cladodont tooth (Pragian, from Algeria) without striae but the enameloid is very badly preserved- is an asymmetrical tooth in number of cusps; it leads to propose a new process of budding. The model of a continuous growth in Palaeozoic teeth with cusps is proposed to correspond to chondrichthyan spine growth. Even with dissociated material, we can conclude about relations of jaw/teeth, and tooth/tooth regarding the vascularisation and the histology. Phylogenetic, morphogenetic, histological and functional aspects may be treated about the evolution of the dermal skeleton.

Technical Session XIII, Friday 3:00

**STABLE ISOTOPES AND REES OF UNGULATES AND XENARTHTRANS FROM HAILE 7G: ELUCIDATING THE PALEOECOLOGY OF A LATE PLIOCENE FOSSIL SITE FROM FLORIDA**

DESANTIS, Larisa, University of Florida/FLMNH, Gainesville, FL, USA; MACFADDEN, Bruce, Florida Museum of Natural History, Gainesville, FL, USA

The newly discovered Haile 7G site, a late Pliocene fossil locality in north central Florida, contains a unique mammalian fauna consisting of abundant tapirs and xenarthrans, and rare horses and carnivores. It is highly fossiliferous and yields about one skeleton per day of field excavations. Clarifying the paleoenvironment of the Haile 7G fossil site will allow a better understanding of the context of mammalian evolution over the past 2 million years in Florida. Haile 7G can be compared to the geographically and temporally similar fossil sites of Inglis 1A and Leisey 1A from Florida. Although many of the taxa from Haile 7G overlap with those present at the glacial Inglis 1A and interglacial Leisey 1A localities, anomalously low ungulate diversity limits stable isotope comparisons to tapirs, a few horses, gomphotheres, and a deer. Nevertheless, stable carbon isotope data from these taxa reveal that Haile 7G principally represents a forested environment. The majority of all taxa sampled are interpreted to have utilized C<sub>3</sub> plant resources, despite the concurrent presence of C<sub>4</sub> grasses at, or within some distance from, the site. Stable isotopic evidence from *Equus* sp. at Haile 7G will facilitate the interpretation of this site as glacial or interglacial based on comparing serial samples to those from the late Pliocene Inglis 1A and Pleistocene Leisey 1A localities. In addition to examining ungulate dietary niches, it may be possible to reliably interpret xenarthran stable isotopes if they are diagenetically altered in a similar manner to ungulate tooth enamel. The degree of diagenesis is evaluated by comparing the relative uptake of rare earth elements (REEs) in ungulates and xenarthrans (e.g. enamel, orthodentine, dentine, bone) from Haile 7G, Inglis 1A, and Leisey 1A. While it is tempting to use xenarthran stable isotope data for paleoecological interpretations, caution must be taken if relative uptake of orthodentine or dentine tissues exceeds that of enamel.

Romer Prize Session, Thursday 11:00

### ANKLE MORPHOLOGY IN EARLY HOMININS

DESILVA, Jeremy, University of Michigan, Ann Arbor, MI, USA

Bipedal locomotion is a hallmark of the human lineage. Upright walking hominins have evolved morphologies of the lower limb skeleton that position both the knee and the ankle joint directly under the center of mass. Skeletal correlates of this geometry include a bicondylar angle of the distal femur, and a horizontal plafond of the distal tibia. Although the bicondylar angle of the distal femur has been studied extensively, the hominin distal tibia has received less attention. The 14 distal tibiae known in the hominin fossil record from 4.12 to 1.53 million years ago were scanned with a portable 3D laser scanner and digitally cross-sectioned to measure the angle formed between the long axis of the tibia and the plane of the ankle joint. These tibiae are from *Australopithecus anamensis*, *A. afarensis*, *A. africanus*, *Paranthropus*, and early members of the genus *Homo*. These data were compared to the same measurement on 30 modern human distal tibiae, and 60 tibiae from wild chimpanzees and gorillas. Whereas African apes have an obliquely oriented tibia relative to the ankle joint, humans and fossil hominins possess a perpendicularly oriented tibia over the ankle. In addition, a technique is presented here in which this alignment of the ankle can be estimated from just an isolated talus. This approach, which quantifies the angle formed between the superior aspect of the talus, and the axis of rotation of the ankle joint, clearly discriminates tali from modern human and African apes. All 15 tali known in the hominin fossil record from 3.18 to 1.53 million years ago, representing *A. afarensis*, *A. africanus*, *Paranthropus*, and early *Homo*, are decidedly human-like for this measure. This new technique is a useful tool for interpreting the locomotion of fragmentary fossil remains of early hominins. Collectively these data demonstrate that the hominin ankle was adapted for bipedality by 4.12 million years ago. Though many hypothesize that early hominins were adept at both terrestrial bipedalism and arboreal climbing, these data suggest that adaptations for bipedality in the hominin ankle are maladaptive for tree climbing and arboreal locomotion.

Technical Session I, Wednesday 12:00

### PALEOECOLOGICAL DISPARITY OF CHADRONIAN FAUNAS BETWEEN THE WHITE RIVER GROUP AND RENOVA FORMATION

DEWAR, Eric, Suffolk University, Boston, MA, USA

Compared to the diverse and widespread Chadronian mammalian faunas of the White River Group (WRG) in the Great Plains, the contemporaneous Pipestone Springs area in the Renova Formation of Southwest Montana preserved a highly endemic fauna. Did feeding guild membership reflect biogeographic differences between these areas? I used evidence from dental use wear to reconstruct the diets of nearly 50 ungulate species, and ecological diversity analysis to describe the paleoecological guilds in these regions. Overall, I found substantial divergence between the guild composition of the two assemblages. In the WRG (39 species), ungulates up to 150 kg had species throughout the browser-grazer range. I categorized nine species in the 25-150 kg size class to mixed feeding diets, with four grazers and four browsers (two generalized and two leaf browsers). Most of the larger species (150-500 kg) formed a browsing guild, except for the entelodonts, which comprised an omnivore or hard-object feeding guild. The largest species in this area were all perissodactyls, and they formed a fairly deep mixed feeding guild. The 23 species in the Renova Formation fauna had a very different guild structure, one dominated by indicators of forest habitats. The smallest species were mixed feeders while there was a deep guild of browsers in the middle size classes. Most of these were generalized browsers, with a few leaf browsing specialists. The browsing guild extends to the 150-500 kg size class, with the largest species, *Megacerops* sp., characterized as a mixed feeder. Based on the relatively similar proportions of guilds throughout time and a wider range of diets in the White River sequence, I propose that this indicates a wider variety of more open habitats there. Data from microwear are concordant with habitat reconstructions based on phytoliths from both regions: the WRG's deep guilds of mixed feeders with some more specialized grazers are nearly absent in the Renova Formation. In the Chadronian, nearly all families demonstrated a tendency toward browsing in the Renova Formation compared to the WRG—even species that were present in both regions showed this divergence.

Poster Session IV (Saturday)

### ANATOMY AND RELATIONSHIPS OF THE LATE TRIASSIC

#### ARCHOSAURMORPH *DOSWELLIA KALTENBACHI*

DILKES, David, University of Wisconsin Oshkosh, Oshkosh, WI, USA; SUES, Hans-Dieter, National Museum of Natural History, Washington, DC, USA

The heavily armored Late Triassic archosauriform reptile *Doswellia kaltenbachi* from the Poor Farm Member of the Falling Creek Formation in the Taylorsville basin (Newark Supergroup) in Virginia is known primarily from a single skeleton. The euryapsid skull has a distinctive occiput with a prominent supraoccipital process that is flanked by posterior "horn-like" projections of the squamosals. Postfrontals, tabulars, and postparietals are absent. Plesiomorphic features of the palate and braincase include a plate-like horizontal parabasisphenoid, a pair of foramina for the internal carotid arteries on the ventral surface of the basisphenoid, and two fields of teeth on the palatal surface of the pterygoid. A sharp angle along the cervical and anterior dorsal ribs clearly separates the dorsal and lateral sides of the neck and anterior thoracic region. The posterior thoracic region has shorter ribs that project laterally and are only slightly curved. The ilium has a laterally deflected blade with numerous deep grooves along its distal edge. The laterally extensive set of osteoderms includes a nuchal element that is composed of several osteoderms that interlock along all margins and lack the arrangement in distinct transverse rows that characterizes the

remainder of the armor. A phylogenetic analysis of basal archosauriforms incorporates new data of *Doswellia* and the taxa *Turfanosuchus*, *Yonghesuchus*, and *Qianosuchus* that have not previously been combined in a single study. Results include a sister-group relationship between *Doswellia* and proterochampsids, placement of *Qianosuchus* as a crurotarsan archosaur, and *Yonghesuchus* and *Turfanosuchus* as successive sister taxa to Archosauria.

Poster Session IV (Saturday)

### APPLICATION AND INTERPRETATION OF BA/CA AND $\delta^{18}\text{O}_{\text{PO}_4}$ PALAEOETHERMOMETERS IN LEPISTOSTEID SCALES

DOMINGO, Laura, Dept. Paleontología, Facultad CC. Geológicas, Universidad Complutense de Madrid, Madrid, Spain; GRIMES, Stephen, School of Earth, Ocean and Environmental Sciences, University of Plymouth., Plymouth, United Kingdom; SOLER-GIJÓN, Rodrigo, Sektion Paläontologie, Museum für Naturkunde, Berlin, Germany; LÓPEZ-MARTÍNEZ, Nieves, Dept. Paleontología, Facultad CC. Geológicas, Universidad Complutense de Madrid, Madrid, Spain

Rare Earth Element (REE) analyses, Ba/Ca and Sr/Ca ratios and  $\delta^{18}\text{O}_{\text{PO}_4}$  analyses were performed upon the ganoinic and isopedine from different types of body scales (i.e. anterior, middle and posterior flank and dorsal body margins) from 2-3 year old juvenile lepisosteids from Fontllonga-3 site with the aim of detecting the most suitable kind of scale to be used for palaeoclimate reconstructions. Fontllonga-3, an Early Danian palaeontological site situated in the Tremp Formation (South Central Pyrenees, Lérida, Spain), represents the earliest Paleogene non-marine vertebrate fauna from the Old World. It has yielded a large number of fish bones, teeth and scales (Lepistosteiformes, Pycnodontiformes, Siluriformes and Osteoglossiformes), as well as bird eggshells and mammal teeth (*Hainina*). The "hat-shaped" REE patterns we obtained are indicative of weak late diagenesis and recrystallization and have also confirmed the palaeoenvironment of Fontllonga-3 lepisosteids as that of an estuary. Ba/Ca and  $\delta^{18}\text{O}_{\text{PO}_4}$  palaeothermometers show that scales from the posterior flank record higher temperatures ( $t(^{\circ}\text{C})_{\text{Ba/Ca}}=28.5\pm 5.2$  and  $t(^{\circ}\text{C})_{\delta^{18}\text{O}_{\text{PO}_4}}=30.5\pm 3.3$ ) when compared to mid-flank scales ( $t(^{\circ}\text{C})_{\text{Ba/Ca}}=25.2\pm 7.4$  and  $t(^{\circ}\text{C})_{\delta^{18}\text{O}_{\text{PO}_4}}=29.1\pm 4.0$ ). This is probably related to the fact that posterior flank scales grow preferentially during the warm season, whilst mid-flank scales (having the greatest number of layers of ganoinic per unit of time) grow all year round and therefore record more palaeoenvironmental and palaeoclimatic variations. Moreover, the mean temperature value recorded by all the ganoinic samples ( $26.7\pm 6.6^{\circ}\text{C}$ ) is more consistent with the temperature of the water in which modern relatives of osteoglossiform fishes (whose remains have been found in Fontllonga-3 together with lepisosteid remains) inhabit, than the temperature values furnished by the isopedine ( $20.8\pm 5.1^{\circ}\text{C}$ ) when applying Ba/Ca palaeothermometry. Therefore, we propose that caution should be taken when interpreting palaeotemperatures from lepisosteid scales since depending on the type of the scale selected, different palaeoclimatic information will be obtained.

Poster Session IV (Saturday)

### A POSSIBLE OCCURRENCE OF ZYGOPHYSETER (CETACEA, PHYSETEROIDEA) IN NORTH AMERICA

DOOLEY, JR., Alton, Virginia Museum of Natural History, Martinsville, VA, USA

Modern physeteroids are essentially cosmopolitan in their distribution. Yet fossil sperm whales seem to have distinctly regional distributions, with most fossil taxa confirmed only in their type areas. *Zygophyseter varolai* was described in 2006 based on a skull and partial skeleton from Late Miocene deposits in southern Italy, and like many sperm whales is known only from the holotype specimen. In March 2008 a fragmentary physeteroid that seems to have affinities with *Zygophyseter* was discovered and excavated on the Rappahannock River in Richmond County, Virginia. This specimen was collected from Bed 14 in the Calvert Formation, which has an estimated age of approximately 14 Ma. This is considerably older than the 8.14-10.5 Ma age of the holotype of *Zygophyseter*. The Virginia specimen includes portions of both maxillae, the right jugal and part of the right lacrimal, both dentaries, and numerous teeth. Preserved elements are all comparable in size to corresponding elements in *Zygophyseter*. Teeth were present in both the upper and lower jaws. The teeth have large roots and small conical crowns with crenulate enamel. As in *Zygophyseter* the teeth have prominent gingival collars, universal apical wear, and frequent occlusal wear. The long, slender jugal is similar in shape to that of *Zygophyseter* and has a large articular facet at the posterior end of the jugal, indicating that this bone was in contact with the zygomatic process of the squamosal. *Brygmophyseter*, from the Middle Miocene of Japan, is similar in size and dental morphology to both *Zygophyseter* and the Virginia specimen, but lacks a jugal-squamosal contact.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 12:00

### THE CRANIAL ENDOSKELETON OF *TIKTAALIK ROSEAE* (TETRAPODOMORPHA, ELPISTOSTEGALIA)

DOWNS, Jason, Academy of Natural Sciences of Philadelphia, Philadelphia, PA, USA; DAESCHLER, Edward, Academy of Natural Sciences of Philadelphia, Philadelphia, PA, USA; JENKINS, JR., Farish, Harvard University, Cambridge, MA, USA; SHUBIN, Neil, University of Chicago, Chicago, IL, USA

The fin-limb transition in the Late Devonian (375-363 Ma) was accompanied by dramatic morphological changes throughout the skeleton. Among these, the reorganization of the

cranial endoskeleton is of particular interest because changes in the braincase, palate, and branchial skeleton have a direct bearing on respiration, feeding, and structural support during the early stages of terrestrialization. The fossil record has not been particularly forthcoming on details of this transition, particularly regarding the sequence of character acquisition. This has manifested as a morphological gap between the conditions observed in finned versus limbed tetrapodomorphs, giving the impression that the cranial endoskeleton of early limbed forms was the product of a rapid shift. *Tiktaalik roseae*, as the sister group to limbed tetrapodomorphs, provides an opportunity to address the relative timing of change across this transition. Several specimens were prepared in three-dimensional detail revealing new information about the morphology of and relationships between the components of the internal head skeleton. The cranial endoskeleton of *T. roseae* is primitive in many respects, sharing with more basal tetrapodomorphs the presence of a basicranial fenestra, a lateral commissure, a ventrally-directed vestibular fontanelle, and an unfused endoskeletal intracranial joint. At the same time, *T. roseae* shares certain derived features with limbed taxa including an enlarged basal articulation and a flat, horizontally-oriented palatoquadrate. The reduced hyomandibula of *T. roseae* appears intermediate between the condition observed in other finned tetrapodomorphs and that observed in early limbed taxa. The cranial endoskeleton of *T. roseae*, like the skull roof and postcranial skeleton, exhibits a combination of primitive, intermediate, and derived characters that helps to illuminate the stepwise sequence of character change between the finned and limbed conditions. This sequence of modifications suggests trends in improving head mobility while restricting intracranial kinesis. With a more solidly constructed head capable of moving independent of the body, *T. roseae* demonstrates an important intermediate stage in the vertebrate transition to a terrestrial existence.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 11:00

#### ENDOCASTS OF NOTOUNGULATES AND BRAIN EVOLUTION IN EXTINCT SOUTH AMERICAN UNGULATES

DOZO, María, Centro Nacional Patagónico, Puerto Madryn, Argentina

Notoungulata was South America's most diverse (morphologically as well as taxonomically) and successful indigenous ungulate group. Three suborders are recognized: Notioprogonia (primitive notoungulates of Paleocene and Eocene), Typotheria (notoungulates resembling rabbits or large rodents) and Toxodontia (notoungulates which ranged from sheep-like to rhino-like in size and body form). We studied endocasts from ten of the fourteen families of notoungulates, which were of Casamayoran, Divisaderan, Deseadan, Colhuehupian, Santacrucian, Friasian, Montehermosan and Chapadmalalan South American Land Mammals Ages (Eocene-Pliocene). Paleoneurological studies of these notoungulates allow the following hypotheses as preliminary conclusions: It was not possible to discern or describe a single common encephalic pattern to the notoungulates with regard to external brain morphology. The neuromorphological diversity of the notoungulates is consistent with their morphological as well as taxonomic diversity. The neuromorphological diversity of the notoungulates is also consistent with different neurological response to of different ecological types. The neuromorphological traits are consistent with the osteological and dental traits that have been used to define different examples of convergence between notoungulates and North American (perissodactyls and artiodactyls) and South American (rodents) mammals. This indicates that equivalent ecological types develop brains with similar morphologies.

Poster Session IV (Saturday)

**AN EARLY NORTH AMERICAN OCCURRENCE OF POLYCOTYLIDAE (PLESIOSAURIA) FROM THE CLEARWATER FORMATION (EARLY CRETACEOUS; EARLY ALBIAN) OF NORTHERN ALBERTA, CANADA**  
DRUCKENMILLER, Patrick, University of Alaska Museum, Fairbanks, AK, USA;  
RUSSELL, Anthony, University of Calgary, Calgary, AB, Canada

Industrial-scale, open-pit mining of oil sands in northeastern Alberta, Canada has resulted in the serendipitous discovery of several plesiosaur and ichthyosaur skeletons from the Lower Cretaceous (lower Albian) Wabiskaw Member of the Clearwater Formation. In 1995, a partially articulated skeleton of a short-necked plesiosaur was recovered from a 2.5 meter-thick, glauconitic, muddy sandstone unit of the Wabiskaw Member. The specimen is preserved within a single large concretion, measuring 2.4 by 1.0 meters that has split along the bedding plane containing the bones. The concretion was further fragmented into large pieces during the discovery process, which involved heavy machinery. With the exception of the skull and anterior-most cervical vertebrae, the skeleton is largely complete, and includes much of the semi-articulated vertebral column, numerous ribs and gastralia, a partial scapula, both coracoids and pubes, a partial ischium, and portions of all four limbs including propodials, and associated portions of the zeugopodia and autopodia. Vertebral proportions, as well as propodial, epipodial, and pectoral girdle morphology, permit referral of this specimen to the Polycotylidae, a clade of cosmopolitan, short-necked plesiosaurs known primarily from Upper Cretaceous successions. The new lower Albian specimen from Alberta represents one of the earliest stratigraphic occurrences of Polycotylidae in North America, and in the world. As such, it provides new data on early polycotylid evolution and distribution, and challenges hypotheses of an Australasian origin of this clade.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 8:45

#### MORPHOLOGICAL PATTERNS AND PHYLOGENETIC TRENDS IN THEROPOD BRAINCASE PNEUMATICITY

DUFEAU, David, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

The braincases of theropod dinosaurs are generally highly pneumatic, and the often complicated systems of air chambers have become important phylogenetic characters. The individual identities, detailed morphological conformations, and homologies of the bony recesses, however, remain poorly resolved, undercutting their phylogenetic utility. Moreover, testing functional hypotheses (e.g., audition) cannot begin until these fundamental problems are addressed. As part of a larger study of braincase pneumaticity in Archosauria, we have identified at least three systems that are involved in pneumatizing the braincase—the median pharyngeal, subcondylar, and paratympenic systems—all three of which are variably present in theropods. Dozens of theropod braincases thus far have been subjected to CT scanning and 3D visualization, including the ceratosaurs *Ceratopsaurus* and *Majungasaurus*, the basal tetanurines *Allosaurus*, *Marshosaurus*, and *Acrocanthosaurus*, the tyrannosaurids *Gorgosaurus* and *Tyrannosaurus*, the ornithomimids *Gallimimus* and *Struthiomimus*, the oviraptorosaurs *Avimimus* and *Citipati*, the alvarezsaurid *Shuvuuia*, and the deinonychosaurs *Byronosaurus*, *Saurornithoides*, *Troodon*, *Dromaeosaurus*, *Deinonychus*, and *Tsaagan*, and numerous birds. This study goes beyond presence/absence data to include parameters such as relative volumes, interconnections, and relationships to other systems (e.g., neurovasculature). Pneumatic attributes are variable among theropods, but patterns are emerging. Some sinuses are very consistent and present in all theropods (rostral tympanic recess) or restricted to certain groups (caudal tympanic recess in coelurosaurs). Other recesses are more erratic in their distribution. For instance, elements of the mandibular arch (quadrate, articular) are pneumatic in tyrannosaurids, some ornithomimids, at least one carcharodontosaurid, troodontids, and birds, but not dromaeosaurids. There is a general trend for increasing diversity and extent of sinuses on the theropod line to birds.

Technical Session IX, Thursday 3:00

#### LOWER EOCENE FOSSIL BIRDS FROM THE OKANAGAN HIGHLANDS (PACIFIC NORTHWEST OF NORTH AMERICA)

DYKE, Gareth, University College Dublin, Dublin, Ireland; ARCHIBALD, Bruce, Simon Fraser University, Vancouver, BC, Canada; MATHEWES, Rolf, Simon Fraser University, Vancouver, BC, Canada

Although Paleocene and Eocene-aged sediments are abundant on the Pacific northwest coast of North America (Cascadia, encompassing parts of Canada and the USA), very few fossil birds of this age have been hitherto reported. Limited known records are of marine birds, including the extinct 'penguin-like' pteropterids and ocean-going 'pseudotoothed' pelecaniforms. This contrasts with an extremely abundant fossil record for early Paleogene birds from east of the Rocky Mountains (deposits in Alberta, Montana, Wyoming and Utah). We present five new avian skeletal specimens from a series of lake deposits spanning a more than 1,000 km transect along the Okanagan Highlands in southern British Columbia and northern Washington State. These taxa include new records of terrestrial and forest-dwelling birds, the first from west of the Rocky Mountains. Phylogenetic interpretations of these new Lower Eocene (Ypresian) birds indicate that one is a member of the extinct coraciiform lineage Primobucconidae, one is a sandcoleid mousebird and one occupies a basal position within Galliformes, the 'fowl-like' assemblage. Other isolated bones are referable to the anseriform clade Presbyornithidae, closely related to extant ducks and geese; the likely body-size of other taxa is estimated from their regurgitated pellets. In addition to well-preserved skeletal specimens of birds (including some complete wing feathering), we have identified avian fossil material (i.e., feathers, isolated bones, pellets and trackways) from eight distinct stratigraphically-constrained sites along the Okanagan Highlands transect, representing a range of temperate climatic zones and non-marine sedimentary environments (including lakes and swamps). The Okanagan basins preserve unique paleoenvironments, new to the Eocene bird fossil record and have been tightly constrained by their floras and constituent insect faunas. The Okanagan fossil birds are thus tied to paleotemperature and paleoelevation. Although little explored to date, there is no doubt that these fossil sites will yield additional specimens to the Pacific record of early Paleogene birds.

Technical Session XIX, Saturday 2:15

#### A RE-EVALUATION OF A WELL-PRESERVED SKULL OF ACROCANTHOSAURUS ATOKENSIS SUPPORTS ITS CARCHARODONTOSAURID AFFINITIES

EDDY, Drew, North Carolina State University, Raleigh, NC, USA; CLARKE, Julia, North Carolina State University, Raleigh, NC, USA

Considerable debate has surrounded the phylogenetic position of *Acrocanthosaurus atokensis* from the Early Cretaceous Antlers Formation of North America. Many phylogenetic analyses place *Acrocanthosaurus* as the sister taxon to *Allosaurus*, whereas others recover it as a member of Carcharodontosauridae, a derived group of large-bodied, Gondwanan allosauroids. Examination of a well-preserved skull of *Acrocanthosaurus* (NCSM 14345), as well as a digital endocast generated from a CT scan of the braincase,

has provided new information regarding the morphology of the palatal complex and inner surfaces of the skull and mandible, features that were obscured by matrix during a previous description. From this new data, twenty-two novel characters were added to a data matrix (164 characters; 17 terminals) that included twelve ingroup taxa previously recovered within Allosauroidae. Analysis of this matrix recovered a single most parsimonious tree that placed *Acrocantiosaurus* as a derived member of Carcharodontosauridae, with *Tyrannotitan*, *Eocarcharia*, and *Neovenator* as successively more basal carcharodontosaurid taxa. Adding proposed allosauroid taxa known from specimens lacking cranial material (i.e. *Lourinhanosaurus*, *Siamotyrannus*, *Megaraptor*, and *Fukuiraptor*) into this analysis created a polytomy at the base of Allosauroidae that included *Tyrannotitan*, *Eocarcharia*, and *Neovenator*. However, *Acrocantiosaurus* remained the sister taxon to Carcharodontosaurinae, a placement supported by the following characteristics: a sinuous medial groove for the maxillary dental lamina; a small accessory process between the quadratojugal prongs of the jugal; and a lateral curvature of the lacrimal dorsal to the lacrimal pneumatic recess. Additionally, pneumatic features of the quadrate and the shape of the ectopterygoid of *Acrocantiosaurus* resemble those of the derived carcharodontosaurid taxa *Mapusaurus* and *Giganotosaurus*, respectively. These and other features observed from NCSM 14345 may represent: (1) autapomorphies distinguishing *Acrocantiosaurus* from other allosauroids, or (2) synapomorphies of Carcharodontosauridae that cannot be optimized until more complete specimens are recovered.

Poster Session III (Friday)

**A MORPHOLOGICAL STUDY OF CAPTORHINUS AGUTI USING X-RAY COMPUTED TOMOGRAPHY: NEW INSIGHTS ON A WELL-STUDIED SPECIES**  
EGBERTS, Sebastian, Jackson School of Geosciences, University of Texas at Austin, Austin, TX, USA

*Captorhinus aguti*, a eumetoposid from the Lower Permian of Texas and Oklahoma, is a well known taxon critical to understanding the evolutionary relationships among the major lineages of reptiles. X-ray computed tomography of an exceptionally preserved skull of a Texas Memorial Museum specimen of *Captorhinus aguti* revealed new internal features of this species that were never before recognized. The TMM specimen comes from fissure fills deposits of the Dolese Brothers quarry in Oklahoma. Because most of the skull elements are well articulated, detailed three-dimensional reconstructions of the relationships and orientations of articulations and sutures are now available. The septomaxilla is more complex than previous reconstructions have shown. It is not simply a round, sheet-like structure, but has a rather complex construction. The lateral side is dominated by a wide foramen, which forms a short canal and exits into the nasal capsule. It is the direct anterior extension of the lacrimal duct. For the first time an almost undeformed sphenethmoid can be studied. The sphenethmoid is goblet-shaped in cross-section and is dorsally broader than previous reconstructions have shown. X-ray computed tomography allowed the examination of the braincase in almost complete articulation and confirms previous observations. The dorsal side of the palate is well preserved and easily accessible with this non-destructive method. The vomer and the palatine build the groove for the vomeronasal organ. The epipterygoid and pterygoid form a tight tongue-in-groove structure that is indistinguishably fused towards the center of the contact. These new discoveries in the skull morphology of *Captorhinus aguti* will contribute important characters into future phylogenetic analyses. This is especially valuable because this species is the most common captorhinid included in prior analyses.

Poster Session IV (Saturday)

**ARTICULATED AND ASSOCIATED SHARK VERTEBRAE FROM THE LATEST CRETACEOUS-EARLIEST PALEOGENE BASAL HORNERSTOWN FORMATION (NEW JERSEY)**

EGERTON, Victoria, Drexel University, Philadelphia, PA, USA; LACOVARA, Kenneth, Drexel University, Philadelphia, PA, USA; SCHEIN, Jason, New Jersey State Museum, Trenton, NJ, USA; GALLAGHER, William, New Jersey State Museum, Trenton, NJ, USA; POOLE, Jason, Academy of Natural Science, Philadelphia, PA, USA

A fossilized shark (Elasmobranchii indet.) with over 50 articulated and associated vertebrae was discovered in the basal Hornerstown Formation in Gloucester County, New Jersey. Shark remains from this locality are known primarily from teeth (*Cretolamna appendiculata*, *Squatina* sp., *Squalicorax pristodontus*, *Odontaspis cuspidata*) and isolated vertebrae. The specimen is associated with a *Cucullaea-Turritella* assemblage and two articulated caudal vertebrae and coracoid and humerus from a crocodylian (indet.). The shark vertebrae have a lamnoid-type centra that are amphicoelous with concentric rings on the cranial and caudal ends. The Hornerstown Formation is a glauconitic sand interpreted as a shallow (less than 50m) productive marine deposit. Within the Hornerstown Formation the Main Fossiliferous Layer (MFL), ranges from the late Cretaceous into the early Paleogene and contains more than 60 vertebrate and invertebrate taxa. A number of researchers have interpreted the MFL as a transgressive lag deposit. The articulated and associated elasmobranch vertebrae, as well as articulated *Thoracosaurus* and *Hyposaurus* remains, found by us appear to preclude energetic reworking along a ravinement surface during the deposition of the MFL. Instead, our evidence suggests a time-averaged assemblage of fossils, which accumulated in a quiescent shelf environment, below wave-base, and under a relatively low rate of sedimentation.

Poster Session I (Wednesday)

**CARNIVORANS FROM THE PONDAUNG (MYANMAR) AND KRABI (THAILAND) FAUNAS: CHANGE OF TAXONOMIC DIVERSITY IN THE MIDDLE TO LATE EOCENE OF SOUTHEAST ASIA**

EGI, Naoko, Kyoto Univ. Primate Research Inst., Inuyama, Japan; TSUBAMOTO, Takehisa, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; NAKAYA, Hideo, Kagoshima Univ., Kagoshima, Japan; KUNIMATSU, Yutaka, Kyoto Univ. Primate Research Inst., Inuyama, Japan; TAKAI, Masanaru, Kyoto Univ. Primate Research Inst., Inuyama, Japan

Paleontological expeditions of the Eocene sediments in Myanmar and Thailand yielded new materials of several undescribed carnivorans. Five species of carnivorans were found from the late middle Eocene Pondaung Formation in central Myanmar. These were identified as two nimravids, two miacids, and one amphicyonid. Five families have been suggested to be present in the late Eocene Krabi fauna (southern Thailand). Observations on the new specimens indicated that the undescribed species previously reported as an indeterminate Caniformia and an indeterminate Ursoidea are both closely related to basal arctoids such as *Cephalogale*. As a result, carnivorans from the Krabi fauna consist of two nimravid genera, one miacid, one mustelid, and one or two affinities of *Cephalogale*. The occurrences of carnivorans in these two faunas were compared with those in other middle to late Eocene faunas in southern China (Lower and Upper Lumeiyi, Donjun, Naduo, and Gongkang). Nimravids, miacids, an amphicyonid, and *Cephalogale* have been known from the other faunas in addition to the Pondaung and/or Krabi faunas. Thus, unlike the other mammals known from the Pondaung and Krabi faunas, the carnivorans (except the mustelid) are not endemic to the faunas. Nimravids are the most common carnivorans and are known from the oldest to the youngest faunas. The other carnivoran families joined the faunas in the late middle or the late Eocene, increasing the taxonomic diversity of carnivorans. Carnivorous mammals occupy 19 and 17 per cent of mammal species in the Pondaung and Krabi faunas, respectively. These percentages are higher than those in the older middle Eocene faunas. The middle Eocene faunas including the Pondaung differ from the late Eocene faunas such as the Krabi, in that a half of the carnivorous mammal species is creodonts. These comparisons suggested that the increase of carnivorans resulted in higher percentage of carnivorous mammals in the fauna and higher taxonomic diversity at the end of the middle Eocene, and that the replacement of creodonts by carnivorans occurred during the late Eocene.

Technical Session XVIII, Saturday 3:00

**LIFE HISTORY OF AN EXTINCT WHITE SHARK (*CARCHARODON* SP.) FROM THE PLIOCENE, PISCO FORMATION OF PERU**

EHRET, Dana, Florida Museum of Natural History/University of Florida, Gainesville, FL, USA; MACFADDEN, Bruce, Florida Museum of Natural History/University of Florida, Gainesville, FL, USA; HUBBELL, Gordon, Jaws International, Gainesville, FL, USA

The vertebral centra of sharks preserve a record of incremental growth and life history throughout ontogeny. In some species, such as the white shark *Carcharodon carcharias*, annual growth is recorded in the form of growth couplets (annuli). These annuli are composed of a dark band, representing a period of slower growth during a cooler season, and a light band, representing a period of faster growth during the warmer season. By counting these incremental growth bands in available fossil specimens, one can deduce the relative age of an individual shark in order to learn more about its life history. Here we apply this method to an exceptionally well preserved white shark, *Carcharodon* sp., from the early Pliocene (~ 4 Ma), Pisco Formation of Peru consisting of 45 vertebral centra, this specimen also contains 222 teeth, portions of the neurocranium, Meckel's cartilages, and palatocrura. Analysis of the vertebral centrum using x-radiography shows that the individual was approximately 20 years old when it died. A total length estimate of 4.9 meters is calculated based on regression analysis of the associated teeth and centra. Combining the age and total length estimates allows extrapolation an accurate growth curve for this individual. Interestingly, the early Pliocene white shark grew at a slower rate compared to the extant white shark, *Carcharodon carcharias*. Both indirect and direct evidence of feeding behavior for the same species is also recorded from the same locality. Thus, in addition to many scratched and gouged whale bones preserved within the Pisco Formation, in what appears to be a scavenging event, a partial tooth crown of the *Carcharodon* sp. is embedded within the mandible of a mysticete whale. When combined, this information elucidates the life history of an early Pliocene white shark and allows comparisons with extant *Carcharodon carcharias*.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 10:30

**VARIATION AMONG ENDOCASTS OF THE BONY LABYRINTH OF ZHELESTIDS (MAMMALIA: EUTHERIA)**

EKDALE, Eric, The University of Texas at Austin, Austin, TX, USA

Zhelestids form a paraphyletic group of Late Cretaceous mammals. There is a thorough description of the external morphology of the petrosal, which houses the bony labyrinth of the inner ear, but there is little information about the internal morphology of the bony labyrinth. In this study, I used high resolution X-ray computed tomography (CT) to construct digital endocasts of the bony labyrinth of several specimens of zhelestids. I used these endocasts to measure aspects of the inner ear structures that are thought to be related to behavior and

phylogeny. The measurements include coiling of the cochlea, the radii of curvature of the semicircular canals, and angular deviations of the canals to their respective planes. The morphology of the bony labyrinth of zhelestids is consistent with that of other fossil and extant eutherians. One notable feature present in the inner ear of zhelestids is the secondary common crus, which is a fusion of the lateral and posterior semicircular canal that enters the posterior ampulla. The cochlea also coils between one and one and a half turns. The isolated zhelestid petrosals likely represent more than one species since several zhelestid species are recognized based on teeth, but the degree of variation observed in the sample compares favorably to that observed within single extant mammal species. The planarity of the semicircular canals, or how well a canal fits onto a single plane, was the most variable feature. The coiling of the cochlea and radii of curvature of the canals do not vary significantly in the specimens examined, indicating that there is little variation between individuals within species, or among closely related species in the case of zhelestids. The morphology of the bony labyrinth of zhelestids is phylogenetically uninformative. Both the secondary common crus and a cochlea completing just over one turn are ancestral features of therian mammals, which would be consistent for excluding zhelestids from crown Placentalia. However, these characteristics are present in some members of the crown, so the morphology of the inner ear can neither include nor exclude zhelestids from Placentalia.

Technical Session XVIII, Saturday 2:00

**TAPHONOMIC ANALYSIS OF EARLY VERTEBRATE OCCURRENCES FROM THE CANADIAN ARCTIC AND WESTERN USA**

ELLIOTT, David, Northern Arizona University, Flagstaff, AZ, USA; FIORILLO, Anthony, Museum of Nature and Science, Dallas, TX, USA

Taphonomic analysis was carried out on diverse faunas of Paleozoic vertebrates from the Early Devonian Beartooth Butte Formation, Wyoming and localities around the Boothia Uplift, arctic Canada including the Late Silurian Cape Storm Fm., the Early Devonian Snowblind Bay Fm., and the Late Silurian-Early Devonian Peel Sound Formation. These areas were chosen as providing abundant vertebrates, good sedimentary exposures, and a range of shallow marine, tidal flat, fan-margin, and estuarine environments. Detailed measurement and lithologic descriptions of short stratigraphic sections across the vertebrate horizons, sedimentary structures, and fossil content were used to interpret depositional processes and environments. The sites contain abundant macrovertebrate remains with each representing an assemblage of fishes dominated by heterostracans with less common placoderms, and infrequent acanthodians and sarcopterygians. Basic taphonomic problems addressed included cause of death, whether the faunas were allochthonous or autochthonous, the decomposition and fragmentation styles of early fishes, the hydrodynamic behavior of skeletal fragments, and the extent to which this contributed to the preservation of agnathan-eurypterid-lingulid-ostracod associations. The preservation quality of individual bones is good to excellent, regardless of mode of preservation as an articulated or associated skeleton, or as an isolated element. Articulated specimens are extremely rare, with the most abundant mode of preservation being isolated plates. Almost all of the accumulations studied consisted of disarticulated plates and scales indicating that transport and sorting were dominant aspects in the taphonomic history of these assemblages. The Cape Storm fauna was concentrated in shallow offshore environments and transported onshore during a major storm, while the Snowblind Bay fauna inhabited fluvial environments on a fan complex and was transported into the nearshore environment. The Peel Sound localities suggest vertebrates inhabited an alluvial fan complex but were then transported to the fan-delta margin, while the Beartooth Butte fauna inhabited an estuarine environment.

Poster Session I (Wednesday)

**GETTING TO THE ROOT OF TEETH AND BITE FORCE: A COMPARATIVE STUDY USING FINITE ELEMENT ANALYSIS**

ERGAS, Emmanuel, University of Washington, Seattle, WA, USA; SELF, Casey, University of Washington, Seattle, WA, USA

A great diversity of tooth forms are observed in both the fossil record and extant taxa. Our study addresses the prominent forms within this array, variations on a simple cone. Crown shape and root development affect the magnitude and distribution of stresses within teeth, which may play a role in the evolution of these structures. The ability of the dentition to withstand the stresses produced during food capture and consumption is a limiting factor of maximum bite force. We used finite element analysis to explore how the distribution of stress in isolated teeth is affected by crown angularity, bilateral constriction, recurvature, and the presence or absence of a root. Variations of conical, elliptical, and recurved teeth were matched with roots of varying depth to quantify patterns in stress distribution changes as a result of crown and root morphology. In the acrodont condition, bilateral constriction and acute crown angles served to decrease the maximum observed stresses by 8% in both cases. Addition of roots to purely conical crowns decreased the peak stresses. Increasing the length of roots produced a further reduction in stresses, up to 14%. Peak stresses reduced roughly 20% by adding roots to bilaterally constricted crowns. Crown recurvature creates an asymmetry in stresses with a compliment of compression and tensile stresses on either side of the crown in the plane of curvature. A tooth that experiences a lower peak stress under a given load would thus be better suited to withstand higher loading. Working under the assumption that teeth of equal volume are of equal energetic investment, our results suggest that minor changes in one geometric parameter can lead to a tooth that responds quite differently to the same applied loads. We suggest that the evolution of bilateral constriction and root elongation may allow greater bite forces with similar stress levels. Further analyses may consider crown and root apex curvature and development of multiple cusps.

Technical Session VI, Thursday 1:45

**ROUGHING IT: DENTAL COMPLEXITY IN BAMBOO FEEDERS AND THE INFERENCE OF MESIC ENVIRONMENTS**

EVANS, Alistair, Institute of Biotechnology, University of Helsinki, Finland; ZOHDY, Sarah, Institute of Biotechnology, University of Helsinki, Finland; WRIGHT, Patricia, Stony Brook University, Stony Brook, NY, USA; JERNVALL, Jukka, Institute of Biotechnology, University of Helsinki, Finland

Bamboos, grasses belonging to the family Poaceae, are highly fibrous, with culms containing close to 50 percent cellulose. This together with phytoliths makes bamboo a challenging food to consume and digest. Specialization for bamboo feeding has evolved several times in mammals. Primates, bears, and muroid rodents all have living species that rely largely on a bamboo diet. While phylogeny, size, and life history are highly divergent among these bamboo specialists, they do share some adaptations to feeding on bamboo. One shared feature is dental morphology, and here we apply a 3-dimensional method to assess crown feature complexity, or surface roughness, in bamboo eating lemurs, pandas, and rodents. Our analyses of dentitions show that bamboo specialists have highly complex cheek tooth morphology irrespective of the taxon-specific morphological details. The high complexity values can be related to the high number of tooth crown features, or 'tools', required to process fibrous bamboo. In addition to comparable levels of high dental complexity, all the studied taxa have low tooth crowns. This is in stark contrast to the tall teeth of ungulates feeding on grass in open and more seasonally dry environments. Furthermore, with more pronounced dry seasons, the ranges of the bamboo feeders with the most complex teeth have contracted. These results suggest that fossil taxa with dental complexity comparable to modern day bamboo feeders can be used to infer mesic conditions.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 8:30

**ENDOCRANIAL ANATOMY OF LAMBEOSAURINE DINOSAURS: IMPLICATIONS FOR CRANIAL CREST FUNCTION AND EVOLUTION**

EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; WITMER, Lawrence, Ohio University, Athens, OH, USA; RIDGELY, Ryan, Ohio University, Athens, OH, USA; HORNER, John, Museum of the Rockies, Bozeman, MT, USA

Interpreted in a phylogenetic context, brain endocast and nasal cavity morphology and ontogeny represent powerful tools to test functional hypotheses in extinct vertebrates. In order to test hypotheses of cranial crest function, endocasts of six corythosaurin lambeosaurines were generated through computed tomography and three-dimensional rendering and visualization software. The specimens represent a range of ontogenetic stages from the taxa *Lambeosaurus*, *Corythosaurus*, and *Hypacrosaurus*. The morphology of brain cavity endocasts in lambeosaurines differs little from that of hadrosaurines. The undivided olfactory region confirms that the olfactory bulbs were small and proximally situated with respect to the hemispheres. The hemispheres form a relatively large proportion of the overall size of the endocast, accounting for approximately 43% of the total endocranial volume at all ontogenetic stages. Relative to total endocast volume, the cerebrum is larger than that of many ornithischians and large theropods, but compares favorably to the maniraptoran theropod *Conchoraptor* (43%) and *Archaeopteryx* (45%) of considerably smaller body size. The nasal cavity reconstructions of juvenile *Lambeosaurus*, *Corythosaurus*, and *Hypacrosaurus stebingeri* are very similar, and appear relatively consistent with their reconstructed adult conditions. The vestibule forms the largest part of the nasal cavity, and the main olfactory region is closely associated with the olfactory bulbs and outside of the main airway. In *Hypacrosaurus altispinus*, the nasal vestibule is strikingly elongated and convoluted compared to all other corythosaurs. When interpreted in the context of lambeosaurine phylogeny, this suggests a strong selective pressure for nasal cavity function that operated independently from changes in the external shape of the crest. The vestibular apparatus reveals for the first time that the detailed structure of the lambeosaurine inner ear closely resembles that of hadrosaurines, and therefore confirms key assumptions of previous estimates of auditory sensitivity in the group as it relates to the resonance model of crest function.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**MAMMALIAN MIGRATION PATTERNS IN TIMES OF GLOBAL WARMING - IMMIGRATION AND LOCAL EXTINCTION IN CENTRAL EUROPE AT THE END OF THE LAST GLACIAL**

FAHLKE, Julia, Steinmann Institute for Geology, Mineralogy, and Paleontology/Bonn University, Bonn, Germany

The late phase of the Last Glacial (Weichselian/Würmian in Central Europe, corresponding to the American Wisconsinian) was a time of discontinuous but overall climatic amelioration, characterized by cooler and warmer intervals (stadials and interstadials), and followed by the marked Holocene warming. Mammal species are adapted to their respective habitats, including the restriction to or preference for certain climatic conditions. In times of a favorable climate, populations expand their distribution ranges from core areas to temporal distribution areas. When the climate deteriorates (with respect to the specific requirements), they do not, as often suggested, emigrate, following the suitable climate, but go locally extinct. Throughout the Pleistocene Central Europe served as such a temporary distribution area. During interglacials mammals requiring temperate conditions immigrated

from glacial refugia in the south (France, Spain, Italy, and the Balkans). During glacial species dependent on cold and dry climate reached Central Europe from the northeast and east (Baltic states and Russia). To test this model on the latest extinction event at the Pleistocene/Holocene transition, detailed information on mammal faunas from over 300 localities of the Weichselian/Würmian Lateglacial and Early Holocene (15,000- 8,000 <sup>14</sup>C BP) were collected, analyzed, and interpreted. It is shown that the pattern of immigration and local extinction did not only occur during the alternating longer-time glacial and interglacials. It is also detected for the small-scale Lateglacial stadials and interstadials. Thereby, even species belonging to the same group of climatic preference (e. g., adapted to temperate conditions) are affected to a different extent. The importance of various climatic and geographical factors for population dynamics is discussed. It is found that the effect of precipitation is oftentimes underestimated, and that the positions of the varying coastlines and the retreating glacial front must be taken into account. Furthermore, a human impact on the extinction of typical Ice Age mammals like the mammoth is, at least for Central Europe, considered to be unlikely.

Technical Session XIX, Saturday 3:45

#### USING FINITE ELEMENT ANALYSIS TO AID INTERPRETATION OF DINOSAUR TRACKS

FALKINGHAM, Peter, University of Manchester, Manchester, United Kingdom; MARGETTS, Lee, University of Manchester, Manchester, United Kingdom; MANNING, Phillip, University of Manchester, Manchester, United Kingdom

The interpretations of vertebrate tracks are made on an almost entirely qualitative morphological basis. Track morphology, however, has been shown to vary with substrate properties (moisture content, grain size, etc), foot morphology, and biomechanics (i.e. the gait and kinematics). Even with these parameters constant, an exposed undertrack can show gross morphological differences to the original surface trace dependent upon its depth within a track volume. This results in a single animal being capable of producing a multitude of morphologically distinct tracks. In order to interpret tracks correctly, we need to understand the effects that each parameter (of sediment consistency and of loading conditions) has on track morphology. Finite Element Analysis (FEA) has been used in palaeontology for understanding the distribution of stress within materials such as bone, and recently in sediment during track formation. A computer based model can provide a quantifiable test bed for repeatable experimentation with accurate control over specified mechanical and biological parameters. Sediment properties can be adjusted independently, and loading conditions (the action of the foot interacting with the substrate) can also be varied. This means that parameter effects can be quantified, and specific scenarios for fossil specimens can be reverse-engineered and ultimately reconstructed. Here, fossil tracks are interpreted in light of results from FEA; dinosaur 'track books' from the Amherst College Museum of Natural History, and a Cretaceous palmate bird track. The subsurface deformation of the FEA tracks is directly comparable with Amherst track books. The palmate track is used to create FEA simulations which offer an alternative interpretation other than a webbed foot – sediment failure and collapse between digits producing the appearance of webbing.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

#### A REPORT ON THE DISCOVERIES MADE AT THE GOLTER RANCH LOCALITY (HEMPHILLIAN) IN ANTELOPE COUNTY, NEBRASKA

FAMOSO, Nicholas, South Dakota School of Mines and Technology, Rapid City, SD, USA

In the summer of 2007, excavations began at a new Hemphillian locality in Antelope County, Nebraska. The Golter Ranch locality produced a diverse assemblage of vertebrate fossils from the Ash Hollow Formation. Hemphillian taxa such as Emydidae, Testudinidae, Druidae, Sciuridae, Felidae, Gomphotheriidae, *Teleoceras fossiger*, Equidae, and Camelidae were found. Ninety-five percent of the specimens belong to *T. fossiger* and Testudinidae. The condition and orientation of the specimens gives the appearance that the site was a seasonal watering hole. Vertebrate specimens show skid marks caused by trampling before fossilization. A high percentage of specimens are also vertically oriented and are associated but fractured. This evidence indicates trampling in a low energy environment. The Golter Ranch locality is stratigraphically higher than the Ash Hollow deposits seen at Ashfall Fossil Beds State Historical Park. Taxonomic and stratigraphic evidence indicates that this site is about 2 to 4 million years more recent than the ash deposits (11.83 Ma) found at Ashfall Fossil Beds State Historical Park. The scarcity of Equidae and the dominance of *T. fossiger* demonstrates a unique ecological environment.

Romer Prize Session, Thursday 10:15

#### EVOLUTION AND FUNCTION OF THE SUPRACRANIAL SINUSES IN CERATOPSID DINOSAURS AND THE FRONTAL SINUSES IN BOVID MAMMALS

FARKE, Andrew, Raymond M. Alf Museum of Paleontology, Claremont, CA, USA

Cranial sinuses located dorsal to the endocranial cavity and ventral to the horncores occur in both horned dinosaurs (ceratopsids, with supracranial sinuses) and some horned mammals (bovids, with frontal sinuses). The function of these sinuses has been debated, although many workers have suggested that the sinuses in bovids serve a role in shock absorption during horn-to-horn combat. By analogy, the sinuses of *Triceratops* and kin have been hypothesized to serve a

similar purpose. However, this alleged shock absorptive function has never been verified, even for extant bovids. Thus, finite element modeling (FEM) was used to examine the functional role of the frontal sinuses in domesticated goats. Models of the skull, with varying frontal bone and sinus morphology, were loaded under simulated head-butting conditions. It was found that the sinuses are only moderately effective as shock absorbers, are poorly placed for protecting the brain from blows to the horns, and are located in areas of bone under low stress. Furthermore, in a comparative analysis of 63 species of bovid, no statistically significant link was found between head-butting behavior and sinus morphology (quantified as relative size or structural complexity) after consideration of phylogenetic effects. Based on the results in bovids, the hypothesis that sinuses acted as shock absorbers in ceratopsids is weakened. In this clade, however, unlike in Bovidae, the sinuses form through a secondary roofing of the skull in conjunction with excavation of bone. Further inferences of behavior in ceratopsids from bovids are hampered by drastic differences between the groups in the placement of the sinuses relative to the horns as well as differences in horn position and orientation. The development of a closed sinus from an open depression in ceratopsids was associated at least in part with an anatomical reorganization of the ceratopsian skull which resulted in a thickening of the skull roof.

Poster Session III (Friday)

#### DETERMINING LOCOMOTOR STYLE OF *OPHIACODON* (SYNAPSIDA) USING ANALYSIS OF AXIAL SKELETON MORPHOLOGY

FELICE, Ryan, Tulane University, New Orleans, LA, USA; ANGIELCZYK, Kenneth, Field Museum Of Natural History, Chicago, IL, USA

The basal synapsid *Ophiacodon* has been long interpreted as being a semi-aquatic piscivore. This interpretation is based on several morphological and taphonomic clues. *Ophiacodon* lacks claws and caniniform teeth, and has hind limbs significantly longer than its forelimbs. It also shows poor ossification throughout the skeleton, which is unique among pelycosaurs. Finally, some *Ophiacodon* material has been found in marine limestones, in contrast to the more terrestrial sediments that produce other basal synapsids. Although these clues suggest an amphibious lifestyle, no rigorous analysis of this hypothesis has been performed. To test if *Ophiacodon* was semi-aquatic, we carried out statistical comparisons of vertebral proportions. Bucholtz and others have stressed the importance of body stiffness in undulatory propulsion, as well as the correlation between the proportions of centra and neural spines to the flexibility of the axial skeleton. Longer, spool shaped centra indicate increased flexibility, whereas more disc shaped centra correlate with greater stiffness. Taller neural spines indicate increased axial musculature and increased stiffness. Semi-aquatic tetrapods are expected to increase flexibility in the propulsive region of the skeleton (the tail) compared to the region which is not propulsive (the torso or trunk). We measured the length, width, and height of centra, height of neural spines, and length and depth of zygapophyses, as well as limb bone lengths (when available) of several *Ophiacodon* specimens in which the vertebral column is articulated. These measurements were compared to measurements of both terrestrial and semi-aquatic tetrapods. Terrestrial taxa included several pelycosaurs (*Varanops*, *Aerosaurus*, *Sphenacodon*, *Dimetrodon*, *Casea*), as well as two extant terrestrial varanid lizards (*Varanus komodoensis*, *Varanus niloticus*). The semi-aquatic tetrapods all were extant and included crocodylians (*Osteoleaemus tetraspis*, *Caiman crocodilus*) and squamates (*Amblyrhynchus cristatus*). Preliminary comparisons suggest that the vertebral column of *Ophiacodon* is similar to that of other pelycosaurs, calling into question its distinctive way of life.

Technical Session II, Wednesday 8:45

#### INTRA-TOOTH VARIATION IN ISOTOPE VALUES OF LATE PLIESTOCENE BISON (*BISON*) AND HORSE (*EQUUS*) REVEALS SEASONAL RESOURCE COMPETITION AT RANCHO LA BREA, SOUTHERN CALIFORNIA

FERANEC, Robert, New York State Museum, Albany, NY, USA; HADLY, Elizabeth, Stanford University, Stanford, CA, USA; PAYTAN, Adina, University of California, Santa Cruz, Santa Cruz, CA, USA

Determining how organisms partition or compete for resources within ecosystems allows for an understanding of how communities are assembled. The late Pleistocene deposits at Rancho La Brea are exceptionally diverse in both mammalian carnivores and herbivores, and represent a unique opportunity to study resource use and partitioning among the fauna. Resource use was examined in bison and horses by analyzing the stable carbon and oxygen isotope values found within tooth enamel. The data were used to address: (1) did bison and horse compete for resources at Rancho La Brea? (2) were there seasonal differences in the diet of each species, and were there certain times of the year when competition is more significant? (3) are the diets typical of a migrating species? Data were gathered by serially-sampling seven bison and five horse individuals. The oxygen isotope results for both species show a pattern indicative of enamel growth during different seasons. One to two years was captured from individual teeth. Carbon isotope values reveal a more subtle seasonal pattern for individuals. Significant differences were observed between bison and horse diet. Both taxa ate a diet dominated by C<sub>3</sub> plants, but bison individuals regularly incorporated C<sub>4</sub> plants into their diets, while horses ate C<sub>4</sub> only occasionally. Bison had greater total variation in carbon isotope values than horse implying migration away from Rancho La Brea. Bison also appear to incorporate more C<sub>4</sub> plants into their diets during winter, which corresponds to conclusions from previous studies suggesting that Rancho La Brea, primarily surrounded by C<sub>3</sub> plants, was used by bison only during late spring. The examination of intra-tooth isotopic variation, which reveals intra-seasonal resource use among bison and horse at Rancho La Brea, highlights the utility of isotopic techniques to understand the intricacies of ecology within and between ancient mammals.

Technical Session II, Wednesday 8:15

**A NEW LATE PLEISTOCENE FAUNA FROM CENTRAL MEXICO AND ITS PALEOBIOLOGICAL-ENVIRONMENTAL SIGNIFICANCE**  
FERRUSQUIA-VILLAFRANCA, ISMAEL, INSTITUTO DE GEOLOGIA, UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO, MEXICO, Mexico; DE ANDA-HURTADO, PATRICIA, INSTITUTO DE GEOLOGIA, UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO, MEXICO, Mexico

The Pleistocene mammal record of Mexico is quite large, however the faunas fully described including their stratigraphic setting are largely restricted to the Trans-Mexican Volcanic Belt; hence, to improve understanding of Mexico's (and North America's too) mammalian taxonomic makeup and evolution is necessary to broaden provenance and number of such faunas. Studying of a new fauna from the Sierra Madre Oriental Morphotectonic Province significantly contributes to this end. The fossil material comes from sedimentary fillings of karst geomorphs developed in the limestone ranges making up the Sierra Madre; it chiefly constitutes accumulations of prey birds regurgitations, given that volumetrically micro-mammals far outnumber other size groups, and that some pellets are still discernible. The assemblage includes 23 species, 17 genera, 10 families and 6 orders; reptiles are marginal. Murids consist of 16 largely Late Irvingtonian/Rancholabrean-Holocene, still extant species, one arvicoline and 15 sigmodontines. Geomyids include a single species. Litopomyphans consists of a shrew (identified species) and a mole. Lagomorphs involve two rabbit species, one is restricted to the Late Rancholabrean. Larger mammals comprise the extant carnivores *Canis lupus*, *Lynx* sp. and *Panthera onca*, the perissodactyl *Equus* sp., the artiodactyl *Odocoileus hemionus* (extant) and the Late Rancholabrean antilocaprid *Stockoceros conklingi*. Based on the above, the age of the fauna is Late Rancholabrean; it correlates best with the San Josecito Cave fauna (from the Sierra Madre too). Given the small sample size, the diversity and species richness are large, much more so than those of the extant fauna from adjacent areas. This fact and the taxonomic makeup indicate that the fauna probably belonged to a mixed forest-open woodland community, set in a cooler and less dry environment than that current in the locality area. The remarkable sigmodontine species sympatry evidences a high microhabitat diversity and a fine niche partitioning. The rodent population structure is biased toward the young adult-adult segment, which is more exposed to bird predation.

Technical Session V, Wednesday 3:45

**INCREASED ENCEPHALIZATION AND ORBIT ORIENTATION IN CARNIVORA (MAMMALIA)**  
FINARELLI, John, University of Michigan, Ann Arbor, MI, USA; GOSWAMI, Anjali, University of Cambridge, Cambridge, United Kingdom

Orbit orientation in mammals determines degree of stereoscopic vision and direction of the field of view, and has been hypothesized as an indicator of predation mode and diurnality/nocturnality. Within the carnivorous family Felidae (cats), more vertically-oriented orbits have been linked to increased encephalization (brain volume scaled to body mass). Using 3D landmark data for the skulls of 72 fossil and extant taxa, we constructed orbital, midline and basal planes, calculating two angles of intersection describing orbit orientation: convergence (deviation of orbital plane from midline plane) and frontation (deviation from basal plane). These values were compared to estimates of degree of encephalization using phylogenetically-corrected regressions. There is broad overlap in bivariate plots of convergence vs. frontation between the major carnivorous subclades Caniformia and Feliformia; thus, observed ranges in orbit orientation are similar across these groups. At the level of Carnivora, no significant association exists between encephalization and orbit orientation, and Feliformia similarly shows no significant correlations. Significant correlations exist in the Caniformia between encephalization and both convergence and frontation, although these are due solely to the family Canidae (dogs). Similarly, when Felidae is examined individually, significant correlations exist between both angles and encephalization. For both families, there is a significant positive correlation between encephalization and frontation, indicating more vertically oriented orbits as relative brain volume increases. Among dogs, higher encephalization is associated with significantly lower convergence angles: more laterally-facing orbits. For cats, the trend is opposite, with higher encephalization associated with more convergent, forward-facing orbits. These inter-clade differences may be the result of selection on hunting behavior, or may reveal differing developmental constraints on the orbital/zygomatic region in response to increases in the volume of the neurocranium.

Preparators' Session, Thursday 12:00

**HEALTH AND SAFETY IN THE PREP LAB: A STEP-BY-STEP GUIDE TO INSTALLING AN EFFICIENT AND COST EFFECTIVE DUST COLLECTING AND VENTILATION SYSTEM**  
FINLAYSON, Heather, Utah Field House of Natural History State Park Museum, Vernal, UT, USA; SROKA, Steven, Utah Field House of Natural History State Park Museum, Vernal, UT, USA; NELSEN, Thomas, Utah Field House of Natural History State Park Museum, Vernal, UT, USA

After hearing some presentations regarding the importance of proper ventilation at the First Annual Fossil Preparation and Collections Symposium given at Petrified Forest National Park in April of 2008, our museum decided to take a serious look at the dust collecting system we currently use in our own lab. After hiring a new intern to do fossil preparation, the

activity in our lab increased substantially along with an abundance of fine dust accumulating on work surfaces and lab equipment. It became obvious that our current system was simply not sufficient enough to vent the fine dust particles suspended in the air out of the room, not to mention the inherent health and safety issues that arise from inhaling rock dust, fumes, and other particulates. After communicating with other institutions about their prep lab dust collecting and ventilation systems, we came to the realization that no formal standards have ever been developed for what would be considered an optimal system that takes into account the size of the room, the amount of airflow needed for sufficient dust removal, and the appropriate type and size of unit needed for the very specialized work that is done in a preparation lab. Our goal is to share the step-by-step process we used for the design and installation of our new system. We hope that the results of our project can serve as a template for other institutions that need a simple, affordable system that is both efficient and addresses the health and safety of their staff.

Technical Session XIX, Saturday 3:30

**A LATE CRETACEOUS HIGH LATITUDE, HIGH DIVERSITY DINOSAURIAN MEGATRACKSITE FROM DENALI NATIONAL PARK ALASKA**  
FIORILLO, Anthony, Museum of Nature and Science, Dallas, TX, USA; HASIOTIS, Stephen, University of Kansas, Lawrence, KS, USA; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan

A newly discovered megatracksite containing thousands of vertebrate and invertebrate tracks and trackways, preserved on five successive beds, in the Upper Cretaceous Cantwell Formation of Denali National Park in the central Alaska Range records a remarkably high diversity of vertebrates and invertebrates. These traces are found in a lake-margin deposit in Denali National Park and offer a unique glimpse into this Late Cretaceous Arctic continental ecosystem. The Cantwell Formation is an extensive rock unit exposed throughout much of Denali National Park and elsewhere in the central Alaska Range. This rock unit is thousands of meters thick and was deposited near its current latitude. It is comprised of a lower, dominantly fluvial sedimentary unit and an upper, mostly volcanic unit which. Sedimentation was mainly in alluvial fan, braided stream, and lacustrine environments, at times with a marginal-marine influence. The megatracksite was formed in distal coastal plain environments. Pollen data suggest that these sedimentary rocks are late Campanian or early Maastrichtian in age and, thus, this site is correlative with the well-known dinosaur localities of the North Slope of Alaska. Tracks attributable to hadrosaurs dominate the megatracksite, identified by the frequent preservation of ungual impressions. Small and large theropod tracks and bird tracks are also represented, though in much lower frequencies. In addition to these tracks, associated with this site are numerous coprolites—comparable with those produced by herbivores, tail impressions, and depressions that likely resulted from the dinosaurs lying down. Invertebrate trace fossils interpreted as mud-loving beetles, nematode annelids, dipteran fly larvae horizontal burrows, and mayfly larvae burrows are in association with the vertebrate tracks. The emergence of modern mayflies in the higher latitudes is restricted to the warmest one or two months of the year, suggesting the season of formation for this megatracksite. The remarkable assemblage of traces demonstrates that the northern polar region of the Cretaceous greenhouse world supported a biologically rich continental ecosystem.

Technical Session II, Wednesday 12:00

**PALEOBIOLOGICAL ANALYSIS OF A HOLOCENE MAMMOTH TUSK, ST. PAUL, PRIBILOF ISLANDS, BERING SEA**  
FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; ROUNTREY, Adam, University of Michigan, Ann Arbor, MI, USA; TEDOR, Randy, University of Alaska Anchorage, Anchorage, AK, USA

During dredging operations in the municipal harbor of St. Paul Island (Bering Sea), a mammoth (*Mammuthus primigenius*) tusk was encountered and salvaged through timely action by the US Army Corps of Engineers and the Office of the State Archaeologist of Alaska. Collagen from a sample of interior tusk dentin yielded an AMS date of just over 6,000 <sup>14</sup>CyrBP. The tusk thus records Holocene survival of a taxon that was extirpated from nearby mainland areas thousands of years before. Other Holocene mammoths are known from St. Paul, but this is the first relatively complete tusk, and thus the first opportunity to compile a record of life history and environment from a long sequence of dentin increments. The tusk's moderate length (177 cm from its broken tip to the proximal margin), relatively small maximum girth (34.7 cm near its proximal end), and relatively short pulp cavity led us to identify it provisionally as female. We then sectioned it longitudinally to facilitate sampling of the entire sequence of dentin increments and to display what we already predicted (from exposures near the sample extracted for dating) would be a visually striking series of annual increments. Annual increments exposed on the longitudinal surface were thicker than expected (perpendicular to appositional surfaces) and showed longer than expected yearly increments to tusk length, with little periradicular relief on an annual scale (implying low seasonality). The first two of these traits suggest we are dealing with a male rather than a female, and the short pulp cavity then implies a male advanced in life. The tusk's moderate size suggests reduced body size for St. Paul mammoths relative to mainland counterparts. Remarkably, annual dentin increments are even more clearly displayed under ultraviolet light than under normal illumination, making it easy to count years in the tusk. We observe a record of 22 years, preceded in life by a period that could have been about 15 years, now lost to tip fracture. Stable isotope analyses and measurements of periodic subannual increments allow us to characterize features of diet, growth rates, and environment of this late-surviving population of mammoths.

Technical Session XX, Saturday 3:00

**THE ORIGIN OF BALEEN WHALES**

FITZGERALD, Erich, Smithsonian Institution, Washington, DC, USA

In the spectrum of placental mammal diversity, the immense baleen whales (Cetacea: Mysticeti) represent specialization in the extreme. Central to the extreme biology of mysticetes is their unique suspension feeding mechanism: a so-called key innovation. The origin of mysticetes and their remarkable feeding apparatus has intrigued and eluded scientists since Darwin discussed the subject in his *Origin of Species*. Now, a nexus of fossil, molecular and developmental data provide novel insights into the transition from archaeocetes to Mysticeti, diversification of toothed mysticetes, and evolution of functional complexes. Pivotal here are toothed mysticetes from the Late Oligocene of southeast Australia, including the mammalodontids *Mammalodon* and *Janjucetus*. Morphological features of *Mammalodon* and *Janjucetus* are functionally linked to suction feeding and raptorial prey capture, respectively. Thus, toothed archaic mysticetes employed a range of prey capture strategies beyond that seen in extant Mysticeti. Comprehensive phylogenetic analysis yields a novel hypothesis of toothed mysticete relationships: a basal clade of undescribed toothed mysticetes from South Carolina, an austral toothed mysticete clade (Llanocetidae + Mammalodontidae), and monophyletic Aetiocetidae are posited as successive sister taxa to edentulous baleen whales (Chaemysticeti). Stratigraphic calibration of this phylogeny implies that the initial diversification of Mysticeti occurred during the Late Eocene, prior to the acquisition of suspension feeding or baleen. Formerly considered implicit in the origin of Mysticeti, suspension feeding apparently evolved long after mysticetes diverged from odontocetes.

Preparators' Session, Thursday 8:15

**DELICATE FOSSIL SKULLS FROM A RICH HOLOCENE SITE: WHICH TECHNIQUES WORKED BEST FOR PREPARATION, DISPLAY, AND TRANSPORTATION**

FITZGERALD, Erin, University of Chicago, Chicago, IL, USA

Fossil vertebrates, including humans, recovered at a Holocene site in the Sahara were extremely fragile and preserved in a loose sandy matrix. Due to the quantity of specimens excavated, and the range of preservation, a variety of techniques were used. During preparation, most skulls required special attention so as not to lose associations; others required extensive reconstruction. Some skulls required the development of a new technique that would allow researchers the option of opening the cranial vault for access to the interior of the specimen. The pieces were mounted individually, on plaster cradles, which contribute to the practice of conservation by limiting the use of glues. After preparation, the best preserved skulls were fitted to custom mounts, which assisted photography and research as well as readying the specimens for display. After their completion, skulls and any associated bones and holders were placed in custom fitted foam-lined cases for safe storage, easy access, and transportation. These skulls have been safely transported for CT scanning and presentations, and will be ready for transport back to Niger, their country of origin.

Poster Session II (Thursday)

**PLASTER**

FITZGERALD, Vicki, Yale Peabody Museum of Natural History, New Haven, CT, USA

Plaster seems to be a simple substance that can be created by dumping the powder into water, mixing and applying the "batter". The setting of plaster is, however, an exothermic chemical reaction. There are many problems that can interfere with the chemical reaction that causes plaster to set, especially so in the field. These can cause difficulties such as a watery mix that never sets, plaster the consistency of talcum powder, or cracking caused by moving partially cured plaster. In every stage of plaster use, whether in the field or the lab, there are key considerations such as water and air temperature, ratio of plaster to water, mixing speed, technique, and application methods. The final use for the plaster needs to be assessed in order to choose the right kind of plaster: for example is the plaster needed for a mother mold, a mold, a cast, a field jacket, a brace, or a long-term storage jacket? Does the plaster need to set quickly as in field conditions or does the technician need the maximum amount of time to manipulate the plaster before setting? With practice this medium is a great help with fossil collecting, reproduction and storage. There are many ways of handling plaster, this paper will present some of the methods in use at the Yale Peabody Museum that may be adapted for particular needs.

Poster Session III (Friday)

**LIFE HISTORY AND TAPHONOMY: WHY FOSSIL APES SHOULD BE RARE**

FLEAGLE, John, Stony Brook University, Stony Brook, NY, USA; SHAREEF, Omar, Stony Brook University, Stony Brook, NY, USA

Taphonomy is the study all of the factors that influence the way in which the fossil record samples living assemblages of organisms from the past. A primary determinant of the likelihood of a living organism becoming a fossil is the relative probability of its death. Within any assemblage of mammals, species can vary greatly in their patterns of life history and mortality. In some species, individuals rarely live more than a few years, while in others, individuals normally live for decades. Thus, in equilibrium conditions, for equal

population sizes, animals with slow life histories will provide fewer potential fossils per year than animals with fast life histories. A comparison of life history patterns among African mammals demonstrates that for the same number of living individuals in an ecological community, there should be more dead warthogs and antelopes than apes or elephants.

Technical Session XVI, Saturday 9:30

**A NEW SPECIES OF BASAL ARCHOSAUFOMORPH FROM THE LATE TRIASSIC OF MADAGASCAR**

FLYNN, John, American Museum of Natural History, New York, NY, USA; NESBITT, Sterling, American Museum of Natural History, New York, NY, USA; PARRISH, Michael, San Jose State University, San Jose, CA, USA; RANIVO HARIMANANA, Lovasoa, Departement de Paleontologie et d'Anthropologie Biologique, Universite d'Antananarivo, Antananarivo, Madagascar; WYSS, Andre, Univ of California Santa Barbara, Santa Barbara, CA, USA

A remarkable fossil vertebrate assemblage including traversodonts, a dicynodont, rhynchosaurs, and other reptile remains has been recovered from the Late Triassic "Isalo II" (Makay Formation) of southwestern Madagascar over the past 10 years. This assemblage includes nearly a dozen, well-preserved, associated and partially articulated reptile skeletons recovered from a single apparently monotypic bone-bed. Originally considered a "prosauropod" (based on fragmentary gnathic remains), and closely resembling *Azendohsaurus* specimens from Morocco, this material is now referred to a new species of *Azendohsaurus*. This extends the geographic range of *Azendohsaurus* and aids in temporal correlation of this assemblage. Although *Azendohsaurus* has consistently been considered an early dinosaur (based on dental and gnathic features resembling those present in basal sauropodomorphs), the abundant skeletal material now available from Madagascar argues strongly against its sauropodomorph, and even dinosaurian, affinities. Instead the new taxon was analyzed within the context of an extensive archosauromorph character matrix, was found to represent a close relative of the archosauriforms rather than a member of Dinosauria. Features previously considered diagnostic of the "prosauropods" (= basal sauropodomorphs) thus are revealed here to occur homoplasically in at least one clade of non-dinosaurian archosauromorphs, indicating a complex evolution and distribution of features traditionally considered to be derived within archosaurs. Tooth morphology and our microwear studies indicate that *Azendohsaurus* was an herbivore, feeding on soft plants and that its jaw motion was simple and orthal. Herbivory thus evolved early within basal archosauromorphs, and appeared multiple times within this clade, including within the Dinosauria in taxa with similar tooth morphologies. The presence of teeth resembling those of early sauropodomorphs and ornithischians in a taxon marked by inarguably basal archosauromorph cranial and postcranial attributes highlights the risks of uncritically referring isolated, Middle-Late Triassic (or even later), "leaf-shaped" teeth to Dinosauria.

Technical Session XIII, Friday 2:00

**PALEOBIOGEOGRAPHIC AFFINITY ACROSS SOUTHERN ASIA DURING THE MIOCENE: SMALL MAMMALS REFLECT THE ORIENTAL REALM**

FLYNN, Lawrence, Harvard University/Peabody Museum, Cambridge, MA, USA

The fossil record of the Indian Subcontinent is remarkable for its increasingly well known fossil assemblages, superposed in unambiguous temporal relationships. These assemblages, especially the Siwalik sequence of northern Pakistan, are also well paleomagnetically. The record spans much of the Miocene Epoch, especially the Middle and Late Miocene, and outlines changes in faunal composition through that time. Elsewhere in the Indian subcontinent, Oligocene and Pliocene sediments yield an aggregate, detailed picture of paleofaunas during approximately the last 30 million years. Initial impressions of Siwalik paleofaunas focused on both unique aspects and elements shared with Africa, for example hominoids, implying faunal ties westward. Some small mammals are also shared with Africa and neighboring Asia to the north. As the microfossil record from the Siwaliks, Thailand, and South China develops, affinities eastward become apparent. Each region has distinctive elements, but a growing number of taxa are recognized to resemble each other at the generic level. These reflect biogeographic affinity, much along the lines of the Oriental biogeographic province recognized in living faunal assemblages. Middle Miocene elements shared across South Asia include tree shrews, lorises, the small catterhine *Dionysopithecus*, newly recognized diatomid rodents, flying squirrels, early bamboo rats, and muroids such as *Potwarmus* and *Spanocricetodon*. Late Miocene records add to this list with hares, porcupines, the tree squirrel *Ratufa*, and burrowing bamboo rats. It is important to recognize the complexity of South Asian paleobiogeography, and the purpose here is to document the considerable proportion of the fauna shared with regions to the east. This supports recognition in deep time, probably since the Oligocene, of the Oriental paleogeographic realm. The Oriental Realm was not an exclusive, fixed entity, but a corridor of selective faunal dispersal. Recognition of the time depth of presently observed biogeographic provinces supplies an important dimension for reconstructing faunal histories on a global scale.



Technical Session XV, Friday 3:30

**FROGS (ANURA) FROM THE EARLY EOCENE OF VASTAN LIGNITE MINE, GUJARAT, INDIA**

FOLIE, Annelise, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; RANA, Rajendra, H.N.B. Garhwal University, Srinagar, India; SAHNI, Ashok, Panjab University, Chandigarh, India; ROSE, Kenneth, Johns Hopkins University School of Medicine, Baltimore, MD, USA; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

A new vertebrate fauna from the early Eocene Vastan lignite mine of Gujarat (west-central India) is being sampled intensively, and its composition and paleobiogeographic affinities are increasingly better known. The deposits belong to the Cambay Formation and are middle to late Ypresian in age. They already yielded several continental mammals, such as the oldest primates, bats, artiodactyls, rodents, and lagomorphs of the Indian Subcontinent. Among the herpetofauna, agamid lizards and snakes have been described recently and indicate a high diversity. The frogs are still not described. Here, we report the presence of about 380 frog bones found among other microvertebrates remains. At least three taxa referred to Ranoidea and Discoglossidae are identified at Vastan, based on well-preserved atlas, thoracic, and sacral vertebrae, and on urostyles, ilia, maxillae, prearticulars, humeri and radio-ulnae. However, some of the ilia resemble the morphology of Myobatrachidae. This typical Australian family could therefore also be present in the early Eocene of India. The composition of the Vastan frog fauna is reminiscent of those from the Upper Cretaceous of India. All of the evidence taken together suggests a mixed Laurasiatic and Gondwanan origin of the Vastan herpetofauna.

Poster Session III (Friday)

**RECONSTRUCTING PALEOGEOGRAPHIC PATTERNS USING A TIME CALIBRATED AREA CLADOGRAM**

FOLINSBEE, Kaila, University of Toronto at Mississauga, Mississauga, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

Correlation of historical biogeographic patterns to geologic and climatic events in Earth History is a crucial step in reconstructing evolutionary processes in diverse clades, and a critical component of paleontological research. Quantitative methods that allow the reconstruction of past biogeographic distributions are well known, but it is difficult to determine the precise timing of dispersal and vicariant speciation events. We present a new and intuitive method to time calibrate General Area Cladograms that is applicable to biogeographic analyses based on fossil taxa, extant taxa, or a combination of both. Nodes on the general area cladogram (or GAC) correspond to speciation events in a group of taxa; general nodes are those at which a large number of unrelated clades speciate. We time calibrate the GAC using first appearance data from the fossil record, and molecular clock estimates of splitting events between extant taxa. In a GAC composed strictly of fossil taxa, species on each branch have associated temporal context. Therefore, these branches can be time-calibrated in the same way as a standard paleontological phylogeny, as the first occurrence of the oldest fossil taxon on each branch denotes the minimum age of that branch. For GACs built on phylogenies of extant taxa, the oldest molecular clock estimate of the divergence times associated with the node is used, except where it is younger than the oldest fossil date. Time-calibrated GACs can then be evaluated against independent data (e.g. marine transgressions and sea-level changes, glacial episodes, climate change and tectonic events such as mountain and desert formation), allowing a quick and intuitive means of assessing hypotheses for events that drove speciation. We present an example using a PACT (Phylogenetic Analysis for Comparing Trees) analysis of African Neogene mammals. This analysis reveals that most mammal clades undergo episodes of biotic expansion associated with the Neogene climatic optimum (ca. 16 Ma) and episodes of vicariant speciation and range restriction to central Africa correlated to the onset of increased aridity and cooler temperatures around 2.5 Ma.

Technical Session XX, Saturday 4:00

**NEW PLIOCENE AUSTRALODELPHIS (DELPHINIDAE) AND RIGHT WHALES (BALAENIDAE) FROM VESTFOLD HILLS, ANTARCTICA, IMPLY TAXONOMIC AND ECOLOGICAL TURNOVER IN THE SOUTHERN OCEAN SINCE 4 MA**  
FORDYCE, Robert, University of Otago, Dunedin, New Zealand; QUILTY, Patrick, University of Tasmania, Hobart, Australia

Fossil Cetacea from Marine Plain (68.5 deg S, Vestfold Hills, Antarctica) suggest that Pliocene high latitude cetacean communities differed markedly from today. The fossils are from marine pebbly mudstone and sandstone of the thin Sørsdal Formation (Early Pliocene, 4.5-4.1 Ma), which formed in a sheltered embayment affected by sea ice but warmer than today. The 15+ undescribed specimens from Marine Plain represent more of the remarkably ziphiid-like *Australodelphis mirus*, plus a new species of *Australodelphis*, and a small right whale (Balaenidae). The new *Australodelphis* is larger than *A. mirus* (cbl 745+ mm, cf 605+ mm), with a flatter-based (less cylindrical) rostrum. Shallow alveolar grooves lack alveoli; no teeth have been found. Like *A. mirus*, the skull has *Mesoplodon*-like premaxillary flanges and a prenarial depression below a high nodular vertex. The stylohyal is unexpectedly long (~195 mm), thin, and excavated dorsally, suggesting enlarged styloglossus muscle and specialized suction-feeding; in *A. mirus*, the stylohyal is also excavated, but is robust and short (110+ mm). As in *A. mirus*, the periotic has a long posterior process, while the bulla

is ventrally twisted. Post-thoracic vertebrae are long, to ~115 mm, unlike living delphinids. Skull and ear features confirm *Australodelphis* as Delphinidae, but whether in crown or stem is uncertain. Skull, jaw, and hyoid form indicate ziphiid-like suction feeding, and vertebral form suggests swimming habits unlike living delphinids. The right whales comprise small incomplete isolated rostra (one arched), a mandible (~1380 mm), a squamosal, and isolated tympanoperiotics. These indicate one or more species with a small skull. Balaenidae genus not determined. *Australodelphis* has not been reported beyond the Antarctic; presumably it evolved there in the absence of, and ecologically equivalent to, small ziphiids. Small delphinids and small ziphiids do not occupy modern Antarctic waters, and ziphiid-like delphinids and small balaenids are extinct globally. These Antarctic early Pliocene fossils support the idea of significant taxonomic and ecological turnover amongst Cetacea since 4 Ma.

Technical Session IV, Wednesday 3:30

**A MULTI-PROXY, MULTI-DEPOSITIONAL ENVIRONMENT APPROACH TO RECONSTRUCTING PALEOHYDROLOGIC CONDITIONS USING STABLE ISOTOPES ACROSS THE LATE CRETACEOUS (CAMPANIAN) FORELAND BASIN OF MONTANA**

FOREMAN, Brady, University of Wyoming, Laramie, WY, USA; FRICKE, Henry, Colorado College, Colorado Springs, CO, USA; ROGERS, Raymond, Macalester College, St. Paul, MN, USA

This study reconstructs paleohydrologic conditions across the Campanian foreland basin of Montana using  $\delta^{18}\text{O}$  values from unionid bivalve shells, gar scales, crocodile teeth, and carbonate sediments derived from ancient river, stream, pond, lake, and soil deposits. Samples were obtained from the Two Medicine Formation (up-dip alluvial plain) and coeval Judith River Formation (coastal lowlands). This multi-proxy, multi-depositional environment approach captures  $\delta^{18}\text{O}$  variability linked to precipitation histories, catchment structure, biologic behaviors, and taphonomic mixing. Lacustrine carbonates, paleosol carbonate nodules, and unionid bivalves from coastal ponds and up-dip streams display  $\delta^{18}\text{O}$  values between -8.32‰ (VPDB) and -10.76‰, interpreted to capture local meteoric precipitation within the basin. In contrast, unionid bivalves from large fluvial sandstones display  $\delta^{18}\text{O}$  values near -16.22‰, likely due to high elevation runoff in the Sevier highlands. The  $\delta^{18}\text{O}$  of gar scales and crocodile teeth display a proximal-to-distal gradient between the up-dip alluvial plain and coastal lowlands with gar scales ~1.28‰ more negative and crocodile teeth ~4.55‰ more negative on average in the up-dip alluvial plain. We attribute this gradient to a combination of (1) progressive rain out as storm tracks move east to west across the basin and possible monsoonal precipitation, (2) movement of the organisms between aquatic environments, and (3) taphonomic contamination between pond and fluvial sites. Finally, our data document a negative shift in regional  $\delta^{18}\text{O}$  values between the Campanian and Maastrichtian stages possibly related to global cooling recorded in the marine realm.

Poster Session II (Thursday)

**THE NORTHERNMOST RECORD OF *EUROLAGUS FONTANNESI* (MAMMALIA, LAGOMORPHA) FROM THE LATE MIOCENE (MN 9) LIGNITE DEPOSITS IN BELCHATÓW (POLAND)**

FOSTOWICZ-FRELIK, Lucja, Institute of Paleobiology Polish Academy of Sciences, Twarda 51/55, PL 00-818, Warsaw, Poland; KOWALEWSKA, Magdalena, Museum and Institute of Zoology Polish Academy of Sciences, Wilcza 64, PL 00-679, Warsaw, Poland

*Eurolagus* (= *Amphilagus*) *fontannesi* was a large ochotonid known from the Late Miocene of western and central Europe. The relatively scarce remains of this species are known from a few fossil sites ranging from Spain to Poland. The earliest occurrence dates from the Early Miocene (Rothenstein 1, Germany, MN 5) and the latest from the early Late Miocene (Terrassa, Spain, MN 10). *Eurolagus fontannesi* was reported from Poland previously from only one locality (Opole, Silesia), but the material was lost during World War II, and thus its revision was impossible. Newly discovered material from the lignite beds of Belchatów A (Central Poland) is the northernmost known occurrence of this monotypic genus. The modern equivalent of the Belchatów A environment, as inferred from plant assemblages, are mixed mesophytic forests in the Caucasus, Iran, and India. The material consists of highly carbonized isolated teeth, representing almost all loci, except for the incisors, in stages of wear from the slightly worn juvenile to heavily worn specimens. On the basis of P2 count the  $MNI=5$  was calculated. Tooth morphology and dentine and enamel structure (in cross-section) of the upper and lower molars were studied using scanning microscopy both in low and high vacuum (without/with coating) conditions. In addition, EDAX analysis was performed on the external and sectioned surfaces. The element detecting and mapping facility revealed highly reductive depositional environment with pyrite crystals formed on the tooth surface and a high level of carbonization. The dentine surface is heavily cracked, indicating the temporal drying of the poorly consolidated sediment, but the enamel structure was not influenced by these conditions. The enamel of lower molars exhibits a relatively thin decussating external layer (with weakly developed Hunter-Schreger bands) and gently inclined internal radial layer. The extinction of *Eurolagus* was related to the Vallesian crisis, pronounced in the significant drying of the European climate. The first signs of this event may be observed in Belchatów A, marked by the immigration of *Microtocricetus* and disappearance of *Neocometes*.

Preparators' Session, Thursday 8:30

#### JACKETING THE DESERT SANDS

FOX, Marilyn, Yale Peabody Museum of Natural History, New Haven, CT, USA; BIBI, Faysal, Yale University, New Haven, CT, USA; HILL, Andrew, Yale University, New Haven, CT, USA

In December of 2007, a team from the Yale Peabody Museum of Natural History traveled to Abu Dhabi, United Arab Emirates, to work in conjunction with the Abu Dhabi Authority for Culture and Heritage. The team prospected in Miocene age deposits of the Baynunah Formation along the Persian Gulf coast, and discovered and excavated specimens that included an elephantid jaw and a partial ratite, while a crocodylian skeleton remains for future excavation. While Abu Dhabi is truly a sand desert, coastal sites are quite humid, slowing plaster drying times significantly. The excavation of bone that was fractured apart by evaporites and weathering, lying in soft and loose sand, presented several issues that were considerably different from those presented by the more usual siltstones or mudstones. The typical pedestal method for jacketing is less than successful in such sand, because the partially capped jackets usually slump prior to flipping. One answer is to heavily consolidate the specimen and surrounding sand, but again, due to the humidity, consolidant drying time is slowed. Overzealous consolidation in the field, furthermore, creates later challenges to preparation. Butvar B76 or PVA B15 in acetone, as less viscous consolidants, proved to be more appropriate than thin Paraloid B72 in acetone, while an attempt to use Aquazol 200 in water proved ineffective. Another technique is to jacket far more of the matrix than is needed for the stability of the specimen and cut away the extraneous plaster and matrix after the jacket is flipped over. This paper will discuss some of the logistics involved with this and other international fieldwork, as well as considerations of methods and materials for consolidation and excavation of fragile specimens in loose sands.

Poster Session II (Thursday)

#### IMPROVING LOW-MAGNIFICATION MICROWEAR TECHNIQUES USING HIGH DYNAMIC RANGE IMAGING

FRASER, Danielle, University of Calgary, Calgary, AB, Canada; FURR, Robin, University of Lethbridge, Lethbridge, AB, Canada; THEODOR, Jessica, University of Calgary, Calgary, AB, Canada

The study of microscopic features on mammalian teeth has traditionally involved the use of a scanning electron microscope. Low-magnification microwear analysis uses a stereoscopic dissecting microscope to examine features under 30-50X magnification, allowing the collection of larger amounts of data in a more cost effective manner. However, photographic images of the microwear features have been difficult to reproduce when using light microscopy. The tooth casts are translucent and highly reflective, making photographic visualization of surface textures difficult. We used high dynamic range imaging (HDRI) to enhance the photographic appearance of microwear features at low magnification. HDR images are generated by combining multiple exposures of the same base scene, allowing software to determine the true amount of light seen by the camera. This allows the representation of areas that are brighter or darker than what can be shown by film or traditional file formats. Using a digital SLR camera attached to the microscope, a series of bracketed exposures are taken with equally spaced f-stop settings and combined in the computer, using an HDR software package. The resulting file can then be processed to compress the total dynamic range of the visible light in the image into a range that can be reproduced by print or monitors, as well as combining visible detail from all source images. This corrects for shadows or overexposures that are difficult to avoid in single images. The appearance and contrast of the microwear features were improved and the amount of surface detail that can be visualized in the photographs was increased using this method. In addition, using HDRI can alleviate the need for extensive experimentation with lighting setups for rapid data capture. This is an important extension of the low magnification microwear method and will produce high quality images for use in palaeoecological studies. Importantly, this method produces high quality images of publication quality without the difficulty of providing adequate lighting under the microscope.

Poster Session III (Friday)

#### IS *MALERISAURUS* A PROTOSAUR?

FRASER, Nicholas, National Museums Scotland, Edinburgh, United Kingdom; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, USA; MUELLER, Bill, Museum of Texas Tech University, Lubbock, TX, USA

The status of the genus *Malerisaurus* as a protosaurus has been called into question in recent years. Here we re-evaluate the known material of the two referred species: *Malerisaurus langstoni* from the Dockum Formation of Texas and *Malerisaurus robinsonae* from the Maleri Formation of India. A recent re-interpretation of *Malerisaurus langstoni* suggested that all the material could be referred to *Trilophosaurus*. While our study confirms that at least some of the postcranial material is referable to *Trilophosaurus*, the cranial portion was incorrectly identified; in particular a pterygoid with two rows of teeth was figured as part of the skull roof and lateral wall. Currently, protosaurian affinities cannot be discounted for part of this material. The material referred to *M. robinsonae* supposedly comprises two individuals intimately associated with the trunk region of a phytosaur, *Parasuchus hislopi*, and it is assumed to represent the gut contents of this individual. The non-phytosaurian material includes at least two quite separate taxa. While one may represent a protosaurian

the other has a very distinctive ilium that is unlike any previously described for a protosaurus. The suggestion that *Malerisaurus robinsonae* might pertain to a trilophosaur is not supported.

Poster Session III (Friday)

#### BAYESIAN MODELING OF VERTEBRATE PALEOCOMMUNITIES IN THE JUDITH RIVER FORMATION (UPPER CRETACEOUS: CAMPANIAN), NORTHCENTRAL MONTANA

FREEDMAN, Elizabeth, Museum of the Rockies, Bozeman, MT, USA

Bayesian statistical methods are emerging as powerful tools for modeling complex systems, and are widely used in medical genomics, and cladistics of extant and fossil taxa. Modern ecological studies are also exploring the utility of these models, but Bayesian methods have not yet been applied to paleoecology. Here I present a Bayesian microsite model, which compares the abundances of isotaphonomic elements in repeated samples to recreate the original community abundance ratios of Cretaceous taxa. To account for the effects of differential transport and preservation biases, analyses are limited to isotaphonomic groups – bones with similar physical characteristics (*e.g.* size, shape, and density) that have presumably shared comparable transport and depositional histories and thus been affected equally by similar taphonomic biases. The prolific microfossil assemblages of the Judith River Formation (Upper Cretaceous: Campanian) exposed in Kennedy Coulee, Montana supply fossil samples for the Bayesian model. Kennedy Coulee contains hundreds of microsites within a small geographic (2 km) and stratigraphic range (30 m), which minimizes ecosystem variance due to fluctuations in base level, climate, and faunal turnover. Matrix samples (300kg) have been collected and screenwashed from two sites representing each of the fossiliferous lithologies in Kennedy Coulee: sandstone, siltstone, and mudstone, for a total of six sampling sites. As each sample's data is added to the model, the distribution of probabilities narrows, increasing the accuracy of the paleocommunity abundance reconstructions. Ultimately, this model will enable analyses of changes in ecosystem composition over time and geography, and highlight differences between modern and ancient community structure.

Poster Session III (Friday)

#### A NEW MICROVERTEBRATE ASSEMBLAGE FROM THE ARIKAREEAN (EARLY MIOCENE) JOHN DAY STRATA, CENTRAL OREGON

FREEMD, Theodore, National Park Service, Kimberly, OR, USA; WHISTLER, David, John Day Fossil Beds National Monument, Kimberly, OR, USA

Productive underwater screen sieved microvertebrate sites have been notably rare within any of the middle Eocene through late Miocene strata within the John Day Basin. Recent work from atypical exposures of the "Kimberly Member" (later Arikareean) of the John Day Formation to the north of the classic localities has provided a new sample consisting of thousands of specimens. Our preliminary analysis of this assemblage reveals that several of the lineages suggest stronger Asiatic affinities of John Day faunas than has been reported. Notable additions to the John Day include a new protosciurine, a new last appearance datum for the didelphid *Copedelphys*, new species of *Proscalopus* and *Leptodontomys*, and possibly the first American record of *Apeomys*. The quarry samples exceed previously described numbers of *Herpetotherium*, *Proscalopus* and other erinaceoids, and include new records of *Petauristodon*, *Camperstallomys*, *Plesiosminthus*, *Leptodontomys*, and *Wilsonsoresox*. These additions to the John Day faunas described to date are a result of isochronous depositional variability within the geographic extent of the sequence, and a disproportionate number of presumed fossorial inhabitants preserved in a non-zeolitized matrix that permits disaggregation and recovery.

Technical Session XVIII, Saturday 3:45

#### EXTINCTION SELECTIVITY AMONG MARINE TELEOSTS AT THE CLOSE OF THE CRETACEOUS

FRIEDMAN, Matt, University of Chicago, Chicago, IL, USA

Deep-time perspectives on extinction provided by paleobiological studies are viewed as increasingly relevant to modern biodiversity crises, but remain unexplored for many threatened groups. Extinction in the fossil record of fishes has received very little attention, and the few studies focused on this topic have been decidedly qualitative. Here, a phylogenetically explicit genus-level dataset comprising over 240 genera was used to explore extinction selectivity among marine teleosts during the end-Cretaceous extinction. For each genus, two ecologically relevant parameters were recorded: (1) body size (measured as the natural logarithm of lateral area; body size is a correlate of many important aspects of life history); (2) jaw closing mechanical advantage (the ratio of lower jaw in- and out-levers; jaw mechanics give clues about feeding ecology). In addition to genera that make their last appearance in the Maastrichtian and those known to have survived the extinction, this study also considers lineages implied to have crossed the Cretaceous-Paleogene boundary by phylogeny, but which have not been directly sampled. Characteristics of inferred boundary-crossers were estimated using models of character evolution based on Brownian motion. Two variants were considered: punctuated and gradual change. Taken together, 38 lineages make their last appearance in the Maastrichtian, while another 54 survive and continue into the Cenozoic. Resampling tests indicate that victims

represent a non-random subset of taxa present in the Maastrichtian; this conclusion is robust to the taxonomic composition of the dataset and variation in models of trait evolution. Logistic regressions consistently reveal a significant, positive relationship between body size and extinction risk, but show no significant relationship between survivorship and jaw mechanics. These results are congruent with modern ecological studies indicating increased vulnerability in large-bodied fishes.

Poster Session I (Wednesday)

**NEW MIDDLE EOCENE (UINTAN) CARNIVOROUS MAMMALS FROM THE DEVIL'S GRAVEYARD FORMATION OF TRANS-PECOS TEXAS**

FRISCHIA, Anthony, University of California, Los Angeles, CA, USA; KIRK, E., University of Texas, Austin, TX, USA

The Devil's Graveyard Formation (DGF) encompasses a large expanse of Eocene volcanoclastic sediments exposed in the Trans-Pecos volcanic field of Texas. In the 1970s, field parties led by J.A. Wilson collected a large number of vertebrate fossils from Uintan, Duchesnean, and Chadronian horizons in the DGF. Recent collecting in the DGF by field parties from the University of Texas at Austin has yielded new specimens of carnivorous mammals from the late Uintan (U13) Purple Bench locality. This new collection of late Uintan carnivores includes creodonts, carnivorans, and mesonychians. The creodonts are represented by a small proviverrine form and a larger limnocyonine, both of which are probably new species. The new carnivoran specimen is a P4-M1 of *Miocyon*. Additionally, a new fragmentary specimen of *Harpagolestes* preserves much of the lower dentition. Combining these new specimens with previously published faunal lists for the DGF allows for an investigation of regional endemism of carnivorous taxa across the Uintan NALMA. Creodonts are the least widely distributed carnivore group, and only occur at one or two Uintan localities. By contrast, carnivoran and mesonychian genera are widely represented across localities, although different species occur at each locale. This distribution of Uintan carnivoran genera and species is similar to the distribution of modern small carnivorans (mainly herpestids and viverrids) across tropical/sub-tropical Africa, and favors the use of modern Africa as a model for carnivore community structure in the North American Eocene.

Technical Session XI, Friday 9:30

**POSTCRANIAL ANATOMY OF THE PERMIAN THERAPSID *SUMINIA GETMANOVI*, THE OLDEST KNOWN ARBOREAL TETRAPOD**

FRÖBISCH, Jörg, University of Toronto, Mississauga, ON, Canada; REISZ, Robert, University of Toronto, Mississauga, ON, Canada

The highly specialized skull of the basal anomodont *Suminia getmanovi* from the Late Paleozoic of Russia has been studied in great detail but its postcranial anatomy remains largely undescribed. For this study, more than a dozen recently collected and mostly complete skeletons provide the most comprehensive picture of any basal anomodont. The material indicates that in addition to its derived cranial anatomy *Suminia* also displays a large number of autapomorphic features in its postcranium. These include an elongate neck, a long tail with an expanded anterior region, a procoracoid with an anterior and a posterior notch at its ventromedial margin, an iliac blade with a robust ridge at the anterior edge of its medial surface, a pubis with a pronounced puboischial fenestra and a separate obturator foramen, and elongate limbs. Further autapomorphic characters are displayed in the autopodium, which composes about 40% of the entire limb length. These features comprise an enlarged, triangular first distal carpal, a short, robust first metacarpal, a first distal tarsal that assumes a metapodial shape, a crescent-shaped distal tarsal 4, elongate penultimate phalangeal elements, as well as a reversal to the plesiomorphic condition for amniotes with a phalangeal formula of 2-3-4-5-3 (manus) and 2-3-4-5-4 (pes). This is achieved by insertion of disc-like phalangeal elements between the proximal and penultimate phalanges in digits III and IV (manus and pes) as well as V (pes only). This combination of morphologically distinct characters combined with the small body size (~50 cm body length) strongly suggests that *Suminia* was an arboreal animal with grasping abilities, and, thus, represents the oldest skeletal evidence for arboreality in the fossil record of tetrapods. This is supported by a morphometric analysis of digital proportions in comparison with other non-mammalian synapsids and extant terrestrial and arboreal tetrapods. Moreover, in the light of the new material *Suminia* represents the most complete basal anomodont or even basal therapsid, offering new insights into the early evolution of Therapsida.

Technical Session XV, Friday 2:15

**TESTING THE IMPACT OF MINIATURIZATION ON THE PHYLOGENY OF PALEOZOIC DISSORPHOID AMPHIBIANS**

FRÖBISCH, Nadia, McGill University, Montreal, QB, Canada; SCHOCH, Rainer, Staatliches Museum für Naturkunde, Stuttgart, Germany

Among the diverse clade of Paleozoic dissorophoid amphibians, the small, terrestrial amphibamids and the neotenic branchiosaurids have frequently been suggested as possible antecedents of either all or some of the modern amphibian clades. Classically, amphibamids and branchiosaurids have been considered to represent closely related taxa within dissorophoids, but despite their importance for the controversial lissamphibian origins, a comprehensive phylogenetic analysis of small dissorophoids has thus far not been attempted. We investigated the relationships of amphibamids and branchiosaurids

based on an integrative data matrix, which was analyzed using a number of analytical techniques, including parsimony analyses with characters treated as ordered and unordered, Bayesian analyses, and an assessment of the fit of yielded tree topologies with the distribution of taxa in the stratigraphic rock record. Both branchiosaurids and amphibamids represent miniaturized taxa and miniaturization is also thought to have played a central role in the evolution of modern amphibians. A second set of analyses was performed, eliminating characters associated with a miniaturized morphology to test whether similar developmental pathways linked to miniaturization lead to an artificial close relationship of branchiosaurids and amphibamids. The results consistently show that miniaturization characters are not responsible for the close clustering of the two groups. Instead, even when characters associated with a miniaturized morphology are excluded, branchiosaurids are a monophyletic clade nested highly within derived amphibamids, demonstrating that branchiosaurids represent a clade of secondarily neotenic amphibamids. This indicates that many of the characters shared by one or both of these groups with modern amphibians may have evolved at the base of the clade including amphibamids and branchiosaurids and provides a new framework for the discussion of their evolutionary history and the origin of modern amphibian taxa.

Poster Session I (Wednesday)

**A REVIEW OF LATE PLEISTOCENE TO HISTORIC VERTEBRATE FAUNAS RECOVERED FROM CAVES AND KARST FEATURES AT CAMP BULLIS, TEXAS**

FROEHLICH, David, Austin Community College, Austin, TX, USA; FROEHLICH, Laura, Froehlich and Froehlich Consulting, Austin, TX, USA; TOOMEY, Rickard, Mammoth Cave International Center for Science and Learning, WKU, Bowling Green, KY, USA; VENI, George, George Veni and Associates, Carlsbad, NM, USA

Since 1993, multidisciplinary karst investigations have occurred at Camp Bullis, north of San Antonio in Bexar and Comal counties, Texas. Vertebrate remains have been recovered from 62 caves and 11 karst features. The majority were collected as loose bones on cave floors during reconnaissance for endangered species conservation and hydrogeologic research. In a few cases, limited test pits or excavations to further explore the caves and karst features have recovered vertebrate remains, and in two cases, detailed paleontological excavations have been carried out. Vertebrate remains range from introduced species to Pleistocene extinct fauna or extralimital taxa. The majority of the caves preserve demonstrably recent historic or late Holocene faunas, but several caves have significant paleontological potential. These include Flach's Cave (TMM-45555, *Mammuthus* and *Geochelone wilsoni*? present), Root Canal Cave (TMM-43430, fauna includes *Synaptomys cooperi*), B-52 Cave (TMM-43437, *Blarina* and *Microtus* present in one area), and Isocow Cave (TMM-43427, early Holocene to Pleistocene? stratified sample - *Geochelone wilsoni* present). In two cases, the conservation work required the systematic excavation of bone bearing sediments (Flying Buzzworm Cave TMM-43429, and Pain In the Glass Cave TMM-43442). Both of these caves yielded extensive microfauna during wet screening. The Flying Buzzworm fauna was a mixture of two components, a historic component that included historic debris and a Pleistocene? component (with extralimital taxa *Sorex*, *Thomomys*, and *Onychomys*). Pain In the Glass Cave yielded two stratified components, an upper mid-Holocene? fauna stratigraphically superposed over a Pleistocene? fauna (extinct *Mammuthus*, and *Equus*, as well as extralimital *Scalopus*, *Thomomys*, *Cynomys*, and ?*Glaucomyx*). Neither fauna is particularly unique, but were excavated for necessity. While not Camp Bullis' prime paleontological sites, their excavation demonstrate interesting assemblages of taxa and the potential for important vertebrate investigations in this protected and limited-access military reservation. We hope this paper will spur interest and further research at Camp Bullis.

Poster Session III (Friday)

**A BIOMECHANICAL MODEL FOR FORELIMB POSTURE IN EXTANT AND EXTINCT TETRAPODS**

FUJIWARA, Shin-ichi, The University of Tokyo, Tokyo, Japan

The position of the shoulder girdle on the rib cage and joint angles among limb elements determine the forelimb posture of the animal. It is however hard to reconstruct the forelimb postures of extinct quadruped animals mainly due to lack of osseous connection between the forelimb and trunk and to the large range of motion capable at each joint. Through mechanical examinations of skeletons of extant species of tetrapods, I came up with a method to reliably reconstruct the position of the scapular blade and the elbow joint angle of quadrupeds during their propulsive phase. First, the "thoracic" ribs of quadrupeds resist downward force of body weight and upward ground reaction force conducted through serratus muscles that arise from the lateral side of the "thoracic ribs" and insert on the proximal portion of the scapulae. "Thoracic" ribs of quadrupeds therefore are expected to have relatively high strength against vertical compression. In order to verify this model, the two dimensional finite element stress analyses were conducted on the rib cages of nine quadrupeds (eight mammals and one crocodylian) and two bipedal birds. According to the analyses, the "thoracic" ribs beneath the scapulae of quadrupeds showed relatively high strength against the vertical compression. The corresponding ribs in bipeds, on the other hand, did not show such significant changes in strength through the rib cage. Secondly, the elbow joint angle and forelimb morphology was examined in 25 species of extant mammals. This analysis suggested that, during the propulsive phase, the species examined keep the orientations of the olecranon and humerus perpendicular to each other. At these

angles, major extensor muscles, such as the triceps, are theoretically assumed to maximize the lever arm at the elbow joint. Based on these analyses on extant animals, the position of high-strengthened ribs in the rib cage and the orientation of olecranon are reliable tools for reconstructing forelimb postures of quadrupeds, regardless of their taxonomic attributes and body sizes. This method can thus be applied to extinct forms.

Technical Session XI, Friday 11:00

**A NEW NON-MAMMALIAN EUCYNODONT (SYNAPSIDA: THERAPSIDA) FROM THE LOWER TRIASSIC OF CHINA, AND ITS BIOSTRATIGRAPHIC IMPLICATIONS**

GAO, Ke-Qin, Peking University, Beijing, China; FOX, Richard, University of Alberta, Edmonton, AB, Canada; ZHOU, Chang-Fu, Shenyang Normal University, Shenyang, China; LI, Da-Qing, China University of Geosciences, Beijing, China

A new trirachodontid eucynodont, represented by a well-preserved skull, was recently recovered from richly fossiliferous Triassic lacustrine deposits exposed in the Beishan Hills, northern Gansu Province, China. The new trirachodontid is accompanied by chondrichthyan, actinopterygian, and sarcopterygian fishes, temnospondyl and lepospondyl amphibians, and small lizard-like diapsid reptiles. The new discovery documents the second record of trirachodontid eucynodonts known from China, along with *Sinognathus gracilis* from the Middle Triassic Ermaying Formation exposed in Shanxi Province. Phylogenetic analysis supports the placement of the new taxon as the sister group of *Sinognathus*, and the two together form the sister clade with South African trirachodontids, distinguished from the latter by possession of several derived character states, including extremely short snout and strongly expanded temporal region. The new discovery from northern China is of great biostratigraphic significance. Because trirachodontids have a restricted stratigraphic range in the Triassic, as best documented by the *Cynognathus* Assemblage Zone of South Africa, discovery of the new fossil of this group from northern Gansu Province provides definitive evidence for assessment of a Triassic age of the fishes, amphibians, and reptiles occurring in the lacustrine beds exposed in the Beishan Hills.

Poster Session III (Friday)

**CARBONIFEROUS VERTEBRATE PROVINCIALITY: DEFINING THE ILLINOIS BASIN VERTEBRATE FAUNA**

GARCIA, William, University of North Carolina Charlotte, Charlotte, NC, USA

The Carboniferous vertebrate record has greatly improved in the last twenty years with the discovery of additional faunas in North America, Europe, and Australia. These new localities have broadened our understanding of the composition of Lower Carboniferous faunas and indicate previously unknown similarities among North American fresh- to brackish-water faunas, particularly in the Illinois Basin. These biogeographic patterns appear consistent across numerous vertebrate clades including Tetrapoda and Dipnoi, and possibly Rhizodontida and Acanthodii, and indicate the existence of an Illinois Basin Vertebrate Province during the Lower Carboniferous. The best known Illinois Basin vertebrate faunas (Delta, Goreville, Hancock County) include the colosteid tetrapod *Greererpeton* and the dipnoan *Tranodis*. Both genera are present at all three Illinois Basin localities as well as Greer, WV in the western portion of the Appalachian Basin and are restricted to these Basins. Relative abundance of taxa is comparable at Hancock County and Goreville where the dipnoan *Tranodis* is the most common taxon suggesting close affinities between these faunas. An additional taxon common to this biogeographic region is *Whatcheeria*. Whatcheerids are known from Greer and Hancock County in addition to the articulated material from Delta, Iowa. While whatcheerids are known outside of the Illinois Basin, namely Scotland (*Pederpes*) and possibly Australia (*Ossinodus*), *Whatcheeria* is known only from the Illinois and Appalachian Basins. An additional defining taxon may come from the Acanthodii. *Gyracanthus* is a common component of Illinois Basin faunas, however, the species-level systematics of this genus are in need of revision and conclusions based upon this taxon are dubious at best. Similarities between Illinois and Appalachian Basin faunas are not reflected in British Lower Carboniferous faunas. British faunas are dominated by baphetid tetrapods and lungfish aside from *Tranodis*, neither *Greererpeton* nor *Tranodis* have been found in Great Britain.

Poster Session III (Friday)

**A NEW IGUANODONTIAN (ORNITHOPODA) DINOSAUR SPECIES FROM THE LOWER CRETACEOUS OF MONGOLIA**

GATES, Terry, Utah Museum of Natural History, Salt Lake City, UT, USA; TSOGBATAAR, Khishigjav, Mongolian Paleontological Center, Academy of Sciences, Ulaanbaatar, Mongolia; ZANNO, Lindsay, University of Utah, Dept of Geology and Geophysics, Salt Lake City, UT, USA

During the 1980's, several partial skeletons of a new iguanodontid ornithopod were excavated from lower Cretaceous beds of Khuren Dukh, northeastern Gobi, People's Republic of Mongolia. Previously identified as *Altirhinus*, this new species possesses an antorbital fenestra as well as an autapomorphic nasal and surangular indicating that it is not referable to the latter genus. The holotype specimen of this new taxon (MPC-D100/801) consists of a nearly complete, disarticulated skull that is augmented by at least two other specimens in the MPC collections. The downturned premaxilla is slightly expanded with

low-lying premaxillary rim. A high, triangular maxilla provides the anterior border to a small antorbital fenestra, which the lacrimal and jugal further define. The quadratojugal partially covers the paraquadratic foramen, leaving a narrow opening distinct from that of several other iguanodontian taxa, including *Altirhinus*. The posterior process of the postorbital reflects slightly dorsally as seen in the hadrosaurids *Hypacrosaurus* and *Velafrons*. Although this new species has characteristics mostly associated with hadrosaurid iguanodontians (e.g., long large external nares), features such as the surangular foramen and large, multi-ridged teeth reveal its more basal position within the clade. Phylogenetic analysis places this new taxon within a monophyletic clade representing the sister taxon to *Iguanodon bernisartensis* and indicates a phylogenetic position significantly more primitive than *Altirhinus*. Linear, slightly raised surface cracks on the skull elements from MPC-D100/801 are consistent with modern bone exposure to extensive subaerial weathering.

Poster Session IV (Saturday)

**DINOSAUR FOOTPRINTS AS 3-D RECORDS OF DYNAMIC FOOT-SUBSTRATE INTERACTIONS**

GATESY, Stephen, Brown University, Providence, RI, USA; MCCOMAS, Katie, Brown University, Providence, RI, USA

Tracks made in compliant substrates preserve evidence of the foot movement that created them. We analyzed a moderately deep theropod track from the late Triassic Fleming Fjord Formation of Jameson Land, East Greenland from twenty transverse sections. Subsurface bedding planes were traced to reconstruct undertracks using the 3-D modeling software, Maya. Deformations at the front and rear of the track were relatively straightforward to decipher. At the center, however, the entry and exit of digits II and IV left complexly mixed sediment with no easily discernible patterns. To analyze clearer examples, we made experimental tracks using a severed turkey foot moved through a mixture of dental alginate and sand. By coloring each of six horizontal layers differently, bedding planes were easily identified. We built 3-D polygonal models of one exposed track and its five undertracks in Maya from twenty two transverse sections. These six nested surfaces reveal changes in track quality with depth, the redistribution of material within and among sections, and evidence of toe movement. Unlike a simple vertical punch, simulated turkey foot motion caused a net forward transfer of sediment during penetration. Following the foot's withdrawal, backward slumping significantly distorted the true exit paths of the toes. Simulations that preserve earlier time points will help reveal the 3-D trajectory of individual particles and provide a more complete spatial and temporal understanding of track formation.

Technical Session VII, Thursday 3:15

**PHYLOGENETIC ANALYSIS OF CINGULATA (XENARTHRA) BASED ON POSTCRANIAL DATA**

GAUDIN, Timothy, University of Tennessee at Chattanooga, Chattanooga, TN, USA; BRAMBLETT, Jeremy, University of Tennessee at Chattanooga, Chattanooga, TN, USA

Cingulates are the only armored mammals and include the extant armadillos, the most speciose living taxon in the order Xenarthra, as well as the extinct glyptodonts and pampatheres. Despite several recent morphological and molecular phylogenetic analyses, several aspects of the relationships among cingulates remain unresolved. The goal of the present study is to reexamine these relationships based on a detailed study of the cingulate postcranial skeleton. We conducted detailed skeletal examinations using representatives of all eight living genera of armadillos, along with four extinct armadillo genera, and one glyptodont and one pampatherer genus. A matrix of 87 discrete osteological characters and 18 taxa was constructed and analyzed using PAUP 4.0Beta. Characters were polarized via comparison to three successive outgroups: Pilosa, represented by the three-toed sloth *Bradypus* and the anteater *Tamandua*, the hedgehog *Erinaceus*, and the opossum *Didelphis*. All characters were equally weighted and the 29 multistate characters were unordered. A branch-and-bound analysis resulted in two most parsimonious trees (TL = 302, CI = 0.4073, RI = 0.4915). In the strict consensus tree, *Dasyypus* and *Stegotherium* form a clade that is the sister taxon to all other cingulates. As in several recent studies, a monophyletic Euphractinae is recovered. The sister taxon to the Euphractinae is a clade that includes the two priodontine genera (*Priodontes* and *Cabassous*) along with the fairy armadillo *Chlamyphorus*. The Santacrucian armadillos *Prozaedys* and *Proentatus* form successive sister taxa to this large assemblage of the Euphractinae, Priodontini, and *Chlamyphorus*. A monophyletic Tolypeutinae is not present. Rather, *Tolypeutes* falls into a clade with the extinct horned armadillo *Peltephilus*, the glyptodont *Propalaeohoplophorus*, and the pampatherer *Holmesina*.

Technical Session XX, Saturday 2:45

**IMPACT OF MORPHOLOGY AND FOSSILS ON THE PHYLOGENY OF CETACEA**

GEISLER, Jonathan, Georgia Southern University, Statesboro, GA, USA; GATESY, John, University of California Riverside, Riverside, CA, USA

Despite growing evidence to the contrary, some neontologists continue to question the usefulness of morphological data. Here we describe a case study on the phylogeny of Cetacea that demonstrates the importance of simultaneous analyses that include morphological data coded for extant and extinct taxa. We compiled a data matrix of 73 taxa (44 extinct) coded for 328 morphological characters, 20,617 aligned nuclear DNA

base pairs, 15,587 mitochondrial DNA base pairs, 570 DNA gap characters, and 101 DNA SINE characters. Most parsimonious trees for our combined analysis support monophyly of Odontoceti, Mysticeti, Ziphiidae + Platanistidae, Iniioidea, Iniioidea + Lipotes, Phocoenidae + Monodontidae, Delphinida, and Delphinoidea. To assess the role of morphological and paleontological data in combined analyses, we focused on the decay index. Given that different numbers of taxa can affect decay indices, we used double decay analyses with extant compositions of clades in matrices that included extinct taxa. Simultaneous analyses of morphology and molecules with and without fossils revealed significant hidden support. The sum of all decay indices across the entire tree increased by 316 steps for the analysis that included morphology but not fossils, while an increase of 305 steps was observed for the analysis that included extinct taxa. Examination of individual decay indices revealed that increases occurred where fossil sampling was good and decreases occurred where fossil sampling was poor. For example, relative to the analysis that excluded fossils but retained morphological data, the decay index for Mysticeti increased 13 steps while that for Odontoceti increased by 15 steps. Stem taxa to crown Odontoceti and crown Mysticeti are particularly well represented in the matrix. When extinct taxa are included, optimizations of 12 morphological characters that appear to be synapomorphies of the cetacean crown group are shown to have evolved once in stem odontocetes and again in stem mysticetes, increasing the decay index for each extant suborder. Similar affects are expected higher up the tree when more Miocene and Pliocene cetaceans are included in the matrix.

Poster Session IV (Saturday)

**PRELIMINARY ANALYSIS OF A NEW DIDOLODONTIDAE 'CONDYLARTHRA' (MAMMALIA) FROM THE PALEOGENE OF ITABORAI BASIN, BRAZIL**  
GELFO, Javier, Museo de La Plata, La Plata, Argentina; PAGLARELLI BERGQVIST, Lilian, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

An extraordinary diversity of mammals has been recovered from fissure fill deposits with marls and collapse breccias from São José de Itaboraí Basin, at Rio de Janeiro State. This fauna was the basis for the Itaboraian SALMA (South American Land Mammal Age), also recognized at Las Flores locality, in Patagonia, Argentina; and considered in different works as late Paleocene or early Eocene. The Itaboraian fauna shows a great diversity of mammals represented by metatherian (e.g. Sparassodonta, Didelphimorphia and Microbiotheria) and eutherian (e.g. Notoungulata, Astrapotheria, Xenungulata and Xenarthra). Two lineages of South American strict bunodont ungulates, the Didolodontidae "condylarthrs" and the Protolipternidae litopterns, are best represented in the Itaboraian than in any other SALMA. Undescribed remains belong to a left M3 (FZB 1413PV) and a left m2? (MNRJ 4465V) suggests the presence of at least another didolodontid taxon. Compared to other Itaboraian taxa both teeth are larger than *Paulacoutoia protoconica* but smaller than *Lamegoia conodonta*. As in them, transverse HSB are present in the enamel. The main distinct features of the M3 are: an almost squared outline due to the shortness of the labiolingual axis; labial cingulum absent; mesial and distal cingula large and crenulated; weak and twined hypocone at the end of the distal cingulum and separated from the protocone, but not as much as in *Didolodus multicuspis*; preparaconular and postmetaconular cristae directed to the mid portion of paracone and metacone respectively; straight centrocrista with a small cusplite between paracone and metacone. The m2? shows a trigonid somewhat wider than talonid, and with a wide trigonid basin; paraconid mesial and connated to metaconid; metaconid unusually high and strong; talonid basin opens lingually through a furrow due to the development of the hypoconid and entoconid; hypoconid subequal to protoconid; cristid obliqua running to the labial side of the metaconid and without mesostyle; hypoconulid distally placed and without posteristid and hypocristid. These remains increase the diversity of strict bunodont ungulates for the Itaboraian SALMA.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**GEOGRAPHIC AND TEMPORAL CONSTRAINTS ON THE DISTRIBUTION OF QUATERNARY FAUNAS IN TEXAS**  
GEORGE, Christian, The University of Texas at Austin, Austin, TX, USA

Quaternary paleoecologic reconstructions over large geographic regions often rely on combining faunal data from cave and non-cave sites. Cave faunas have been an essential component of Quaternary paleoecologic reconstructions because they commonly provide data where no other type of fossil site is found. Since cave and non-cave sites do not often overlap geographically and because the taphonomic pathways that accumulate these sites are frequently distinct, these factors may influence any paleoecologic interpretations based on combining faunas from different types of sites. Thus, an understanding of the geographic factors contributing to site formation will enable more robust paleoecologic interpretations of an area. To determine which factors influenced the location of cave and non-cave fossil sites I assembled a GIS (geographic information systems) database of fossil localities in Texas. Texas was selected because it contains a diversity of environments, and it has a broad range of well-studied Quaternary sites. I tested hypotheses of the influence of geology, topography, precipitation and pedology on the distribution of caves and non-cave sites. Most of the caves in Texas were found on the karst-rich Edwards Plateau, but several important caves were located outside of this region, particularly in the Trans-Pecos. This analysis shows strong quantifiable difference between areas with cave sites and areas without. There are also pronounced age differences between cave and non-cave sites. On average non-cave faunas are older. Holocene cave faunas tend to have a wide geographic distribution, whereas the Pleistocene cave faunas are localized to central Texas, and a very small percentage are

older than radiocarbon chronology. In contrast, there are non-cave faunas that represent all of the Quaternary. The geologic history of an area has a strong influence on the type of fossil site found in a given area during the Quaternary period. In the future, I will address whether this phenomenon holds for larger geographic areas, such as North America.

Romer Prize Session, Thursday 9:45

**SEMICIRCULAR CANAL MORPHOLOGY AS EVIDENCE OF LOCOMOTOR ENVIRONMENT IN AMNIOTES**

GEORGI, Justin, Stony Brook University, Stony Brook, NY, USA

The vestibular system is a critical component of the neural control of locomotion in vertebrates. In the vestibule, macular endorgans transduce linear movements of the head and the semicircular ducts transduce rotational movements. Integrated in the cerebellum with visual and proprioceptive inputs, the vestibular signals provide vital information about movement relative to the environment, and drive stabilization reflexes. The semicircular ducts leave distinct canals through the bones of the posterior braincase which preserve some of the morphologies that determine the functional parameters of the semicircular ducts. Therefore, because the semicircular ducts have morphologies that determine the functional response of the system, and because some of these morphologies can be determined via the semicircular canals, it has been previously hypothesized that there are correlations between semicircular canal morphology and locomotion. To test the underlying assumption of this hypothesis, semicircular canal adaptive change, the semicircular canals of a broad array of amniotes were examined. Within the semicircular canals of carnivorous mammals, turtles, varanids and crocodylians there is, despite phylogenetic shape differences, a consistent pattern of shape change that correlates with terrestrial, semi-aquatic, or aquatic locomotor behavior. This pattern is strongest in the anterior semicircular canal where the common crus and the peak of the canal adjacent to the common crus become shorter the more aquatic the animal's behavior. This change in anterior canal shape is strongly tied to factors of limb morphology that correlate with locomotion and not with other factors of skull morphology, supporting the hypothesis that this is adaptive change in the system and not coincidental change. On the basis of this highly correlated, adaptive change, the results of this study then are shown to be applicable to the prediction of locomotor environment in extinct amniotes via examination of the semicircular canals preserved in fossil crocodylians.

Technical Session XVIII, Saturday 2:15

**VERTEBRATE DIVERSITY OF THE LATE DEVONIAN (FAMENNIAN) DEPOSIT NEAR GRAHAMSTOWN, SOUTH AFRICA**

GESS, Robert, University of the Witwatersrand, Johannesburg, South Africa; COATES, Michael, University of Chicago, Chicago, IL, USA

The Waterloo Farm locality is a significant biogeographical outlier. Whereas Late Devonian faunas found in North America, Europe, China, Australia and Eastern Antarctica were tropical, that found at Waterloo Farm was within the Antarctic Circle. The sedimentary setting was a back-barrier estuarine lagoon on the northern shore of the Agulhas Sea. The vertebrate rich black shale lens, represents a shallow embayment, close to the mouth. Anoxic conditions within the sediment led to exceptional preservation of some small organisms. Its sulphurous, acidic nature resulted in poor preservation of large bony elements, generally represented by mineralised compressions. Since exposure in 1985, the outcrop has provided evidence for a growing list of taxa. The fauna was numerically dominated by groenlandaspid arthrodire placoderms, of which *Groenlandaspis riniensis*, was most abundant, and reached a substantial size. Two other species (including *Africanaspis doryssa*) characterised by extremely high median dorsal plates, were less abundant and more modest in size. Antiarch placoderms were represented by *Bothriolepis africana*, which was also relatively large. A ptyctodont has been reported, on the basis of an isolated plate. A lamprey, *Priscomyzon riniensis*, exhibited the oral specialisations and much of the cranial anatomy seen in extant taxa. Acanthodians were fairly diverse, though not common, and included a gyracanthid, at least one diplocanthid (*Diplanthus acus*) and an acanthodid. Chondrichthyans included *Antarctilamna*, elsewhere a mid Devonian Gondwanan taxon, *Plesioselachus macracantha*, and at least one subadult form representing a third taxon of uncertain affinities. A small actinopterygian was amongst the less common taxa. The most abundant sarcopterygian was a coelacanth, represented by numerous juvenile individuals. Long snouted dipnoans were present, as well as a large tristichopterid that exhibits some similarities to *Hynertia*. The top predator, represented by fragments including a large cleithrum, appears to have been a several metre long elpistostegalid-like form.

Poster Session IV (Saturday)

**A NEW GENUS AND SPECIES OF PONTOPORIID (CETACEA, ODONTOCETI) FROM THE LEE CREEK MINE OF NORTH CAROLINA**

GIBSON, Matthew, Georgia Southern University Museum, Statesboro, GA, USA; GEISLER, Jonathan, Georgia Southern University, Statesboro, GA, USA

Based on collections of fossil odontocetes from the Lee Creek Mine (Aurora, North Carolina), we describe a new genus and species of Pliocene pontoporiid dolphin. The holotype consists of a partial skull of a juvenile individual that includes bones of the orbital region, those surrounding the nasal passages, and a detached skull fragment that includes much of the supraoccipital and nearly all of the left exoccipital. The referred specimen is a

skull fragment of an adult individual that includes the posterior end of the nasal process of the left premaxilla and a portion of the maxilla that is sutured to it. Both specimens were collected from spoil piles in the mine; even so, we can infer that both were derived from the Sunken Meadow Member of the Yorktown Formation (4.0-3.8 Ma) based on the lithology of matrix infilling the foramina. They are very similar in anatomy and have a pronounced premaxillary eminence, a key feature of Pontoporiidae. Evidence that the referred specimen is older than the holotype is that the former is larger (corresponding measurements are 25-54% greater), has a better developed premaxillary eminence, has tighter sutures, and has a more complex sutural surface on the maxilla for the jugal. The presence of an anteroposteriorly elongate nasal and low vertex in the holotype is similar to the extant pontoporiid *Pontoporia blainvillei* and differs from Iniidae and Phocoenidae, two other families characterized by a premaxillary eminence. An apparent autapomorphy of this new taxon is the wide space between the nasal process of the premaxilla and the nasal. Based on its overall symmetrical face and the fairly short posterolateral sulcus, it is hypothesized that it occupies a phylogenetic position between the basal Brachydelphinae and a clade including *Pontoporia* and *Pliopontos*. A phylogenetic analysis of Iniioidea (Iniidae + Pontoporiidae) is needed to further resolve relationships within Pontoporiidae and to reconstruct the biogeographic history of this group. Upon formal publication, this taxon will be only the second named pontoporiid from the East Coast of North America, and adds to the growing, extinct diversity of this family.

Technical Session XIX, Saturday 3:00

#### BITE FORCE ESTIMATES FOR *DEINONYCHUS ANTIRRHOPUS* USING TOOTH INDENTATION SIMULATIONS

GIGNAC, Paul, Florida State University, Tallahassee, FL, USA; MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL, USA; ERICKSON, Gregory, Florida State University, Tallahassee, FL, USA; WALSH, Robert, National High Magnetic Field Laboratory Florida State University, Tallahassee, FL, USA

Tooth traces can be informative about the feeding ecology of extinct vertebrates since they allow for comparisons with neontological models. Several authors have made the case for comparing the feeding strategy of *Deinonychus antirrhopus* with the living carnivore *Varanus komodoensis* owing to similar dental morphology thought to biomechanically limit them to flesh shearing. A recently discovered specimen of the Cretaceous ornithomimid *Tenontosaurus tilletti* was found with bite marks attributed to an adult *D. antirrhopus*. These include several exceptionally deep puncture marks through the bone cortices. Since *V. komodoensis* is not known to puncture bone during feeding, this new information brings into question the veracity of a *Varanus-Deinonychus* analogy and points to a somewhat different carcass feeding strategy and physical capacities for *D. antirrhopus*. From the *T. tilletti* specimen we were able to quantify the minimal bite force capacities of *D. antirrhopus* using tooth indentation simulations. The resultant data showed that approximately 3000 N of force was required to recreate one of the bite marks. This translates to a posterior-most bite force of at least 7500 N. Comparison to living vertebrates shows that the bite force of *D. antirrhopus* is higher than those reported for large carnivores but is on par with values recorded for comparably-sized crocodylians. It is not thought that *D. antirrhopus* relied heavily on its jaws and teeth for acquiring prey resources; yet, this animal was also not incapable of biting through bone. Although such behavior may have been rare, it indicates that the bite forces for *D. antirrhopus* were higher than had been previously expected and helps elucidate the limitations of *V. komodoensis* as a model for *D. antirrhopus* feeding.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 11:45

#### ENCEPHALIZATION RESIDUALS IN TERRESTRIAL AND AQUATIC MAMMALS, LIVING AND FOSSIL: BASELINE FOR COMPARISON

GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA

We often read that primitive primates have an encephalization quotient or EQ of 0.5 (indicating that the brain is one-half the weight expected for an average living mammal of that body weight), while humans have a much larger EQ of 7.5 (7.5 times the expected weight). This is misleading. The problem is the scale. What is important is not an absolute difference from expectation, but the proportional difference. Adding a gram of tissue to a 5-gram brain is different proportionally and functionally from adding a gram to a 1500-gram brain. Ratios, like biological measurements, have to be corrected for proportion. This is done using logarithms, and the most intuitive way to compare brain sizes is on a  $\log_2$  or halving-doubling scale. When properly scaled, allometric relationships are linear, and quantification is appropriately expressed as an encephalization residual (ER) rather than a quotient. Expected or predicted brain weight  $E_p$  is determined empirically from the allometry of observed brain weights  $E$  and body weights  $P$ . Regression of  $\log_2 E$  on  $\log_2 P$  for a representative sample of 778 terrestrial mammals yields  $E = 0.74 \cdot P - 4.00$ , meaning  $E_p = 0.74 \cdot P - 4.00$ .  $ER_{TC}$ , the encephalization residual for terrestrial mammals as a class, the difference between an observed brain weight and the expected brain weight for that mammal, is  $ER_{TC} = E - E_p$ . Terrestrial mammals grouped at lower taxonomic levels have lower regression slopes as a predictable artifact of loss of statistical power. A primitive primate has a brain weight about one-half or 1 halving of expectation ( $ER_{TC} \approx -1$ ), while humans have a brain about 3 doublings of expectation ( $ER_{TC} \approx +3$ ). Marine Cetacea do not fit the terrestrial mammal line: Odontoceti have larger brains for their body size, while Mysticeti have larger bodies for their brain size. In all cases,  $ER_{TC}$  appears to be the appropriate baseline for comparison.

Poster Session I (Wednesday)

#### CTENACANTH SHARKS FROM THE UPPER DEVONIAN CLEVELAND SHALE OF OHIO

GINTER, Michal, Institute of Geology, University of Warsaw, Warszawa, Poland

Based on earlier identifications of ctenacanth spines and the analysis of tooth morphology of sharks from the upper Famennian (Upper Devonian) Cleveland Shale of northern Ohio, at least three different species of *Ctenacanthus*, namely *Ct. concinnus* (formerly known as *Ct. clarki* and *Ct. compressus*), *Ct. terrelli* and *Ct. tumidus*, can be distinguished there. Articulated skeletons of only the first of these species are known to-date. The teeth associated with skeletons of *Ctenacanthus compressus*, appear to be morphologically identical to those of "*Cladodus*" *concinnus*, a species based on isolated teeth from the same area and formation. Similarly to the situation in *Ct. compressus*, two size classes can be distinguished among the fully grown teeth of "*Cl.*" *concinnus*. Due to such resemblances, these two taxa are considered conspecific and, consequently, a new taxonomic combination, viz. *Ctenacanthus concinnus*, is proposed. Two other tooth-based species from the Cleveland Shale, "*Cladodus*" *terrelli* and "*Cl.*" *tumidus* are also considered to represent the genus *Ctenacanthus*. Close phylogenetic relationships between *Ctenacanthus*, the Mississippian shark *Cladodus*, and the Frasnian-Famennian *Cladodoides wildungensis* are confirmed based on similarities in tooth morphology. "*Stethacanthus resistens*" is a junior synonym of *C. wildungensis*. Most of a plethora of microscopic shark teeth from the Upper Devonian and Lower Carboniferous, thus far referred to as *Symmorium* or *Stethacanthus*, were misidentified. Probably many of them actually represent ctenacanthiforms.

Technical Session V, Wednesday 2:15

#### THE ONTOGENY OF THE AUDITORY BULLA IN MONGOOSSES (HERPESTIDAE: MAMMALIA)

GISHLICK, Alana, Yale University, New Haven, CT, USA

The mongooses have what is perhaps the most diverse array of auditory bulla morphologies of any carnivoran group. While the morphology of the auditory bulla, and the basicranium in general, has been extensively studied, there have been few studies of the ontogeny of the bulla. In order to elucidate the heterochronic patterns and processes involved in shaping the mongoose auditory bulla, especially in relation to the acquisition of an enlarged bulla volume, I examined the ontogeny and ontogenetic allometry of eighteen species of mongooses. Ontogeny was established by using tooth eruption sequences as a proxy for age, and ontogenetic allometry using linear regression. My results indicate that bulla ontogeny is highly variable early in development, and while the heterochronic pattern may be the same, the processes underlying that pattern may be very different, even in closely related species. This is especially important to the question of the independent acquisition of an enlarged bulla volume in three species, *Ichneumia albicauda*, *Paracynictis selousi*, and *Cynictis penicillata*. These species, all part of the same clade, have different bulla morphologies, and the results from this study shows that they also differ in bulla ontogeny. These different processes suggest an independent acquisition of an enlarged auditory bulla, rather than being inherited from a common ancestor. The differences in bulla morphology and ontogeny suggest that what is important for selection is a larger bulla volume, rather than a particular bulla morphology. The individual bulla dimensions also appear to be ontogenetically dissociated from each other, allowing them to vary independently to produce a wide range of bulla morphologies. The development of the bulla is not canalized and allows for the range in bulla volume and bulla morphology. The variety of processes present in the ontogeny of the auditory bulla of herpestids offers insight into the evolution of growth and its interaction with selection in the adaptation to new environments.

Poster Session IV (Saturday)

#### BIOMECHANICAL INVESTIGATIONS OF THE LONG SNOOT IN *PLATEOSAURUS*

GOESSLING, Rainer, Research Group of Biomechanics, Faculty of Engineering, Ruhr-Universität, Bochum, Germany; WITZEL, Ulrich, Research Group of Biomechanics, Faculty of Engineering, Ruhr-Universität, Bochum, Germany; DISTLER, Claudia, Zoology and Neurobiology, Faculty of Biology, Ruhr-Universität, Bochum, Germany

Long snouts in animals have developed by natural selection. There are biological advantages of long snouts, i.e. for prey capturing. However, these advantages come at a cost. Mechanically, biting with the front teeth causes a bending moment in the snout which is accompanied with high bending stress in the bone. Based on Wolff's Law, bone density and thickness are correlated with the occurring stress. If bending moments could be reduced, bony light-weight constructions characterized by minimal mass and weight could be built. Using finite element (FE-) models we investigated how bending moments can be minimized and how skulls of extinct animals were functioning. For the skull of *Plateosaurus* we varied mechanical equations to reduce all bending moments. This approach provides information about the mechanical loading of different structures and offers an interpretation of their functions. Our analysis indicates that a flexible mandibular symphysis reduces shear and tensile stresses in the mandibular branches, which would appear in a fused symphysis as a consequence of the configuration of mandible adductors in *Plateosaurus*. The cartilago transiliens found in crocodiles and tortoises combines some of the adductor tendons to reduce bending in the sagittal plane of the mandible. Based on our analysis we postulate the presence of a cartilago transiliens for the skull of *Plateosaurus* to achieve equilibrium

of forces and moments. Furthermore we investigated the loading of the processus retroarticularis. Our results indicate that the jaw opening and closing musculature of *Plateosaurus* was in part acting simultaneously, as known for recent crocodiles. This strategy enhances muscle activity but reduces the maximum stress in bones.

Poster Session IV (Saturday)

**CRANIOFACIAL ONTOGENY IN *VELOCIRAPTOR MONGOLIENSIS***

GOMBERT, Joseph, Carthage College, Kenosha, WI, USA

*Velociraptor mongoliensis* is one of the few dromaeosaurids that is known from several well-described skeletons and skulls, but the growth changes in this species are undescribed. Our objective was to reconstruct the growth series of *V. mongoliensis* using a numerical parsimony analysis of osteological characters. We obtained data from casts of skulls (AMNH 6515, PIN 3143/8) and from the primary literature (GIN 100/25, GIN 100/982). We found eleven ontogenetically informative traits among four specimens that we analyzed in PAUP under a branch-and-bound search, with the characters unordered and of equal weight. The holotype (AMNH 6515) was recovered as the least mature specimen and PIN 3143/8 was recovered as the most mature specimen, which is consistent with the small size of the holotype. The results indicate three growth stages in *V. mongoliensis*, which are listed in order from least mature to most mature: (1) the antorbital fenestra increases in height, the concavity in the dorsal margin of the snout becomes shallow, and the depression on the frontal that is ahead of the dorso-temporal fossa becomes deep; (2) the maxillary tooth row shifts caudally below the caudal half of the antorbital fenestra; and (3) the orbital fenestra increases in length, and the ventral margin of the jugal becomes straight. In conclusion, the greatest changes during growth in the skull of *V. mongoliensis* occur in the snout, which might be evidence for a more forceful bite in the most mature animals than is seen in less mature individuals.

Technical Session XVIII, Saturday 2:45

**RUPELIAN ELASMOBRANCH ASSEMBLAGE FROM THE EL CIEN AND SAN GREGORIO FORMATIONS FROM BAJA CALIFORNIA SUR, MEXICO**

GONZALEZ-BARBA, Gerardo, Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico

The Rupelian elasmobranch assemblage from Baja California Sur are reported, consisting of oral teeth, rostral spines, gill rakers, dermal denticles, vertebrae and caudal stinging spines, recovered by surface collecting and screening. To date 27 families, 38 genera and 44 species, including 33 sharks and 11 rays or batoids have been recorded from the basement of the El Cien and San Gregorio formations, cropping out in the Pacific bank of Baja California Sur. The assemblage and stratigraphic sequence shows a mixture of warm temperate and cold temperate waters and from shallow to outer platform settings, including pelagic and benthic taxa. There are strong affinities with the Rupelian faunas from the Tethys and Paratethys realms, but there are some influences from other contemporaneous deposits known from the Pacific basin and Northwest Atlantic region too. Most of the recorded genera occurs still in the area, but some of them are restricted now to the Caribbean or Indo-Pacific regions. Assessing the ease of movement of species across the isthmus of Central America. Some are extinct mostly circum global pelagic taxa. The Rupelian sharks and rays are poorly known globally, and Baja California Sur offers one of the few places where they are abundant and occur within a relatively complete Eocene-Oligocene succession that yields selachian remains throughout.

Technical Session IV, Wednesday 2:00

**FRACTIONATION IN FOSSIL BIOAPATITE: PHYLOGENY AS A CONFOUNDING FACTOR**

GOODWIN, Mark, University of California Museum of Paleontology, Berkeley, CA, USA; HOLROYD, Patricia, University of California Museum of Paleontology, Berkeley, CA, USA

Stable isotopes of fossil bone and teeth are often used in paleobiological and paleoenvironmental studies. Enamel is compositionally complex, and the  $PO_4$  (phosphate) and  $CO_3$  (carbonate) components are not equally resistant to postmortem diagenesis. In mammalian bioapatite,  $\delta^{18}O$  from  $CO_3$  and  $PO_4$  are linearly correlated when mineralized in equilibrium at  $\sim 37^\circ C$ . Prior work indicates  $CO_3$  should be enriched  $\sim 8\%$  compared to  $PO_4$  in unaltered bioapatite. This value is used widely as a measure of the preservation of a primary isotope signal and to determine if samples are diagenetically altered. It is established, however, on a taxonomically limited data set primarily composed of ungulates. Recent work has hypothesized that variations in body temperature among taxa may be reflected in  $CO_3/PO_4$  offsets, but more data are needed. Here we present new data that nearly doubles that currently available for  $\delta^{18}O$  from simultaneous analysis of fossil mammal tooth enamel  $CO_3$  and  $PO_4$ . More than 40 individuals from 7 formations from the middle Eocene and Miocene of California were analyzed. Oxygen from coeval  $CO_3$  &  $PO_4$  were significantly correlated in 6 of 7 formations and consistently show a  $\sim 6\%$  enrichment that is comparable to other reported fossil data. Alternative interpretations of this difference in relative enrichment include taxonomic differences among modern and fossil data sets or behavioral or physiological differences between fossil and living taxa. Independent of the causal mechanism, these results suggest caution in interpretation of  $\delta^{18}O$  from fossil samples. Most studies rely solely on the simultaneous production of  $\delta^{18}O$  and  $\delta^{13}C$  from enamel or bone  $CO_3$ . Coeval  $PO_4$  analysis from each locality is essential to identify diagenesis in

fossil bioapatite. Further, these data suggest that it also may be necessary to incorporate an understanding of phylogeny and/or inferred behaviors in order to interpret  $\delta^{18}O$  values derived solely from enamel carbonates.

Poster Session I (Wednesday)

**ENAMEL MICROSTRUCTURE OF MULTITUBERCULATE MAMMALS FROM THE EARLY-MID CRETACEOUS OF NORTH AMERICA**

GORDON, Cynthia, University of Oklahoma, Norman, OK, USA; WELLS, Jennifer, University of Oklahoma, Norman, OK, USA; CIFELLI, Richard, University of Oklahoma, Norman, OK, USA

The enamel microstructure of multituberculates falls into one of three types: non-prismatic, prismatic or gigantoprismatic. A recent review holds that most members of the Cimolodonta suborder have prismatic enamel, with only the Taeniolabidoidea having gigantoprismatic enamel. Members of the suborder Plagiaulacida have been shown to possess non-prismatic enamel (with some debatable exceptions). Herein we report on the enamel microstructure of some members of the "*Paracimexomys* group" of multituberculates from the Cedar Mountain Formation, Utah (ca 98.5 Ma). Study of these basal members of Cimolodonta to date includes one species each of *Bryceomys*, *Janumys*, *Paracimexomys* and *Ameribaatar*, and two species of *Cedaromys*. Results in hand suggest that probably all of these taxa possess prismatic enamel. Interestingly, *Janumys*, which had been tentatively placed in the Plagiaulacida, possesses prismatic enamel. Earlier studies have reported that *Gliriodon* and *Eobaatar*, both plagiulacids, possess gigantoprismatic enamel. Subsequently, it has been suggested that *Gliriodon*, at least, has non-prismatic enamel; our own investigations indicate that the two conditions are not always easily distinguished. These contradictory results for more primitive multituberculates underscore the need for reappraisal of earlier results and more comprehensive study, including increased taxonomic and intraspecific, sampling. Examining the microstructure of stem Cimolodonta is important in establishing the transition from non-prismatic to prismatic enamel types. Although enamel microstructure has been used in many phylogenetic analyses, the contradictory findings of some of these studies, and the apparent utility of this character, will remain problematic as long as studies continue to employ inconsistent methodology and non-standard terminology.

Technical Session I, Wednesday 9:30

**DEVELOPMENTAL MODULARITY AND THE MARSUPIAL-PLACENTAL DICHOTOMY**

GOSWAMI, Anjali, University of Cambridge, Cambridge, United Kingdom; WEISBECKER, Vera, University of New South Wales, Sydney, Australia; SANCHEZ-VILLAGRA, Marcelo, Universität Zürich, Zürich, Switzerland

The contrasting evolutionary histories of marsupial and placental mammals have been debated for decades. The speciose placentals have radiated into diverse niches, while marsupials are limited in taxonomic, ecological, and morphological diversity. This disparity has often been attributed to their different reproductive strategies. Marsupials give birth to highly altricial young with only well-developed forelimbs, to crawl to the teat, and oral apparatus to suckle. Placentals develop mainly in utero, and young are relatively precocial at birth. These differences in reproductive patterns have been tied to clear differences in sequence heterochrony between marsupials and placentals. Marsupials accelerate the development of their facial skeleton and forelimbs and delay the development of their brain and hindlimbs, although the specific polarity of these heterochronies has been difficult to establish. It has also been hypothesized that coordinated shifts in developmental timing occur among functionally- or developmentally-related structures, such as the forelimbs and oral apparatus in marsupials. Here, we use new developmental sequence data and revised polarities of heterochronic shifts for 11 marsupial and 14 placental species to assess the integration of developmental timing in skeletal elements. Using rank correlation analysis, we tested if coordinated shifts occur in 19 hypothesized functional sets of cranial and postcranial elements. Results demonstrate that marsupials and placentals differ markedly in the integration of developmental timing. Marsupials show significant modularity in the development of the postcranial skeleton, with independent anterior and posterior postcranial developmental modules, while placentals, with the exception of bats, show significant integration of the entire appendicular skeleton. There are few significant developmental modules in the cranium, although placentals show greater integration in the facial region than marsupials do. These differences in developmental modularity support morphometric studies of postcranial modularity and may relate to differences in morphological diversity between these clades.

Fossils and the Evolutionary Patterns of Ostariohsans, One of the Largest Vertebrate Clades, Saturday 8:15

**FOSSIL FISHING ONE PIECE AT A TIME, WITH A CATFISH EXAMPLE FROM THE LATE CRETACEOUS OF MADAGASCAR**

GOTTFRIED, Michael, Michigan State University, East Lansing, MI, USA; OSTROWSKI, Summer, Michigan State University, East Lansing, MI, USA

Articulated fossil fish specimens provide a tremendous amount of morphological data for phylogenetic analysis, and have commonly been the preferred focus of detailed descriptive and systematic studies. Isolated skeletal elements and teeth, in contrast, are often frustrating

and present serious challenges due to the morphological conservatism of many aspects of fish skeletal anatomy, and the dangers of incorrectly assigning isolated non-related material to the same taxon, or, conversely, not recognizing such relationships when they are in fact valid. Nevertheless, while conceding that these (and other) challenges exist, isolated specimens do contribute crucial data that expand our understanding of fish evolution, diversity, and biogeography – particularly from certain temporal intervals, and from higher-energy environments where preservation of articulated specimens does not occur. “Fish bits” are crucial for establishing first occurrence data of many groups, thus contributing to biogeographic studies and to establishing clade divergence timing for molecular clock analyses. As a specific example, two decades of exploring the Late Cretaceous record of the Mahajanga Basin in Madagascar have yielded an enormous amount of paleontological data, including a very diverse and often spectacular array of tetrapods (mammals, avian and non-avian theropods, sauropods, crocodylomorphs, lizards, snakes, turtles, and frogs), along with osteichthyan and chondrichthyan remains. In contrast to the tetrapod record, which does include some articulated and associated specimens, the bony fishes are found one element at a time, with vertebral centra, fin spines, and teeth relatively common, and cranial elements less typical. Among these are isolated partial jaws, vertebrae, and fin spines attributable to catfish (Siluriformes), representing the only pre-Cenozoic record of this biogeographically significant clade from Madagascar. This material offers a rare glimpse of Cretaceous catfish from the eastern side of Gondwana during this poorly known interval in ostariophysan history.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 8:00

**THE ENDOCRANIUM AND ENDOCAST OF PLACODERM FISHES**  
GOUJET, Daniel, Muséum National d'Histoire Naturelle, PARIS, France

Among vertebrates the Placoderms are a monophyletic group of gnathostomes presently considered as the sister group of all other members of that ensemble. They show a curious mixture of highly derived characters and basal gnathostome synapomorphies. Many of them present a high degree of ossification and in several a very detailed anatomy of both the endocranium and the endocast have been described since the original cartilaginous endoskeleton is lined by a fine laminar bone layer. It shows a generally tubular brain cavity with a larger diameter in the region housing the metencephalon. The regional differentiation can however be inferred through the position of the nerve canal exits from the main endocranial (brain) cavity. In many cases, these canals are not even grouped under the brain as is often the case in later gnathostomes but ordered more or less in a row pattern. With their external foramina clearly identified on the outer wall of the endocranium a precise identification of the cranial nerves is now accepted. Presently, such endocast have been prepared in good detail in several placoderm orders: Early Arthrodira, Acanthothoracids, Petalichthyida, Rhenanida. Despite some differences in detail, common features that may be primitive for all gnathostomes emerge from a comparison with the other groups.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 9:15

**OSTARIOPHYSAN HISTORICAL BIOGEOGRAPHY AND DISTRIBUTION PATTERNS**

GRANDE, Lance, Field Museum of Natural History, Chicago, IL, USA; GRANDE, Terry, Loyola University Chicago, Chicago, IL, USA

The Ostariophysa is a complex assemblage of fishes that are as different morphologically from each other as they are similar. The group also has a complex distribution pattern with some members exhibiting a world wide distribution (e.g., gonorynchiforms), while others like the characiforms and gymnotiforms are endemic to South America. Distribution patterns and an extensive fossil record dating back to the Upper Jurassic has resulted in countless biogeographic scenarios incorporating all possibilities such as centers of origin, dispersal, vicariance, and a combination of all three. Recent molecular data suggests that the origin of the Ostariophysa predates the breakup of Pangea, while fossil data suggests that the basal ostariophysan subgroup, Gonorynchiformes had a Tethys Sea origin. These scenarios however, outside of a sound phylogenetic foundation, are little more than story telling. This contribution examines the historical biogeography and distribution patterns of the two main ostariophysan subgroups, the Gonorynchiformes and the Otophysi. Robust phylogenies of all ostariophysan subgroups are used to set a phylogenetic framework. Fossil taxa are used to date possible divergence times and to better understand the distribution pattern of each subgroup. Preliminary data suggests that the Ostariophysa does indeed have a long and complex evolutionary history. Gaps in our knowledge, as well as, points of incongruence are assessed. Lastly, the historical biogeography of the Ostariophysa is considered in light of it most recently proposed sister-group, the Clupeomorpha. Examining the evolution of Ostariophysa in a broader phylogenetic context will no doubt prove insightful.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 12:00

**FOSSILS, MORPHOLOGY AND PHYLOGENETIC RELATIONSHIPS OF OSTARIOPHYANS**

GRANDE, Terry, Loyola University Chicago, Chicago, IL, USA

The Ostariophysa as we know it today exhibits tremendous morphological variation, a widespread geographic distribution and a rich fossil record dating to the Upper Jurassic. It consists of two main groups: the Anotophysa or Gonorynchiformes and the Otophysi, or those fish with a functioning Weberian apparatus. For many years the Ostariophysa was a systematic enigma. Its phylogenetic placement within Teleostei was debated, along with its taxonomic composition, and the monophyly of many of its subgroups, the Gonorynchiformes in particular. Because of the importance of ostariophysans both scientifically and economically, phylogenetic studies of Ostariophysa and ostariophysan subgroups are numerous. Studies based exclusively on the molecular data or a combination of morphology and DNA characters have contributed greatly to a better understanding of the group. These studies however have concentrated on extant members almost to the neglect of fossil forms. Very few studies have attempted to combine fossil taxa with Recent forms. Fossil ostariophysans are rich in untapped morphological information, and when added to phylogenetic reconstruction, have resulted in a more complete understanding of the evolution and historical biogeography of the group. This contribution reviews the current hypotheses of ostariophysan relationships, and explores the impact of fossil taxa on the whole, and on individual subgroups such as gonorynchiforms, cypriniforms, characiforms, siluriforms and gymnotiforms. The morphology of key fossil ostariophysan taxa such as †*Chanooides macropoma* and †*Lusitanichthys characiformis* not yet incorporated into phylogenetic reconstruction is also examined and reassessed. †*Chanooides* for example, from the marine Eocene beds of Monte Bolca, may be pivotal to a better understanding of the evolution of the Weberian apparatus and the Otophysi. The final goal of this contribution is to integrate fossil taxa, such as †*Chanooides*, into well corroborated phylogenies to assess the impact of fossil data on ostariophysan phylogenetics.

Poster Session I (Wednesday)

**WHAT IF THE EFFECTS OF A MASS EXTINCTION ARE SO PERVASIVE THAT THEY CAN BE RECOGNIZED IN THE DEPOSITIONAL ENVIRONMENTS?**

GRANDPRE, Rachel, University of Rhode Island, Kingston, RI, USA; FASTOVSKY, David, University of Rhode Island, Kingston, RI, USA; SHEEHAN, Peter, Milwaukee Public Museum, Milwaukee, WI, USA; ISBELL, John, University of Wisconsin-Milwaukee, Milwaukee, WI, USA

It is well understood that the Cretaceous-Tertiary (K/T) extinction drastically altered global ecosystems; however, a question heretofore unasked is if the dramatic biotic changes might have reached beyond the biota and affected earliest Tertiary landscapes. This study examines the sedimentological context of the biotic recovery in the earliest Tertiary as it is exposed in the Western Interior of the United States. In eastern Montana and western North Dakota, a distinctive lithofacies transition above the K/T boundary reveals an episode of anomalous sedimentation in the earliest Tertiary. Previous explanations have involved tectonic and/or sea-level changes, however these scenarios make gradual predictions that do not reflect the sudden widespread sedimentation change observed at the K/T boundary as seen in the Western Interior. Our study tests an alternative hypothesis: that ubiquitous, temporary, but dramatic flooding due to asteroid impact and the associated events are responsible for the lithofacies transition. To test this hypothesis, we have initiated a focused sedimentological study of the anomalous interval in the MT-ND region. Our results suggest that there is evidence for extensive flooding, high rates of sedimentation, and landscape instability including inhibited paleosol formation. The observed lithofacies correspond to what might be predicted in the aftermath of deforestation and landscape denudation. The idea that observed geomorphic changes could be related to a disruption of landscapes could contribute to a new perspective on the interpretation of post-extinction ecosystems.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**BONE HISTOLOGY AND GROWTH IN *PLACERIAS HESTERNUS* (THERAPSIDA: DICYNODONTIA) FROM THE *PLACERIAS* QUARRY (LATE TRIASSIC), ARIZONA, USA**

GREEN, Jeremy, North Carolina State University, Raleigh, NC, USA

Studying the growth strategies employed by Permo-Triassic dicynodonts (Synapsida: Therapsida) may be crucial to understanding the evolution of physiology among non-mammalian therapsids. Previous analyses of growth via long bone histology reveal that small-medium (skull length < 400 mm) Late Permian and Early Triassic dicynodonts grew in a rapid, sometimes periodic, manner. However, similar growth studies are lacking for large (skull length > 400 mm) Late Triassic dicynodonts. This study addresses this missing data through histological analysis of the large (skull length = 680 mm) Late Triassic dicynodont *Placerias hesternus*. *Placerias* Quarry (Chinle Formation, Arizona, USA) is a Late Triassic fossil locality that has yielded remains from ~39 individuals of *P. hesternus*, including a robust sample of limb elements ideal for histological analysis. This study tests the hypothesis that growth strategy in Late Triassic dicynodonts (represented by *P. hesternus*) is similar to growth in Late Permian-Early Triassic forms. Transverse ground sections from mid-diaphyses of 23 *P. hesternus* limb bones (3 humeri; 4 ulnae; 4 radii; 5 femora; 3 tibiae; 4 fibulae) from *Placerias* Quarry were examined in plane-polarized



and cross-polarized light. Collagen fiber/vessel orientation, cortical bone thickness, frequency of growth lines, and extent of secondary reconstruction were recorded. Bone microstructure in *P. hesternus* is characterized by primary fibrolamellar bone with frequent growth lines, while secondary reconstruction is limited to larger bones in the sample. These results reveal that *P. hesternus* grew in a rapid, possibly cyclic, manner, similar to growth patterns observed in Late Permian-Early Triassic dicynodonts. This suggests that peramorphic change in growth rate (acceleration) and/or duration (hypermorphosis) could explain large size in Late Triassic taxa. Influence of exogenous factors, such as depositional environment and paleoclimate of *Placerias* Quarry, on growth in *P. hesternus* will be evaluated. These results will be discussed in the context of the evolution and acquisition of derived mammalian traits (rapid growth, high metabolic rate) among synapsids.

Technical Session XIV, Friday 3:00

**COMPARATIVE ONTOGENESIS OF THE POSTCRANIA OF THREE HADROSAURID TAXA AND ONE BASAL IGUANODONTIAN TAXON**  
GUENTHER, Merrilee, Saint Joseph's University, Philadelphia, PA, USA

Understanding the ontogeny of an organism is crucial to fully understanding its evolutionary history. The growth series represented by hadrosaurid and basal iguanodontian taxa provide an opportunity to study ontogeny and the possible influence of heterochrony. Heterochrony can result either in a change in the rate of development of a morphological character, or in a change in the sequence of developmental events between ancestral and descendant taxa. The hadrosaurid taxa *Maiasaura peeblesorum* and *Hypacrosaurus stebingeri* are represented by two of the best growth series available for dinosaurian taxa. Both growth series include abundant postcranial elements. The dataset provided by these two taxa allows for a high-resolution comparison of the two ontogenies. The purpose of such a comparison is to attempt to explain the differing adult morphologies of these two hadrosaurid taxa by determining differences in their developmental pathways. *Brachylophosaurus canadensis* is also included in the study along with the basal iguanodontian, *Tenontosaurus tilletti*. The growth series for these two taxa are not as complete as for the other two taxa, but they provide a broader context for comparing ontogenies both within the Hadrosauridae and within Iguanodontia. The analysis shows that although the hadrosaurids have different adult postcranial morphologies, in the earliest growth stages their elements are all quite similar. However, early in development, when the individuals are still of a relatively small body size, the taxa begin to show differences in the patterns of growth in the appendicular skeleton. The more gracile hadrosaurine elements of *Maiasaura* and *Brachylophosaurus* may indicate paedomorphosis resulting from the postdisplacement of the onset of the development of a number of appendicular morphological characteristics, such as the deltopectoral crest of the humerus. Conversely, the robust appendicular skeleton of the lambeosaurine, *Hypacrosaurus*, may be the result of peramorphosis characterized by acceleration and/or predisplacement of the growth trajectories of appendicular characters, particularly in girdle elements.

Poster Session III (Friday)

**SKELTAL ARCHITECTURE AND LAUNCH MECHANICS OF PTEROSAURS**  
HABIB, Michael, Johns Hopkins School of Medicine, Baltimore, MD, USA

Pterosaurs exhibit a unique suite of flight-related morphological traits. Utilizing comparative analyses of long bone structural strength, trabecular bracing patterns, and muscle attachment expansion in both pterosaurs and birds, it appears that most pterosaurs launched quadrupedally. This is consistent with bone morphology and trackway evidence, and explains why the largest pterosaurs greatly exceeded the size of known birds. Most published pterosaur launch models assume a bipedal, avian-style launch, but this assumption has been misleading. Pterosaur elements do not scale like birds. In pterosaurs, forelimb bone strengths scale faster than the structural strength of the hindlimb, yielding large humeral: femoral strength ratios at large body sizes. In birds, hindlimb elements average greater strength than forelimb elements at body sizes above 550 grams. *Anhanguera piscator*, for example, displays a humeral to femoral structural strength ratio over 56 times that measured for a wandering albatross. Long bone pneumaticity was likely more important for increasing strength (through expansion of long bone diameter) than lowering skeletal weight. Azhdarchoid pterosaurs evolved a suite of traits associated with improved terrestrial ability and rapid launch. This pattern explains why the largest pterosaurs were derived from the azhdarchoid lineage - the traits critical for powerful launching and improved terrestrial gait were co-opted in the evolution of giant size. Overall, the general model of pterosaurs as lightly loaded animals with hyper-light skeletons and low overall body weights is weakly supported. Instead, structural evidence indicates that pterosaurs were powerful animals capable of powerful bursts of flapping and leaping launches, even at large body sizes.

Technical Session II, Wednesday 11:30

**LINGERING EFFECTS OF PAST HOLOCENE CLIMATE IN FOREST COMMUNITIES OF SMALL MAMMALS IN YELLOWSTONE NATIONAL PARK, WYOMING, USA**

HADLY, Elizabeth, Stanford University, Stanford, CA, USA

Nineteen AMS-radiocarbon dates and 2885 fossil specimens representing 31 species from Waterfall Locality were used to ascertain the late Holocene history of a spruce-fir forest small mammal community in northern Yellowstone National Park. Results show that the

dynamics of small mammals in forests are very different than dynamics of small mammals in open habitats within the same ecosystem, even though both were affected by the same climate changes. In terms of ecological perturbations, grasslands experienced fires an average every 20-25 years in this ecosystem, while fires in the spruce-fir forest occurred every 300-500 years. Resilience was different too: grasslands completely recovered from disturbance within decades, while the forests have taken centuries to rebuild their community structure. The small mammals of Waterfall Locality demonstrate that the community of today still shows lingering effects of past warming, forest fires, and debris flow events that took place in the past 3500 years. Closed forest specialists (e.g., *Glaucomys sabrinus*, *Clethrionomys gapperi*, *Tamiasciurus hudsonicus*, *Tamias* spp.) have been declining and open-habitat specialists (e.g., *Microtus montanus*, *Spermophilus armatus*, *Zapus princeps*) have increased. In effect, there is still incomplete recovery of the spruce-fir forest community present thousands of years ago. That climate can impact the dynamics of open versus closed habitats differently has been little appreciated, even when the communities share many of the same species. I conclude that the role of climate in shaping the earth's biota is transmitted through the communities in which the species are found and is not just an individualistic response to abiotic conditions. Thus, some communities will exhibit more resilience in the face of future warming than will others, even when their constituent faunas are similar.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 9:30

**NEW EARLY PLIOCENE HOMINID FOSSILS FROM THE WORANSO-MILLE (CENTRAL AFAR, ETHIOPIA) AND THE QUESTION OF PHYLETIC EVOLUTION IN EARLY AUSTRALOPITHECUS**

HAILE-SELASSIE, Yohannes, Cleveland Museum of Natural History, Cleveland, OH, USA

The Woranso-Mille Paleontological study area is located in the Central Afar region of Ethiopia ca. 340 miles northeast of the Ethiopian capital Addis Ababa. Since 2004, more than 1900 identifiable vertebrate fossil specimens have been collected from the study area including about 40 hominid fossil specimens. Radiometric dates have yielded bracketing ages of 3.6 Ma and 3.8 Ma for the hominid fossils from Aralee Issie, Mesgid Dora, and Korsi Dora localities. A tuff immediately below the fossil horizon yielding all the hominid fossils from these areas is dated to 3.73 Ma. Some researchers have hypothesized that early Pliocene *Australopithecus anamensis* was possibly ancestral to *Australopithecus afarensis* largely owing to the lack of autapomorphies in either species. These researchers tested this hypothesis by conducting a cladistic analysis based on four temporally successive fossil samples of *A. anamensis* (Kanapoi, Allia Bay) and *A. afarensis* (Laetoli and Hadar). They used 20 morphological characters of teeth and jaws and concluded that the most parsimonious tree suggested that each group shares apomorphies only with geologically younger groups. The hominid fossils from the Woranso-Mille study area sample a geological time between Allia Bay and Laetoli. Available dentognathic specimens from the study area were metrically and morphologically analyzed. Preliminary results show that the new specimens share morphological characters with both *A. anamensis* and *A. afarensis*, particularly in molar morphology and size. However, a p3 from Aralee Issie appears to morphologically fall outside what is known for the time between Allia Bay and Laetoli/Hadar. Metric proportions of this new Aralee Issie p3 are more ape-like than either of the two *Australopithecus* species (chronospecies). While the results in general lend support to an ancestor-descendant relationship between *A. anamensis* and *A. afarensis*, they also caution that characters on single isolated teeth should be dealt with cautiously, particularly in analyzing directional trends in phyletic evolution.

Poster Session III (Friday)

**NEW MATERIAL OF PLESIADAPIS FROM THE LATE PALEOCENE BULLION CREEK FORMATION OF WESTERN NORTH DAKOTA**

HAIRE, Scott, University of Minnesota, Dept of Water Resource Science, St. Paul, MN, USA; HANKS, H., Marmarth Research Foundation, Marmarth, ND, USA; HOGANSON, John, North Dakota Geological Survey, Bismarck, ND, USA; LYSON, Tyler, Yale University Dept. of Geology and Geophysics, New Haven, CT, USA

Extensive field work in the late Paleocene Bullion Creek Formation of Western North Dakota has produced a significant assemblage of reptilian and mammalian fossils including *Borealosuchus formidabilis*, *Champsosaurus gigas*, turtles (*Protochelydra zangerli*), gars, and several mammals. Screen washed matrix collected during 2007 has produced numerous teeth, skull elements, a nearly complete dentary and several postcranial elements of *Plesiadapis* sp., as well as several multituberculate teeth. The fossils were preserved in a fine grained channel sand and clay silt overbank deposit. The locality is approximately 21 meters from the contact between the Bullion Creek and Sentinel Butte formations (Tiffanian 4) and is stratigraphically equivalent to the Wannagan Creek quarry, which produced 24 species of mammals. This new locality combined with the Wannagan Creek quarry represents one of the most taxonomically diverse late Paleocene sites in the Williston Basin. The new material helps document the faunal composition from this relatively poorly studied northern assemblage during the late Paleocene and provides an opportunity for future comparative studies to the better studied fauna from the more southerly Powder River Basin.

Poster Session I (Wednesday)

**INSIGHTS INTO THE APPLICATION OF A GEOGRAPHIC INFORMATION SYSTEM TO THE TERAPA, SONORA, MEXICO PALEONTOLOGICAL SITE**  
HAIST, Brandon, Department of Geography, Planning, and Recreation, Northern Arizona University, Flagstaff, AZ, USA

The Terapa paleontological site is located about 183 km south of the Arizona border in Sonora, Mexico. Marsh sediments estimated now to be approximately 40,000 years old preserve a diverse assemblage of 70 taxa including extinct neotropical fauna. The region of Sonora, Mexico has had an active volcanic history, which in part has led to the preservation of paleontological record. The most recent volcanic activity, referred to as the Moctezuma Group, resulted in a basalt flow near what is now Terapa that led to the formation of a marsh habitat, which is the origin of the fossil bearing sediments. Applications of Geographic Information System (GIS) technology led to the development of this site's first paleontological GIS. ESRI's ArcGIS software and multiple Global Positioning System (GPS) units were used to collect and manage data including fossil sites, erosion/hydrology, and modern cultural features. NASA's Landsat and the Geospatial Information Authority of Japan's ALOS imagery allowed creation of teaching materials that were useful in both the United States and Mexico. Use of ArcGIS allows efficient display of sedimentological and faunal data of selected sites. Photo interpretation of Imagery aided in focused field prospecting which led to discoveries of previously undetected fossil sites. Preliminary testing involving ArcGIS and Photoshop determined fossil site geospatial data is not randomly dispersed within the main fossil basin. GIS technology has proven a useful enhancement to traditional paleontological methods.

Poster Session IV (Saturday)

**THE DISTRIBUTION AND FUNCTION OF THE INTRAMANDIBULAR JOINT IN NON-AVIAN THEROPODS**  
HALL, Justin, Stony Brook University, Stony Brook, NY, USA

The distribution and function of the intramandibular joint (IMJ) between the dentary/sphenial bones and the post-dentary bones of theropod dinosaurs has been a classic problem in paleontology. Hypotheses for the function of this joint have ranged from no function, to assisting in gape expansion for swallowing large food items, to resistance of shock upon jaw impact or movement around a prey item. Efforts to derive the function of this joint have met further problems since there may be at least 2 separate morphological forms within non-avian Dinosauria (as exemplified by *Herrerasaurus* and *Eoraptor*). Further, many recovered specimens do not have well preserved bones in this region of the jaw. Additionally, though many extant squamates possess an IMJ and use them in life, the morphology is slightly different and even in squamates, the function of the IMJ is not well studied outside of snakes, which use the IMJ to assist in swallowing large prey items. In this study, I describe the intramandibular joint for a representative of each major clade of non-avian theropod dinosaurs. I used Finite Element Analysis (FEA) to load two-dimensional and three-dimensional models under conditions mimicking various predation strategies. I also created models with an intramandibular joint and ones without. The bites that I modeled were a head-first bite with vertical forces acting on the anterior teeth, a crushing bite with forces on the posterior teeth, a torsional bite with forces crossing from medial to lateral to simulate a prey item that is moving laterally with respect to the predator and finally, a bite mimicking the way the muscles pull on the actual jaw based on muscle scars. The patterns that resulted from these analyses were visually compared and specimens were clustered based on which specimens scored similarly under a given loading. Relative to the model without the intramandibular joint, inclusion of the IMJ led to a reduction in principal strain in that area of the jaw. This suggests that the intramandibular joint serves a shock-absorbing role in many theropods.

Poster Session II (Thursday)

**ACTIVITY PATTERN AND COMPARATIVE OPTIC FORAMEN SIZE IN AVIANS**  
HALL, Margaret, Midwestern University, Glendale, AZ, USA; IWANIUK, Andrew, University of Lethbridge, Lethbridge, AB, Canada

Evaluating the relationship between hard and soft tissue is crucial for fossil interpretation, including visual paleoecologies. The optic nerve (CN II) is the sole output of visual information from the ganglion cell layer of the retina to the brain in vertebrates. The size of the optic nerve is closely associated with activity pattern (the time of day when an animal is awake and active), and in many birds the size of the optic foramen is closely associated with the size of the optic nerve. Thus, in some birds it may be possible to interpret information about activity pattern from the morphology of the optic foramen. This study is in two parts. First, we surveyed more than 500 bird skulls, including both passeriformes and non-passeriformes, to determine and describe the different optic foramen morphologies found across avian groups; only some optic foramen morphologies likely correspond well with the size of the optic nerve and are therefore appropriate for activity pattern analyses. Secondly, we compared the optic foramen sizes of nocturnal and diurnal birds with discrete optic foramina in order to test the hypothesis that, when corrected for eye size, nocturnal birds will have a smaller optic nerve and therefore a smaller bony optic foramen than diurnal birds, based on the differences in retinal pooling between the two groups. Both ANOVA and least-squares regression analyses yielded a significant difference in maximum optic foramen diameter between diurnal and nocturnal birds with diurnal birds having a significantly larger optic foramen than nocturnal birds. Previous work has shown that nocturnal birds have a

significantly larger inner diameter of the sclerotic ring than diurnal birds. Here, we found a significant relationship between optic foramen maximum diameter and the inner diameter of the sclerotic ring. Specifically, birds with a larger inner diameter of the sclerotic ring consistently have a smaller optic foramen. Therefore, the size of the optic foramen could be used to interpret the visual paleoecology of fossil birds.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**SKELETAL ANATOMY OF THE LATE CRETACEOUS SHARK *PTYCHODUS MORTONI* FROM THE SMOKY HILL CHALK MEMBER OF THE NIOBRARA FORMATION IN WESTERN KANSAS**  
HAMM, Shawn, The University of Texas at Dallas, Richardson, TX, USA

A partial skeleton of *Ptychodus mortoni* (KUVP 59061) was recovered from the Smoky Hill Chalk Member, Niobrara Formation in western Kansas. This specimen is unique because it preserves cranial and postcranial elements, including neurocranium, palatoquadrates, Meckel's cartilages, upper and lower dentitions, ethmoid, ceratohyal, a pectoral fin, a dorsal fin, vertebrae, and denticles. The neurocranium is elongated and rectangular, and the Meckel's cartilages and palatoquadrates are also elongated. The mode of attachment of the jaws to the neurocranium inferred to be hyostylic. The lower dentition is partially articulated and measures 58 cm in length, and there are 290 exposed teeth between the two dentitions. Vertebral centra are fused to the rear of the neurocranium, and these are circular in outline, well calcified, and have paired fossae signifying the locations of neural and haemal arches. Four distinctive denticle morphologies were recovered from various regions of the skeleton. An elongated structure measuring 38 cm in length and 25 cm in width consists of eight clearly delineated, parallel tabular plates of calcified cartilage prisms, and this is considered to be a plesiodic pectoral fin. Another cartilaginous structure measuring 40.5 cm in length and 20 cm in width is composed of nine parallel and rectangular cartilages. Because the structure passes along three of the largest vertebrae (60-70 mm diameter), it is interpreted to represent the ceratotrichia of a dorsal fin, rather than a pectoral, anal or caudal fin. There is no evidence for development of a spine at the base of the dorsal fin, and lack of this element would preclude inclusion of *Ptychodus* within Hybodontiformes (as currently defined). In contrast to modern durophagous elasmobranch taxa that have dorsoventrally flattened bodies, the skeletal remains of *P. mortoni* indicate that the taxon had a fusiform body. In addition, comparisons to other co-occurring shark taxa (i.e., *Cretalamna*, *Cretoxyrhina*) suggest that *P. mortoni* was capable of high mobility and attained body sizes up to, and possibly exceeding, 5 meters in length.

Poster Session II (Thursday)

**STABILIZATION AND REPAIR OF LARGE CRACKS IN SIDERITE ROCK**  
HANKS, H., Marmarth Research Foundation, Marmarth, ND, USA; HAIRE, Scott, University of Minnesota, Dept of Water Resource Science, St. Paul, MN, USA

An articulated hadrosaur with skin impression preserved over large portions of the body was collected in 2006. The skin was preserved as a siderite mold. Large cracks in the siderite were evident prior to the excavation but were not fully treated because of the possibility of damaging the fragile skin. These cracks, some as large as 10 millimeters, were treated in the laboratory after the blocks had been prepared down to near the level of the skin. Since the blocks contain both prepared and unprepared skin impressions as well as bone underlying the surface of the matrix a technique was developed to stabilize both edges of the fracture zones in stages using various viscosities of cyanoacrylate glue. Penetrant stabilizer was applied first to seal the cracks. Increasing viscosities of glue were then applied until the cracks were completely filled resulting in complete stabilization of the cracks. This technique has also been used on vertebrate trackways from the Late Paleocene Bullion Creek Formation prior to their removal from the field. Application of increasing viscosities of cyanoacrylate glues is a successful method for gluing solid rock.

Poster Session IV (Saturday)

**SEQUENCE OF TRIASSIC MARINE REPTILE FAUNAS IN SOUTHWESTERN CHINA AND ITS PALEOGEOGRAPHIC AFFILIATION**

HAO, Wei-cheng, Department of Geology and Geological Museum, Peking University, Beijing, China; JIANG, Da-yong, Department of Geology and Geological Museum, Peking University, Beijing, China; SUN, Yuan-lin, Department of Geology and Geological Museum, Peking University, Beijing, China; SUN, Zuo-yu, Department of Geology and Geological Museum, Peking University, Beijing, China

Triassic marine reptile faunas from southwestern China show a sequence of five levels in descending order as: Level 1, age of mid-Carnian, exposed in Guanling County (Guizhou), contains abundant ichthyosaurs (*Guizhouichthyosaurus*, *Guanlingsaurus*, *Qianichthyosaurus*), thalattosaurs (*Anshunsaurus*, *Xinpusaurus*), placodontia sauropterygians (*Sinocymodus*, *Psephochelys*). Some of them, e.g. *Xinpusaurus* and *Guanlingsaurus* show strong phylogenetic close to Late Triassic *Panthalassa Nectosaurus* and *Shonisaurus*, while some, e.g. *Anshunsaurus* show phylogenetic close to western Tethyan *Askeptosaurus*. It may propose that southwestern China of eastern Tethyan, with South China Block being sutured to North China Block, turn more open to southeast to the *Panthalassa* through the Nanpanjiang Basin in Late Triassic. Level 2, age of earliest Carnian, exposed in Wusha of Xingyi City (Guizhou), contains ichthyosaur

(*Guizhouichthysaurus*), pistosauroid sauropterygian (*Yunguisaurus*). Level 3, age of latest Ladinian-earliest Carnian, exposed in Dingxiao and Wusha of Xingyi City, and Luoping (Yunnan), yields pachypleurosauria sauropterygian (*Keichousaurus*), nothosaurid sauropterygians (*Nothosaurus*, *Lariosaurus*), thalattosaurs (*Anshunsaurus*). Level 4, age of Ladinian, exposed in Luoping County (Yunnan), contains sauropterygians (*Keichousaurus*, *Lariosaurus*). Level 5, age of mid Anisian, exposed in Panxian County (Guizhou), contains mixosaurid ichthyosaur (*Mixosaurus*, *Phalarodon*), pachypleurosauria sauropterygian, nothosaurid sauropterygian (*Nothosaurus*, *Lariosaurus*), placodontia sauropterygian (*Placodus*), protosauroid (*Dinocephalosaurus*) and strange *Qianosuchus*. This site located some far from Nanpanjiang Basin and may more open to northwest, and shows strong western Tethyan paleobiogeographic affiliation in the Middle Triassic.

Poster Session IV (Saturday)

**A NEARLY COMPLETE SPECIMEN OF *STRATODUS APICALIS* (TELEOSTEI: DERCEITIDAE) FROM THE UPPER NIOBRARA FORMATION OF SOUTH DAKOTA, USA**

HARRELL, Lynn, South Dakota School of Mines and Technology, Rapid City, SD, USA

Since its initial description in 1872, *Stratodus apicalis* has been known from only a few fragmentary skulls, short vertebral segments, and scattered osteoderms. Consequently, the taxonomic position of *S. apicalis* has been uncertain and the subject of much debate. In 2006, a new specimen of *S. apicalis* was recovered from the Niobrara Formation along the bank of the Missouri River near Oacoma, South Dakota. This new specimen, which is housed at the South Dakota School of Mines and Technology, is nearly complete and is partially articulated. The specimen consists of a partial skull, a complete vertebral column, fin rays, osteoderms, and the caudal endoskeleton. The skull possesses the distinctively pitted, triangular palatines that are diagnostic of the species. Other partially preserved skull elements include the ectopterygoids, sphenotics, frontals, pterotics, and basioccipital. The vertebral column consists of 83 separate centra of which 28-30 are caudals. The anteriormost thoracic vertebrae are slightly elongated and all possess reduced neural spines. Several fin elements are present and preserved in partial articulation. These include an elongate dorsal fin, pectoral fin, pelvic fin, and anal fin. Numerous triradial osteoderms are present, some in articulation. Osteoderm shape and position indicate that there was one lateral row on each side and at least one dorsal or ventral midline row present. The caudal endoskeleton possesses a convoluted suture between hypurals 2 and 3. A quantitative cladistic analysis was performed using known cranial characters from described specimens and adding postcranial characters from the current specimen. Results show that *Stratodus apicalis* belongs to the monophyletic clade Derceitidae based on the presence of an unkeeled operculum, reduced precaudal neural spines, and the presence of a convoluted suture between hypurals 2 and 3.

Technical Session VIII, Thursday 2:15

**NEW LONG-SNOUDED DYROSAURID (CROCODYLIFORMIA, MESOEUCROCODYLIA) FROM THE PALEOCENE OF NORTHEASTERN COLOMBIA**

HASTINGS, Alexander, University of Florida, Gainesville, FL, USA; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, USA

The fossil record of dyrosaurid crocodyliforms spans the Late Cretaceous to Middle Eocene of Africa, Asia, North America, and South America. Prior to the discovery of the Paleocene-aged Cerrejón fossil site in Colombia, dyrosaurid specimens from South America were limited to a few fossils with only two taxa diagnosed. Previously we reported the discovery of a new short-snouted dyrosaurid based on three nearly complete skulls from Cerrejón related to *Hyposaurus rogersii* from North America. Here we describe a second new dyrosaurid from the Cerrejón fossil assemblage. The new taxon is represented by three lower jaws of varying completeness. The diagnostic posterior region including the surangular, articular, and angular bones is preserved in one specimen. In addition, one mandible was found with associated maxillary fragments, including several teeth. The teeth of the new taxon are relatively stout with strong anterior and posterior carinae and are not recurved as in *Dyrosaurus* from the Eocene of Africa, or *Guarinisuchus* from the Paleocene of Brazil. The teeth also lack the 'twisted' carinae of *H. rogersii*. At least partial dentaries are present in all specimens, and tooth position is known for one specimen, enabling in-depth comparison to other known dyrosaurid mandibles. The new mandibles have a reduced seventh dentary tooth and a jaw articulation with a laterally depressed retroarticular process, both diagnostic characteristics of Dyrosauridae. The rostrum of the new taxon is much more elongate than the recently described short-snouted form from the same site. Results from a cladistic analysis using 80 characters for 17 dyrosaurid species with relatively complete cranial and mandibular material, suggest that the new taxon is basal to a clade uniting *Rhabdognathus* and *Atlantosuchus* + *Guarinisuchus*. The included *Rhabdognathus* species are known from Paleocene (and possibly Late Cretaceous) deposits in Africa, and *Atlantosuchus* is known from the late Paleocene of Morocco. Our results indicate an early Paleocene (possibly Late Cretaceous) dispersal from Africa to South America with a radiation of dyrosaurid crocodyliforms in the Paleocene of tropical South America.

Poster Session II (Thursday)

**REVERSIBLE FILLER: A FRESH LOOK AT BUTVAR-76**

HAUGRUD, Shawn, East Tennessee Museum of Natural History, Gray, TN, USA; COMPTON, Brian, East Tennessee Museum of Natural History, Gray, TN, USA

B-76 (polyvinyl butyral) has long been used in fossil preparation as an adhesive. By changing the ratio of solvent to solution and using a variety of new techniques, B-76 can be used to create filler that is both reversible and archival and therefore preferable to other more traditional fillers. Due to its several desirable properties, it is ideal for making specimens ready for museum display without detracting from their research value. B-76 filler can be reversed with very little trouble, which makes it a better candidate for museum prep than more commonly used fillers that are permanent. Serious damage occurs if permanent fillers must be removed, a process that often involves grinding tools. B-76 filler can be dissolved with the application of acetone. The process can be accelerated by removing the bulk of the filler with cutting tools. B-76 filler is very strong but can easily be removed with a razor, and the remnants can then be dissolved away and cleaned off. B-76 in its purest form is translucent. From a researcher's standpoint this can be desirable as traditional fillers obscure the actual fossil and make it unclear what is real and what is replicated. Yet it still holds the various elements together in a pleasing way suitable for display. If the first priority for the specimen is display and the preparator so desires, various coloring substances can be mixed into the filler while it is being made. B-76 can also be used to coat the breaks/contacts and then traditional filler can be used to fabricate the missing elements with the B-76 acting as a buffer that can later be removed. B-76 filler is incredibly strong. Even when stretched into thin sheets its performance when stressed is remarkable. Unlike other fillers it is not brittle, it holds a rigid form but should not crack under extreme stress. In fact it should bend somewhat before any tearing occurs. In this way it could be compared to metal where other fillers are more like cement. Due to this strength it can be used to rebuild extremely thin or delicate structures, such as palates more accurately.

Poster Session I (Wednesday)

**PORASPIDINE HETEROSTRACANS (CYATHASPIDIDAE: PORASPIDINAE) FROM THE DEVONIAN OF THE MACKENZIE MOUNTAINS OF CANADA**

HAWTHORN, Jessica, University of Alberta, Edmonton, AB, Canada

Poraspidine cyathaspid specimens are described from the Man On The Hill (MOTH) locality in the Mackenzie Mountains in the Northwest Territories of Canada, which has produced a taxonomically diverse assemblage of well-preserved early vertebrate specimens. At least three distinct taxa are present, and are distinguished based mainly on the shape and relative proportions of the dorsal shield, and the pattern and coarseness of the dentine ridges that comprise the ornament of the dermal skeleton. The description of these specimens contributes to the understanding of evolutionary trends in morphology within *Poraspis* and other poraspidines. Representatives of Poraspidinae are known from other localities within the Mackenzie Mountains, as well as the Canadian Arctic, Spitsbergen, and both western and eastern Europe. As the Canadian Arctic has been proposed as a centre of origin and site of adaptive radiation for *Poraspis*, the description of the poraspidine fauna from the MOTH locality allows for improved comparisons with other poraspidine-bearing localities to generate more informed hypotheses on the distribution and dispersal patterns in this subfamily.

Technical Session XIV, Friday 1:45

**DEFENSIVE WEAPONS OF THYREOPHORAN DINOSAURS: HISTOLOGICAL COMPARISONS AND STRUCTURAL DIFFERENCES IN SPIKES AND CLUBS OF ANKYLOSAURS AND STEGOSAURUS**

HAYASHI, Shoji, Hokkaido University, Sapporo, Japan; KENNETH, Carpenter, Denver Museum of Nature & Science, Denver, CO, USA; WATABE, Mahito, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; MATEUS, Octávio, Museu da Lourinhã, Lourinhã, Portugal; BARSBOLD, Rinchen, Mongolian Academy of Sciences, Ulaan Baatar, Mongolia

Thyreophoran dinosaurs have spike- and club-shaped osteoderms probably used for defensive weapons. The structural and histological variations have been little known. Here, we provide the comparisons of the internal structures in defensive weapons of ankylosaurs and stegosaurs, using spikes of a polacanthid (*Gastonia*) and a nodosaurid (*Edmontonia*), clubs of ankylosaurids (*Saichania* and *Ankylosauridae* indet. from Canada), and spikes of stegosaurids (*Stegosaurus* and *Dacentrurus*), which sheds light on understandings of evolutionary history and functional implications of defensive weapons in thyreophorans. In ankylosaurs, the structural and histological features of spikes and clubs are similar with those of small osteoderms in having thin compact bones, thick cancellous bones with large vascular canals, and abundant collagen fibers. A previous study demonstrated that each of three groups of ankylosaurs (polacanthid, nodosaurid, and ankylosaurid) has distinct characteristic arrangements of collagen fibers in small osteoderms. This study shows that spikes and clubs of ankylosaurs maintain the same characteristic features for each group despite of the differences in shapes and sizes. Conversely, the spike-shaped osteoderms in primitive (*Dacentrurus*) and derived (*Stegosaurus*) stegosaurids have similar structure to each other and are significantly different from the other types of stegosaur osteoderms (throat bony ossicles and plates) in having thick compact bones with a medullary cavity. These lack abundant collagen fibers unlike ankylosaur osteoderms. The spikes of

ankylosaurs and stegosaurs are similar in shape, but their structural and histological features are different in having unique structures of collagen fibers for ankylosaurs and thick compact bones for stegosaurs, providing enough strength to have large spikes and to use them as defensive weapons. Although the shapes of ankylosaur clubs are different from spikes, the internal structures are similar, suggesting that ankylosaurs maintain similar structures despite of different shapes in osteoderms. These results indicate that ankylosaurs and stegosaurs used different strategies independently to evolve defensive weapons.

Technical Session III, Wednesday 3:30

**ASSEMBLY AND BIOGEOGRAPHY OF NORTH AMERICAN PALEOGENE SNAKE FAUNAS BASED ON AN EXPANDED FOSSIL RECORD**

HEAD, Jason, University of Toronto Mississauga, Mississauga, ON, Canada; HOLROYD, Patricia, University of California Museum of Paleontology, Berkeley, CA, USA

The North American record of Cenozoic snake faunas is extensive, but understanding of the timing and mechanisms driving their assembly is poorly constrained due to phylogenetic and taxonomic ambiguity. We reexamined the fossil record of Paleogene snakes based on samples from the mid-Paleocene to middle Eocene of the Western Interior and the middle Eocene of southern California in order to address biogeographic and phylogenetic hypotheses. Our reassessment indicates that: 1) taxa previously referred to Anilioidea are phylogenetically indeterminate fossorial ecomorphs that are not monophyletic with South American and Asian pipe snakes and shield-tailed snakes; 2) *Helagras prisciformis* (Paleocene, Torrejonian) represents the only known North American record of an archaic, South American madtsoiid, based on cranial and postcranial remains; 3) specimens referable to extant bovid clades appear at the Paleocene-Eocene boundary; and, 4) the ubiquitous, early-middle Eocene bovid genus *Boavus* is a basal member of the South American bovine clade. This revised record indicates that the archaic or indeterminate forms comprising Paleocene faunas were reorganized by immigration of unambiguous crown-group alethinophidians during the Eocene, coincident with long and short-term temperature increases. The first occurrence of modern bovid clades is recorded at the Paleocene-Eocene Thermal Maximum by small-bodied taxa tentatively referable to the Ungaliophiinae+*Charina* clade followed by the introduction of large-bodied (SVL > 1 meter) taxa (*Boavus*) during the Cenozoic climatic optimum beginning in the late early Eocene. Assembly of the Paleogene North American snake faunas was exclusively the result of Central and South American immigration (including both archaic forms and modern bovid clades) during globally warm intervals, a pattern consistent with other herpetofaunal (lizards and turtles) and paleofloral records. Conversely, modern snake faunas are derived primarily from Asian immigration during the Neogene (viperids, elapids, most colubroids).

Poster Session IV (Saturday)

**EXCEPTIONAL TAXONOMIC DIVERSITY FROM A SINGLE SITE: THE UPPER TRIASSIC MONCURE MICROVERTEBRATE LOCALITY, CUMNOCK FORMATION, SANFORD SUB-BASIN, NORTH CAROLINA, USA**

HECKERT, Andrew, Department of Geology, Appalachian State University, Boone, NC, USA; MITCHELL, Jonathan, Department of Geology, Appalachian State University, Boone, NC, USA; SCHNEIDER, Vince, North Carolina Museum of Natural Sciences, Raleigh, NC, USA; OLSEN, Paul, Lamont Doherty Earth Observatory, Palisades, NC, USA

Late Triassic nonmarine vertebrate assemblages are often paucispecific and dominated by archosaurs, synapsids, or temnospondyls. The Moncure microvertebrate fauna is unique in preserving abundant, albeit fragmentary, fossils of dipnoans, temnospondyls, archosauromorphs, and synapsids. Dipnoan toothplates from the site are minute (3-8 mm anteroposterior length) with 5-7 sharp ridges radiating through 120° from the mesial corner, thus we refer them to *Asiatoceratodus* (= *Arganodus*). These are the first records of lungfish from the Newark Supergroup. Other osteichthyans include abundant semionotids and probable redfieldiids, both represented by scales, teeth, and fragmentary skull and dentulous elements. Temnospondyl fossils are isolated small centra and textured skull elements consistent with assignment to Metoposauridae indet. aff. *Apachesaurus*. Amniote fossils include numerous teeth of both archosauriforms and cynodonts. The archosauriform teeth include representatives of typical larger taxa (phytosaur, "rauisuchians"), mid-sized taxa (*Revueltosaurus* sp.), and several smaller morphotypes, including teeth assignable to the putative ornithischian *Galtonia gibbidens* (Huene), which is best considered Archosauriformes *incertae sedis*. The *Revueltosaurus* teeth range from tiny (1 mm) to more typical 3-6 mm crown height and are distinct from the type species *R. callenderi* Hunt. Teeth we refer to *Galtonia* are small (<2 mm crown height), conical to recurved, with relatively few (~7) denticles that are oblique to the tooth margin and occupy prominent carinae that are laterally compressed relative to the main body of the tooth. This is the first record of *Galtonia* from outside the type locality in Pennsylvania. Synapsid fossils consist of numerous small, polycusate teeth similar to the chiniquodontid *Microconodon* as well as less common traversodont teeth. Few of *Microconodon* teeth possess a cingulum, but many have an incipiently bifurcated root. The Moncure fauna thus demonstrate how a single microvertebrate locality can alter our understanding of a basin's fauna as it includes many new records as well as taxa not normally associated with the Newark Supergroup.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**PALAEODIETARY RECONSTRUCTION AND FUNCTIONAL MORPHOLOGY OF BOVID MOLARS**

HEYWOOD, James, The Leverhulme Centre for Human Evolutionary Studies, Dept. Biological Anthropology, University of Cambridge, Fitzwilliam St., Cambridge, United Kingdom

The objective of this study was to provide a new means of dietary reconstruction for extinct Bovids using the form of the occlusal surface of upper molars. Using characteristics of exposed enamel and dentine with methods based on 2-dimensional images, 78 species of bovid were analysed using Discriminant Function Analyses (DFA) in a 5 group dietary classification. DFA conducted with occlusal surface characters allowed a successful classification of 78% of specimens. After the addition of published crown height data, classification was improved to 82%. Classification success increased further still if mixed feeders are distinguished between those that prefer open versus closed habitats. Broadly, grazers and frugivores possessed thicker enamel than other groups, whereas grazers differed further by having more enamel ridges, in particular the central ridge. Most classification errors were browsers classified as mixed feeders, and vice versa. This is in accordance with a previous study on southern African bovids where most mixed feeders clustered with browsing taxa. Other misclassifications were concentrated on taxa whose dietary grouping was uncertain, or where phylogenetic influences were strong. Browsers and most mixed feeders differ little in occlusal form, crown height being the only major difference. In addition to providing predictive algorithms for diet reconstruction, this study suggests that there is selection in favour of a change in occlusal form only above a certain level of grass consumption. Mixed feeders incorporating significant amounts of grass may be able to cope with this dietary component through cranial morphological, physiological or behavioural adaptations. The classification functions calculated allow accurate classification of unknown fossil samples with data on both worn and unworn upper molars. In addition, the method has potential to be applied to other ruminant groups with similar occlusal characteristics, in particular the mostly extinct family Antilocapridae.

Technical Session XIX, Saturday 2:00

**THE FACIAL SKIN OF MAJUNGASAURUS CRENATISSIMUS (ABELISAURIDAE: SAURISCHIA): PRONOUNCED DERMAL METAPLASIA AS THE CAUSE OF RUGOSITY IN ABELISAURID SKULLS**

HIERONYMUS, Tobin, Ohio University College of Osteopathic Medicine, Athens, OH, USA; WITMER, Lawrence, Ohio University College of Osteopathic Medicine, Athens, OH, USA

Abelisaurid theropods are characterized by pronounced bony ornamentation present on their skulls, ranging from rugosity to structures interpreted as horn cores. This ornamentation was directly overlain by skin in life, and has often been compared to the bony ornamentation associated with heavily cornified plates such as the rhamphotheca of birds and turtles. We investigated the bony ornamentation of the abelisaurid theropod *Majungasaurus* by comparing the histology and gross morphology of its ornamented bone with similar bony structures seen in extant sauropods. We sampled an area of rugose bone from a *Majungasaurus* lacrimal (UA 8718). This sample was  $\mu$ CT scanned, embedded in polystyrene resin, and sectioned at 1 mm intervals. A set of skin/bone contact samples from several extant sauropod taxa were embedded in polymethylmethacrylate resin and sectioned at 0.8 mm intervals for synoptic comparison. We found that the fine-scale bony ornamentation of *Majungasaurus* is composed of metaplastically ossified dermal tissue. Large fiber bundles from the base of the preserved dermis formed crossed arrays, an organization consistent with dermis that is subject to relatively high mechanical stress. Similar arrays of fiber bundles attach avian rhamphotheca to bone. This arrangement contrasts to the parallel arrays of smaller-diameter fiber bundles that attach squamate scales or crocodylian skin to underlying bone. Although the base of the dermis itself is directly preserved by ossification, the morphology of the overlying epidermis must be inferred from gross osteological correlates. The diversity of gross correlates across the skull of *Majungasaurus* are consistent with a range of epidermal structures, from lightly cornified and tightly adherent skin (e.g. *Chelydra*, *Alligator*), to heavily cornified epidermal sheets (e.g. avian rhamphotheca), to elaborate epidermal scales (e.g. *Moloch*). Given the apparent bias in theropods towards dorsal nasal and frontal crests, an elaboration of scaled epidermis across the skull roof, involved in comparatively high-energy agonistic behaviors, is suggested as the most likely alternative.

Technical Session II, Wednesday 9:00

**INTERPRETING PAST CLIMATE USING MACROPHYSICAL CLIMATE MODELING AND ISOTOPIC ANALYSIS OF MAMMAL TEETH: TWO METHODS, ONE STORY?**

HIGGINS, Pennilyn, University of Rochester, Rochester, NY, USA; MACFADDEN, Bruce, Florida Museum of Natural History, Gainesville, FL, USA

Climate models provide estimates of climate variables (such as mean annual temperature, MAT, and mean annual precipitation, MAP) over periods of time in the geological past. Macrophysical climate models (MCM) differ from the more widely used general circulation models (GCM), by providing temporally high-resolution (~100 years) and site-specific estimations of monthly values of variables such as temperature and precipitation. However,

MCMs are only applicable for the most recent 40ka. Seasonal changes in climatic variables are modeled for seven radiometrically dated fossil localities. Four of these localities (Dam Local Fauna and Rainbow Beach, ID; Burnham Site, OK; and Tule Springs, NV) represent the time of maximum extent of North American glaciers, the Full Glacial (20-15ka), and the other three (Natural Trap Cave, WY; Dry Cave, NM; Murray Springs, AZ) represent the time as the ice began to recede, the Late Glacial (15-10ka). Seasonal variations in temperature and precipitation modeled by MCMs are compared with interpretations of seasonal variation based upon serial oxygen isotopic analysis of hypsodont teeth (mostly *Equus* and *Bison*) collected from each of these localities. Additionally, the modeled seasonal variations are used to predict the expected abundances of different plant functional groups (PFG), especially C3 and C4 functional groups during those these times. These predictions are compared with carbon isotopic values from the same teeth. We find that patterns of oxygen isotopes predicted using MCMs are reflected in isotopic data from teeth. However, predictions of PFGs based upon the MCMs do not always agree with the isotopic results, particularly when the MCM predicts an extremely dry or hot environment. Finally, we find that the concentration of atmospheric  $pCO_2$  during glacial events does not appear to be a dominant control on the relative abundance of plants utilizing the C4 metabolic pathway. Instead, the distribution of C4 vegetation in the past could be ascribed to variables such as MAT and MAP; however, more work on modern environments of extreme heat and aridity is needed.

Poster Session III (Friday)

**PINACOSAURUS GRANGERI COMES OF AGE: ONTOGENETIC CHANGES IN THE ANKYLOSAURIAN SKULL**

HILL, Robert, New York College of Osteopathic Medicine, Old Westbury, NY, USA;  
NORELL, Mark, American Museum of Natural History, New York, NY, USA

*Pinacosaurus grangeri*, from Upper Cretaceous strata in Mongolia and China, was the first ankylosaur described from the Asian continent and to date it remains the most completely known. Several well-preserved skulls have permitted the first interpretations of cranial sutures in ankylosaurs, supported inferences about ankylosaur ontogeny and phylogeny, and exemplified the unique narial anatomy of this dinosaur species. We report here on several previously undescribed cranial specimens, which represent morphological intermediates between known specimens of *P. grangeri*. The most complete of these skulls is slightly larger overall than most 'juvenile' ankylosaur skulls. It possesses more extensive, symmetrical development of nasal rugosities and associated cephalic osteoderms, additional development of rugosities on the caudal parietal margins, and a flattened premaxillary palate. The osteodermal 'horns' overlying the squamosal bones are larger and morphologically distinct from those of other *Pinacosaurus* specimens. Whereas the left osteoderm is solidly fused onto the underlying squamosal, the right element remains unfused. This indicates the osteogenetic autonomy of the squamosal osteodermal protuberances and suggests that developmental timing can exhibit asymmetry in ankylosaurs. Ontogenetic trends in *P. grangeri* include overall elongation of the snout, concomitant rostrocaudal elongation of some accessory narial openings, and elaboration of cephalic osteoderms in the nasal, squamosal, quadratojugal, and parietal regions. Re-examination of the holotype skull suggests that, contrary to previous descriptions, no known specimen of *P. grangeri* possesses a complete complement of fused osteoderms solidly roofing the skull and obscuring cranial sutures, as in other ankylosaurids. Instead, cephalic osteoderms are most reliably identified as secondary elements that cross sutural boundaries in certain skull regions. These observations essentially support a relatively basal phylogenetic position for *P. grangeri*, but some characters in the adult may be attributable to heterochronic development.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**THE EVOLUTION OF RIBCAGES IN MESOZOIC THEROPODS: AN ANALYSIS OF SKELETAL ELEMENTS USING PARSIMONY**

HIRASAWA, Tatsuya, The University of Tokyo, Tokyo, Japan

Ribcage morphology in theropods has been poorly documented so far, despite its essential role in the respiratory pump and implications for the evolution of air sacs-mediated breathing mechanisms seen in extant birds. In order to infer the evolutionary process of ribcage architectures, I examined osteological characters associated with this structure in Mesozoic theropods. In this study, I used 96 species of Mesozoic theropods, and 11 outgroup taxa. Data on ribcage anatomy, namely vertebrae, vertebral and sternal ribs, sterna, and furculae were collected by direct observations on museum specimens as well as from the literature. I focused on articulated skeletons, but incomplete or disarticulated ribcage elements were also investigated. To minimize effects of postmortem deformations, multiple specimens were observed for each taxon whenever possible. Character evolution was traced on a compiled phylogenetic framework, in which I have collapsed nodes that I consider controversial based on recent published analyses, using Mesquite 2.01. The results demonstrate the following evolutionary process. Ossifications of the furcula, sternum, and sternal rib emerged in this order toward extant birds. Subsequently, ossified uncinata processes were polyphyletically acquired. These findings reveal that these mechanical refinements were accumulated in a stepwise pattern with changes occurring both within and outside Aves, thus suggesting gradual changes of costal aspiration mode in theropods. Only a few specimens preserved detailed morphology of the vertebral rib, but there are still some differences apparent among non-avian theropods. For example, in tyrannosaurids, three pairs of ribs bear the potential articular surfaces for the cartilaginous sternal ribs, and such a surface faces caudomedially

as each rib curves caudally toward the distal end. In contrast, the corresponding ribs of the dromaeosaurid *Saurornitholestes* curve cranially toward the distal ends. This difference may reflect different modes of interlocking movement of vertebral and sternal ribs during the costal aspiration breathing between these taxa.

Poster Session I (Wednesday)

**TRIONYCHID TURTLES (TRIONYCHOIDEA; TESTUDINES) FROM THE EARLY CRETACEOUS OF CENTRAL JAPAN**

HIRAYAMA, Ren, Waseda University, SILS, Tokyo, Japan

Soft-shelled turtles (Trionychidae) have perhaps the most bizarre shell among all turtles. Their earliest record can be traced back to the Early Cretaceous (Albian or Aptian) of Asia (Uzbekistan and Japan). Few shell remains (SBEI 1728 and 1729: isolated right seventh costal and left seventh peripheral plates) have been collected from the Early Cretaceous Akaiwa Formation of the Tedoru Group of Hakusan City (Ishikawa Prefecture, Central Japan) since 1994 and are thought to be an ancestral form. The geological age of the Akaiwa Formation has been dated as the late Neocomian or Barremian based on biostratigraphic floral evidence. The shell materials suggest a rather small sized individual with only 10 cm long carapace. The shell surface is decorated by a very coarse sculpture, consisted of irregular ridges and deep depressions. No trace of shell sulci are found. Scute loss seems to be an advanced feature acquired independently by trionychids, advanced carettochelyids (Carettochelyidae), and derived sea turtles such as dermochelyids. The combination of scute loss and distinct sculpturing are known only from trionychids and some carettochelyids. However, the coarse sculpture of the Akaiwa material suggests close relationship with trionychids, as carettochelyids have no such strong decorations. Therefore, it might be concluded that these materials belong to an early primitive form of stem-trionychid with retained peripherals. Even more primitive trionychoids with shell sulci are quite abundant from the Kuwajima Formation, dated as the Neocomian, underlying the Akaiwa Formation. Nonetheless, no advanced type without scute sulci was found from the Kuwajima Formation, whereas the earliest trionychids are known from the Kitadani Formation (dated as the Aptian) overlying the Akaiwa Formation. Thus, soft-shelled turtles might have evolved from an ancestral form during rather short geologic time span around the Barremian period in Asia.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 11:15

**DATING THE CYPRINIFORMES TREE OF LIFE**

HIRT, Michael, University of Minnesota, Saint Paul, MN, USA; SIMONS, Andrew, University of Minnesota, Saint Paul, MN, USA

The Cypriniformes is a large group of primary freshwater fishes containing more than 3,500 species in eight families, and are found in Africa, Asia, Europe, and North America. The oldest cypriniform fossils date to the Early Paleocene approximately 62 million years ago, although there is speculation that the order originated in the Cretaceous or even earlier. Fossils are known only from four cypriniform families, Catostomidae, Cobitidae, Cyprinidae, and Nemacheilidae and only catostomids and cyprinids are reasonably represented in the fossil record. We present the first large-scale analysis of divergence times of cypriniform families and subfamilies as well as an estimate of the divergence of cypriniforms from other ostariophysans using fossil calibrated molecular phylogenies. We used one mitochondrial protein-coding gene, cytochrome *b*, and four nuclear genes, Early Growth Response Protein 2b, Interphotoreceptor Retinoid Binding Protein, Recombination Activating Gene 1 and Rhodopsin to infer relationships among cypriniform families and subfamilies using Maximum Likelihood and Bayesian methods. Divergence times were estimated using penalized likelihood. Taxon sampling included representatives from all cypriniform families and subfamilies; results from this work and previous studies indicate that recognition of at least eight families is appropriate (Balitoridae, Botiidae, Catostomidae, Cobitidae, Cyprinidae, Gastromyzontidae, Nemacheilidae, and Vaillantellidae). We include representatives of other ostariophysan orders as outgroups and to provide calibration points outside Cypriniformes. Minimum ages for nodes on the molecular phylogeny were determined from fossils from the cypriniform families Catostomidae, Cobitidae, Cyprinidae, and Nemacheilidae and from fossils from other ostariophysans. Preliminary results indicate that the origin of Cypriniformes substantially predates the earliest known fossils and that the estimates of divergence based on molecular data are consistent with the fossil data.

Poster Session II (Thursday)

**A LIGHT IN THE MUSEUM. APPLICATIONS OF LIGHT DETECTION AND RANGE (LIDAR) IMAGING IN PALAEOONTOLOGY**

HODGETTS, David, University of Manchester, Manchester, United Kingdom; BATES, Karl, University of Manchester, Manchester, United Kingdom; RARITY, Frank, University of Manchester, Manchester, United Kingdom; PHILLIP, Manning, University of Manchester, Manchester, United Kingdom

Light Detection And Range (LIDAR) imaging is a remote method of collecting three dimensional (3D) spatial and geometrical data that has to-date been under-utilized in palaeontology. Its primary data output is a dense point cloud that represents a precisely sampled replica of an object's surface geometry. A fully integrated digital camera allows

photographic images to be combined with LiDAR point clouds to produce interactive photo-realistic 3D models. The Differential Global Positioning System (DGPS) built into the LiDAR unit provides sub-metre global position information and allows data to be integrated with other georeferenced datasets. As a non-invasive method of attaining geometrically precise 3D digital models, LiDAR enables palaeontologists to explore fossils and fossil sites on the desktop where an exceptional level of visualization can be combined with analytical facilities unique to the digital environment. 3D geological mapping using LiDAR has provided the necessary framework for interpretation of fossiliferous localities in the context of their 3D sedimentary facies, improving understanding of the stratigraphic and palaeoenvironmental context of fossil sites. High-resolution photo-realistic models also offer remote interactive access through virtual fieldtrips, and may contribute significantly to geoconservation and geoeducation at palaeontological heritage sites. Building on its use to model the 3D geometry of fossil dinosaur tracks, we have also recently used LiDAR to digitize skeletal mounts of theropod dinosaurs, producing scale models that have been used to examine the mass, inertial properties and locomotor mechanics of these animals.

Technical Session VI, Thursday 3:15

**THE EFFECTS OF EXOGENOUS GRIT ON THE MICROWEAR OF EXTANT UNGULATES AND THE IMPLICATIONS FOR PALEODIET INTERPRETATIONS**  
HOFFMAN, Jonathan, University of Wyoming, Laramie, WY, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA

Microwear analysis is a method of evaluating the abrasiveness of diets that has been widely used for paleodiet interpretations of extinct ungulates. The method quantifies microscopic wear (under 35X magnification) primarily in terms of scratches and pits. Based on the microwear of modern taxa, a predominance of scratches had initially been used to interpret highly abrasive grazing diets. However, the abrasiveness may not be solely attributable to endogenous components of plant material (i.e. phytoliths). Exogenous grit, such as aridity-induced dust or volcanic ash, may be a contributing abrasive factor to microwear, which limits its use as a paleodiet tool. To evaluate the effects of exogenous grit and better understand the relationship between microwear and paleodiet, controlled-feeding experiments were conducted on a captive population of sheep (*Ovis aries*) at the Red Buttes Environmental Biology Laboratory at the University of Wyoming. Various vegetation types were fed to the sheep, including leafy browse material, C<sub>4</sub> grasses, and C<sub>3</sub> grasses. Each plant type was also coated with increasing amounts and grain sizes of exogenous grit. Molds were made of the sheep cheekteeth after sufficient exposure to each diet (microwear reflects the last few meals an animal ate before the mold was made, a phenomenon known as the "Last Supper Effect"). Casts of the cheekteeth were then made and analyzed under 35X magnification to assess the correlation between exogenous grit and microwear.

Poster Session IV (Saturday)

**3-D FINITE ELEMENT STRUCTURE SYNTHESIS OF THE SHOULDER GIRDLE IN *DIPLODOCUS LONGUS***

HOHN, Bianca, Ruhr-University of Bochum, Bochum, Germany; WITZEL, Ulrich, Ruhr-University of Bochum, Bochum, Germany; PREUSCHOFT, Holger, Ruhr-University of Bochum, Bochum, Germany

Forelimb posture and biomechanics of the shoulder girdle in sauropod dinosaurs are still a great topic in vertebrate paleontology. Although some recent studies offer reasonable reconstructions, important aspects of statics, force transmission and muscle arrangement are not considered. Other than the comparative morphological studies, we start our investigation from a functional point of view. After applying the 3-D finite-element structure synthesis (FESS) to a recent archosaur, we now present a FESS of *Diplodocus longus* to investigate the mechanics of the shoulder girdle in this giant sauropod. For reconstruction and mass distribution, we used the individual of the Senckenberg Museum Frankfurt (Germany), supplemented by sternal plates and clavicles of the *Diplodocus* specimen exhibited in the Saurier Museum Aathal (Switzerland). Investigating two alternative conditions, forelimbs were shown in either extended or slightly abducted posture. We assume the sternal plates sited between the coracoids forming together a moderate flexible joint. The musculature and the resulting lines of action were reconstructed by their biomechanical necessities. In a next step, the reconstruction served as the hypothesis, which we have to evaluate using FESS. The above-named skeletal elements formed the solids of the Bauraum in which stresses are allowed to spread in the 3-D finite element model. Under condition of one-limb support, equilibrium between body weight and ground reaction force was established applying appropriate muscle forces. During the analysis, the unstressed areas were being eliminated in iterative calculation steps reducing the Bauraum to the most exact shape regarding the anatomy of *Diplodocus*. The final synthesis shows the model in perfect accordance with the original bony elements, especially the remarkably form of the diplodocoid shoulder blade. The observed stress patterns and occurring muscle forces lead us to the conclusion that there are well-founded mechanical reasons to assume a slightly abducted posture of the forelimbs and the presence of a mobile joint between the coracoid and the sternal plates in diplodocoid sauropods.

Technical Session VI, Thursday 2:30

**TOOTH REPLACEMENT IN HYRACOIDEA (MAMMALIA): EVIDENCE FOR FIVE PREMOLARS IN AN EXTANT PLACENTAL MAMMAL?**

HOLBROOK, Luke, Rowan University, Glassboro, NJ, USA

Previous studies have characterized the dental formula of extinct and extant hyracoids as including four premolars and, in some taxa, a premolariform canine or milk canine. The similarity of the canine to a fifth premolar has been noted before, and I argue here that the evidence supports the interpretation that hyracoids possess five premolars. Ontogenetic series of extant hyraxes demonstrate that all four of the generally accepted premolar loci have a deciduous generation that is replaced by permanent teeth. Typically, in those eutherians that retain it, the first premolar is not replaced. Instead of the unusual condition of a retained milk canine and a replaced first premolar, I propose that these two teeth are, respectively, the retained deciduous first premolar and the replaced second premolar. The proposed arrangement requires that hyracoids possess five premolars, but it otherwise retains a typical pattern of tooth replacement for eutherians. Possession of five premolars is considered to be ancestral for therians and therefore could be a retained ancestral character in hyracoids. Possession of five premolars also occurs in some tethytheres, and hyracoids have been allied with tethytheres by a number of studies.

Preparators' Session, Thursday 9:45

**FAMILY REUNION: A COMPOSITE RECONSTRUCTION OF THE *TYRANNOSAURUS REX* HOLOTYPE SKULL**

HOLLAND, Michael, Michael Holland Productions, Bozeman, MT, USA

In 1905, the genus *Tyrannosaurus* was erected in Osborne's description of AMNH 973, a large skeleton excavated in 1902 from Hell Creek sediments in Eastern Montana. The specimen was housed in the American Museum of Natural History until 1941, when it was purchased by the Carnegie Museum of Natural History. Though about fifty percent of the skeleton is preserved, the skull is substantially incomplete, with only eight of the cranial elements present. The original 1942 fossil and plaster reconstruction of the skull crowned the skeletal mount that stood in the Carnegie Museum for over sixty years. Recently, for display in the new dinosaur exhibits at CMNH, the entire skeleton was dismantled for cleaning and remounting into a posture consistent with current science. Issues of weight, fragility, and research access necessitated using casts for the skull on the finished mount. A complete cranial reconstruction would require obtaining or fabricating the numerous missing skull elements. A curatorial decision was made to use as many casts of actual *Tyrannosaurus rex* fossils as possible in the new skull reconstruction. In an effort to use those elements most consistent in size and morphology with the holotype material, casts of cranial elements from five different specimens of *Tyrannosaurus rex* (including the holotype) were employed. The processes described here include assessment and selection of available specimen casts, modifications to chosen elements, and assembly and reconstruction to produce what is finally an anatomically accurate reconstruction of this iconic and historic holotype specimen.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 11:45

**ENDOCRANIAL MORPHOLOGY OF *GOGONASUS* (TETRAPODOMORPHA) REVEALED BY HIGH RESOLUTION MICRO-TOMOGRAPHY**

HOLLAND, Timothy, Monash University/Museum Victoria, Melbourne, Australia

Discovered in 2005, the first complete specimen of the tetrapodomorph fish *Gogonasmus andrewae* from the Frasnian Gogo Formation of Gogo, Western Australia was significant in providing previously unknown information regarding endoskeletal pectoral fin morphology and the spiracular chamber. Preserved in excellent uncrushed condition, the specimen also allows unprecedented detailed description of basal tetrapodomorph braincase anatomy using tomography. Until now, the most rigorous description of a tetrapodomorph fish braincase material was that of *Eusthenopteron foordi* by Erik Jarvik. This study involved Sollas's grinding technique, which ultimately destroyed the specimens under study. Using new CT-scanning facilities at the Australian National University, tomograms of the ethmosphenoid and otic-occipital regions of the braincase in *Gogonasmus* feature resolution of up to 2-3 microns and up to 120 times magnification. Information presented will allow comparison between the endocranium of *Gogonasmus* and other sarcopterygian fish, while also confirming the veracity of Jarvik's work on the braincase of *Eusthenopteron*. Specific points of interest include an internal division between the ethmoid and sphenoid division of the ethmosphenoid, the internal cranial cavity and the shape of the olfactory capsule. This data will hopefully shed new light on fundamental character states within the basal Tetrapodomorpha and ultimately help resolve phylogenetic issues surrounding the origins and diversification of these fishes and how they gave rise to early tetrapods.

Poster Session III (Friday)

**NEW INSIGHTS INTO JAW MUSCLE ANATOMY IN DINOSAURS**

HOLLIDAY, Casey, Department of Anatomy, Marshall University, Huntington, WV, USA

Jaw muscles are a critical component to understanding cranial anatomy and inferring feeding function in fossil taxa. However, detailed identifications of relevant anatomical structures, their homologies, and evolutionary patterns of inferred soft tissues are often met with

challenging evidential hurdles when studying diverse and speciose extinct groups such as dinosaurs. Jaw muscle inferences lend themselves to a spectrum of accuracy ranging from seemingly easily-addressed identifications of presence or absence to more unobtainable attributes such as tissue-level physiological characteristics. Nonetheless, a balance can be struck between these robust and tenuous hypotheses of structure and function. A broad survey of the heads of extant and fossil archosaurs was conducted within the framework of the Extant Phylogenetic Bracket approach in order to track homologies and to gauge the robusticity of soft-tissue inferences in the adductor chamber of non-avian dinosaurs. Osteological correlates were identified and scored for their significance for inferring soft-tissue anatomy. These data support many, but not all aspects of previous interpretations and in some cases they suggest constrained, biologically-feasible, novel interpretations of anatomy. A brief, comparative atlas of dinosaur jaw muscle anatomy is presented. Case studies are presented that explore classical and new interpretations of protractor and temporal muscles among major clades of dinosaurs. Rules of construction for important cranial regions such as the muscles of the dorsotemporal fossa, the lateral surface of the mandible, and the orbitotemporal region are reviewed. Whereas certain muscles are more easily and accurately reconstructed (e.g., m. adductor mandibulae posterior), the positions and sizes of others are left to a number of anatomical and phylogenetic vagaries (e.g., m. levator pterygoideus, m. pseudotemporalis superficialis, m. pterygoideus ventralis). Coupled with new modeling methods, this anatomical foundation will serve to increase the resolution of inferences of cranial function and evolution in dinosaurs.

Technical Session VI, Thursday 2:00

**NEW DATA ON DENTAL ERUPTION PATTERNS IN CONDYLARTHS AND AFROTHERES**

HOLROYD, Patricia, University of California Museum of Paleontology, Berkeley, CA, USA

Recent work on living mammals suggests that delayed eruption of permanent teeth (i.e., premolars) may be an afrothere synapomorphy. However, delayed or non-eruption of permanent teeth is also known outside of Afrotheria (e.g., select rodent lineages). Further, growth data and precise information on timing of dental eruption is limited for many mammals. Understanding the evolution of these characters is also complicated by the relative rarity of juvenile individuals in the fossil record and the fact that few of the growth measures used for extant taxa are applicable to the more fragmentary fossil record. Alternate methods for assessing growth include scoring of relative growth stages of developing teeth and identifying tooth eruption patterns using a combination of standard medical and micro-CT X-ray imaging. I applied these methods to document dental eruption patterns and relative tooth development in phenacodontid (*Meniscotherium*, *Ectocion*, and *Phenacodus*) and “hyposodontid” (*Apheliscus* and *Hyopsodus*) “condylarths” and fossil representatives of hyracoids and macroscelideans. Taxa were selected based on availability of juvenile specimens with partial to full dentaries having a combination of adult and deciduous teeth. All taxa showed the common eutherian pattern of antero-posterior eruption of both premolars and molars, but showed differences in the relative timing of eruption. Both living and fossil afrotheres examined showed both delayed eruption and development of the posterior premolars relative to the molars. Although *Apheliscus* has been suggested to be related to Afrotheria, both it and *Hyopsodus* lack delayed development and eruption, with p4 erupting coincident with the posterior molars. In contrast, phenacodontids show eruption delays (p4 erupting after m3) as seen in hyracoids and macroscelideans. These findings highlight the need for more developmental data to be gathered before they can be used effectively in phylogeny reconstruction.

Technical Session XVII, Saturday 8:30

**HYRACOTHERIUM, EOHIPPUS AND DAWN HORSES**

HOOKER, Jerry, Natural History Museum, London, United Kingdom

170 years after the first discovery of *Hyracotherium*, the relationships of dawn horses (primitive equoids) on either side of the Atlantic are still poorly understood. To reduce paraphyly, the original generic names *Hyracotherium* and its supposed synonym *Eohippus* have been augmented in recent years by several new ones. Despite this, the name *Hyracotherium*, based on a European type species and shown to be a primitive palaeothere, is still commonly used for all North American species. *Eohippus* has also recently been resurrected incorrectly for a small North American horse clade. The question of timing and direction of dispersal between the two continents is also in contention. The greatest barrier to resolving these issues is intraspecific variation, which is demonstrably high in the often extensive North American assemblages. In Europe, this has been more difficult to assess, but long-term collecting at the Early Eocene site of Abbey Wood, UK, has accumulated the largest European assemblage of dawn horses so far. In addition, the discovery of a fourth upper dentition of the rare type species *Hyracotherium leporinum* from the London Clay narrows somewhat the likely range of variation for this species. Cladistic analysis of some of the best assemblages from North America and that of Abbey Wood, plus less well represented European ones, produces some problematic ghost ranges for North America and temporally reversed node order for Europe. It also implies three intercontinental dispersal events, one to the west and two to the east. Certain key characters nevertheless differentiate the North American and European assemblages, suggesting substantial parallel evolution on the two continents, following a single episode of dispersal from east to west at the beginning of the Eocene.

Technical Session VI, Thursday 1:30

**IS THERE A SCALE MISMATCH BETWEEN CHANGING DIET AND CHANGING DENTAL MORPHOLOGY?**

HOPKINS, Samantha, University of Oregon, Eugene, OR, USA

Dental morphology is commonly used as a proxy for diet in fossil mammals. Studies of isotopic data from fossil mammals have shown that dental morphology as understood from extant proxies is not always indicative of the diets of fossil species. One possible explanation is that dental morphology varies on a much longer time scale than does diet. Diet can vary to some degree even within a species, but remains conserved at some level. Using a database of over 400 species-level diet observations for living small and medium-sized mammals, I have reconstructed diets at several different levels of precision, from precise, percent wise composition to broad-scale carnivore-herbivore-omnivore designations. Dental morphology is described on the basis using both qualitative (i.e. bunodont vs. lophodont) and quantitative (i.e. tooth row area) characters. Both diet and dental morphology were plotted onto a phylogeny using both parsimony and likelihood to reconstruct ancestral states. Preliminary data suggest that diets, even when drawn very broadly, tend to vary on a finer scale than does dental morphology. Substantial phylogenetic inertia results in mammals eating diets which would often not be indicated from simple consideration of their dental morphology. This result indicates that caution is necessary in inferring species-level diet from tooth morphology.

Technical Session XIV, Friday 2:45

**A JUVENILE SKULL OF THE ORNITHOPOD DINOSAUR *DRYOSAURUS LETTOWVORBECKI* - IMPLICATIONS FOR THE CRANIAL ONTOGENY IN ORNITHOPODS**

HÜBNER, Tom, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany

*Dryosaurus lettowvorbecki* is a basal member of the Iguanodontia (Ornithopoda, Ornithischia) from the Upper Jurassic of East Africa. The material of *D. lettowvorbecki* comprises thousands of mainly isolated elements of different growth stages, excavated from a single quarry 2.5 kilometers northwest of the Tendaguru Hill in Southeast Tanzania. One of the most complete specimens known is the juvenile skull BSPG AS I 834 housed in the Bavarian State Collections in Munich, Germany. The articulated skull is partially distorted and lacks only most of the preorbital elements, the quadratojugals, and the palatines, but is otherwise well preserved. Acid preparation, CT-scans of the inner part and the comparison with material of other collections enable to provide a reconstruction of the skull in lateral and dorsal view. In order to identify ontogenetic variations, the skull of BSPG AS I 834 was compared to other skull remains representing different size categories. All ontogenetic differences in the skull elements of *D. lettowvorbecki* are found to be related to the closure of the sutures, the relative decrease of the orbit, the relative lengthening of the preorbital skull part and the jaws, and the development of stronger attachment sites for the muscles of the jaw and neck. Resultant from this study, more than one or two single features are necessary to clearly determine the growth stage of a specimen, which has been demonstrated on *Thescelosaurus neglectus* and *Gasparinisaura cincosaltensis*. Finally, evolutionary tendencies in the skull anatomy from basal iguanodontians to hadrosaurs, such as the lengthening of the skull, the increase of the number of tooth positions, or the shortening of the frontals, are already observed in the ontogeny of the skull of *D. lettowvorbecki* and confirm the importance of heterochrony in the evolution of ornithopod dinosaurs.

Poster Session III (Friday)

**THE PRELIMINARY STUDY ON A NEW HYSILOPHODONTID DINOSAURS FROM SOUTH KOREA**

HUH, Min, Faculty of Earth System and Environmental Sciences, Chonnam National University, Gwangju, Korea, South; LEE, Daegil, Korea Dinosaur Research Center, Chonnam National University, Gwangju, Korea, South; LIM, Jong-Deock, Natural Heritage Center, National Research Institute of Cultural Heritage, Daejeon, Korea, South; NORMAN, David, The Sedgwick Museum of Earth Sciences, University of Cambridge, Cambridge, United Kingdom

In 1999, a dinosaur-nesting site was discovered in Upper Cretaceous sediments, exposed from the coast of Bibong-ri in the Boseong-gun. The Bibong-ri site is a rich and diverse nesting area, including over 200 dinosaur eggs and 17 egg clutches. The clutches contain between 3 and 16 eggs and most of those eggs are top-broken and filled with surrounding sediments. The egg site was designated as National Monument No. 418 in 2000. It was also nominated as an UNESCO World Heritage property in 2008 (tentative site in 2002). Compare to the sites from the Two Medicine Formation of Montana and the Oldman Formation of Alberta, the egg site is much more diversified. In 2003, an articulated dinosaur skeleton was collected from the Seonso Formation of Bibong-ri. The skeleton was composed of 4 cervical vertebrae, 9 dorsal vertebrae, 18 dorsal ribs, both scapulae, both coracoids, left humerus, incomplete right humerus, incomplete radius, incomplete ulna, sternal plates, left femur, left tibia, left fibula, isolated caudal vertebra, and fragmentary remains. The well-preserved skeleton has typical characteristics of hysilophodontids in which scapular is shorter than humerus and femur is shorter than tibia. The scapula has a greatly expanded dorsal end as in *Hysilophodon foxii*. The discovered skeleton from Bibong-ri has reniform-shaped sternal plates, a prominent deltopectoral crest on the humerus, a sharp-

edged fourth trochanter, and triangular form of the fourth trochanter's cross section. The new hypsilophodontid skeleton retains a three-dimensional form and has well-articulated posture. The lack of disarticulation and weathering designates minimal subaerial exposure. It also suggests that the skeleton was rapidly entombed while still alive. The sediment texture and composition of the matrix is consistent with those ones from the nests. The close association of the hypsilophodontid dinosaur with nesting sites provides an opportunity of studying a social behavior and biological relationship of the Late Cretaceous dinosaurs. The hypsilophontid dinosaur is the first articulated dinosaur skeleton in Korean Peninsula.

Poster Session II (Thursday)

#### LATE BLANCAN RODENTS AND LAGOMORPHS FROM THE HAILE 7G LOCAL FAUNA, NORTH-CENTRAL FLORIDA

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A recently completed (April 2008) 3-year excavation by the FLMNH of a late Pliocene sinkhole pond deposit (Haile 7G) resulted in recovery of over 600 partial-to-complete tetrapod skeletons and at least 76 vertebrate taxa. Of these, 29 are mammals, including over 150 skeletons of medium- to large-sized herbivores, especially *Tapirus*, *Megalonyx*, *Eremotherium*, and *Holmesina*. But small mammals, especially rodents and leporids, are not uncommon and provide significant biochronologic, biogeographic, and paleoecologic information. The Haile 7G rodents include three relatively large taxa, the porcupine *Erethizon poyeri*, the beaver *Castor californicus* (first eastern U.S. record), and a capybara, and six or seven smaller species, an arvicoline (muskrat-sized taxon), a geomyid (*Geomys propinetus*), two peromyscines (*Reithrodontomys* and *Peromyscus*), and two or three species of *Sigmodon*. The latter appears to group into three distinct size classes similar to those of *Sigmodon minor*, *S. medius*, and *S. curtisi*. However, the smallest morphotype is rare (N=2) and could be an outlier of the medium-sized species. Increased sampling and further analysis of cusp morphology is needed to make identifications to the species level. *Sigmodon* is the only relatively abundant taxon at the site to live in open, grassy habitats, as all others would have favored freshwater aquatic or densely forested habitats. Roosting raptorial birds are a possible source for the *Sigmodon* remains. Three leporine lagomorphs are also present. Most common is *Sylvilagus webbi*, a large species known only from the late Blancan of Florida. Two partial skeletons represent the first directly associated cranial and postcranial elements of this species. The next most common leporine is indistinguishable from the extant *Sylvilagus floridanus* in terms of size and morphology of the p3. The rarest leporine is represented by a single p3 that matches the distinctive enamel pattern and small size of *Aztlanolagus agilis*, previously known only from the southwestern U.S. and northern Mexico. Over 3 metric tons of matrix from the site remain to be screenwashed, so small mammal diversity and sample sizes should rise substantially.

Poster Session III (Friday)

#### THE FIRST ANKYLOSAUR TRACK FROM THE JURASSIC

HUPS, Kent, Manuel High School, Denver, CO, USA; LOCKLEY, Martin, University of Colorado at Denver, Denver, CO, USA; FOSTER, John, Museum of Western Colorado, Grand Junction, CO, USA; GIERLINSKI, Gerard Polish Geological Institute, Warszawa, Poland

A well-preserved but isolated pentadactyl manus track resembling *Tetrapodosaurus* was recently found in the Morrison Formation of Western Colorado. This is the first published report of an unequivocal Jurassic ankylosaur track from anywhere in the world. Globally, only three other reports, all from the Cretaceous (of western Canada, Colorado and Maryland) provide clear evidence of a pentadactyl manus consistent with ankylosaur manus morphology. The track, which is 24 cm long and 30 cm wide, is larger than all the Cretaceous examples, and larger than any Jurassic foot skeletons that could be inferred to belong to potential trackmakers. The footprint, preserved as a complete natural cast, was found in the Brushy Basin Member of the Morrison Formation at Cactus Park on the Uncomphagre uplift near Grand Junction. This area is also rich in skeletal remains including *Mymoorepelta*, various saurischians (sauropods and theropods) and the crocodylian *Goniopholis*. The Cactus Park specimen resembles basal thyreophoran manus tracks of the Early Jurassic ichnogenus *Moyenisauropus natator* (supposedly scelidosaurid prints) and the Cretaceous ichnogenus *Tetrapodosaurus* (derived ankylosaur ichnites), but it differs from purported stegosaur manual track of *Stegopodus* (from the Morrison Formation of Utah) and *Deltapodus* of the Jurassic of Europe (which lacks well-preserved manus traces). Therefore the find gives new insight into hitherto unreported ornithischian forms in the Morrison Formation.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 9:30

#### RELATIVE FOREBRAIN SIZE IN THEROPOD DINOSAURS, NON-AVIAN REPTILES, AND BIRDS

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Dinosaur forebrain volume can be calculated from endocasts, using the ratio (42%) of the forebrain to the corresponding endocast portion in extant adult non-avian archosaurs

(alligators). The next step is quantifying relative forebrain size. The ratio of forebrain mass (MCb) to brain mass (MBr) is useful, but this ratio does not indicate size relative to body size and can vary with either MCb or mass of other brain divisions. For instance, snakes have a large MCb:MBr ratio, owing to a much-reduced cerebellum, but the smallest relative brain mass of (non-avian) reptiles, as indicated by a low REQ (Reptile Encephalization Quotient, a measure of brain mass relative to body mass). Among reptiles, alligators have the highest MCb:MBr ratio but an average REQ. A solution is to quantify relative forebrain mass using regression equations relating MCb to body mass (MBd), where  $\log MCb = \log a + (b \times \log MBd)$ , and calculating a Forebrain EQ, where  $CbEQ = MCb / (aMBd^b)$ . For extant reptiles, this equation has values  $b = 0.534$ ;  $a = 0.0065$ ;  $N=36$ . For birds,  $b = 0.6244$ ;  $a = 0.061$ ;  $N=136$ . For reptiles, the MCb:MBr ratio correlates poorly with REQ ( $r=0.40$ ), but the CbEQ correlates well ( $r=0.93$ ). For birds, the MCb:MBr ratio correlates well with the Bird BEQ ( $r=0.81$ ) but the CbEQ correlates much better ( $r=0.99$ ). Because log CbEQs of reptiles and log CbEQs of birds were normally distributed, theropod log CbEQs were calculated. Tyrannosaurids (*T. rex*, *Gorgosaurus*) had reptile log CbEQs 1.7 – 2.8 standard deviations (SDs) above the mean reptile log CbEQ; their log bird CbEQs were 4.9 – 5.8 SDs below the bird mean. Other than maniraptorans, tyrannosaurids are among the most encephalized dinosaurs, but forebrain size is within the range of reptiles. The contemporaneous *Carcharodontosaurus* has log reptile CbEQs 0.45 – 0.94 SDs above the reptile mean, and bird log CbEQs 6.2 – 6.6 SDs below the mean bird CbEQ, demonstrating greater relative forebrain size in the lineage leading to avians.

Poster Session I (Wednesday)

#### A FUNCTIONAL INVESTIGATION OF THE EVOLUTION OF CHAMELEON NARROW SURFACE LOCOMOTION VIA A MORPHOLOGICAL COMPARISON OF ARBOREAL TETRAPOD FORELIMB RANGES-OF-MOTION

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Despite, or because of, an entire suite of remarkable nonpostural traits, the highly derived forelimb morphology of chameleons draws little attention from postural researchers. The forelimb stance and gait of chameleons differs markedly from those of other lacertilians because of adaptations for narrow surface movement, such as limited brachiation, and a step cycle with fully adducted humeri. These movements are aided by a pectoral girdle that has evolved into mobile limb elements and extensive increases for all forelimb joint ranges-of-motion (ROMs). Chameleon forelimb osteology is unusual because lacertilian forelimbs are otherwise noted for their conservative morphology throughout a wide range of ecomorphs. Thus a comparative study of the forelimb functional morphology of chameleons and other small arboreal tetrapods, focusing on joint ROMs and articulations, allows differentiation of morphological patterns characteristic of narrow surface locomotion from those for broad surface locomotion. Here we report on the glenoid and elbow joint ROMs that complement the extreme soft tissue movements of the pectoral girdles in *Chamaeleo chamaeleon*, *gracilis*, and *jacksonii*. These measurements were compared with respective ROMs from the arboreal lacertilian *Anolis carolinensis*, the arboreal marsupial *Opossum virginiana*, the arboreal sciurid *Tamiasciurus hudsonicus*, and the arboreal primate *Macaca fascicularis*. Our results quantify previous qualitative reports of the greater mobility of chameleon forelimb joints as compared to the more restricted ROMs found in other arboreal lacertilians, and lend credence to suggestions that the enhanced forelimb movements in species of *Anolis* that have adapted to narrow surfaces are convergent upon the ROMs of chameleons. Moreover we find that the type of locomotion permitted by chameleon ROMs also parallels those of arboreal therians. We use these comparisons as the basis for identifying common morphological patterns for narrow surface locomotion in small arboreal tetrapods. Our results also suggest a method for evaluating narrow surface locomotive capabilities in purportedly arboreal fossil tetrapods, such as some drepanosaurids.

Technical Session XI, Friday 8:15

#### BIOTIC RESPONSES TO CLIMATE CHANGE IN THE PERMO-CARBONIFEROUS TRANSITION, PART II: BETA DIVERSITY, REGIONAL EVOLUTIONARY RESPONSES, AND VAUGHN'S FAUNAL CLINE

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The recognition of terrestrial vertebrate faunal provinces and their distributions across Euramerica during the Permo-Carboniferous (C/P) transition demands greater inquiry into the biotic and abiotic factors influencing observed distributions. Vaughn recognized that evidence of aridification appeared lower in the Four Corners region than in the Texas-Oklahoma Permian sequence, and suggested that a west-east climatic gradient played an important role in shaping Early Permian terrestrial vertebrate communities and their distributions. Fluctuations in taxonomic compositions of faunas within each region may provide further insights into the dynamics of Late Pennsylvanian versus Early Permian community structure and stability. We re-examined Vaughn's hypothesis by studying different aspects of C/P terrestrial vertebrate community composition and ecology, including relative beta-diversity through time and spatial distributions of physiologically adaptive behaviors, such as the sudden proliferation of estivation behavior in fully aquatic freshwater taxa (e.g., gnathorhynchid lungfish and lysorophians). We calculated mean beta diversity to compare the level of regional faunal diversity over four regional bins and seven global stages. Pairwise taxonomic comparisons of localities allows a greater degree of discrimination between taphonomic biases, spatial shifts in regional diversity,



and changes in ecosystem health. We hypothesized if faunas responded to variations in climate (intensified seasonal aridification) on a west-east gradient, then (1) fragmentation-like effects would produce high coefficients of dissimilarity and (2) estivation behavior in response to environmental stress would both be distributed along this axis into the Early Permian. Changes in beta diversity appear to be most closely tied to regional climatic shifts associated with progressive fragmentation of Pennsylvanian-type faunas. Ultimately, we emphasize geographic variation in ecosystems, community structure and ecology during the C/P transition and caution the practice of selecting “representative” faunas in studies of extinction and biodiversity.

Poster Session III (Friday)

**THE UTILITY OF TOOTH ENAMEL MICROSTRUCTURE IN IDENTIFYING ISOLATED DINOSAUR TEETH**

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Isolated dinosaur teeth are often more common than dinosaur skeletal material at many localities, especially microsites. The diagnosis of isolated dinosaur teeth is an inexact science, as weathering, wear (due to the animal's mastication), and breakage render the identification of some teeth into a paleontological Rorschach test. Even with relatively pristine samples, most dinosaur teeth can only be assigned to the family level or above, as teeth among genera and species within the same family are often identical. While some dinosaur teeth are considered diagnostic at the generic or species level, all attempts to identify isolated dinosaur teeth based on external morphology are subject to error. Without diagnostic skeletal material, there is always some chance that supposedly diagnostic teeth might belong to a novel taxon for which skeletal material has not yet been discovered. Enamel microstructure provides a new tool for identifying isolated dinosaur teeth that are too broken or worn to identify on the basis of external morphology. In addition, it can help distinguish teeth that are similar in morphology but have different enamel, such as ankylosaur and posterior pachycephalosaurid teeth or *Allosaurus* and tyrannosaurid teeth. While enamel microstructure may not always narrow the identity of an indeterminate specimen to the generic or species level, it allows for a more accurate identification. Eight isolated teeth, specimens originally identified by myself or others as “Carnosauria” indet., theropoda indet., *Nanotyrannus* sp., Tyrannosauridae indet., Troodontidae indet., Pachycephalosauridae indet., Hadrosaurinae indet., and cf. *Thescelosaurus* sp., were sectioned and their enamel microstructure examined using scanning electron microscopy. After studying the enamel microstructure of these teeth, three of the specimens could be identified to genus, and the taxonomic identity of all the teeth were better understood.

Poster Session I (Wednesday)

**THE LATE PLEISTOCENE SNAKE FAUNA (REPTILIA: SQUAMATA) OF THE RYUKYU ARCHIPELAGO, SOUTHWEST JAPAN, WITH SPECIAL REFERENCE TO THE FORMATION PROCESS OF THE EXTANT SNAKE FAUNA OF THIS REGION**

IKEDA, Tadahi, Museum of Nature and Human Activities, Hyogo, Sanda, Japan; OTSUKA, Hiroyuki, Kagoshima University Museum, Kagoshima, Japan; OTA, Hidetoshi, Tropical/Biosphere Research Center, University, of the Ryukyus, Okinawa, Japan

The Ryukyu Archipelago is a chain of fairly old continental islands located in humid subtropical East Asia between Japan mainland and Taiwan. A number of fossil snake vertebrae has been collected from the Upper Pleistocene cave and fissure filling deposits on several islands of the Ryukyus, but due to the difficulties in their identifications, many of these fossils remained unidentified. In this study, we first established a taxon-character table for vertebrae of the extant East Asian snakes on the basis of a number of specimens collected from this and adjacent regions. We then applied this table for identification of the fossil vertebrae from the Late Pleistocene Ryukyus. The fossil vertebrae, identified to four genera of three families, suggested that the Late Pleistocene snake fauna was much concordant with the extant fauna, and that on most islands the fossil snakes were supposedly ancestors of the extant species/subspecies. In this regard, the Late Pleistocene snake fauna of Miyakojima Island proved to be exceptional because it included several genera/species, such as *Protobothrops* sp. (Viperidae), that do not occur on this island at present. Such taxa seem to have gone extinct from this island during the Late Pleistocene. On the other hand, fossil vertebrae of many snake taxa from the Late Pleistocene Ryukyus were distinctly larger in overall size than vertebrae of their putative descendants on each island. This suggests that in many snake lineages of the Ryukyu Archipelago, the body size has rapidly reduced since the Late Pleistocene, presumably as a result of decrease in body size or total quantity of prey animals available on each island.

Poster Session I (Wednesday)

**VERTEBRATE PALEONTOLOGY AND STRATIGRAPHY OF THE UINTA FORMATION (MIDDLE EOCENE) IN THE LELAND BENCH-UTELAND BUTTE AREA, UTAH COUNTY, UTAH: AN UPDATE**

IMHOF, Margaret, SWCA Environmental Consultants, Inc., Vernal, UT, USA; KNAUSS, Georgia, SWCA Environmental Consultants, Inc., Sheridan, WY, USA; MURPHEY, Paul, San Diego Museum of Natural History, San Diego, CA, USA; BROWNE, Lori, SWCA Environmental Consultants, Inc., Broomfield, CO, USA

The Uinta Formation of the Uinta Basin in northeast Utah is the stratotype of the Uintan North American Land Mammal Age. In April 2007, a block paleontological inventory of approximately 24,000 acres located on the Uintah and Ouray Reservation in the Leland

Bench and Ute land Butte area was initiated prior to oil and gas development. The fieldwork was completed in May 2008. Stratigraphically, the area occurs in the upper part of Uinta Formation informal member B (upper unit of Wagonhound Member) and the lower part informal member C (lower part of Myton Member). The area is noteworthy because it has been largely off limits to paleontological collecting since the early 1980's and contains the well known fossil mammal locality Myton Pocket discovered by O. A. Peterson in 1912. Our documentation and analysis included detailed geographic locations and lithologic descriptions of localities, taxonomic identifications, a measured section through the Uinta Formation in the western part of the study area, and geospatial analysis of locality distribution. This survey produced a high number of localities due to the intensive block survey methodology. Over 4,500 localities were discovered. Of these, 450 produced well preserved fossil vertebrates including relatively complete mammalian skeletal and dental specimens that add to the data currently available in museum collections. At the request of the Tribe, no fossils were collected. Instead, all identifiable fossils were photographed and significant specimens were molded in the field for casting in the laboratory. Although the faunal analysis is ongoing, the diverse fauna observed thus far in the area includes mammals, turtles, crocodylians, squamates, fish, gastropods, and invertebrate trace fossils. Among the mammals, the artiodactyl sample is the most diverse, consisting of six genera (*Diplobunops*, *Protoreodon*, *Protylopus*, *Leptoreodon*, *Pentacemylus*, *Hylomeryx*). Other mammalian taxa includes four families of perissodactyls, three genera of rodents, *Mytonolagus*, as well as carnivores, and creodonts.

Technical Session XVI, Saturday 10:15

**NEW AGE CONSTRAINTS FROM THE CHINLE FORMATION REVISE GLOBAL COMPARISONS OF LATE TRIASSIC VERTEBRATE ASSEMBLAGES**

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Studying the tempo of past evolutionary processes in different parts of the world requires precise global correlations of fossil bearing strata. The Upper Triassic Chinle Formation of southwestern North America contains several diverse fossil vertebrate assemblages that are major references for understanding Triassic tetrapod biostratigraphy and the origin and early evolution of dinosaurs. Comparison of Chinle assemblages with other records of Triassic terrestrial vertebrates worldwide is hampered by the lack of high-resolution geochronologic constraints. Preliminary results of new ID-TIMS U/Pb single zircon ages from the base of the Blue Mesa Member of the Chinle Formation in eastern New Mexico yield a coherent weighted mean  $^{206}\text{Pb}/^{238}\text{U}$  age of  $219.2 \pm 0.7$  Ma. This represents a maximum age constraint for overlying strata because the zircons are from a redeposited tuffaceous sandstone. This age provides the first precise geochronologic constraints for classic Chinle vertebrate assemblages from the Mesa Redondo and Blue Mesa Members, and places them within the Norian stage. Contrary to previous correlations using vertebrate biostratigraphy, these new age data indicate that the Chinle Formation is mostly or wholly younger than the Ischigualasto Formation of northwestern Argentina, which is constrained by a recalculated  $^{40}\text{Ar}/^{39}\text{Ar}$  age of 231.4 Ma (corrected for age of the standard and normalized for comparison with the U-Pb system), and may instead be partially correlative with the overlying Los Colorado Formation. This weakens support for a global tetrapod-based biostratigraphy during the Late Triassic Period. This new correlation of the Chinle Formation also indicates that early dinosaur evolution was not globally synchronous. Dinosaurs are rare throughout the Chinle Formation, but are more abundant and species rich in coeval strata from Argentina, South Africa, and central Europe. These new data emphasize that precise non-biostratigraphic age constraints are required for accurate global comparisons of early Mesozoic terrestrial assemblages.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 8:15

**THE EVOLUTION OF AFRICAN OLD WORLD MONKEYS FROM 4.5 TO 3.0 MA**  
JABLONSKI, Nina, The Pennsylvania State University, University Park, PA, USA; FROST, Stephen, University of Oregon, Eugene, OR, USA

The fossils of Old World monkeys have been recovered from many of the same localities and strata as those of hominins. These discoveries have led to investigations of possible ecological and behavioral parallels between members of cercopithecoïd and hominin lineages. By the terminal Miocene and early Pliocene, well-differentiated members of the modern Old World monkey subfamilies Colobinae and Cercopithecoïd were present in Ethiopia and Kenya. These medium- to large-bodied (about 10-35 kg) monkeys inhabited closed habitats and included the arboreal colobines, *Kuseracolobus* spp. and *Paracolobus enkorikae*, and the earliest known papionins, *Pliopapio alemui* and African representatives of *Macaca*. The period between 4.5 and 3.0 ma witnessed considerable diversification of monkeys in eastern Africa, as open and seasonal habitats became more widespread. This interval was dominated by the rise of two key genera in eastern Africa, the papionin, *Parapapio*, and the colobine, *Cercopithecoïdes*. Both genera underwent considerable regional diversification into numerous, mainly terrestrial species, all of which were short-lived. The ancestors of the two modern African papionin clades of *Lophocebus/Theropithecus/Papio* and *Mandrillus/Cercocebus* probably evolved from *Parapapio* forebears by this time. By the mid-Pliocene, the stage was set for the rise of *Theropithecus* species and the large, terrestrial colobines that were to dominate much of primate evolution during the African Plio-Pleistocene.

Technical Session VIII, Thursday 1:45

**A LOWER CRETACEOUS TURTLE EGG CLUTCH FROM CHINA CONTAINING THE OLDEST *PENICILLIUM***

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Evidence of animal-fungal interactions is very limited in the fossil record but provides important information on paleoecosystems. We report the first in situ fossil turtle egg clutch with associated permineralized fungi from the Lower Cretaceous (Albian) Liangtoutang Formation of northeastern China. The clutch contained a minimum of 27 spherical, hard-shelled turtle eggs preserved in a ripple cross-laminated, red, fine-grained sandstone. The eggshell thickness of the 34–52 mm eggs varies from 0.7–1.0 mm and consists of radiating acicular spherulites of aragonite, a mineral characteristic of all extant turtle eggs. The egg size, shape, and eggshell microstructure closely resemble that of some modern large-bodied tortoises of the genus *Chelonoidis*. Energy dispersive x-ray (EDX) analysis of exceptionally well-preserved fungi in one egg showed that the structures are permineralized. This fungus represents the oldest known intact *Penicillium* (Eurotiomycetes) from the fossil record and includes extensive hyphae and intact asexual structures (phialides, conidiophores, echinulate conidia). The invasion of the Cretaceous turtle egg suggests a fungal lifestyle that has remained unchanged for 100 million years. Our findings suggest that adverse environmental conditions or genetic abnormalities first compromised the integrity of the egg, allowing invasion by opportunistic soil fungi. However, the apparent invasion of only one egg in the clutch also reinforces the idea that effective defenses against microbial invaders have a long history as well.

Poster Session IV (Saturday)

**VERTEBRATE FAUNA FROM THE PALEOGENE CALVERT BLUFF FORMATION, TEXAS**

JANUS, Tracey, Texas A&M University, College Station, TX, USA; STIDHAM, Thomas, Texas A&M University, College Station, TX, USA

The Calvert Bluff Formation is a Late Paleocene to Early Eocene unit composed of fossiliferous lignites, sandstones, and mudstones that were deposited in a coastal environment. In addition to the plant fossils common in the formation, a single outcrop of the Calvert Bluff Formation in Bastrop, Texas that appears to be a storm-bed contains the first records of invertebrate and vertebrate fossils. Currently the position of the Paleocene-Eocene Boundary in the Calvert Bluff Formation is unknown, but the site is relatively close to the boundary. Screen-washing sediment collected from the Bastrop site has produced hundreds of teeth and bone fragments of a diversity of sharks, rays, drum, catfish, gar, turtles, and crocodylians. The turtle material appears to include 2 to 3 taxa, including one species of trionychid. The crocodylian material composed of teeth and osteoderm fragments may represent an alligatorid. The shark fauna from this site is particularly diverse and includes species of *Alopias*, *Odontaspis*, *Carcharias*, *Rhizoprionodon*, *Galeorhinus*, *Scyliorhinus*, *Pachygaleus*, *Physogaleus*, *Serratolamna*, *Striatolamna*, *Ginglymostoma* and *Abdounia*. Pelagic sharks (including *Serratolamna* and *Striatolamna*) are the most common fossils at the site, *Abdounia* is the most common benthic shark present, and tetrapod remains are rare. This chondrichthyan fauna most resembles similar aged faunas from Mississippi (~50% of genera shared) and Virginia (87% of genera shared). However, *Alopias* and *Rhizoprionodon* (with numerous specimens in the Calvert Bluff Formation) have not been identified in the Tuscahoma, Bashi, or Nanjemoy Formations. While the Bastrop shark fauna is consistent with an Early Eocene age, an older age of this Texas locality would then make some specimens (*Alopias* and *Rhizoprionodon*) from the site the oldest known. The mixture of freshwater (gar, turtle), near shore (*Rhizoprionodon*), and pelagic marine (*Serratolamna*) taxa in the locality indicates deposition of the bed in possible estuarine or near shore marine conditions.

Poster Session II (Thursday)

**PLEISTOCENE LAGOMORPHS FROM CATHEDRAL CAVE, NEVADA**

JASS, Christopher, Vertebrate Paleontology Laboratory, UT-Austin, Austin, TX, USA

Rabbits [*Sylvilagus nuttalli* (Nuttall's cottontail) and *Lepus townsendii* (white-tailed jackrabbit)], and pikas [*Ochotona princeps* (North American pika)] were included in early studies concerning montane mammalian biogeography in the Great Basin and subsequent research continued to emphasize the importance of lagomorphs in such studies. New lagomorph specimens collected from Cathedral Cave provide insight into biotic changes that occurred within the Great Basin prior to the latest Pleistocene. Approximately 2000 isolated lagomorph teeth were recovered during excavations at Cathedral Cave in 2003. For the most part, attempts to make detailed taxonomic identifications focused on isolated, lower, third premolars (p3) and dentaries that retained the p3. Taxonomic identifications were made using a data-reliant approach intended to minimize geographic and temporal assumptions. While this approach to identification is conservative, the resultant data set is appropriate for inclusion in future analyses of regional biotic change. Lagomorphs recovered from the site include new regional records of two extinct taxa, *Aztlanolagus agilis* and *Brachylagus coloradoensis*. Other identified lagomorphs include *Brachylagus idahoensis*, *Ochotona* sp. and *Sylvilagus* or *Lepus* sp. The presence of a posteriorinternal reentrant fold on the p3 of some specimens of *Ochotona* sp. is inconsistent with previous descriptions and suggests that the range of variation present in the individual teeth of pikas needs to be evaluated in further detail. Evaluation of crenulation patterns of *Aztlanolagus agilis* from Cathedral Cave showed no distinct trends towards increasing complexity.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 12:00

**FOSSILS, BRAINS, AND BEHAVIOR: ENDOCASTS AS BRAINS**

JERISON, Harry, UCLA, Los Angeles, CA, USA

Fossil "brains" are endocasts molded by the cranial cavity. In birds and mammals endocasts are brainlike in size and shape, and they provide evidence of evolutionary enlargement of the brain as a whole, of the forebrain in birds, and of the mammalian neocortex. Brain size is determined mainly by its (allometric) regression on body size in all vertebrates. Encephalization is the residual from the regression. Mammalian neocorticalization has been greatest in primates and least in marsupials. Olfaction, inferred from the size of the olfactory bulbs, has been reduced in primates (including humans) and cetaceans. Olfactory bulbs and "medulla" (endocast foramen magnum) are enlarged in endocasts relative to their size in the brain, probably by space occupied by non-neural tissue. Midbrain exposure, clear in bat endocasts and clearer on their brains and in other orders of mammals, may be masked in endocasts. Optic lobes (midbrain exposure of superior colliculi) in birds enable one to measure forebrain enlargement. The avian Wulst is absent in *Archaeopteryx* but evident in endocasts of some later Tertiary birds suggesting that vision (and perhaps bird song) became more prominent avian adaptations. Analyzed by digital technology, these generalizations are supported by 3D data on several hundred endocasts. There is behavioral evidence of social behavior (from assemblages of fossils), of brooding behavior (from clusters of dinosaur eggs associated with adult fossils), and of locomotor capacities (from fossil appendages). These are overall trends, with many variations among fossil species just as living species vary. Although encephalization is undoubtedly related to the evolution of "intelligence," one should keep in mind the remarkable performance of relatively small-brained living species, such as rats and pigeons, in thinking about intelligence as a behavioral capacity.

Poster Session IV (Saturday)

**TRUE TAILBEND OCCURRED IN TRIASSIC--EVIDENCE FROM THE TRIASSIC ICHTHYOSAUR SKELETONS OF SOUTH CHINA**

Ji, Cheng, Department of Geology and Geological Museum, Peking University, Beijing, China; JIANG, Da-yong, Department of Geology and Geological Museum, Peking University, Beijing, China; MOTANI, Ryosuke, Department of Geology, University of California, Davis, CA, USA; HAO, Wei-Cheng, Department of Geology and Geological Museum, Peking University, Beijing, China; SUN, Zuo-yu, Department of Geology and Geological Museum, Peking University, Beijing, China

The true tailbend is a remarkable feature of fish-shaped ichthyosaurs (Parvipelvina) with considerable functional significance, indicating the presence of a crescent-shaped caudal fin. It comprises wedge-shaped centra that are slightly wider dorsally than ventrally. Its occurrence in more basal ichthyopterygians has been suggested, but the early evolution of the feature is still controversial. Here we report the true tailbends in two complete skeletons of *Guizhouichthysaurus* from the Middle to Late Triassic of Guizhou Province, southwestern China. One skeleton from the Zhuganpo Member (Late Ladinian, Middle Triassic) of the Falang Formation of Wusha, Xingyi City, is well preserved and exhibits a clear tailbend. Its total length is 6.63 m, skull 0.93 m and tail 3.32 m. It has about 239 vertebrae including about 66 presacral vertebrae, 3-4 sacral vertebrae and 169 caudal vertebrae which are mostly exposed laterally, especially the tail. Anticlination of the caudal neural spines around the tailbend is not preserved. We measured the dorsal and ventral widths of the caudal centra with vernier calipers and then the dorsal/ventral width ratios were plotted against the vertebral number. The ratios were above 1.1 in centra No. 105 to 111, whereas most others had ratios near 1.0, fluctuating between 0.9 and 1.1. Therefore, the vertebrae No. 105 to 111 are clearly wedge-shaped. The second and incomplete skeleton of *Guizhouichthysaurus* from the Wayao Member (early Carnian, Late Triassic) of the Falang Formation of Guanling also presents similar feature of tailbend near the 40th preserved vertebra, while there are about 110 vertebrae preserved. Our study shows for the first time that wedge-shaped tailbend centra already existed in merriamosaurs as early as late Middle Triassic. The next step is to examine the other osteological correlates of the crescent-shaped caudal fin.

Technical Session XVI, Saturday 9:00

**A SAUROPTERYGIAN OF SMALL HEAD WITH SPECIAL DENTITION (REPTILIA, SAUROPTERYGIA) FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA**

JIANG, Da-yong, Department of Geology and Geological Museum, Peking University, Beijing, China; RIEPPEL, Olivier, Department of Geology, The Field Museum, Chicago, IL, USA; MOTANI, Ryosuke, Department of Geology, University of California, Davis, CA, USA; HAO, Wei-cheng, Department of Geology and Geological Museum, Peking University, Beijing, China; SUN, Yuan-lin, Department of Geology and Geological Museum, Peking University, Beijing, China

The Pelsonian (Anisian, Middle Triassic) of Panxian, Guizhou, China has thus far yielded a fauna that shows a strong western Tethyan influence, with almost all species being congeneric with western Tethyan species. We now report a unique taxon from the Upper Reptile Horizon of Panxian Fauna, associated with abundant specimens of *Mixosaurus panxianensis* and fish, which represents a hitherto unknown type of eosauroptrygia. The new eosauroptrygian differs from any other sauroptrygian by its unique specialization of the jaws and dentition. The complete and articulated skeleton is 95.5 cm long, whereas

its head is small and slender, with a skull length of 7.6 cm. Of the total length, the head comprises about 8%, the neck 13.5%, the trunk 33%, and the tail the remaining 45.5%. The preorbital region of the skull is much longer than the postorbital region, with jaws forming a slender, elongated and pointed rostrum ending with a large number of small, monocuspid, and vertically positioned teeth. There are in excess of 45 to 50 tooth positions in both the upper and lower jaws. The individual teeth show a characteristic morphology, in that the basally expanded tooth crown is distinctly set off from a basal pedicel. Apically, the crown terminates in a blunt pointed tip. This slender and pointed rostrum is quite unique in Sauropterygia, but looks similar to the edentulate rostrum of thalattosaur *Endennasaurus acutirostris* from the Norian (Late Triassic) of Italy. This taxon is ascribed to Sauropterygia based on the curved and distally expanded humerus, and the posterodorsal process of the clavicle faceted to anteromedial surface of its anteroventral extension of the scapula. It represents a new taxon with the following diagnostic characters apart from its unique jaws and dentition: frontals paired; parietal unpaired; scapula with distinct posterodorsally extending blade, terminating in a straight posterior margin; ilium with distinct preacetabular process at base of distinct dorsally extending iliac blade; pubis plate-like, of rounded contours; two carpal (intermedium and ulare) and tarsal (astragalus and calcaneum) ossifications.

Technical Session IX, Thursday 2:15

**SKULL MORPHOLOGY OF ENANTIORNITHES (AVES: ORNITHOTHORACES)**  
JINGMAI, O'Connor, Natural History Museum of Los Angeles County, Los Angeles, CA, USA; CHIAPPE, Luis, Natural History Museum of Los Angeles County, Los Angeles, CA, USA

Enantiornithines are the most speciose avian clade in the Mesozoic, however with less than half of known taxa preserving skull material, our understanding of their cranial morphology remains incomplete. Here we present a comprehensive overview of the current knowledge of enantiornithine skull anatomy and discuss the range of morphologies known for the main cranial elements. The typical enantiornithine skull retains numerous ancestral features such as the lack of fusion among bones, the presence of a postorbital, a primitive quadrate, an unforked dentary, and teeth. The rostrum is well known and shows considerable variation; the premaxilla varies in degree of fusion and the relative lengths of the nasal and maxillary processes. The nasals range from broad to narrow, with the maxillary process reduced or absent. The relative lengths of the premaxillary, jugal, and nasal processes of the maxilla vary considerably; in no taxa is a second accessory maxillary fenestra known. The bones of the braincase are typically unfused. The foramen magnum in all taxa in which preserved is directed caudally, not ventrally. Typically the dentaries are incompletely fused rostrally, and the lower jaw is imperforate. Enantiornithine teeth show considerable diversity in numbers, size, morphology and placement ranging from taxa with large teeth found throughout the jaws to taxa with small, anteriorly restricted teeth to the fully edentulous. Despite limited preservation of skull material, a number of trophic specializations can be deduced from the range of preserved morphologies further hinting at the diversity of the Cretaceous Enantiornithes.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny,  
Wednesday 10:30

**PLACODERMS WITH TEETH THAT BITE BACK**

JOHANSON, Zerina, Natural History Museum, London, United Kingdom; TRINAJSTIC, Kate, University of Western Australia, Perth, Australia; BRAZEAU, Martin, Uppsala University, Uppsala, Sweden; SMITH, Moya, King's College London, London, United Kingdom

Placoderms have been resolved as the sister group of crown-group gnathostomes, representing the most primitive jawed vertebrates, but the presence of teeth homologous with those of chondrichthyans, acanthodians and osteichthyans is controversial. Thus, the co-evolution of teeth with jaws is questioned. Also teeth, defined as only those developing from a dental lamina, are proposed as a synapomorphy of all groups except placoderms. Teeth so defined formed ordered rows, of regulated tooth size and shape, and successive teeth are added only from one aspect. These criteria were applied to fossils such as the "Acanthodii", when tooth whorls were judged to indicate teeth that had formed from a dental lamina. However, although tooth whorls are not present in placoderms, regulated tooth addition can be inferred within one group of placoderms, Arthrodira. Teeth of each row are of increasing size and new ones restricted to one location on all gnathal elements. In this taxon, statodont tooth rows form with new teeth sequentially located at one end only, where tissue is out of the biting surface. Within basal vertebrates the concept of a dental lamina applies specifically to sharks. However, new studies on the teleost dentition show that all teeth develop without a dental lamina forming. First teeth are superficial and successional teeth develop from sites in the older tooth germ epithelium. This developmental mechanism for tooth addition could explain inferred modes of tooth patterning in the arthrodirans, i.e. both without a dental lamina. Previously, these results were interpreted within the context of placoderm monophyly, suggesting that teeth evolved separately within the group, occurring only within the derived arthrodirans, but absent from more phylogenetically basal taxa. The implications of alternative phylogenetic arrangements considering both placoderm monophyly and paraphyly are explored here. In the present results, placoderm paraphyly would carry the implication that arthrodiran dental patterning is potentially homologous with that seen in Crown-group Gnathostomata.

Technical Session IV, Wednesday 2:30

**THE MICROBIAL ROLE IN EARLY DIAGENETIC MINERALIZATION OF VERTEBRATE SOFT TISSUE WITHIN BONE**

JOHNSON, Elizabeth, North Carolina State University, Raleigh, NC, USA; SCHWEITZER, Mary, North Carolina State University, Raleigh, NC, USA

Microbial processes assist in preserving soft tissues by inducing anoxia, chemically altering the pH of local microenvironments, and acting as passive nucleation sites through either cell bodies or biofilm secretions to induce mineral precipitation. These microbially mediated processes greatly increase the rate of mineral precipitation compared to abiotic conditions, and therefore, may play a role in early diagenetic mineralization correlated with exceptional preservation. Here, we report the results of actualistic experiments designed to test the hypothesis that microbes play an important role in early diagenesis to preserve vertebrate remains. Extant chicken tibiae were de-fleshed and either chemically decreased (simulating pre-burial exposure) or untreated (simulating rapid burial). Bones were subsequently buried in pure quartz, medium grained sand and allowed to degrade for approximately four weeks. This process resulted in differential sand cementation directly adjacent to bone fragments. Cemented and unconsolidated sediments were examined for authigenic minerals and microbial biomarkers, supporting the hypothesis of microbial involvement in early diagenesis and forming the basis for a predictive model for vertebrate bone entrance into the fossil record. To test this model, we examined sediments associated with dinosaur remains from which soft tissues (vessels and cells) were recovered. Scanning electron microscopy (SEM) was used to test for the presence of microbial morphotypes in sediments, and X-ray diffraction (XRD) was used to identify authigenic mineral phases in sandstone cements and/or microbial bodies to verify these were mineralized, and not recent contaminants. Finally, chemical extracts of sediments surrounding exceptionally preserved dinosaur bones were examined by mass spectrometry for the presence of muramic acid, a biochemical fingerprint of microbes, and other biomarkers to verify the role of microbes in early cementation resulting in exceptional preservation.

Poster Session I (Wednesday)

**MORPHOMETRIC ANALYSIS OF CRANIAL MORPHOLOGY IN PINNIPEDS (MAMMALIA, CARNIVORA): DISPARITY, DIMORPHISM, ECOLOGY AND ONTOGENY**

JONES, Katrina, University of Cambridge, Cambridge, United Kingdom; GOSWAMI, Anjali, University of Cambridge, Cambridge, United Kingdom

Pinnipeds (seals, sea lions and walrus) are fully aquatic carnivores (Mammalia, Carnivora) that show a wide range of feeding and reproductive strategies and have a global distribution. This study examined pinniped cranial morphology and the factors that have influenced their evolution. 3D morphometric data from 138 specimens (20 genera) were collected using a digitizer and analysed with Procrustes analysis and Principal Components Analysis. Ecological correlates of shape, ontogeny and dimorphism were examined. Data from previous studies of terrestrial carnivores were also included for comparison. The three pinniped families occupy distinct areas of morphospace, despite significant ecological overlap. While most species within Phocidae (seals) and Otariidae (sea lions) cluster near the mean shape for their respective family, a few species in both families converge onto Odobenidae (walrus) space. These convergences can be separated into feeding (*Erignathus*, *Hydrurga*) and reproduction-related (*Cystophora*, *Mirounga*, *Otaria*) adaptations, demonstrating that different selection pressures can produce similar morphologies. Interestingly, taxa that converge onto Odobenidae space also display longer ontogenetic trajectories. The young for these taxa cluster near the mean shape for their respective families, showing that the cranial convergences develop primarily during the juvenile growth period. Dimorphism is apparent in some of these convergent species, and those (*Cystophora*, *Otaria*) showing the most extreme cranial shape dimorphism display less body size dimorphism, possibly due to larger female body size in polar waters. Pinniped cranial disparity is comparable to that of terrestrial carnivores, despite representing far fewer species. This remarkable discordance between taxonomic and morphological diversity indicates that pinnipeds have undergone strong selective pressures on cranial morphology, probably due to adaptations to a marine lifestyle. We conclude that the extreme specialization of the pinniped postcranial skeleton for swimming has placed increased importance on the cranium for feeding and reproductive specializations, resulting in a wide range of cranial morphology.

Technical Session III, Wednesday 1:45

**THE FIRST PRE-PLEISTOCENE RECORD OF A TUATARA (*SPHENODON*)-LIKE ANIMAL FROM NEW ZEALAND AND IMPLICATIONS FOR THE OLIGOCENE DROWNING**

JONES, Marc, UCL, University College London, London, United Kingdom; TENNYSON, Alan, Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand; EVANS, Susan, UCL, University College London, London, United Kingdom; WORTHY, Trevor, Adelaide University, Adelaide, New Zealand

Despite the lack of a pre-Pleistocene fossil record, it is widely assumed that the ancestors of the Tuatara (Rhynchocephalia: Sphenodontinae: *Sphenodon*) were part of an "archaic" fauna that has been present on New Zealand (NZ), since 'Zealandia' separated from Gondwana 82–60 million years (Ma) ago. The continuous presence of emergent land has recently been

questioned, however, because widespread marine deposits of Oligocene age are associated with an apparent gap in the terrestrial record. This “Oligocene drowning” hypothesis implies that the ancestors of the Tuatara colonised NZ from a currently unknown and now extinct Neogene population after land re-emerged but before the Pleistocene. We report the discovery of two partial dentaries from the Early Miocene (19-16Ma) Manuherikia Group, Central Otago, NZ that have characters found in Tuatara and Mesozoic sphenodontines: acrodont tooth implantation, a skirt of secondary bone on the labial surface of the jaws, pyramidal teeth with apex positioned anteriorly, and a wear pattern consistent with the presence of an enlarged palatal tooth row and prooral jaw movement. This material represents the oldest NZ record and, globally, it is the only unambiguous record of a rhynchocephalian bridging a 70 Ma gap between the Late Mesozoic and late Pleistocene. A Miocene record of a *Sphenodon*-like rhynchocephalian reduces the time available for oceanic dispersal from ~23 to ~7 Ma, if Zealandia was submerged ~23.5Mya. Given that the area of land required to sustain a viable population of *Sphenodon* is small (e.g. Stephens Is., 1.5 km<sup>2</sup>, pop = >30,000), and that evidence of an emergent landmass the size of Stewart Is. (966 km<sup>2</sup>) would easily be lost during local tectonic changes, we favour a vicariant history for Tuatara in NZ. This is congruent with evidence from other taxa (e.g. freshwater mussels, ratites). Irrespective of pre-Miocene biogeographic history, this material is the first direct evidence that the ancestors of the Tuatara, an animal often dismissed as unsophisticated, survived in NZ through the global temperature drop at the end of the Mid-Miocene optimum (c. 8C) and the Pleistocene glacial-interglacial oscillations.

Technical Session XVII, Saturday 9:45

#### **DIETARY CHANGE IN THE PERISSODACTYL *PLAGIOLOPHUS MINOR* ACROSS THE EOCENE/OLIGOCENE TRANSITION IN EUROPE**

JOOMUN, Sarah, Royal Holloway University of London, Egham, United Kingdom; HOOKER, Jerry, Natural History Museum, London, London, United Kingdom; COLLINSON, Margaret, Royal Holloway University of London, Egham, United Kingdom

The Late Eocene to Early Oligocene was a period of global climatic change, from greenhouse to icehouse conditions. The “Grande Coupure” was a major mammalian faunal turnover which occurred in the earliest Oligocene of Europe, coincident with the beginning of permanent polar Cenozoic glaciation (O<sub>1</sub>). Most of the endemic European mammal fauna became extinct and there was a large number of incoming taxa from Asia. Of the larger mammals, the perissodactyls and artiodactyls were the most affected by this event. *Palaeotherium* and *Plagiolophus* are members of the endemic European perissodactyl family Palaeotheriidae. All species of the genus *Palaeotherium* became extinct at the Grande Coupure and *Plagiolophus minor* was the only member of the family to survive the Grande Coupure and persist over a wide area. Dental mesowear encompasses occlusal relief and cusp shape whilst dental microwear takes the form of microscopic pits and scratches on the tooth enamel. Both forms of wear are produced by the interaction of ingested material with the teeth and can be used to determine diet and to help reconstruct palaeoenvironments. The microwear of *Plagiolophus minor* from the pre-Grande Coupure sites of La Débruge, France and Frohnstetten, Germany is found to be significantly different from the post-Grande Coupure sites of Soumaillies and Ronzon, France. The pre-Grande Coupure specimens have more polished enamel surfaces and fewer pits, suggesting a less abrasive leaf diet than the post-Grande Coupure specimens. There is a reduction in the mesowear variable of occlusal height across the Grande Coupure, also suggesting an increase in abrasiveness of the diet. This indicates that there was a change in the diet of *Plagiolophus minor* across this climatic and biotic event. Microwear also shows that the diet of pre-Grande Coupure *Palaeotherium medium* differed from that of both pre- and post-Grande Coupure *Plagiolophus minor*. *Plagiolophus minor* did not move into the dietary niche of the extinct *Palaeotherium medium* after the Grande Coupure.

Technical Session VIII, Thursday 2:00

#### **THE RESPONSE OF TURTLES TO THE BREAKUP OF PANGAEA: VICARIANCE VERSUS DISPERSAL**

JOYCE, Walter, Yale Peabody Museum of Natural History, New Haven, CT, USA; LYSON, Tyler, Yale University, New Haven, CT, USA

Turtles are an ideal group for paleobiogeographic investigations because fragmentary material is extremely common worldwide and can be attributed to various clades with considerable confidence. Furthermore, because many clades of living turtles possess a wide-spectrum of terrestrial to aquatic habitat preferences and because a tight correlation exists today between these habitat preference and dispersal pattern, it is possible to make qualitative statements regarding the barriers and bridges that existed in the past. Our comprehensive review of the turtle fossil record, combined with recent phylogenetic analyses, reveals that stem-turtles possessed a world-wide distribution and that they readily dispersed throughout Pangaea due to their terrestrial habitat preferences. After the breakup of Pangaea, remnant groups survive on various continents and show a pattern of vicariance. Following the mid-Jurassic and the acquisition of fresh-water aquatic habitat preferences by the ancestor of the turtle crown, turtles fragment into three primary clades that correspond to North America + Europe (Paracryptodira), East Asia (Pancryptodira), and Gondwana (Panpleurodira). Panpleurodiras split by the mid-Cretaceous into a northern (Pelomedusoides) and southern (Chelidae) clade and this pattern persists through the breakup of Gondwana. This clarifies the conflicting area-cladograms obtained from either clade. In general, much of today's turtle distribution can be explained by vicariance. Marine

and near-shore turtles (Protostegidae, Cheloniodea, and Bothremydidae) generally show worldwide distribution patterns, as is evidenced by their global distribution. Ironically, terrestrial turtles often overcome marine barriers as well, but this does not seem to have influenced their global distribution. Various Late Cretaceous to recent land bridges provided routes for the dispersal of fresh-water turtles, but it appears that only semi-terrestrial or salt-tolerant cryptodires were able to fully take advantage of these opportunities.

Technical Session XVII, Saturday 11:30

#### **FEEDING ECOLOGY AND NICHE PARTITIONING OF THE UNGULATE FAUNA FROM LAETOLI TANZANIA**

KAISER, Thomas, Biocenter Grindel and Zoological Museum, University of Hamburg, Martin-Luther-King-Platz 3, 20146 Hamburg, Germany; HARRISON, Terry, Center for the Study of Human Origins, Department of Anthropology, New York University, 25 Waverly Place, New York, NY 10003, USA

The Pliocene ungulate fauna from the hominid-bearing Laetoli succession (Southern Serengeti, Tanzania) is investigated with regard to feeding adaptations, niche segregation and dietary change over time. Analysis of dental mesowear is applied to 23 ungulate taxa from the Upper Laetoli Beds (ULB) (3.46-3.76 Ma) and Upper Ndolanya Beds (UNB) (2.58-2.66 Ma), including Equidae, Bovidae and Giraffidae, and these results are compared to extant species. Equids represent the only grazers throughout the succession. All ULB Alcelaphini and Hippotragini are inferred to be intermediate feeders, in contrast to their modern counterparts that are mostly grazers. This implies a dietary shift in these lineages since the Pliocene. These data also suggest that extant ungulates from closely related lineages, such as those from the same tribe or even genus, may not serve as appropriate actualistic models for reconstructing dietary behavior or paleoecology using the principle of taxonomic uniformitarianism. The three species of giraffids and the remaining bovid taxa from Laetoli were either browsers or intermediate feeders, but not grazers. The almost complete absence of the grazing guild at Laetoli, and the heavy reliance on browsing by most herbivores, do not support previous inferences that the paleoenvironment was dominated by grassland. Within the Laetoli succession it appears that fundamental feeding niches converged over time, with grazers increasingly engaged in feeding on less abrasive components and intermediate feeders exploiting more abrasive diets. Niche partitioning in the Laetoli ungulates appears to reflect evolutionary transformations in the major lineages in response to environmental change. Within the succession it appears that the diversity of feeding niches generally decreased. This indicates that the mosaic woodland habitats typical of the ULB environment no longer existed by the time of deposition of the UNB. After a hiatus of 0.8 Ma, the UNB environment was largely devoid of forest and woodland patches and can be characterized as predominantly open grassland.

Technical Session VII, Thursday 3:30

#### **TOOTH MICROSTRUCTURE IN FOSSIL AND RECENT SLOTH (MAMMALIA, FOLIVORA)**

KALTHOFF, Daniela, Swedish Museum of Natural History, Stockholm, Sweden

Sloths are one of the few mammal taxa whose cheek teeth lack the hard, protective enamel cover and are made up mainly of the softer, porous dentine. However, sloth teeth show functionally structured wear facets, even with sharp cutting blades, like other mammals. How is that possible? As one of the characteristics of toothed xenarthrans, sloths (as well as armadillos, and their extinct relatives) have developed euhyposodont teeth with a layered composition of different dentine types and with cementum. The tooth tissues have been treated with a new preparation technique which combines three different processes: etching, staining and fixating. SEM analysis reveals microstructural details which could not be achieved before. In comparison to other mammals, structural differences in the orthodentine seem to have a major effect on the biomechanical qualities of that tissue and might be the key to its extraordinary properties in sloths.

Technical Session XI, Friday 9:45

#### **A NEW THEROCEPHALIAN FROM THE *CISTECEPHALUS* ASSEMBLAGE ZONE OF SOUTH AFRICA AND NEW INFORMATION ON THEROCEPHALIAN SYSTEMATICS**

KAMMERER, Christian, University of Chicago, Chicago, IL, USA

A new, large therocephalian from the *Cistecephalus* Assemblage Zone (AZ) (Late Permian Beaufort Group) of South Africa is described. The new taxon is represented by two individuals formerly labeled as gorgonopsians in collections: a complete cranium with partial postcranium and a partial snout with attached lower jaws. The new taxon is characterized by a unique suite of characters including a massively expanded vomer, two precanines, and teeth present on the palatal boss of the pterygoid. This taxon was included in a phylogenetic analysis of therocephalians constructed using new data from a comprehensive global taxonomic review of the group. In this analysis, the new taxon is recovered as the most basal member of Akidnognathidae. Within Akidnognathidae, the Russian taxon *Annatherapsidus* is the sister group to the remaining South African akidnognathids, such as *Akidnognathus*, *Olivierosuchus*, and *Euchambersia*. In addition to elucidating phylogenetic relationships within therocephalians, the current review illustrates that previous reports of therocephalian survivorship across the Permo-Triassic extinction boundary in the Karoo are overinflated. The supposed boundary-crosser taxa *Ictidosuchoidea*, *Ictidosuchops*, and

*Tetracyonodon* are in actuality restricted to the Permian. *Itidosuchooides*, formerly considered to range from the *Tapinocephalus* to the *Lystrosaurus* AZs, is restricted to the *Tropidostoma-Dicynodon* AZs. Early records of this taxon represent misidentified hofmeyriids and juvenile scylacosaurids and Triassic records of this taxon represent indeterminate juvenile baurioids (“scaloposaurs”). *Tetracyonodon tenuis* is a juvenile *Lycideops*, a taxon known only from the *Dicynodon* AZ. Supposed Triassic “*Tetracyonodon*” specimens have been assigned to this taxon on the basis of juvenile characteristics. The only therocephalian species currently known to definitively cross the P-Tr boundary is the akidnognathid *Tigrisuchus simus* (senior synonym of *Moschorhinus* spp.) However, the results of the current phylogenetic analysis suggest that minimally four therocephalian lineages must have survived the P-Tr extinction.

Poster Session III (Friday)

**RECONSTRUCTING LATE CRETACEOUS CLIMATE IN THE MAHAJANGA BASIN OF NORTHWESTERN MADAGASCAR**

KAST, Sophia, Geology Department, Macalester College, Saint Paul, MN, USA; ROGERS, Raymond, Geology Department, Macalester College, Saint Paul, MN, USA; CURRY ROGERS, Kristina, Geology Department, Macalester College, Saint Paul, MN, USA

The Upper Cretaceous Maevarano Formation, situated in the central portion of the Mahajanga Basin, has yielded some of the most well-preserved vertebrate fossils known from Gondwana. These fossils provide insights into Late Cretaceous faunas in general, and also yield pivotal clues that pertain to the paleobiogeography of Gondwana. Previous taphonomic work on bonebeds in the formation suggests that the Maevarano paleoenvironment was semiarid and strongly seasonal. To date, however, there has not been an effort specifically devoted to reconstructing paleoclimate of the Mahajanga Basin in the Late Cretaceous. This study examines sedimentological and geochemical evidence from the Maevarano Formation in an effort to provide a more exacting paleoenvironmental framework. The focus is on the red beds of the Masorobe Member, which comprise the lower 80 meters of the formation. The Masorobe Member, which yields many of the same taxa as the overlying Anembalemba Member, consists of pedogenically-modified fluvial and floodplain deposits. X-ray diffraction analyses of the clay fraction indicate that the dominant clay species are saponite, montmorillonite, and sepiolite. These clays are most commonly developed in sub-humid to semiarid climates, and sepiolite is a particularly telling arid indicator. The occurrence of abundant saponite is also significant, because it suggests that the weathering of basalts situated a few tens of km up dip from the study area contributed significantly to the clay fraction. The composition of framework grains in Masorobe sandstones is also consistent with a semiarid climatic regime, because labile minerals (e.g., K feldspars) comprise a significant fraction of the sand-sized material. The geochemistry of selected soils in the study interval also supports this interpretation, with climofunctions yielding rainfall estimates ranging from 430 to 1100 mm/year. Finally, this work has confirmed the presence of fine-grained debris flow deposits in the Masorobe Member, and their presence is suggestive of a highly seasonal environment prone to intense downpours (other triggers of mass flows were investigated, and deemed highly unlikely).

Poster Session II (Thursday)

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 11:30

**NEW DATA ON ENCEPHALIZATION IN MIOCENE NEW WORLD MONKEYS: IMPLICATIONS FOR ANTHROPOID BRAIN EVOLUTION**

KAY, Richard, Duke University, Durham, NC, USA; KIRK, E., University of Texas, Austin, Austin, TX, USA; MALINZAK, Michael, Duke University, Durham, NC, USA

Increased brain size relative to body size is a feature that distinguishes living anthropoid primates (platyrrhine monkeys of the New World, and catarrhine monkeys, apes and humans of the Old World) from the smaller-brained “prosimians” (lemurs, lorises, and tarsiers). Fossil evidence suggests that stem catarrhines had relatively small brains, and thus increases in encephalization must have occurred independently in platyrrhines and catarrhines. We report the first CT measurements of endocranial volume (ECV) in the early Miocene (~16.5 to 21 Ma) stem platyrrhines *Tremacebus* and *Dolichocebus*, and provide additional data on the ECV of *Homunculus*. Corrected for head size, these three taxa had relatively small ECVs compared with living platyrrhines. The relative ECVs of *Tremacebus* and *Dolichocebus* are within the lower limits of the extant platyrrhine range. By contrast, the relative ECV of *Homunculus* falls below the range of extant platyrrhines and within the size range of extant “prosimians”. *Homunculus* also has an enlarged optic canal, which is functionally linked to the presence of high visual acuity. These data again confirm that high visual acuity evolved in anthropoids before they had attained modern degrees of encephalization. Our results further suggest that brain enlargement has occurred at least four times independently in Platyrrhini (i.e., in stem platyrrhines, Cebidae, Atelidae, and Pitheciidae). Brain size reduction has also occurred at least once, in Cebidae. These data reinforce the conclusion that the increased encephalization characteristic of living anthropoids is the product of parallel selection for increased brain size in multiple evolutionary lineages.

Poster Session IV (Saturday)

**TAXONOMY OF ANCHITHERIUM (PERISSODACTYLA, MAMMALIA) FROM THE HIRAMAKI FORMATION, GIFU PREFECTURE, JAPAN, AND ITS SIGNIFICANCE ON ASIAN ANCHITHERIUM DIVERSITY**

KAZUNORI, Miyata, Fukui Prefectural Dinosaur Museum, Fukui, Japan; YUKIMITSU, Tomida, National Museum of Nature and Science, Tokyo, Tokyo, Japan

An *Anchitherium* specimen with a nearly complete series of the upper cheek teeth (P<sup>2</sup>-M<sup>2</sup>), from the upper part of the Hiramaki Formation, Kani City, Gifu Prefecture, Japan, was tentatively referred to a nomen dubium, *Anchitherium* “*hypohippoides*” without discussion. Despite that it is one of the best specimens providing significant upper dental characters of Asian *Anchitherium*, the specimen had not been examined under complete preparation. The upper cheek teeth in the Japanese specimen show unique characters with straight and flattened ectolophs, narrow and sharp mesostyles, incipient crochets, and labial enamel protuberances at the lingual mouth of the median valleys. The lack of abundant *Anchitherium* materials from Asia makes the taxonomic assessment of the Japanese *Anchitherium* difficult. Nevertheless, the comparisons with other *Anchitherium* indicate a similarity with *A. gobiense* from China in having large size and relatively expanded hypostyles and suggest it being distinguished from European *A. aurelianense*. The latest and reliable data of the fission track dating reasonably indicate that the upper part of the Hiramaki Formation extends from 18 to 17 Ma. The presence of Japanese *Anchitherium* implies a farther diversity of *Anchitherium* in the late Early Miocene of East Asia.

Poster Session II (Thursday)

**OLDEST CRANIUM OF A HORNED ARMADILLO (PELTEPHILIDAE, LATE OLIGOCENE, BOLIVIA): CLUES REGARDING BASAL CINGULATE MORPHOLOGY**

KEARNEY, Kellyn, Manhattan College, New York, NY, USA; SHOCKEY, Bruce, Manhattan College and AMNH, New York, NY, USA

For their horns and slicing teeth, peltephilid armadillos have been a minor sensation. Ameghino characterized them as horned predators, something of a chimera between a rhino and a tiger. Though this “killer armadillo” scenario may be doubted today, peltephilids still stimulate our curiosity by way of their basal position among cingulate xenarthrans. Knowledge of the oldest (and most primitive) peltephilid presents an opportunity to examine hypotheses regarding polarities and character transformations in cingulates and perhaps even in pilosan lineages of xenarthrans. We describe the skull of a new peltephilid armadillo from the late Oligocene of Salla, Bolivia. Referral of this Deseadan South American Land Mammal “age” taxon to the Peltephilidae is based upon the presence of cranial horns, closed anterior dental arcade, its broad and heavy skull having a short rostrum with apparently only seven upper and seven (but sometimes eight) lower teeth, and a mandible that has its deepest dimension at the symphysis. Also the occipital condyles in both the Santacrucian species of *Peltephilus* and in this unnamed taxon are somewhat triangular in shape rather than rectangular as in dasypodid armadillos. The Deseadan taxon is generically distinct from the Santacrucian *Peltephilus* by way of its lack of a domed brance, having occipital condyles even with (rather than below) the tooth level, usually having an unfused mandibular symphysis, and whereas the first upper teeth in *Peltephilus* face fully forwards, they are oblique in the Salla peltephilid. Also, the medial border of the auditory bulla is not firmly fused to the basioccipital region as it is in *Peltephilus* spp. This geologically older peltephilid of Salla shows several characteristics that we regard as being plesiomorphic compared to other known peltephilids. These include the flatter cranial vault, unfused bulla, frequently unfused mandibular symphyses, and the tendency for eight teeth to develop in the mandible, rather than just seven as typically occurs in peltephilids.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**TAPHONOMY OF A TRICERATOPS BONEBED FROM THE UPPER HELL CREEK FORMATION, GARFIELD COUNTY, MONTANA**

KEENAN, Sarah, University of St Andrews, St Andrews, United Kingdom

Ceratopsid dinosaurs are notable for their common occurrence in bonebeds, both monospecific and multispecific in composition. However, until recently this has not been encountered for the chasmosaurine *Triceratops*, making this site particularly important for an understanding of ceratopsids. The aim of this investigation was to examine “Quittin’ Time”, a *Triceratops* bonebed in the Hell Creek Formation (of the latest Maastrichtian age, ~67-65 Ma) located in Garfield County, Montana, and to establish a facies interpretation and the taphonomy of the site. The locality was associated with abundant organic material, including woody debris, large seeds and other fragments in isolated silty lenses, all incorporated within a mudstone matrix, indicating preservation within a floodplain environment. From the repetition of cranial elements, the minimum number of individuals (MNI) was determined to be 3, with the possibility of a fourth juvenile. Based on the level of articulation and association of many of the elements, lack of abrasion or any preferred orientation, the individuals accumulated as a result of transport and deposition via “float-and-bloat” through a fluvial system. Such a process also explains the loss of distal elements. Whether or not these individuals—one sub-adult, one large juvenile and one small juvenile—died synchronously could not be determined. However, due to preservation within the same horizon, similar condition of the bones and close proximity, the remains likely accumulated during the same or closely spaced flooding event(s). The discovery and detailed record

of a *Triceratops* bonebed has wide-reaching implications. The relatively small scale of the bonebed, both in terms of area and number of individuals, implies that future work on *Triceratops* sites requires careful scrutiny of each element, as multiple individuals may not be as obviously represented as with other ceratopsid species.

Preparators' Session, Thursday 9:00

**CHALLENGE: HOW TO EXCAVATE, PREPARE, DISPLAY AND TRANSPORT DELICATE ARTICULATED FOSSILS FOUND IN UNCONSOLIDATED SAND?**  
KEILLOR, Tyler, University of Chicago, Chicago, IL, USA

Recovering a diverse fossil fauna from a rich Holocene site in the Sahara of Niger proved challenging due to an unconsolidated sandy matrix. Reversible consolidants were used in the field to harden the sand, facilitating jacketing of articulated specimens. In the lab, careful preparation maintained the articulations while exposing anatomical details. Skeletons were treated as thin slabs, leaving supportive, hardened sand between ribs, for example. After carefully sealing the pores in the sand, each hardened specimen/slab was molded with silicone rubber. Lightweight and durable polyurethane casts, with embedded support stands, can be exhibited in a novel way: displayed vertically, the viewer can walk around a specimen to observe the in-situ pose of the fossil from either side. Lightweight fiberglass holders, created for both sides of each fossil specimen, provide support and permit flipping and viewing from front or back. These holders nest within custom fiberglass travel shells, which bolt together. A remarkable series of three intertwined *Homo sapiens* skeletons illustrate the entire preparation process developed for this site.

Technical Session VIII, Thursday 2:30

**NEW INFORMATION ON GUARINISUCHUS MUNIZI (CROCODYLIFORM, DYROSAURIDAE) FROM THE MARIA FARINHA FORMATION (EARLY PALEOCENE), BRAZIL**

KELLNER, Alexander, Museu Nacional, Rio de Janeiro, Brazil; BARBOSA, JOSÉ, Universidade Federal de Pernambuco, Recife, Brazil; VIANA, MARIA, Universidade Estadual Vale do Acaraú, Sobral, Brazil; SILVA, JÉSSICA, Museu Nacional, Rio de Janeiro, Brazil; SILVA, HELDER, Museu Nacional, Rio de Janeiro, Brazil

Dyrosauridae comprises marine crocodylomorphs whose record in South America is extremely meager, consisting of fragmentary specimens of indeterminate taxonomic affinities. Recently a complete skull and lower jaw, associated with some postcranial elements, were collected in the Early Paleocene Maria Farinha Formation (northeastern Brazil) and named *Guarinisuchus munizi*. This taxon, the most complete described dyrosaurid from South America so far, differs by having the postorbital region of the skull more elongated and the basioccipital 'V'-shaped, with a distinct ventral depression. The Poty Quarry, where *Guarinisuchus* was collected, shows the K-P boundary. The Maastrichtian Gramame Formation, present under the boundary, yielded several mosasaur teeth indicating that those marine reptiles were quite diverse in this region. No evidences of those reptiles were found in the overlying Maria Farinha Formation, where dyrosaurid remains are present in some number (several new specimens are being found) suggesting that at least in this part of the globe, dyrosaurid occupied the niche of major predators of shallow marine environments left by mosasaurs after the K-P transition. A preliminary phylogenetic analysis of Dyrosauridae confirms previous studies showing that the most primitive members of the group (e.g., *Chenaniusuchus*, *Sokotosuchus*) are found in North Africa, and indicates that *Guarinisuchus* is closely related to African forms (e.g., *Arambourgisuchus*). From the paleobiogeographic perspective, this pattern might be explained either by dispersal from North Africa to South America or by vicariance, with a common dyrosaurid population living between those continents during the Cretaceous, being separated by the deepening and widening of the Atlantic Ocean. The fact that those marine crocodylomorphs are regarded as good swimmers puts into question how effective this ocean might have acted as a barrier, leading us to favor the dispersal hypothesis. In any case, it is clear from the several dyrosaurid ghost lineages that the early evolutionary history of the group lies within Cretaceous times.

Technical Session XI, Friday 12:00

**THE ONTOGENETIC ALLOMETRY OF LIMB BONES IN MAMMALS AND DINOSAURS AND THE USE OF ONTOGENETIC ALLOMETRY AS A PREDICTOR OF LIFE HISTORY TRAITS**

KILBOURNE, Brandon, University of Chicago/ Field Museum of Natural History, Chicago, IL, USA; MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL, USA

In addition to providing insight into the ontogenetic development of the locomotor system, ontogenetic limb bone allometry may reflect other aspects of an organism's life history, such as adult and neonatal body mass or growth rate. Similar patterns in ontogenetic limb bone allometry in extinct and extant taxa may be useful for inferring life history parameters for extinct taxa. To investigate general trends in ontogenetic limb bone allometry in biomechanically/functionally similar taxa, femoral allometry was assessed in 23 and 24 species of non-avian dinosaurs and terrestrial mammals, respectively. Isometric growth was the most common pattern of growth in dinosaur and mammalian femora; however, non-avian theropods possess a distinct pattern of femoral growth with little to no overlap with mammals and non-theropod dinosaurs. To examine how ontogenetic allometry varies with

other life history parameters in mammals, regressions were performed between femoral allometry and the following life history traits: adult and neonatal body mass, ontogenetic range of body mass, and growth rate. The regressions between femoral allometry and all of the above life history traits were significant, but the majority of the variance in femoral allometry was explained by growth rate. Mammals with high growth rates possess femora that grow isometrically, whereas mammals with lower growth rates have femora that grow increasingly gracile during ontogeny. Overall, during the ontogeny of mammal species, changes in body mass influence changes in limb bone proportions. Caution is warranted when applying these relationships to non-avian theropods, as the internal architecture of long bones in this group differs from both non-theropod dinosaurs and mammals at large body sizes. While comparisons with mammals allow for a biomechanical perspective on allometric trends in non-avian dinosaurs, future work should be on extant birds for a phylogenetic perspective on the ontogenetic growth of long bones in non-avian dinosaurs.

Poster Session III (Friday)

**FIRST UINTAN SPECIMENS OF MAHGARITA (PRIMATES, ADAPIFORMES) FROM THE DEVIL'S GRAVEYARD FORMATION, TEXAS**

KIRK, E. Christopher, University of Texas at Austin, Austin, TX, USA; WILLIAMS, Blythe, Duke University, Durham, NC, USA

J.A. Wilson and F.S. Szalay described a new species of adapiform (*Mahgarita stevensi*) from the Devil's Graveyard Formation (DGF) of Texas. Based on a number of characteristic dental features (e.g., presence of cingular hypocones on upper molars), *Mahgarita* has traditionally been regarded as an Asian immigrant more closely related to Eurasian adapiforms than to North American notharctines. However, the phylogenetic relationships of *Mahgarita* have remained controversial, with various authors suggesting affinities with the Adapinae, Cercamoniinae, or Anthropoidea. Resolution of this controversy has been impeded by a lack of additional fossils. Since the 1970s, *Mahgarita* has been known from only 4 specimens (three crushed crania and one mandible) recovered from an early Duchesnean stratigraphic horizon ("Skyline Channels"). Renewed collecting in the DGF by field parties from the University of Texas at Austin has recently yielded new specimens of *Mahgarita* from the late Uintan (U<sub>13</sub>) Purple Bench locality. These new finds extend the earliest occurrence of *Mahgarita* from approx. 38-39 Ma to 42-43 Ma. New lower dental specimens from Purple Bench also reveal morphological features obscured by wear in the mandible from Skyline Channels. In particular, the lower P<sub>4</sub> of *Mahgarita* has only two cusps (protoconid and hypoconid) joined by a trenchant crest, and lacks a basin in the talonid region. In this respect, *Mahgarita* most closely resembles the small European cercamoniines *Anchomomys* and *Periconodon*, and differs from notharctines, adapines, larger cercamoniines, and *Donrussellia*. These new fossils thus provide further evidence that *Mahgarita* is a derived cercamoniine with Eurasian affinities.

Poster Session III (Friday)

**TAPHONOMY OF THE GASTON QUARRY (EARLY CRETACEOUS, YELLOW CAT MEMBER, CEDAR MOUNTAIN FORMATION), EAST-CENTRAL UTAH: THE CASE FOR EXPANDING THE HYPODIGM OF UTAHRAPTOR BEYOND THE SICKLE-CLAW**

KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA; BARRICK, Reese, CEU Prehistoric Museum, Price, UT, USA; BARTLETT, Jeff, CEU Prehistoric Museum, Price, UT, USA; BIRD, John, CEU Prehistoric Museum, Price, UT, USA; BURGE, Don, CEU Prehistoric Museum, Price, UT, USA

The Gaston Quarry of eastern Utah preserves the type specimens of both the large dromaeosaurid theropod *Utahraptor ostrommaysorum* and the polacanthine ankylosaur *Gastonia burgei* together with a few scattered bones of an iguanodontian ornithomimid. The bones occur in the Yellow Cat Mbr. 5-6 m below the base of the overlying Poison Strip Ss. near the base of a sequence of interbedded, diagenetically enhanced, sandy limestones and siltstones. Although interpreted as representing a wet environment, the absence of aquatic taxa and the presence of barite nodules indicate that permanent water was not present at the site. The lowest bones are impressed into the surface of the second limestone in sequence, which preserves sauropod and ornithomimid tracks, mud cracks, and ripple marks. The majority of the bones are preserved in a thin, pale green sandy siltstone over a lateral distance of about 12 m; the bones are compacted and are further distorted by irregularities in the surface of the underlying limestone and as they cross each other. Bones are also preserved in the overlying limestone bed, most abundantly at the northwest end of the bone bed where the limestone truncates. These bones are completely undistorted, indicating early cementation of the limestones. Bone densities are high with more than 100 bones per square meter, not counting small ankylosaur ossicles. Most long bones are oriented north-south, subparallel to the quarry axis, with a secondary east-west modal alignment. Evidence for strong size sorting is lacking. Although a minimum of six *Gastonia* are represented in the quarry, there is no evidence of more than one specimen of *Utahraptor*, as indicated by the large size of all preserved skeletal elements and by an absence of duplicated elements. Thus, it is proposed that the bones represent an associated skeleton, and the hypodigm of *U. ostrommaysorum* can be expanded from the 2<sup>nd</sup> pedal ungual (sickle-claw) to include all skeletal elements of *Utahraptor* identified from the Gaston Quarry. The resulting hypodigm would now include several skull elements, vertebrae from throughout skeleton, manual elements, tibia, astragalus, and pedal elements.

Poster Session IV (Saturday)

**DIVERSIFICATION PATTERNS OF EARLY SHARKS AND RAYS (CHONDRICHTHYES, NEOSELACHII)**

KLUG, Stefanie, Museum fuer Naturkunde, Humboldt-Universitaet zu Berlin, Berlin, Germany; KRIWET, Juergen, Museum fuer Naturkunde, Humboldt-Universitaet zu Berlin, Berlin, Germany; KIESSLING, Wolfgang, Museum fuer Naturkunde, Humboldt-Universitaet zu Berlin, Berlin, Germany

Neoselachians constitute a well-defined monophyletic clade representing one of the most successful groups of aquatic vertebrates. Their evolutionary history extends back at least into the Early Triassic, although rare isolated teeth from the Palaeozoic may represent plesiomorphic members of this group. The Jurassic is generally assumed to have been an important time in the evolution and diversification of neoselachians. So far, historical biodiversity patterns of neoselachians were either inferred directly from the fossil record or empirically studied using first and last occurrences of taxa. However, the fossil record is biased and care must be taken to remove as much bias as possible. For the study of ancient diversity patterns, the most severe bias results from the heterogeneous quality of the fossil record. Time intervals with many findings of a particular group alternate with times when only few occurrences are reported. Diversity strongly depends on sample size and this heterogeneity needs to be compensated. The relationship between sample size and diversity is non-linear and thus diversity cannot be assessed by extrapolation. We used subsampling approaches, which randomly draws the same quota of occurrences from each time interval (bin), where the quota is dictated by the most poorly sampled bin. A total of 507 occurrences and 96 genera and 175 species, 28 of which are in open nomenclature from the Triassic and Jurassic were assessed to gain reliable information on early neoselachian diversification patterns. The comparison of SIB (taxa in a stratigraphic sample) and boundary-crosser diversity indicates that edge-effects are substantial only in the first and last bin. The sampling standardized pattern of standing diversity is thus one of low fairly constant diversity in the Late Triassic and earliest Jurassic, with a steep rise in the Toarcian towards a Middle and Late Jurassic plateau. Besides the Hettangian-Sinemurian bin (likely due to edge effects), the Toarcian also saw the maximum diversification rate in the Jurassic. These results are similar to results from phylogenetic hypotheses but not from fossil record analyses.

Poster Session III (Friday)

**“GONGBUSAUROUS” AND THE EARLY PHYLOGENY OF THE NEORNITHISCHIA**

KNOLL, Fabien, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; DONG, Zhiming, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

*Gongbusaurus shiyii* (type species of the genus) is based on a premaxillary tooth and a cheek tooth from the Oxfordian of the Upper Shaximiao Formation in Rong County (Sichuan Province, P. R. China). The taxon was first considered a fabrosaurid, but it was afterwards regarded as a hypsilophodontid ornithomimid. More recently, it has been suggested that it may be an ankylosaur. The dentition of *G. shiyii* is of a primitive type so that determining affinities on this basis is problematical. It is possibly a basal neornithischian, but it is provisionally best assigned to Ornithischia indet. “*Gongbusaurus wucaiwanaensis* is based on a fragmentary mandible, caudal vertebrae, and an incomplete forelimb (type specimen) from the Oxfordian of the Shishugou Formation in Fuyun County (Xinjiang Province, P. R. China). The paratype and the referred specimens described with the type include dorsal, sacral, and caudal vertebrae, an incomplete pelvis, and hind limbs. The taxon was first considered a hypsilophodontid, but it was subsequently identified as a fabrosaurid. The caudal process of the ilium with a distinct brevis shelf that first turns medially and then downwards (visible in lateral view) shows that “*G. wucaiwanaensis* is more primitive than *Hexinlusaurus multidentis* (Bajocian, P. R. China). Furthermore, the degree of development of the pubic peduncle of the ilium suggests that “*G. wucaiwanaensis* is more basal than *Agilisaurus louderbacki* (Bajocian, P. R. China). Nevertheless, the caudal extension of the caudal process of the ilium in “*G. wucaiwanaensis* indicates that this taxon is more derived than *Lesothosaurus diagnosticus* (Hettangian, southern Africa). In conclusion, “*Gongbusaurus wucaiwanaensis*, *Agilisaurus louderbacki*, and *Hexinlusaurus multidentis* appear to form a phylogenetic sequence between the most basal neornithischian (*Lesothosaurus diagnosticus*) and more derived taxa such as *Othnielosaurus consors* (Kimmeridgian, USA). This highlights the relevance of the Chinese Jurassic to improve our knowledge of the early phylogeny of the Neornithischia.

Technical Session XIX, Saturday 2:30

**A NEW BASAL ORNITHOMIMID (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS IN HENAN PROVINCE OF CHINA**

KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; LÜ, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; LEE, Yuong-Nam, Korea Institute of Geoscience and Mineral Resources, Daejeon, Korea, South; XU, Li, Henan Geological Museum, Zhengzhou, Henan, China; ZHANG, Xingliao, Henan Geological Museum, Zhengzhou, Henan, China

Henan Province has been known as one of richest places for dinosaur eggs. After the first record of isolated tyrannosaur teeth (named as *Tyrannosaurus luanchuanensis*), the Henan Geological Museum recovered four dinosaur taxa from this province: an iguanodontian (*Nanyangosaurus zhugeii*), a nodosaurid (*Zhongyuansaurus luoyangensis*), a sauropod (*Huanghetitan ruyangensis*), and a dromaeosaurid (*Luanchuanraptor henanensis*). A new

locality, yielded *Luanchuanraptor*, in Tantou Basin in Luanchuan County exposes the Upper Cretaceous Qiupa Formation and is rich in dinosaur eggs and bones, such as undescribed skeletons of an oviraptorid, troodontid, ankylosaurid, ornithomimid and ornithomimid. This study reveals that the disarticulated skeletons of the Qiupa ornithomimid, preserves pelvis and hindlimb elements, is a new taxon and the most basal ornithomimid. A phylogenetic analysis suggests that the Qiupa ornithomimid is placed as a sister taxon to the other ornithomimids. The Qiupa ornithomimid is clearly more derived than *Shenzhouosaurus* (non-ornithomimid ornithomimosaur from the Early Cretaceous) because of the deep brevis fossa of ilium and is more derived than Early Cretaceous forms and *Garudimimus* because of the presence of arctometatarsalian condition, suggesting that the Qiupa form belongs to Ornithomimidae. A short anterior extension of the pubic boot indicates that it is more primitive than the other ornithomimids. The Qiupa ornithomimid differs from the other ornithomimids in having a notch on the lateral surface of the medial posterior process of the proximal end of tibia and a small pit is present at the contact between astragalus and calcaneum, indicating that it is probably a new taxon. Ornithomimids are common in the Upper Cretaceous sediments of Asia, and four ornithomimid taxa are known so far (*Sinornithomimus* and *Archaeornithomimus* from China and *Gallimimus* and *Anserinimus* from Mongolia). The tree topology shows that all of the Late Cretaceous ornithomimids from China are successive stem taxa for the clade of Ornithomimidae, supporting that ornithomimids originated in Asia.

Technical Session IV, Wednesday 2:45

**VISUALIZING FOSSILIZATION HISTORIES IN BONES USING HIGH RESOLUTION ELEMENTAL MAPPING**

KOENIG, Alan, Mineral Resources Team, USGS, Denver Federal Center, Denver, CO, USA; ROGERS, Raymond, Geology Department, Macalester College, Saint Paul, MN, USA; TRUEMAN, Clive, School of Ocean and Earth Science, University of Southampton, Southampton, United Kingdom

Fossilization of bone is a dynamic process controlled by pore water chemistry, hydrology, temperature, microbiology, and bone architecture. Given the inherent complexity of the diagenetic system, the processes and rates of fossilization can be expected to vary both within and between depositional environments. This in turn exerts a major control on preservation potential and the quality of the vertebrate fossil record. Here we reveal the complexities of fossilization using laser ablation inductively coupled mass spectrometry (LA-ICP-MS) to generate high-resolution maps of trace elements in a sample of fossil bones collected from a variety of facies in the Late Cretaceous of Montana and Madagascar (Judith River and Maevarano Formations). The LA-ICP-MS maps generated for this study provide a previously unavailable visualization of the complex physicochemical conditions operating within individual bones during the early stages of fossilization. Some of the bones in our sample show distinct gradients in concentrations of trace elements, with highest concentrations seen at the external margins of bones. Concentration gradients are steep and show an exponential form consistent with uptake via a diffusion-adsorption mechanism. In these bones fossilization clearly occurred before equilibrium was achieved, and the elemental distribution was frozen at the point of recrystallization. Other bones in our sample show more shallow gradients that suggest relatively prolonged bone-water interaction, and by implication, relatively slow rates of recrystallization. Still others show complex patterns of element distribution mediated by variations in bone architecture. This study provides the first direct visual comparison of recrystallization rates among individual fossil bones, and clarifies the fact that exquisite morphological and histological preservation does not necessarily correlate with reduced geochemical alteration or even rapid recrystallization. This study also highlights the potential for using LA-ICP-MS mapping of elemental distributions as a tool to identify bones or regions of bones suitable for prospecting for intact biogeochemical signals.

Technical Session XVII, Saturday 8:45

**ENAMEL DIFFERENTIATION IN EARLY PERISSODACTYLS**

KOENIGSWALD, Wighart, University of Bonn, Bonn, Germany; ROSE, Kenneth, Johns Hopkins University, Baltimore, MD, USA; HOLBROOK, Luke, Rowan University, Glassboro, NJ, USA

Perissodactyls, in contrast to most other ungulates, differentiated the schmelzmuster of the various tooth families in their dentition by reorganising the lateral orientation of the Hunter Schreger-bands. This happened during the early diversification of the group in the Eocene. So far at least four different types of schmelzmuster could be identified. 1. Equoids retained the transverse orientation of HSB which can be regarded as the primitive condition inherited from phenacodontids. 2. Rhinocerotoids have vertical HSB in their premolars and molars, while incisors and canines have transversely oriented HSB. 3. Chalicotheres are characterized by U-shaped HSB in premolars and molars. This schmelzmuster is shared by brontotheres. 4. Tapiroid molars show transverse HSB in the lingual and buccal walls, but in the lophes these HSB bend from both sides into a vertical orientation forming a characteristic interface between both fields. Incisors and canines retain transverse HSB. - The phylogenetic position of *Lophiodon* and *Hyrachyus* has been debated in previous studies. *Lophiodon* shares the typical tapiroid schmelzmuster. *Hyrachyus*, however, is different from rhinos as well as tapirs and might represent a fifth type of schmelzmuster. - The frequent parallelisms in enamel structures complicate the phylogenetic interpretation, but the schmelzmuster might contribute significantly to the reconstruction of the phylogeny since only very specific transformations from one type to another seem to be possible.

Poster Session I (Wednesday)

**SYSTEMATICS OF PLIOPATECARPINE MOSASAURS (MOSASAURIDAE: PLIOPATECARPINI)**

KONISHI, TAKUYA, University of Alberta, Edmonton, AB, Canada

The mosasaur tribe Plioplatecarpini, consists of three genera: *Ectenosaurus*, *Platecarpus*, and *Plioplatecarpus*. The majority of plioplatecarpine specimens are found in the Western Interior Basin (WIB) of North America, although the latter two genera are also known from the margins of the Mediterranean Tethys such as Belgium, France, and possibly northern Africa. *Ectenosaurus* is so far only known from five catalogued specimens from the Santonian exposures in western Kansas, USA, representing at least two species. In a marked contrast, more than 500 specimens of *Platecarpus* are known from the upper Coniacian to lower Campanian exposures of the WIB, most notably from the Smoky Hill Chalk Member in Kansas. Due in part to this rich fossil record, the genus had long been in a state of great taxonomic flux, but observation of more than 350 specimens indicates that two species can be recognized within North America. As well, recent detailed analyses of the plioplatecarpine specimens, found ubiquitously in the lower middle Campanian strata within the WIB, recognize a new, distinct group of plioplatecarpines. This group, including the specimens of *Platecarpus* cf. *P. somenensis* and possibly "*Plioplatecarpus*" *nichollsae*, exhibits more synapomorphies with *Plioplatecarpus* than *Platecarpus* does, and stratigraphically falls between the two genera. Two species of *Plioplatecarpus* are recognized from the upper Campanian and lowermost Maastrichtian strata of the WIB. From the upper Maastrichtian strata of Netherlands and Belgium, two other species of *Plioplatecarpus* are identified. Phylogenetic analysis, based on a novel osteological character set, supports the basal position of *Ectenosaurus* within the plioplatecarpine clade as former studies had suggested, but *Platecarpus* and the lower middle Campanian taxa often form a paraphyletic assemblage leading to a monophyletic post-middle Campanian *Plioplatecarpus*. Nevertheless, at least one most parsimonious tree, the preferred hypothesis, groups *Platecarpus* cf. *P. somenensis* and "*Plioplatecarpus*" *nichollsae* as a monophyletic clade. These results suggest a large systematic revision of the entire plioplatecarpine clade.

Technical Session VII, Thursday 1:30

**A HOMOLGY-BASED NOMENCLATURE FOR DUPLICIDENTATE TOOTH CUSPS DERIVED FROM THE TRIBOSPHEMIC CONDITION**

KRAATZ, Brian, American Museum of Natural History, New York, NY, USA; MENG, Jin, American Museum of Natural History, New York, NY, USA; LI, Chuankui, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Tooth cusp homology for extant and many extinct lagomorphs has remained unclear due to the simplified, derived morphology of their cheek teeth. This has led several workers to propose systems unique to lagomorphs that share little relationship to the tribosphenic terminology used more broadly across Mammalia. This is problematic for understanding patterns of evolution between lagomorphs and all other mammals as teeth have traditionally played prominent roles in reconstructing mammalian evolutionary history. Our inability to utilize a tribosphenic nomenclature for lagomorphs has largely been based on two factors; first, the living members of the order have enamel crowns that are worn early in life and often leave no remnants of enamel cusps, and secondly, there has been a lack of fossil material that fills the evolutionary gap between 'typical' lagomorph tooth crown pattern and ancestral cusp patterning that can be easily reconciled with tribosphenic cusp nomenclature. We propose a new nomenclatural system of tooth cusp homology that can be used across all living and extinct duplicidentates and is consistent with the tribosphenic condition. The system is based on detailed study of unworn cheek teeth of living and extinct representatives of duplicidentates as well as new fossil material that clarifies the transitional tooth morphology between basal taxa exhibiting clear tribosphenic patterns and derived taxa that, until now, have had teeth questionably related to the tribosphenic condition.

Poster Session IV (Saturday)

**NEOSELACHIAN INTERRELATIONSHIPS, FOSSILS, AND THE ORIGIN OF MAJOR NEOSELACHIAN LINEAGES**

KRIWET, Juergen, Museum fuer Naturkunde, Humboldt-Universitaet zu Berlin, Berlin, Germany; KLUG, Stefanie, Museum fuer Naturkunde, Humboldt-Universitaet zu Berlin, Berlin, Germany

Modern Neoselachii (sharks, skates, and rays) are divided into 12 orders and three supraordinal groups (Galeomorphy, Squalomorphy, Batoidea). Phylogenetic hypotheses based on morphological data suggest that batoids are derived sharks, joined with saw sharks and angel sharks in a clade Hynostomata. Molecular phylogenetic analyses, however, are inconsistent with the hynostomata hypothesis and show Batoidea to be sister to all remaining neoselachians. Major topics in neoselachian phylogeny are not only restricted to the position of batoids, but also to the interrelationships and monophyly of several groups (e.g., Carcharhiniformes, Squaliformes). The application of different data sets (morphology vs. genetics) has a fundamental impact on the composition and position of the clades. Partial phylogenies (i.e. those considering only few taxa, limited or different kinds of data sets) are gathered at increasing rates leading to more and more phylogenetic hypotheses, in which the topologies sometimes differ only marginally. This is not trivial, because phylogenetic hypotheses often are used to infer past diversity and diversification patterns of vertebrates. Combined phylogenetic analyses of neoselachian interrelationships with inclusion of fossil

holomorphic representatives from the Jurassic and Cretaceous permit to create calibrated phyletic trees for inferring the timing of cladogenetic events and to reconstruct evolutionary events. Three monophyletic groupings, Batoidea, Galeomorphy, and Squalomorphy are supported. Batoidea is sister to all remaining neoselachians. The split between both occurred early, presumably in pre-Jurassic times. Galeomorphy is a very ancient group with Palaeospinacidae (belonging to Synchodontiformes) being the most plioselachian group. The results support previous hypotheses that a first major diversification event occurred in the Early Jurassic. By the end of the Jurassic, most clades of modern neoselachians were present, with the exception of Lamniformes and Squaliformes, which originated in the Early Cretaceous. The adaptation of Squaliformes to deep-water environments occurred probably very early in their evolutionary history.

Poster Session III (Friday)

**PRELIMINARY PALEOECOLOGIC AND TAPHONOMIC OBSERVATIONS ON THE VERTEBRATE FAUNA OF THE WAYAN FORMATION (ALBIAN-CENOMANIAN) OF EAST IDAHO**

KRUMENACKER, L.J, Idaho Museum of Natural History, Pocatello, ID, USA; JACKSON, Frankie, Montana State University, Bozeman, MT, USA; MOORE, Jason, Texas A&M University, College Station, TX, USA; ROBISON, Steve, U.S. Forest Service, Idaho Falls, ID, USA; VARRICCHIO, Dave, Montana State University, Bozeman, MT, USA

The Wayan Formation (Albian-Cenomanian) of Idaho consists predominantly of variegated mudstones and siltstones with calcareous nodules (indicative of a semi-arid, well-drained floodplain) and fine-grained fluvial sandstones. The Wayan has produced 66 vertebrate localities (14 with in situ material). Twenty-six of these localities yielded remains of small (<3 m long) basal ornithomorphs, constituting fifty-five percent of the identifiable terrestrial vertebrate fossils found. Fine grained floodplain and overbank facies have produced eight in situ partial skeletons of basal ornithomorphs. Articulated vertebrae, pedal elements, and relatively unweathered bones with little abrasion are common in these facies, suggesting low energy burial and/or presence of soft tissues. Other localities in these facies produced a rib of a large ornithomorph, a large (>76 cm long) partial crocodylian skull, and abundant elongatoolithid eggshell concentrations, possibly representing hatched eggs of large theropods. Two basal ornithomorph partial skeletons are known from fine grained channel sandstones. A crevasse splay deposit, a coarse-grained lag deposit, and another coarse grained fluvial deposit have produced fish teeth and most of the larger dinosaur specimens. Dinosaur elements typically consist of fragmentary bones and teeth from ankylosaurs, iguanodonts, and theropods. Fossils from these coarser deposits range from pristine to heavily abraded, suggesting varying degrees of transport, reworking, and/or sub-aerial exposure. The numerical dominance of basal ornithomorphs in floodplain facies may reflect genuine ecological separation and/or a taphonomic bias due to size, but we suggest that, like small herbivores in modern vertebrate communities, small ornithomorphs were numerically dominant in the Wayan paleocommunity. The near absence of larger dinosaur skeletal remains in floodplain facies is likely a function of slow rates of sedimentation on the floodplain.

Technical Session IX, Thursday 3:00

**INSIGHT INTO THE TEMPO OF GALLIFORM EVOLUTION FROM COMBINED PHYLOGENETIC ANALYSES AND A NEW MIOCENE REPRESENTATIVE OF PHASIANIDAE**

KSEPKA, Daniel, North Carolina State University, Raleigh, NC, USA

Galliformes are a widely distributed clade including the Megapodiidae (mound builders), Cracidae (guans, chachalacas and curassows), Numididae (guinea fowl), Odontophoridae (New World quails) and Phasianidae (pheasants, partridges, and allies). Galliformes represent one of the basal divergences within extant Aves, and as such have been the focus of numerous molecular divergence dating analyses. Three recent divergence dating studies concluded that most major extant lineages of Galliformes split prior to the K-T mass extinction, implying temporally deep crown divergences and high levels of survivorship across the K-T boundary. These studies relied exclusively on two Eocene fossils as internal calibration points: *Amitabha urbsinterdictensis* (Bridger Formation: ~50ma) and *Gallinuloides wyomingensis* (Green River Formation: ~55ma). However, the relationships of these fossil taxa have been contested, motivating a new investigation of both taxa. Reexamination of *A. urbsinterdictensis*, aided by further preparation of the holotype and CT scanning, reveals this fossil is not a 'phasianoid' as previously proposed. Multiple synapomorphies indicate *A. urbsinterdictensis* is closely related to living rails (Rallidae). Phylogenetic analyses using a new matrix including 56 galliform taxa scored for 118 morphological characters and incorporating sequence data from ND2 and cytochrome *b* strongly supports exclusion of *G. wyomingensis* from crown Galliformes. Six unambiguous synapomorphies unite crown Galliformes to the exclusion of *G. wyomingensis* and its sister taxon *Paraortygoides messelensis*. The current study reveals that inappropriate internal calibrations may have contributed to overestimation of divergence dates. This finding calls into question the inferred Cretaceous origin of multiple crown galliform lineages. Phylogenetic placement of more fossil taxa is required to fully understand the pattern and timing of galliform evolution. A new taxon from the Miocene Ash Hollow Formation of Nebraska contributes to this endeavor. Represented by an articulated skull and partial skeleton, this fossil represents one of the most complete and earliest well-constrained occurrences of crown Phasianidae in North America.



Technical Session XVII, Saturday 8:00

**FIRST SKULL OF THE CONDYLARTH *ORTHASPIDOTHERIUM EDWARDI* FROM THE LATE PALEOCENE OF BERRU (FRANCE) AND AFFINITIES OF THE ENIGMATIC EUROPEAN FAMILY PLEURASPIDOTHERIDAE**  
LADEVÈZE, Sandrine, Royal Belgian Institute of Natural Sciences, Bruxelles, Belgium; MISSIAEN, Pieter, Ghent University, Ghent, Belgium; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Bruxelles, Belgium

“Condylarths” were highly diverse and widespread during the early Cenozoic. Although North America has the most complete record, “condylarths” were also abundant in the European Paleocene faunas. The Berru and Cernay-lès-Reims sites from the Thanetian of the Paris Basin (northern France) have yielded many mammals and especially condylarth remains. Among them, *Pleuraspidotherium* and *Orthaspidotherium* lie at the heart of a systematic imbroglio, as they have been referred to Meniscotheridae, Phenacodontidae and Mioclaenidae, but their relationships to any particular group of “condylarths” have not been conclusively settled. While the systematic position of pleuraspidotheriids among “archaic ungulates” is still discussed, and while the quest for potential ancestral groups for modern ungulates (Perissodactyla, Artiodactyla) is still active, we here provide new information, particularly from the basicranium. Study of the first complete skull of *Orthaspidotherium* highlights a number of diagnostic characters for a clade Pleuraspidotheridae (i.e., *Pleuraspidotherium* plus *Orthaspidotherium*). A potential synapomorphy for this grouping is the superior ramus of the stapedial artery, which passes through the tegmen tympani. Moreover, pleuraspidotheriids exhibit a mosaic of pleiomorphic and derived characters that distinguish them from other “archaic ungulates”. Some of these characters are shared with modern ungulates, for example the presence of a pseudo-hypocone (present in artiodactyls) and enclosure of the facial nerve by a long tympanic process and tympanohyal (present in perissodactyls).

Poster Session I (Wednesday)

**EARLY HOLOCENE ENVIRONMENT ON THE CLARY RANCH, ASH HOLLOW, WESTERN NEBRASKA: A MULTIPROXY INTERPRETATION USING SEDIMENTS, MICROFAUNA, AND GASTROPODS**  
LADUKE, Thomas, East Stroudsburg University, East Stroudsburg, PA, USA; HILL, Matthew, Iowa State University, Ames, IA, USA; MAY, David, University of Northern Iowa, Cedar Falls, IA, USA; SEMKEN, Holmes, University of Iowa, Iowa City, IA, USA; THELER, James, University of Wisconsin- La Crosse, La Crosse, WI, USA

Interdisciplinary research from 2001 to 2007 on Clary Ranch along the North Platte River was designed, in part, to document the character of regional early Holocene environments. Five alluvial depositional units are recognized at the site. Sediments are stratified and well dated, and contain multiple proxy indicators on past environments. Systematic sampling of these units for microfauna is particularly revealing. Sixteen micromammal species suggest: (1) The upland environment closely resembled the modern arid, short-grass prairie but precipitation was more effective than at present; longer duration and increased snow cover, would increase effective moisture during the period of occupation. (2) A gallery forest in Ash Hollow was better developed than at present and was associated with tall grass prairie stands, meadows, and wetlands. (3) Winter extremes were not as great in the valley; for microfauna, this could have been enhanced by a longer-lasting blanket of snow. (4) Cooler summers, on average, were the norm. (5) The chronological proximity of the Late Paleindian component to glacial non-analog faunal associations in combination with protective north-facing slopes of Ash Hollow, probably assisted preservation of microenvironments suitable for the relict, late-glacial fauna. Noteworthy in the herpetofauna are extralimital records of *Hyla* sp. and *Diadophis punctatus*. *Hyla* and *Diadophis* are characteristic of more mesic climates than found in the vicinity today. The four anuran species identified indicate the presence of wetlands with pools that must have lasted at least 40 to 50 days to support metamorphosis of *Hyla* sp. and *Rana* sp. Analysis of gastropods indicates the following. Between 9900 and 9600 yr B.P., moist substrates were available in protected settings. Between 9500 and 9400 yr B.P., aquatic snails disappear and land snails become rarer. Standing water is no longer present. From 9300 to 9100 some species of terrestrial snails return. These indicate presence of lush prairie vegetation. After ~9000 yr B.P., snail diversity and density decline, indicating a changing regional climate toward drier conditions.

Technical Session XX, Saturday 3:45

**TUSK-BEARING BEAKED WHALES FROM THE MIOCENE OF PERU**  
LAMBERT, Olivier, Institut royal des Sciences naturelles de Belgique, Brussels, Belgium; BIANUCCI, Giovanni, Università di Pisa, Pisa, Italy; POST, Klaas, Naturhistorisch Museum Rotterdam, Rotterdam, Netherlands; URBINA, Mario, Museo de Historia Natural, Lima, Perú

The beaked whales (Ziphiidae) are a toothed whale family including 21 Recent species, ranging in size between 3 and 12 m. Their main prey items are cephalopods, which they catch at important depths and swallow by suction. Most of the Recent ziphiids only bear one or two pairs of mandibular teeth, modified into tusks that erupt and reach a larger size in adult males. These sexually dimorphic tusks are used in intraspecific fights between males; the body surface accumulates unpigmented scars produced by the tusks of the opponent, the scars being considered as indicators for male quality. Additionally, in several genera adult males display a more complete ossification of the vomer in the mesorostral groove of the

rostrum, reducing the risk of fracture when fighting. We report the discovery of two ziphiid taxa from the Miocene lowest levels of the Pisco Formation, Ica desert, Peru: a new genus and species (one specimen) and *Messapicetus* sp. (seven specimens). The first new taxon is characterized by a strong dental reduction: the upper and lower alveolar rows are reduced to a narrow groove, and tiny teeth found in the sediment around the snout are considered not functional. A large alveolus is partly preserved at the end of the dentary, suggesting the presence of an apical tusk. In *Messapicetus* sp. a complete series of maxillary and dentary alveoli is retained, holding shallowly embedded large and transversely flattened teeth, combined with a pair of robust mandibular apical tusks. Furthermore, on the elongated rostrum the thickened premaxillae of the adults are dorsomedially elevated, closing the mesorostral groove dorsally. These new fossil finds (1) confirm that tusks were present in several Miocene ziphiids, likely related to aggressive interactions between males; (2) indicate that some but not all Miocene tusk-bearing ziphiids retained additional functional teeth; and (3) suggest an alternative way to strengthen the rostrum, not homologous to the mesorostral ossification of the vomer, developed in some forms through premaxillary dorsal closure of the mesorostral groove.

Poster Session II (Thursday)

**IDENTIFYING DIFFERENTIAL SIZE TRENDS IN MESOZOIC BIRDS USING NEW DATA AND A NOVEL METHOD**

LAMM, Kristin, North Carolina State University, Raleigh, NC, USA; KSEPKA, Daniel, North Carolina State University, Raleigh, NC, USA; STONE, Eric, North Carolina State University, Raleigh, NC, USA; CLARKE, Julia, North Carolina State University, Raleigh, NC, USA

Previous studies have identified a general trend of phyletic body size increase in both extant and extinct birds. However, an opposite pattern has been inferred for Mesozoic Ornithomorphs, perhaps suggesting that a tendency toward smaller body size in the lineage leading to modern birds could have contributed to differential survival across the K-T boundary. Here, we evaluate patterns of size through time in Mesozoic birds using a revised data set and novel rank correlation approach. This analysis incorporates uncertainty in fossil dates and addresses bias due to the fact that some time intervals are more heavily sampled than others. Our results do not support a decrease in size through time in the lineage leading to modern birds. Instead, a trend toward larger size is recovered for (1) Ornithomorphs, (2) Enantiornithes and (3) all Mesozoic birds considered together. These results could indicate a real pattern of body size increase; alternatively, they might reflect preservation bias in the fossil record. Earlier deposits in low energy environments tend to preserve a wide range of body sizes. Later material is better known from higher-energy fluvial and marine deposits, where larger bodied birds with sturdy skeletal elements may be more amenable to preservation. An animal's body size may relate to many life history variables, including number and size of offspring, growth rate, metabolic rate and ecological role. Evolutionary trends in body size may be used to infer corresponding patterns and processes in these other traits; however, the reliability of such conjecture can be affected by incomplete sampling in the fossil record.

Poster Session IV (Saturday)

**PECTORAL MORPHOLOGY OF FOSSIL HYBODONT SHARKS: NEW INFORMATION AND BROADER IMPLICATIONS**

LANE, Jennifer, American Museum of Natural History and The City University of New York, New York, NY, USA; MAISEY, John, American Museum of Natural History, New York, NY, USA

New fossil material of the hybodont shark *Tribodus limae* (Lower Cretaceous, Aptian/Albian) provides new information on the pectoral endoskeleton in this taxon, allowing for a major revision of its pectoral fin morphology that may be broadly applicable to other Hybodontidae. Four new specimens of *Tribodus* with well-preserved pectoral material are included. Whereas previous specimens of hybodont pectoral fins are typically embedded in matrix and show only the lateral or medial side of the scapulocoracoid, several of the new specimens are preserved in three dimensions and reveal the presence of an oblique narrow ridge on the posterior of the scapulocoracoid, interpreted as the articular process for the pectoral fin. The pectoral articulation of *Tribodus* is structurally similar to that of many neoselachian sharks (the sister group to hybodonts), and represents the first evidence of such a structure in a hybodont. Pectoral morphology of two problematic hybodontiforms, *Onychoselache* and *Tristychius*, differs from that of *Tribodus*. An oblique posterior fin articulation as in *Tribodus* is also present in other Elasmobranchii including xenacanth and ctenacanth (considered the outgroups to hybodonts + neoselachians), indicating that this feature may be primitive for this group. However, it is not present in *Cladoselache* and symmoriforms, which instead have an elongated, laterally positioned articular process. Aside from the structure of the fin articulation, overall morphology of the pectoral fin and girdle of *Tribodus* is similar to that of other hybodontiforms and neoselachians. CT scanning shows that *Tribodus* has an additional diazonal canal not found in other hybodonts. Other pectoral features of *Tribodus* are in agreement with previous phylogenetic hypotheses, supporting the position of *Tribodus* within Hybodontidae.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**FAUNAL SHIFTS AS INDICATED BY MICROVERTEBRATE FOSSILS OF THE LATEST SANTONIAN UPPER MILK RIVER FORMATION, ALBERTA, CANADA**  
LARSON, Derek, University of Alberta, Edmonton, AB, Canada

Microvertebrate fossil localities are a useful source of information when evaluating the diversity, ecology, evolution, and environments of fossil communities. Although microvertebrate accumulations are subject to preservational biases, informative data on representative communities can still be recovered. To counteract these biases, a variety of methods can be employed, including comparing the relative abundances of the same skeletal elements, comparing the ranks of taphonomically similar elements, and sampling from different depositional environments at the same stratigraphic level. Using these methods, the changes in relative abundances in the vertebrate community throughout the latest Santonian Deadhorse Coulee Member of the Milk River Formation of Alberta, Canada, have been evaluated. Studies indicate a fauna much more diverse than has been previously recognized, with representative taxa from older faunas, as well as groups more characteristic of latest Maastrichtian and more southern faunas. With stratigraphic and geographic bounds tightly controlled, as well as a detailed knowledge of relative distance to the paleoshoreline, these changes can be interpreted as actual changes within the fossil community (i.e. not the result of taphonomic processes). With biases accounted for, these faunal changes have implications in the faunal turnover, paleobiogeography, and evolution of fossil groups during this important time in the history of western North America.

Poster Session III (Friday)

**USING ECOLOGICAL NICHE MODELS TO EXPLORE PALEOBIOGEOGRAPHIC PATTERNS**

LAWING, A, Indiana University, Bloomington, IN, USA; MEIK, Jesse, University of Texas at Arlington, Arlington, TX, USA; POLLY, P, Indiana University, Bloomington, IN, USA

We reconstructed (paleo) biogeographic patterns with ecological niche models (ENMs) to infer present and past niches within, and relationships between, species geographic borders. We used ENMs to study the important climatic associations for parapatrically distributed sister species of rattlesnakes, *Crotalus mitchellii* and *C. stephensi*. We georeferenced species occurrence data and projected the potential extent of ranges onto current and reconstructed last glacial maximum (LGM) climate maps. The maps consist of 19 bioclimatic variables derived from monthly temperature and rainfall values. Precipitation in the warmest quarter of the year is the most important variable and explains both species distributions by more than 28%. The next important variables explaining approximately 95% of the distributions are different in number, order and magnitude for each species. Projecting ENMs onto paleoclimatic reconstructions during the LGM allows us to infer Pleistocene refugia. Rattlesnakes respond to different sets of bioclimatic variables, indicating that paleobiogeographic patterns are divergent. The estimated range for *C. stephensi* greatly contracts and migrates south along the southern periphery of its current range, and the range for *C. mitchellii* minimally contracts and remains static. Refugia predictions from the ENM support previous hypotheses of refugia based on molecular phylogeography. Assuming niche conservatism within species, this approach can be used to generate hypotheses about past climate with paleontological data. The approach is also extended to reconstruct the fundamental niche of the common ancestor of a lineage of a clade, and by implication, which bioclimatic variables most strongly influenced diversification of its constituent species.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**A TOTAL EVIDENCE ANALYSIS OF THE EVOLUTIONARY HISTORY OF THE THUNNOSAUR ICHTHYOSAURS**

LAWRENCE, Jessica, Bowling Green State University, Bowling Green, OH, USA

Ichthyosaurs first appear in the Early Triassic with an elongate, lizard-shaped anatomy. The most derived ichthyosaurs including the Late Triassic-Early Jurassic Eurhinosauria and the Late Triassic-Cretaceous Thunnosauria, evolved more streamlined fish-shaped bodies. A species-level cladistic analysis of this derived group of ichthyosaurs, including 17 outgroup taxa and one ingroup taxon, was conducted using PAUP\*. The new analysis is compared to that of a previous genus-level analysis of ichthyosaurs by looking at the clade-defining character state changes in each. I use a total evidence approach, i.e., the phylogenetic analysis plus data on stratigraphic and geographic occurrences, to answer two questions. First, is placing *Stenopterygius* as a sister to the Ophthalmosauria more plausible than a longer ghost lineage for Ophthalmosauria required if *Ichthyosaurus* is its sister taxon, as previously suggested? A phylogenetic tree incorporating stratigraphic ranges is constructed to help quantify the stratigraphic debt using three indices. Four previously defined clades fall apart, including *Leptonectes*, *Stenopterygius*, Eurhinosauria and Ophthalmosauria. Hence, previous suggestions that *Stenopterygius* and Ophthalmosauria be placed as sister taxa is not supported by this analysis. The ophthalmosaurian taxa are pulled down the tree, creating even longer ghost lineages than were previously present. However, overall the species-level phylogeny is more stratigraphically parsimonious than the previous genus-level one. The second objective of this study is to determine whether the radiation of the Ophthalmosauria is due to the tectonic opening of new marine habitats and/or the appearance of morphological novelties. The radiation of the Ophthalmosauria into the Western Hemisphere coincides with Late Jurassic tectonic events in the South Atlantic and western Tethys, as well as nine synapomorphies involving changes to the ear region, lower jaw, forefin (including extra digits), and pelvis. These traits may be associated with adaptations to more efficient swimming in open ocean habitats, aiding the group's biogeographic dispersal.

Technical Session XIV, Friday 2:15

**THE CRANIAL OSTEOLOGY OF *MINMI* SP., A BASAL ANKYLOSAUROMORPH (ORNITHISCHIA: DINOSAURIA) FROM THE EARLY CRETACEOUS (ALBIAN) ALLARU FORMATION OF RICHMOND, NORTH-WESTERN QUEENSLAND, AUSTRALIA**

LEAHEY, Lucy, University of Queensland, Brisbane, Australia; MOLNAR, Ralph, Museum of Northern Arizona, Flagstaff, AZ, USA; SALISBURY, Steven, University of Queensland, Brisbane, Australia

*Minmi* is the only known genus of ankylosaur endemic to Australia. Seven specimens are known from the Early Cretaceous of Queensland. Only two of these have been described in detail: the holotype *Minmi paravertebra* and a near complete skeleton *Minmi* sp. (QMF18101). QMF18101 represents one of the world's most complete and Gondwana's only Early Cretaceous ankylosaur, and is currently the best-preserved dinosaur fossil in East Gondwana. Moreover, the skull of QMF18101 is one of four known ankylosaur skulls in which the majority of sutures have not fused or been obliterated by dermal armour. Molnar provided a preliminary description of this specimen. Further preparation and CT imagery of QMF18101 has revealed new information on the morphology of the cranium, in particular the palate and nasal regions. A character thought to be unique to ankylosaurs among other dinosaurians is the bony secondary palate. The majority of the descriptive literature on bony palates provides ambiguous parameters which to define distinct grades of this feature in fossil vertebrates. Clear osteological boundaries are needed to aid in the identification of palatal forms, not just in dinosaurians, but in all vertebrates. This study used extant and extinct fauna to construct universal definitions. The bones involved in the ankylosaurian bony secondary palate are the same as those in other taxa, nonetheless their osteological configuration is significantly different. Based on the definitions and parameters defined as a result of this study, and contrary to much of the literature, ankylosaurs do not possess a bony secondary palate. They do however possess a bony palate. The phylogenetic position of *Minmi* has fluctuated in previous analyses due to the limited information available and the general lack of understanding of the early forms of this group. Our phylogenetic analysis firmly places *Minmi* basal to the traditional Ankylosauria (Ankylosauridae + Nodosauridae). The creation of a new stem-based group Ankylosauromorpha is therefore proposed to include *Minmi* and other taxa, traditionally thought of as ankylosaurs, that fall outside of Ankylosauria.

Technical Session XIV, Friday 3:15

**RAPID GROWTH OF THE HADROSAUR *HYPACROSAURUS* REFLECTS DIRECT AND INDIRECT EFFECTS OF PREDATION**

LEE, Andrew, Ohio University College of Osteopathic Medicine, Athens, OH, USA; COOPER, Lisa, Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; TAPER, Mark, Montana State University, Bozeman, MT, USA; HORNER, John, Montana State University, Bozeman, MT, USA

Hadrosaurs grew rapidly, but how rapidly they grew remains controversial. Their growth is a key to understanding life-history interactions between predators and prey during the Late Cretaceous. In this study, we longitudinally sampled a sequence of lines of arrested growth (LAGs) from an essentially full-grown hadrosaur *Hypacrosaurus stebingeri* (MOR 549). Spatial locations of LAGs in the femoral and tibial transverse sections of *Hypacrosaurus* were measured and circumferences were calculated. For each bone, a time series of circumference data was fitted to several stochastic, discrete growth models. Our results suggest that the femur and tibia of *Hypacrosaurus* likely followed a Gompertz curve and that LAGs reportedly missing from early ontogeny were obscured by perimedullary resorption. *Hypacrosaurus* reached an age at death of 13 years and took about 10–12 years to reach 95% of its asymptotic size. The age at growth inflection, which is a proxy for reproductive maturity, occurred at about 2–3 years. Comparisons with several small and large predatory theropods reveal that *Hypacrosaurus* grew faster and matured sooner than them. Individuals surviving predation benefited from reduced competition for resources, which fueled the rapid growth to large size.

Poster Session III (Friday)

**A SHORT REPORT OF KOREA-MONGOLIA INTERNATIONAL DINOSAUR PROJECT (1ST AND 2ND YEAR)**

LEE, Yuong-Nam, Institute of Geoscience and Mineral Resources, Daejeon, Korea, South; BARSBOLD, Rinchen, Paleontological Center of Mongolian Academy of Sciences, Ulaanbaatar, Mongolia; JACOBS, Louis, Southern Methodist University, Dallas, TX, USA; CURRIE, Philip, University of Alberta, Edmonton, Canada

The largest dinosaur egg site in the Korean Peninsula was discovered in 1999 at Hwaseong City. Because of the unique setting and scientific importance of that locality, Hwaseong City conserved the area and began planning a new museum. The ambitious plans for the museum call for extensive displays. Therefore, Hwaseong City sponsors the Korea-Mongolia International Dinosaur Project, a five-year effort that began in 2006 with the cooperation of the Korea Institute of Geoscience and Mineral Resources and the Paleontological Center of the Mongolian Academy of Sciences. Scientifically important and display quality specimens of dinosaurs and other fossils collected in the Gobi Desert will be studied and displayed in the new dinosaur museum at the Korean egg site. In the first year of the project, 2006, the base camp was at Ulan Khushu in the central Gobi where the Nemegt Formation was

prospected at Ulan Khushu, Altan Uul, Bugin Tsav, and Guriliin Tsav. We collected fossils, including *Tarbosaurus*, *Gallimimus*, ornithomimids, therizinosaurs, crocodiles, and turtles, from new sites as well as from illegally excavated quarries. Most specimens are partially complete skeletons, except for one complete ornithomimid found at Ulan Khushu. In 2007, we explored the Bayanshiree Formation at Bayan Shiree, Khar Khutul, and Shine Us Khudag in the eastern Gobi, and the Barungoyot and Nemegt formations at Khermeen Tsav in the western Gobi. In the second season we excavated a new, nearly complete sauropod skeleton without skull, ankylosaur skeletons including three skulls, and an oviraptorosaurid nest with embryos. A total of 118 plaster jackets and 46 boxes containing specimens were transported to the Paleontological Center in Ulaanbaatar, some of which were then taken to new preparation facilities in Hwaseong City. The construction of the new museum at Hwaseong preserves an important dinosaur egg locality and conserves the ecologically sensitive area surrounding it, promotes international cooperation, builds collections for research, and fosters education. The authorities at Hwaseong City recognize that it enhances the cultural attraction of their city and promotes ecotourism.

Technical Session I, Wednesday 12:30

**LOCOMOTOR ECOLOGY AND COMMUNITY STRUCTURE OF PREDATOR/PREY RELATIONS IN OLIGOCENE AND RECENT LARGE MAMMALS**

LEVERING, David, University of Oregon, Eugene, OR, USA; HOPKINS, Samantha, University of Oregon, Eugene, OR, USA

Predator-prey relationships are critical to shaping the evolution of locomotor habits in both hunters and hunted. An understanding of how this relationship changes through time, particularly with changes in the structure of the ecosystem, is important to our understanding of major morphological trends in large mammals. Here we use locomotor ecomorphospace (as described by limb bone proportions) to describe ecosystem structure for mammalian herbivores and carnivores. This study uses data from Recent and Oligocene ungulates and carnivores. Oligocene taxa are sampled exclusively from North America, while Recent data are drawn from worldwide in order to allow compensation for the relatively recent Pleistocene megafaunal extinctions. In this study, ecomorphospace is described as the proportion of distal to proximal segments in the forelimb (radius/humerus) and the hindlimb (tibia/femur). These ratios are used to infer aspects of mechanical advantage in the limb stroke, and thus locomotor type. Comparisons of the distributions of taxa in locomotor space reveals ecological and morphological shifts within both predators and prey during the last 35 million years. While phylogenetic factors are partly responsible for the observed disparity between Oligocene and Modern locomotor ecomorphological distribution, ecosystem structure, primarily the spread of grasslands, seem to have had a marked effect on the distribution of locomotor types clearly shown in this study. Dynamics in ecology coupled with shifts in taxonomic diversity and composition have dramatically altered the dominant locomotor strategies since the Oligocene, particularly in carnivores. Simultaneously, the distribution of locomotor strategies in herbivores has shown little alteration, changing primarily in abundance and in which clades occupy which zones of locomotor ecomorphospace.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 8:45

**CARBON ISOTOPIC EVIDENCE FOR *ARDIPITHECUS* HABITAT AT GONA, ETHIOPIA**

LEVIN, Naomi, University of Utah, Salt Lake City, UT, USA; SIMPSON, Scott, Case Western Reserve University, Cleveland, OH, USA; QUADE, Jay, University of Arizona, Tucson, AZ, USA; CERLING, Thure, University of Utah, Salt Lake City, UT, USA; FROST, Stephen, University of Oregon, Eugene, OR, USA

*Ardipithecus* fossils found in late Miocene and early Pliocene deposits in the Afar region of Ethiopia, along with *Sahelanthropus tchadensis* from Chad and *Orrorin tugenensis* from Kenya, are among the earliest known human ancestors and considered to be the predecessors to the subsequent australopithecines (*Australopithecus anamensis* and *Au. afarensis*). Current paleoenvironmental reconstructions suggest a wooded habitat for both *Ardipithecus kadabba* and *Ar. ramidus*, but more open and varied environments for other hominids living in Africa during the late Miocene and early Pliocene. To further evaluate the environmental context of *Ardipithecus*, we present stable carbon isotope data of 182 fossil herbivore teeth from *Ardipithecus*-bearing fossil deposits in the Gona Paleoanthropological Research Project area, in the Afar region of Ethiopia. The sampled teeth include representatives of all major fossil herbivore taxa and the majority of the mammalian biomass that lived in the same time and place as the hominids. We also present isotopic data of extant herbivore teeth from a range of ecoregions in Ethiopia, Kenya, and the Democratic Republic of the Congo (e.g., montane moorlands and grasslands, montane forests, lowland forests, forest-savanna mosaics, grasslands, and bushlands). When compared to extant herbivores from eastern Africa, the spectra of isotopic results from herbivores found in late Miocene *Ar. kadabba* and early Pliocene *Ar. ramidus* sites at Gona are most similar to isotopic values from extant herbivores living in bushland and grassland regions, but dissimilar to those from herbivores living in closed-canopy forests, montane forests, and high-elevation grasslands. The tooth enamel isotopic data from fossil herbivores make it clear that *Ardipithecus* at Gona lived among a guild of animals whose diet was dominated by C<sup>4</sup> grass, and where there is no record of closed-canopy vegetation.

Poster Session III (Friday)

**A MIXED MARINE/NON-MARINE AND TERRESTRIAL MICROVERTEBRATE ASSEMBLAGE FROM THE LATE CRETACEOUS (LATE SANTONIAN-EARLY CAMPANIAN) MENEFEE FORMATION OF NEW MEXICO: FAUNA, BIOSTRATIGRAPHY, AND PALEOECOLOGY**

LEWIS, Caleb, University of New Mexico, Albuquerque, NM, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA

We report a finalized faunal list for an earliest Campanian mixed marine/non-marine aquatic and terrestrial fauna from the Allison Member of the Late Cretaceous (late Santonian–early Campanian) Menefee Formation of northwestern New Mexico. This is a poorly known time interval in the Western Interior, so this fauna is crucial to our understanding of the biostratigraphy and evolution of the Late Cretaceous Western Interior. The assemblage contains *Lonchidion*, *Squatina*, *Squatirhina*, *Ischyrrhiza*, *Ptychotrygon*, *Dasyatis*, *Dasyatis* n. sp., one n. gen. et. n. sp., *Myledaphus* n. sp., *Cretodus*, *Scapanorhynchus*, *Serratolamna*, *Cretolamna*, and *Carcharias* and generically indeterminate osteichthyans, including lepisosteids, amiids, pycnodontids, and phyllostodonts, numerous *Brachychampsa*-like crocodilian teeth, Tyrannosauridae indet., *Saurornitholestes*, *Richardoestesia isosceles* and *R. gilmorei*, and also three multituberculate premolars and three cf. Marsupialia molars. The formation and site's (NMMNH L-5636) sedimentology indicate that it represents an alluvial floodplain paleoenvironment as part of a deltaic setting, with SW-NE paleoflow, poor drainage and common swampy environments. The aquatic fauna is composed of 73% freshwater or freshwater-tolerant taxa and 27% marine forms, and when combined with the geochemistry of the siderite from the site indicates a dominantly freshwater paleoenvironment with regular marine influences indicates a depositional setting of distal alluvial floodplain to proximal estuarine. Biostratigraphic constraints yield a likely age of 83 Ma, with a definite range of 80-83.5 Ma, based on the co-occurrences of several taxa with *Scapanorhynchus raphiodon*. The taphonomy indicates that the mixed marine/non-marine assemblage is allochthonous or nearly autochthonous, whereas the terrestrial assemblage is allochthonous. A dominance-diversity curve demonstrates an ecological evenness in the local biota represented by the site with no one form ecologically dominant. A rudimentary food web can be theorized from this assemblage as well, although much more sampling from other sites is still needed to confirm these paleoecological claims.

Poster Session II (Thursday)

**PRELIMINARY ANALYSIS OF THE FLORISBAD SMALL ANIMAL ASSEMBLAGE**

LEWIS, Patrick, Sam Houston State University, Huntsville, TX, USA; BRINK, James, National Museum, Bloemfontein, Bloemfontein, South Africa; KENNEDY, Alicia, Sam Houston State University, Huntsville, TX, USA; CAMPBELL, Timothy, Sam Houston State University, Huntsville, TX, USA

Florisbad is a Middle Stone Age locality in the Free State Province, South Africa, well-known for an archaic *Homo sapiens* cranium discovered there in 1932. The fossils and artifacts from Florisbad are recovered from what is primarily a spring deposit approximately twelve meters deep. While substantial work has been accomplished on the materials excavated from this site, what can be learned about the paleoenvironment from the microvertebrates has not been fully explored. More broadly, the makeup and distribution of the small animal fauna of the Free State Province is largely undocumented, negatively impacting our understanding of geographic and temporal ranges of many Plio-Pleistocene taxa. This study, therefore, is focused on the identification of the microvertebrate remains in order to: 1) refine our understanding of the paleoenvironment associated with the Florisbad cranium; and 2) provide a more complete picture of small vertebrate distributions throughout the Plio-Pleistocene. Morphological analyses and dental microwear patterns are used. Much of the Florisbad small vertebrate material is fragmentary with diagnostic elements primarily limited to isolated molars. Preliminary analysis of the material has found a small but diverse assemblage including springhares, rabbits, rodents, amphibians and reptiles. In support of prior research on sediments and the large mammal fauna, a permanent water source is indicated by the presence of taxa such as *Otomys* sp. and amphibians. The occurrence of several springhares in the assemblage also indicates a light woodland, as they generally prefer open ground and are absent from heavy woodlands and tall grassveld.

Poster Session III (Friday)

**THE SKULL OF A LARGE MULTIPLE TOOTH-ROWED CAPTORHINID (AMNIOTA: EUREPTILIA) FROM THE MIDDLE PERMIAN SAN ANGELO FORMATION OF KNOX COUNTY, TEXAS**

LIEBRECHT, Torsten, Museum für Naturkunde Berlin, Berlin, Germany; MÜLLER, Johannes, Museum für Naturkunde Berlin, Berlin, Germany; SUMIDA, Stuart, California State University San Bernardino, San Bernardino, CA, USA

The cranium of a large captorhinid with four rows of maxillary teeth is described in detail. The skull, which was collected in the early 1960s by Everett C. Olson at the Kahn Quarry, Knox County, Texas, lacks both lower jaw and braincase, is heavily flattened due to sedimentary compaction. It was originally attributed to *Rothianiscus multidentata*, a species erected on the basis of a single poorly preserved specimen from another locality in northern Texas, but has since never been investigated in detail. Given that especially in

the last few years our knowledge of captorhinid evolution has improved significantly, we re-examined the San Angelo skull in the light of these new findings. A three-dimensional reconstruction of the skull was performed by building a wax model to scale. On the basis of this reconstruction it became apparent that the taxon possesses the characteristic anatomy and typical proportions of a derived captorhinid such as a narrow, elongate snout and a wide posterior part of the skull, with the postparietals forming part of the dorsal roof of the cranium. However, the taxon also shows some unique features, such as the jugal reaching far anteriorly and the skull table being anteroposteriorly very short. Furthermore, the median tooth rows of the unusually large posterior teeth show a distinctive wear pattern, which is exceptional among captorhinids. A phylogenetic analysis places the specimen within the Moradisaurinae, the clade of the most derived, exclusively multiple tooth-rowed captorhinids, as sister to the clade including *Moradisaurus* and an as yet undescribed captorhinid from India. Despite this analysis, however, the taxonomic status of the specimen is still problematic; solving this problem will require a thorough taxonomic revision of the Middle Permian captorhinids from Texas.

Poster Session I (Wednesday)

**THE FORGOTTEN MAMMOTH SITE: THE STERNBERG ELEPHANT QUARRY IN LANE COUNTY, KANSAS**

LIGGETT, Gregory, Northern California Natural History Museum, California State University, Chico, Chico, CA, USA; BEVER, Gabe, Division of Paleontology, American Museum of Natural History, New York, NY, USA

In 1894, Charles H. Sternberg excavated a site in northeastern Lane County, Kansas, where he reportedly collected as many as 200 elephant teeth, which suggests a minimum number of 50 individuals. Many of the teeth apparently did not end up in scientific collections, so the total number of teeth cannot be verified. The site was described as a small basin in the Niobrara Chalk, below fossiliferous exposures of Ogallala rocks. Despite an effort to scour historic and museum records for clues, and a number of field trips to the region, the exact location of the site has not been established. Sixty catalogued specimens curated in three museum collections (American Museum of Natural History, University of Kansas Museum of Natural History, and the San Diego Museum of Natural History) are likely from the site. We measured the teeth and assigned them to tooth position and ontogenetic age categories. Eighty-six percent of the individuals were 29 years old or younger (African elephant years), similar to the overall pattern of age distribution for the Hot Springs Mammoth Site. A similar taphonomic filter (sinkhole) should be considered for the Kansas site. A great deal of variation in the characters customarily used to distinguish mammoth species was observed in these specimens. Lamellar frequency (number of tooth plates in 10 cm) ranged from 5.4 to 14.0 in 27 lower teeth, and 3.7 to 10.0 in 24 upper teeth. Enamel thickness varied from 1.4 to 2.5 mm. Researchers recognize extreme variation in elephant dentition. Furthermore, most workers routinely assign all the North American elephantids to *Mammuthus*. However, the dental characters of *Mammuthus* species significantly overlap those of *Elephas* species, making objective taxonomic assignment on dental morphological grounds alone tenuous. The available dental data currently do not support a more refined identification than Elephantinae. Taking taxonomic assignment beyond what the morphology alone supports gives an illusion of resolution that may in fact be hindering the advancement of knowledge about elephantid relationships and biogeography.

Poster Session IV (Saturday)

**DISCOVERY OF THE LONGEST BABY SAUROPOD TRACKWAY FROM KOREA**  
LIM, Jong-Deock, Natural Heritage Center, National Research Institute of Cultural Heritage, Daejeon, Korea, South; KONG, Dal-Yong, Natural Heritage Center, National Research Institute of Cultural Heritage, Daejeon, Korea, South; KIM, So-Young, Natural Heritage Center, National Research Institute of Cultural Heritage, Daejeon, Korea, South; KIM, Tae-Hyeong, Natural Heritage Center, National Research Institute of Cultural Heritage, Daejeon, Korea, South; NAM, Sang-Chan, Natural Heritage Center, National Research Institute of Cultural Heritage, Daejeon, Korea, South

As one of the world-renowned localities for Cretaceous dinosaur tracksites, the southern coast of Korea has produced well-preserved trackways. Korean Cretaceous Dinosaur Coast has five tracksites which were nominated as UNESCO World Heritage property. In 1982, Goseong County produced the first Korean dinosaur footprints. The County yielded a trackway made by a baby sauropod. The trackway consists of 16 manus and 18 pes and the length of the pes is between 9.3 and 15.3cm. The length of the baby sauropod trackways is 3.9m. A new dinosaur tracksite was discovered in Geumseong, Euisong County and total numbers of footprints are 114, including seven trackways. More than 20 individuals made those footprints. Sauropod and theropod trackways were occurred at the same stratigraphic level. 62.3% of them are sauropod footprints and 33.3% are theropod footprints. The new tracksite lies within the Sagok Formation (110 MYA) of Gyeongsang Basin and the non-marine deposit implies that it is time-correlated with the Haman Formation, which has produced theropod, sauropod, ornithopod, and bird footprints. Two trackways in the new site include small-sized quadrupedal footprints, which suggest baby sauropods. 60 footprints of baby sauropod dinosaurs were discovered and belonged to two separate baby sauropods. The tracks indicated close association of the two baby sauropod dinosaurs that walked together in one direction toward a herd of sauropods. Also, trackways of two adult sauropods were discovered next to the baby sauropod trackways. The length of two baby sauropod trackways is 4.35m and 4.25m of each, respectively. The longest baby sauropod trackway consists of 29

footprints, which are 15 manus and 14 pes. The average length of manus and pes is between 2.28cm and 9.10cm, respectively. The new site contains 38 tracks of theropods, including four trackways. There is a possibility that two of them are potential interactions with the baby sauropod dinosaurs, because they traveled in same direction in close contact.

Technical Session III, Wednesday 2:45

**CONVERGENCE OF GIGANTISM IN MOSASAURS DOES NOT REFLECT A CONVERGENCE OF GROWTH STRATEGY**

LINDGREN, Johan, Lund University, Lund, Sweden; LEE, Andrew, Ohio University College of Osteopathic Medicine, Athens, OH, USA

Mosasaurs were marine lizards that originated and diversified during the last 25 million years of the Cretaceous Period. During their relatively brief geological existence, gigantism evolved independently in at least two lineages: the Russellosaurina and Mosasaurinae. Although preliminary skeletochronological analyses suggest that russellosaurines grew rapidly and completed skeletal growth within 8–13 years, to date, little is known about the growth patterns of mosasaurine mosasaurs. Our goals in the current study were to: (1) assess the evolution of mosasaur growth rates and duration in the context of extant and extinct lepidosauromorphs; and (2) test whether russellosaurines and mosasaurines share a common growth strategy to attain gigantic size. We longitudinally sampled sequences of lines of arrested growth from the limb bones of 18 lepidosauromorphs including five mosasaurs and reconstructed their growth trajectories using stochastic, discrete-time growth models. From those models, bone circumferential growth rates and durations were calculated. To standardize for differences in bone size and growth period, we calculated relative growth rates (RGR). RGRs were mapped onto a phylogeny of the Lepidosauromorpha to assess evolutionary trends in growth strategies. Our results show that russellosaurines have markedly greater RGRs than mosasaurines. This suggests that russellosaurines evolved large body size primarily through phyletic increases to growth rate whereas mosasaurines did so through primarily through phyletic increases to growth duration.

Technical Session II, Wednesday 10:30

**TIMING OF EXTINCTIONS AMONG LATE-PLEISTOCENE MEGAMAMMAL TAXA IN SOUTH AMERICA**

LINDSEY, Emily, University of California, Berkeley, Berkeley, CA, USA; BARNOSKY, Anthony, University of California, Berkeley, Berkeley, CA, USA

The timing of the late-Quaternary megafaunal extinctions among different taxa and different geographic regions can provide crucial information about extinction models such as overkill versus ecological adjustment, and response of biota to late-Pleistocene climate change. In order to determine the chronology of these extinctions in South America, we are compiling and evaluating the abundant radiocarbon dates that have been published for South American megafauna. We have analyzed the last appearance dates (LADs) for a variety of megafauna species ranging geographically from Brazil to southern Patagonia. Dates were ranked as to robustness using a modified Mead-Meltzer scale, incorporating criteria including type of material dated; strength of stratigraphic association; when and where the analysis was performed; and dating method (AMS vs. standard). Dates were calibrated using OxCal4, with both the IntCal and ShCal calibration curves for comparison. We found that LADs reported for late-Pleistocene megafauna in South America in some cases appear much later than those for analogous taxa in North America. We have found “reliable” South American LADs as young as 10166 cal BP for *Smilodon*; 9696 cal BP for horse; 8010 cal BP for sloth; and 7159 cal BP for glyptodont. Ecological analogs in North America were apparently all extinct before 11,300 cal BP. There may also be geographic differences in timing of extinctions within the South American continent; so far, the youngest reported dates for extinct equid and xenarthran taxa all issue from the Southern Cone. Given the very old dates reported for archaeological sites in southern South America (including Monteverde in southern Chile at 14,700 cal BP) and contemporaneous-to-earlier onset of late-Pleistocene climate changes relative to the Northern Hemisphere, these findings indicate a longer extinction window in South America than in North America, and suggests that whatever the cause of these extinctions, it was less abrupt in South America.

Poster Session IV (Saturday)

**A NEW CATOSTOMID FROM NORTHEASTERN CHINA**

LIU, Juan, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; CHANG, Mee-mann, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

A new genus and species of the Catostomidae is established based on a collection of one nearly complete fish with a broken pharyngeal bone and a few pharyngeal teeth nearly *in situ*, several pharyngeal bones with teeth and disarticulated bones. The materials are from Huadian Formation, middle Eocene, Gonglangtou Coal Mine, Huadian, Jilin Province, northeastern China. The new articulated specimen is large-sized and deep-bodied with an estimated standard length of ca. 300 mm. The body depth is 156 mm, thus is just about half of its standard length. The assignment of the fish to the Catostomidae is based on its falciform pharyngeal bone with one row of numerous (45-60) compressed teeth, and the bone is much smaller than in other cypriniforms, compared with the body size of the fish. The new fish distinguishes from all known catostomids (both extinct and extant) in its

long anal fin with four unbranched and 17-18 branched rays, and extremely short caudal peduncle, only about one fourth its depth. The new fish is similar to the Eocene-Oligocene *Amyzon*, which then had a transpacific distribution, in many respects: the number and shape of the pharyngeal teeth, the short mouth gape, the long anterodorsal arm of the opercle, the broad preopercle, the semi-lunar interopercle, the presence of a long and wide fronto-parietal fontanelle, and the cleithrum with broad ventromesial flange. At the same time, it shows a few characters uniquely shared with the Recent catostomid, *Myxocyprinus asiaticus*, which is dwelling in upper and lower reaches of the Yangtze River and endemic to China. Those include: a very long dorsal fin, with its branched fin rays around 50, and a long anal fin (IV 17-18), their fin rays stretching back beyond the base of caudal fin. More details for the genus definition are presented in our ongoing paper and the specific name is not given here in accordance with the rules of nomenclature.

Technical Session X, Friday 11:30

#### DINOSAURS AND THE CRETACEOUS TERRESTRIAL REVOLUTION

LLOYD, Graeme, University of Bristol, Bristol, United Kingdom; RUTA, Marcello, University of Bristol, Bristol, United Kingdom; TARVER, James, University of Bristol, Bristol, United Kingdom; BENTON, Michael, University of Bristol, Bristol, United Kingdom

The observed diversity of dinosaurs reached its highest peak during the mid and late Cretaceous, the 50 million years (myr) that preceded their extinction, and yet this explosion of dinosaur diversity may be explained largely by sampling bias. It had long been debated whether dinosaurs were part of the Cretaceous Terrestrial Revolution (KTR), from 125-80 myr ago (Ma), when flowering plants, herbivorous and social insects, squamates, birds, and mammals all underwent a rapid expansion. Although an apparent explosion of dinosaur diversity occurred in the mid Cretaceous, coinciding with the emergence of new groups (e.g. neoceratopsians, ankylosaurid ankylosaurs, hadrosaurids, and pachycephalosaurs), results from the first quantitative study of diversification applied to a new supertree of dinosaurs show that this apparent burst in dinosaurian diversity in the last 18 myr of the Cretaceous is a sampling artefact. Indeed, major diversification shifts occurred largely in the first one-third of the group's history. Despite the appearance of new clades of medium to large herbivores and carnivores later in dinosaur history, these new originations do not correspond to significant diversification shifts. Instead, the overall geometry of the Cretaceous part of the dinosaur tree does not depart from the null hypothesis of an equal rates model of lineage branching. Further, we conclude that dinosaurs did not experience a progressive decline at the end of the Cretaceous; nor was their evolution driven directly by the KTR.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 10:00

#### DEVONIAN PLACODERM EMBRYOS AND THE ORIGINS OF VERTEBRATE SEX

LONG, John, Museum Victoria, Melbourne, Australia; TRINAJSTIC, Kate, University of Western Australia, Perth, Australia

The recent discovery of the first embryonic placoderm fishes ever found, preserved in 3-D from the Late Devonian Gogo Formation of Western Australia, provides the first data on the reproductive biology of this extinct class of vertebrates. Previous work had identified dermal clasping organs in the males of ptyctodontids, but the external shape of the claspers, adorned with dermal bone bearing with short sharp hooks, appeared to be a barrier to internal fertilisation. The new specimens confirm that ptyctodontids had an advanced form of viviparity, obligate matrotrophy, as one of the embryos (*Materspiscis*) are preserved showing the presence of a mineralised umbilical cord. Another specimen (*Austroptyctodus*) shows multiple embryos inside the mother. This documents the earliest known evidence of vertebrate sexual intercourse, and raises questions about the nature of primitive gnathostome reproduction. Viviparity is known to have evolved at least 13 times in teleosts, in all chondrichthyans, in actinistians, and in some amphibians and reptiles. Reversal back from oviparity to spawning is unknown in any vertebrate lineage, so spawning is assumed to be the primitive condition, based on outgroups such as agnathans. We propose that if ptyctodontids are basal to arthrodirans in the placoderm phylogeny, then a reversal to spawning could have driven rapid speciation events in crown group placoderms (the arthrodirans and antiarchs).

Romer Prize Session, Thursday 11:30

#### AERODYNAMIC FUNCTION OF THE HIND LIMB FEATHERS OF *ARCHAEOPTERYX LITHOGRAPHICA*: A WIND TUNNEL STUDY

LONGRICH, Nicholas, University of Calgary, Calgary, AB, Canada

The dromaeosaur *Microraptor gui* and the basal bird *Archaeopteryx lithographica* bore flight feathers on all four limbs, suggesting that the evolution of avian flight involved a "four-winged" phase. However, the aerodynamics of this unconventional arrangement are poorly understood. I used a full-scale wind tunnel model of *Archaeopteryx lithographica* to examine the aerodynamics of the hindlimb airfoils, and found that in terms of lift:drag ratios, the performance of the multi-winged configuration is as good as, or better than, a two-winged configuration. These experiments examined (1) the flow patterns around the hindlimb, and (2) the lift and drag produced by the hindlimbs. Smoke-wire visualization shows that unlike aircraft wings, the hindlimbs do not use an attached flow to generate lift.

Instead, the sharp leading edge causes flow separation, which results in the formation of a detached leading edge vortex (LEV) similar to the LEV operating used by the tail of extant birds; the LEV remains stable at very high angles of attack, which may have made the hindlimbs useful as stabilizers. Measurements made with a force balance in a low speed, low-turbulence wind tunnel show that the hind limbs can generate lift even when they are held partially abducted; the lift forces generated match well with previous aerodynamic calculations. Surprisingly, the added lifting surfaces do not result in a decreased lift:drag ratio; in some cases the addition of hindlimb airfoils actually results in a higher lift:drag ratio, which would result in flatter glides and more energetically efficient flight. The reason is that a nonplanar geometry is able to distribute vorticity to decrease the induced drag created by the wingtips. This effect is greatest at the lower speeds where induced drag dominates. It is proposed that the hindlimbs of early birds were held partially abducted to achieve the best lift:drag ratio; the dorsolaterally opening acetabulum of *Archaeopteryx* and *Microraptor* would have facilitated this partially sprawling posture. *Microraptor* was probably able to decrease induced drag in the same fashion, but the effect would have been enhanced by the longer hindlimb airfoils.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 9:45

#### ESTIMATING THE TIMING OF THE OSTARIOPHYSAN RADIATION USING MOLECULAR CLOCKS: BENEFITS AND LIMITATIONS

LOPEZ, Juan, University of Alaska Museum of the North, Gainesville, FL, USA; BROUGHTON, Richard, Oklahoma Biological Survey, Norman, OK, USA; MAKINEN, Tuuli, Florida Museum of Natural History, Gainesville, FL, USA

The development and continued refinement of divergence time estimates based on measured genetic differences and fossil constraints are beginning to inform increasingly robust hypotheses of ostariophysan biogeography and diversification. Initial molecular-based estimates of the age of origin of Ostariophysi and major ostariophysan clades indicate that these events took place significantly earlier than the first fossil occurrences of members assigned to the relevant lineages would suggest. The magnitude of these discrepancies profoundly alter the implied geographical setting in which these important and species rich vertebrate clades first arose, therefore it is important to review the evidence and methodology underlying molecular clock estimates and to test them using new independent data sets. One important implication of the molecular based estimates is that early ostariophysan evolution predates the break up of Pangaea, an event of critical biogeographical significance for this largely freshwater-bound group of fishes. Published age estimates derived from mitochondrial genome sequences place the divergence between ostariophysans and their extant sister group at 251 mya, while fossils assigned to that lineage first appear in the Early Cretaceous with *Santanichthys diasii*. These same analyses point to ages of 183 and 173 million years for Cypriniformes and Siluriformes, the two ostariophysan clades with greatest extant diversity. Records of siluriform fossils are only recognized as early as the Late Cretaceous. In this contribution, we take advantage of information being produced by ongoing large-scale collaborative projects (e.g. Tree of Life and Planetary Biodiversity Inventories) to test those estimates and propose alternative hypotheses for the timing of key events in ostariophysan diversification. We also discuss limitations of age estimation using currently available molecular clock methods.

Poster Session II (Thursday)

#### ON THE PRESENCE OF *HISPANOMYS PERALENSIS* (RODENTIA, CRICETINAE) AT BATALLONES (MADRID, SPAIN)

LÓPEZ ANTONÁNZAS, Raquel, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; ÁLVAREZ SIERRA, María de los Angeles, Facultad de Ciencias Geológicas, Madrid, Spain; GARCÍA PAREDES, Israel, Nationaal Natuurhistorisch Museum Naturalis, Leiden, Netherlands; MORALES, Jorge, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; PELÁEZ-CAMPOMANES, Pablo, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

The fossiliferous area of Cerro de los Batallones (Madrid, Spain) is one of the most important discoveries in the European Miocene for its extraordinary richness and excellent state of preservation of its fossils. The Cerro de los Batallones fossiliferous complex (CBFC) includes nine vertebrate traps dated as late Vallesian (upper Miocene). Its faunal assemblage shows a great proportion of carnivores (12 species), which represent more than 90% of the total fossil remains. The micromammals are the second group in relative abundance and include insectivores, lagomorphs, and rodents. Among the latter group, the cricetins are represented by two taxa: *Rotundomys* sp. and *Hispanomys peralensis*. This latter species shows some progressive characters with respect to the older species of the genus such as the absence of cingula surrounding the upper and lower molar valleys, the reduction and simplification of the third molars, and the tendency to increase the number of roots on the first upper molar, to have stronger and higher ectolophs, and to lose the mesoloph on the upper molars. The study of *H. peralensis* from Batallones has evidenced its high morphological variability. Two morphological extremes, representing two quite different evolutionary stages, have been found together with many intermediate forms. This variability is also present in all samples of *H. peralensis* from other Spanish basins. It may either be the result of a hotspot period of morphological reorganisation within the evolutionary lineage or a general reaction to a fluctuating environment by means of a microevolutionary response to natural selection or phenotypic plasticity. The well-evidenced trends together with the good record this species shows in eastern Spain allow to estimate the age of the CBFC as close to the MN10-MN11 boundary (latest Vallesian).

**FISH DIVERSITY AND FAUNAL COMPOSITION DURING THE JURASSIC**  
LÓPEZ-ARBARELLO, Adriana, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany

The Jurassic is an important period for our understanding of fish evolution, since it saw major radiations of many important groups, including neoselachian sharks and teleosts. Previous studies of Jurassic teleost diversity argued for a steady increase in the course of this period, based on counts of number of known taxa per time unit (stage). To test this idea, we looked at actinopterygian faunal composition in several well-known marine lagerstätten, ranging from the Early to the Late Jurassic. The localities looked at were the Sinemurian Liassic of Lyme Regis in England, the Toarcian Posidonia Shale and equivalent beds in western Europe, the Callovian Peterborough Member of the Oxford Shale in Great Britain, and the Kimmeridgian-Thonian lithographic limestones of Cerin, France, and Solnhofen, Germany. The faunal composition of these localities reflects the change from basal elasmobranchs to neoselachians in the chondrichthyan, and also a decrease of non-actinopterygian actinopterygians in the course of the Jurassic. However, it does not show any signal for an increased proportion of teleosts. Instead, the faunal compositions seem to show a complex pattern of diversification of basal neopterygians, diversification and decline of several lineages of basal teleostomorphs, such as the Pachycormiformes, and a varying percentage of true teleosts. Interestingly, if holosteans can be shown to represent a monophyletic group, this would be the group that shows the strongest diversification during the Jurassic. The increase of the total number of teleosts known might thus represent a lagerstätten effect due to the very rich fish faunas from the lithographic limestones of Solnhofen. Furthermore, the Late Jurassic faunas, and especially the teleosts, have been much more thoroughly studied than those from other stages of the Jurassic, which are in need of revision.

Poster Session III (Friday)

**A NEW VERTEBRATE ASSEMBLAGE FROM THE LATE CRETACEOUS OF LUANCHUAN, HENAN PROVINCE, CHINA**

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In recent years, the discovery of many dinosaur eggs in Nanyang City (Neixiang County, Xixia County, and Xichuan County) have made this region one of the richest dinosaur egg sites in the world. Compared with abundant dinosaur eggs, dinosaur skeletons are relatively rare in Henan Province. At present, only a few dinosaurs have been reported. They include the Tyrannosaurid *Tyrannosaurus luanchuensis*, the iguanodontian ornithomimid *Nanyangosaurus zhugeii*, the nodosaurid *Zhongyuansaurus luoyangensis*, the sauropod *Huanghetitan ruyangensis*, and the dromaeosaurid *Luanchuanraptor henanensis*. Among these dinosaurs, only *Luanchuanraptor henanensis* and *Tyrannosaurus luanchuensis* came from the Qiupa Formation, which is the late Late Cretaceous sediments of the Tantu Basin in Luanchuan County. In the last two years, abundant Mesozoic vertebrate fossils have been found from the Qiupa Formation of Luanchuan. Most of them are small to medium sized theropod dinosaurs, including the dromaeosaurid *Luanchuanraptor*, a nearly complete oviraptorosaurid, a relatively large dromaeosaurid sp., a troodontid dinosaur, an alvarezsaurid, and an ornithomimid dinosaur. An ankylosaurid dinosaur, a small ornithomimid dinosaur, the large-sized lizard *Tianyusaurus*, many jaw fragments of small-sized unnamed lizards and small mammals are also found from the same horizon. Except for the above-mentioned specimens, many dinosaur eggshell fragments and incomplete dinosaur eggs have also been found in the same quarry. Therefore, they clearly indicate a new distinct fauna, herein called "Luanchuan Fauna". The distinct character of the Luanchuan Fauna is the high diversity of theropods, including dromaeosaurids, ornithomimids, oviraptorosaurids, alvarezsaurids, tyrannosaurids, troodontids and rich lizards and mammals. The Luanchuan Fauna is different from the Nemegt Formation of Mongolia in the faunal composition, which is absent of lizards, mammals. The discovery of small vertebrate fossil assemblages in the Qiupa Formation and the continuous sequences from the late Cretaceous to the Paleocene of the Tantu Basin indicate that the Tantu Basin may be a candidate for the study of the terrestrial K/T boundary.

Poster Session III (Friday)

**TIMING OF TETRAPOD EXTINCTIONS ACROSS THE PERMO-TRIASSIC BOUNDARY**

LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; SPIELMANN, Justin, New Mexico Museum of Natural History, Albuquerque, NM, USA; RINEHART, Larry, New Mexico Museum of Natural History, Albuquerque, NM, USA

A review of the tetrapod record across the Permo-Triassic boundary (PTB) indicates a global evolutionary turnover of tetrapods close to this boundary. There is also a within-Guadalupian tetrapod extinction, probably of global extent, here called the dinocephalian extinction event. The dinocephalian extinction event is a late Wordian or early Capitanian extinction based on biostratigraphic data and magnetostratigraphy (the extinction precedes the Illawara

reversal), so it is not synchronous with the end-Guadalupian marine extinction. The Russian PTB section documents two tetrapod extinction events, one just before the dinocephalian extinction event and the other at the base of the *Lystrosaurus* assemblage. However, generic diversity across the latter extinction remains essentially the same despite a total evolutionary turnover of tetrapod genera, suggesting a faunal replacement event and not a catastrophic extinction. The Chinese and South African sections document the stratigraphic overlap of *Dicynodon* and *Lystrosaurus*. In the Karoo basin, the lowest occurrence of *Lystrosaurus* is in a stratigraphic interval of reversed magnetic polarity, which indicates it predates the marine-defined PTB, so the lowest occurrence of *Lystrosaurus* can no longer be used to identify the PTB in nonmarine strata. Correlation of the marine PTB section at Meishan, southern China, to the Karoo basin based primarily on magnetostratigraphy indicates that the main marine extinction preceded the PTB tetrapod extinction event. The ecological severity of the PTB tetrapod extinction event has generally been overstated, and the major change in tetrapod assemblages that took place across the PTB was the prolonged and complex "replacement" of therapsids by archosaurs that began before the end of the Permian and was not complete until the Middle Triassic. The tetrapod extinctions are not synchronous with the major marine extinctions at the end of the Guadalupian and just before the end of the Permian, so the idea of catastrophic causes of synchronous PTB extinctions on land and sea should be reconsidered.

Technical Session XVII, Saturday 10:30

**SYSTEMATICS AND BIOCHRONOLOGY OF AGRIOCHOERIDAE**

LUDTKE, Joshua, San Diego State University, San Diego, CA, USA

Oreodonts are a prolific component of the North American Tertiary terrestrial fossil record, although the throng of taxonomic names for them has greatly lowered their utility in paleontology. Recent efforts to systematically study the larger family of oreodonts, the Merycoidodontidae, have called into question the monophyly of oreodonts, suggesting that this group may have a much more complicated phylogenetic history than commonly assumed. A systematic study of the smaller family of oreodonts, the Agriocheridae, has yielded results which suggest that oreodonts are a monophyletic group, although agriocherids themselves appear to not be. The number of taxa found in this study is half the number of taxa found in the last published comprehensive report on agriocherids, suggesting that this family, while abundant in the fossil record, may not have been as speciose as recently contended. At a generic level, *Protoreodon* was supported as a paraphyletic assemblage of species. *Agriocheris* appears to be a monophyletic group. Contrary to several recent reports, *Diplobunops* could not be placed within *Agriocheris* and is instead recognized as a distinct genus. Some of the dental morphology which has long been used to diagnose *Agriocheris* appears to have evolved at least three times in Agriocheridae, supporting earlier ideas on the overall homoplasy of the group. The assignment of specimens to species in this largely agrees with previous reports. Agriocherids are first known from the early Uintan with one species already somewhat widespread. During the late Uintan, as has already been observed, they reach a peak in diversity with eight species, six of which appear to coexist in localities in Utah and Wyoming. During the Duchesnean, species diversity appears to decline to one to three species in a biochron. Another peak, during the early late and middle Chadronian wherein four species are recognized, was previously recognized as the beginning of the decline in agriocherid diversity. In the late Chadronian, agriocherids decline in diversity to one or two species, a diversity level they stay at until they last occur in the late early Arikarean.

Poster Session III (Friday)

**PRESERVATION OF DINOSAUR INTEGUMENTARY IMPRESSIONS IN THE UPPER CRETACEOUS KAIPAROWITS FORMATION, GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, SOUTHERN UTAH**

LUND, Eric, Utah Museum of Natural History, Salt Lake City, UT, USA; LOEWEN, Mark, Utah Museum of Natural History, Salt Lake City, UT, USA; GETTY, Michael, Utah Museum of Natural History, Salt Lake City, UT, USA; SAMPSON, Scott, Utah Museum of Natural History, Salt Lake City, UT, USA; ROBERTS, Eric, University of the Witwatersrand, Johannesburg, South Africa

Evidence of nonmineralized vertebrate tissues was once thought to be relatively rare in the Mesozoic fossil record. However, discoveries in the Cretaceous Western Interior Basin have produced numerous dinosaur specimens preserved with associated skin impressions. Many of these specimens have been referred to as "dinosaur mummies" and attributed to mummification in arid environments. Recent finds in the late Campanian Kaiparowits Formation of southern Utah provide new insights into the preservation of dinosaur integumentary impressions that suggest an alternative model for the origin of "dinosaur mummies". We examined occurrences of integumentary impressions at over a dozen sites within the Kaiparowits Formation. In every case, skin impressions were preserved in association with articulated to semi-articulated partial skeletons of single ornithischian dinosaurs in fine-grained fluvialite sandstones, together with preserved botanical remains. Remarkably, nearly all articulated ornithischian dinosaurs excavated to date from fluvial channel deposits in the Kaiparowits Fm. preserve such integumentary impressions. Alluvial architecture and facies analysis, coupled with paleosol and paleobotanical data, all point to the Kaiparowits Fm. as being a relatively wet alluvial system with unusually rapid sedimentation rates, inconsistent with desiccation and mummification. Paleoenvironmental interpretations of at least some other geologic units that preserve dinosaur integumentary remains (e.g., Dinosaur Park Fm., Alberta) are also more consistent with preservation in wet and humid

(versus arid) settings. The overwhelming majority of skin impressions from around the globe are associated with ornithischian dinosaurs (especially hadrosaurs) in fluvial settings. Considered in unison, these data contradict the mummification hypothesis, suggesting instead that the exceptional preservation of dinosaur integumentary impressions within the Kaiparowits Fm. and elsewhere is frequently due to a pair of factors: 1) the pachydermous nature of ornithischian (and particularly hadrosaur) skin; and 2) rapid fluvial burial in fine sands.

Fossils and the Evolutionary Patterns of Ostariophans, One of the Largest Vertebrate Clades, Saturday 11:30

#### FOSSILS, MOLECULES, AND THE AGE OF CATFISHES

LUNDBERG, John, Academy of Natural Sciences, Philadelphia, PA, USA; SULLIVAN, John, Academy of Natural Sciences, Philadelphia, PA, USA

Catfishes (Siluriformes) are a diverse, globally distributed clade of 3300+ extant species; 1 in 20 living vertebrate species is a catfish. All but two of 42 extant and 2 extinct family-level groups of catfishes are confined to freshwater; the oldest fossils are of Late Cretaceous age. Recent molecular phylogenetic work confirms most morphology-based families and lower-ranked taxa, but reshapes our view of higher catfish clades and their continental distributions. We estimate the time course of catfish diversification with fossil-constrained Bayesian relaxed clock (MULTIDIVTIME) analyses of 3660 aligned base pairs from the *rag1* and *rag2* genes for 150 catfish species representing all extant families. Fossil-determined minimum ages, from Late Campanian to Neogene, are applied as constraints on 20 nodes in the tree obtained from a codon-partitioned Bayesian analysis. We argue on paleontological grounds, and with a caveat of imprecision, that Siluriformes originated no earlier than 144 mya. Phylogenetic evidence shows an ancient siluriform presence, if not origin, on South America (SA). The basal dichotomy among crown group catfishes was 125-130 mya between Loricarioidei (SA) and Diplomystidae (SA) + Siluroidei. Origins of the six loricarioid families span late early Cretaceous 120-80 mya. Plesiomorphic Diplomystidae and the now huge Siluroidei split about 120 mya. Many siluroid multifamily and family lines endemic to SA, Asia or Africa rapidly originated around 105-90 mya. All modern catfish families existed before the K/T boundary. Molecular dating and direct fossil evidence place the origins of many genera in the Paleogene. The richly diverse, tropical catfish faunas of SA, Asia and Africa are dominated by endemic multifamily clades. The ancient intercontinental relationships that must unite endemic catfish clades are scarcely resolved. Asian Cranoglanididae + North American Ictaluridae split about 80 mya. Three post-Gondwanan intercontinental dispersals are indicated: Mesoamerican Lacantuniidae nested in a big African clade (divergence 75-94 mya), African *Bagrus* nested in Asian Bagridae and African and Asian members of Clariidae (ca. late Paleogene).

Technical Session VIII, Thursday 1:30

#### HOW DID THE TURTLE GET ITS SHOULDER GIRDLE INSIDE ITS RIBCAGE, OR DID IT?

LYSON, Tyler, Yale University, New Haven, CT, USA; JOYCE, Walter, Peabody Museum of Natural History, New Haven, CT, USA

The apparent relationship of the shoulder girdle inside the ribcage of turtles has puzzled neontologists, embryologists, and paleontologists for centuries. Unlike other extant amniotes where the scapula lies dorsal to several thoracic ribs, the turtle scapula appears to lie inside the thoracic ribs and thus inside the ribcage. However, while the shoulder girdle clearly lies inside the shell, its precise relationship to only those portions of the shell that are considered homologous with other amniotes' ribs and vertebrae remains untested. The neural and costal bones, which make up the majority of the turtle shell, undergo both endochondral and intramembranous ossification and the whole structures have been hypothesized by some to be homologous to the endochondrally ossified ribs and vertebrae of other amniotes. However, fossil, histological, and some embryological data indicate that only the endochondrally ossified portion of the costal and neural is homologous to the ribs and vertebrae. Computed Tomography images manipulated to show only the endochondral portion of the costals and neurals of a sample that covers the full extant tree space of turtles clearly indicate that the turtle scapula does not lie inside the shell, but rather frames the neck and lies anterior to the thoracic ribs. This relationship is homologous to the condition found in basal amniotes (e.g. *Limnoscelus paludis*). In addition, the position of the coracoid is similar to other amniotes in that it lies underneath the ribcage posteriorly to the clavicle and interclavicle. These observations indicate that turtles essentially retained the shoulder girdle of basal amniotes and that the position of this girdle "within" the ribcage is an illusion created by secondary dermal ossifications.

Technical Session XIII, Friday 3:15

#### PHYSICAL PROPERTIES, GEOCHEMISTRY, AND DIAGENESIS OF FOSSIL XENARTHAN TEETH: PROSPECTS FOR INTERPRETING STABLE ISOTOPE EVIDENCE

MACFADDEN, Bruce, University of Florida, Gainesville, FL, USA; DESANTIS, Larisa, University of Florida, Gainesville, FL, USA

Stable isotope analysis (carbon, oxygen) of fossilized enamel is widely used to reconstruct the paleobiology and paleoecology of extinct mammals. Xenarthrans lack enamel, and as such, stable isotope analyses of this group are rare and results presented so far are ambiguous. In xenarthrans the functional analog of enamel is an external dentine called

orthodentine (osteodentine in some taxa; other terms are also used). Little is known about the physical properties and diagenesis of this external dentine, e.g., relative to enamel. In this study we describe the physical properties (such as hardness), mineralogy, and percent organics of xenarthran teeth as compared to other eutherians. Although the primary mineral phase of xenarthran teeth is hydroxylapatite, similar to enamel, xenarthran external dentine can be softer and typically has a significantly higher proportion of organics, similar to dentine and bone of other mammals. In order to quantify relative diagenesis, the uptake of rare earth elements (REEs) was analyzed for external dentine, "regular" (internal) dentine, and bone of xenarthrans as compared to enamel, dentine, and bone of other fossil mammals. We hypothesize that if xenarthran external dentine has lower rates of REE uptake like enamel, as compared to dentine and bone, then stable isotope data can reliably be interpreted from external dentine, as it is from enamel. Our results indicate variation in the physical properties and diagenesis of xenarthran external dentine. For example, *Paramylodon* has low rates of REE uptake (like enamel), whereas other taxa such as *Holmesina* vary in REE uptake between localities and specimens sampled. While these results indicate that in some cases the potential exists for reliably interpreting stable isotopes archived in fossil xenarthran external dentine, it is not as simple as interpreting these kinds of data from enamel. Until a clearer understanding of the patterns of diagenesis emerge, the highest quality stable isotope data from fossil xenarthrans will only come from studies that back up results with an understanding of relative diagenesis, e.g., as determined by REEs.

Poster Session IV (Saturday)

#### AN OVERVIEW OF THE SPINOSAURIDAE (DINOSAURIA, THEROPODA) WITH COMMENTS ON THE BRAZILIAN MATERIAL

MACHADO, Elaine, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

Despite being rare, spinosaurid remains were collected in Africa, Europe, Asia and Brazil, coming from deposits with ages ranging from the Late Jurassic to the Late Cretaceous. In Brazil, two species of this theropod clade were described: *Irritator challengeri* and *Angaturama limai*, both from the Romualdo Member (Santana Formation, Araripe Basin). The possibility that they belong to the same species cannot be ruled out but more material is needed. The best spinosaurid material from this deposit is a partial skeleton (MN 4819-V) composed of a pelvis, a sequence of dorsal, sacral and caudal vertebrae, and some limb elements, including the most complete spinosaurid manus (one claw, phalanges, metacarpals, and one carpal) known so far. Several differences between MN 4819-V and *Suchomimus* were observed, particularly in the pelvis, showing significant morphological differences among those theropods. Another spinosaurid specimen consisting of a premaxilla and maxilla was collected from the Cretaceous Strata from Ilha do Cajual. This material represents the biggest spinosaurid from Brazil, comparable to the largest one reported from Morocco. Supposed spinosaurid teeth were reported from the Cretaceous strata of the Bauru Basin, but their affinities with this theropod cannot be confirmed. The present study confirms previous analysis that divided Spinosauridae in Baryonychinae (*Suchomimus* + *Baryonyx* + *Cristatusaurus*) and Spinosaurinae (*Spinosaurus* + *Angaturama* + *Irritator*).

Poster Session I (Wednesday)

#### TOOTH WHORLS OF EARLY DEVONIAN ACANTHODIANS AND CHONDRICHTHYANS FROM THE MOTH LOCALITY, NORTHWEST TERRITORIES, CANADA

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The Man on the Hill locality (MOTH) in the Northwest Territories of Canada has produced many in situ and isolated tooth whorls belonging to both acanthodians and putative chondrichthyans of Lochkovian (Early Devonian) age. Due to the excellent preservation of the fossils from this locality, we are able to gather a great deal of information about the dentitions of these two groups of fishes. Tooth whorls and other kinds of associated dentitions are enigmatic and are often overlooked or under-described in taxonomic treatments of species. In fact there are many distinctions to be made between the tooth whorls of acanthodians and putative chondrichthyans, including base thickness, vascularization, and mode of tooth addition. These and other characteristics allow us to distinguish the isolated whorls between the two taxa and help us better understand the diversity of the MOTH locality. Notwithstanding the differences between the two types of tooth whorls, there are also many similarities among certain of the morphological types of dentitions and their positions in the oral cavity. These similarities are most likely due to inheritance of the basic dentition from a common ancestor, along with retention of basic similarities in feeding styles in the two descendant groups. In many cases, with examples in both acanthodians and chondrichthyans, the whorls demonstrate a change in tooth type within the life of an individual fish, interpreted as a change in diet between juveniles and adult individuals. Within each major taxon, different species and genera can be identified based on tooth whorl morphology alone. Some tooth-based species have been identified among the articulated skeletons and some have yet to be found as articulated specimens. In the future, investigators should treat tooth whorls as distinguishing characteristics of acanthodians and chondrichthyans. They should make more detailed observations and descriptions of tooth whorls and associated dentitions, a practice that will result in a more complete understanding of the fossil record of early gnathostomes.

Technical Session XII, Friday 12:00

### THE FAUNAL AGE OF MOROTO I AND II, UGANDA

MACLATCHY, Laura, University of Michigan, Ann Arbor, MI, USA; COTE, Susanne, Harvard University, Cambridge, MA, USA; ORLIAC, Maeva, Museum National d'Histoire Naturelle, Paris, France; SANDERS, William, University of Michigan, Ann Arbor, MI, USA; WINKLER, Alisa, Southern Methodist University, Dallas, TX, USA

An age of >20.6 Ma for the Moroto I and II fossil localities was obtained by  $^{40}\text{Ar}/^{39}\text{Ar}$  dating of samples from capping basaltic lavas. This age is older than previously reported radiometric ages generated by conventional K-Ar methods (12–14 Ma). With this older age, fossil evidence from Moroto represents one of the most ancient hominoids known (*Morotopithecus bishopi*), making it useful to set a minimum calibration for the hominoid-cercopithecoid split. The validity of the radiometric dates for Moroto I and II have recently been questioned with the suggestion that the fauna support a later, possibly early Middle Miocene age. This contradictory view may stem from a lack of sites of the same age (~21 Ma) for comparison, and very few sites (with poorly known fauna) of slightly older age (e.g. Meswa Bridge, Eragaleit Beds in Kenya). When this is accounted for, we find the Moroto fauna is consistent with an age of >20.6 Ma. For example, the proboscideans from Moroto include *Eozygodon morotoensis*, known from Meswa Bridge, Kenya (>20 Ma) and Auchas and Elisabethfeld, Namibia (ca. 20–19 Ma and ca. 21 Ma, respectively), but not Wadi Moghara or the Moruorot Mb. at Lothidok 4, as has been claimed. Other specimens at Moroto II resemble *Progomphotherium maraisi* (Amebelodontinae), but are more primitive in occlusal morphology than amebelodonts from Napak (~20 Ma). Also, we find it likely that *Morotochoeris* is not a paleochoerid or a suoid. The dental remains correspond to an indeterminate suiform that is morphologically close to Eocene/Oligocene anthracotherids and cebochoerids. Hyracoid (*Merothyrix bateae*, *Brachythyrix*), macroscelidid (*Miorynchocyon*), ruminant (*Walangania africana*), anthracothere (*Brachyodus*) and several rodent (*Paraphiomys pigotti*, *Megapedetes*, *Zenkerella*) taxa are also consistent with an earliest Miocene age. Species that are known only from Moroto, such as the rodents *Notoicetodon gommeryi*, *Diamantomys morotoensis*, *D. ugandensis*, have little biochronologic value. Overall, the small mammal fauna differs markedly from that at Kalodirr (17.5 Ma). Any broader inferences from the small mammals is confounded by a lack of comparable remains from sites ~21 Ma.

Poster Session I (Wednesday)

### OUT OF ANTARCTICA: PALEONTOLOGICAL RECONNAISSANCE OF LIVINGSTON ISLAND (SOUTH SHETLANDS) AND SEYMOUR ISLAND (JAMES ROSS GROUP)

MACPHEE, Ross, American Museum of Natural History, New York, NY, USA; REGUERO, Marcelo, Museo de La Plata, La Plata, Argentina; STRGANAC, Chris, Southern Methodist University, Dallas, TX, USA; NISHIDA, Yosuke, Southern Methodist University, Dallas, TX, USA; JACOBS, Louis, Southern Methodist University, Dallas, TX, USA

During the 2007–2008 austral summer, accessible portions of Aiptian Cerro Negro Fm (~118 Ma), Livingston Island, and mid-Eocene La Meseta Fm (~45 Ma), Seymour Island, were prospected for terrestrial fossils, both plant and vertebrate. Cerro Negro Fm yielded numerous plant fossils suitable for ongoing paleoenvironmental studies but no vertebrates, in contrast to rich returns from La Meseta Fm—still the only confirmed window into mammalian evolution in Antarctica. The published mammalian fauna of Seymour Island currently consists of 12 species (some not yet formally named): 7 marsupials, 2 pilosans, 1 gondwanatherid, 1 litoptern, and 1 astrapotherid. There are, however, other fossils in existing collections that have never been described or assigned to specific groups. The main subject of this presentation is MLP 91-II-4-3, an upper cheektooth variously described in the literature as “*Mammalia incertae sedis*” and “*bat insectivore*”. The tooth is unfortunately lost, but SEMs exist which are of some help in evaluating its morphology. The tooth appears to be anatomically zalambdodont, featuring a single, prominent cusp (paracone?), little or no talon (area damaged), well-defined posterior cingulum, very prominent mesiostyle, small stylocone, and barely distinguishable distostyle. The mesiostyle helps define the “collar and groove” feature, often seen on zalambdodont cheekteeth, which helps guide preparacrista/protocristid shearing. The tooth—probably a last premolar rather than a molar—does not closely resemble that of any other anatomical zalambdodont, marsupial or placental, although there are some individual points of similarity to certain tenrecids, *Necrolestes*, and *Oligoryctes*. We found no important resemblances to any extant bats, including the few that have quasi-zalambdodont teeth. Although the phylogenetic and biogeographical significance of this specimen is currently nugatory, its existence raises the possibility that the Antarctic Peninsula (Scotia Portal prior to the opening of the Drake Passage) once supported other small to tiny vertebrates, the discovery of which might shed some additional biogeographical light on the origins of this remarkable fauna.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 9:45

### DIGITAL CRANIAL ENDOCAST OF *HADROCODIUM WUI* (MAMMALIAFORMES) AND ITS BEARING ON MAMMALIAN BRAIN EVOLUTION

MACRINI, Thomas, American Museum of Natural History, New York, NY, USA; LUO, Zhe-Xi, Carnegie Museum of Natural History, Pittsburgh, PA, USA

We isolated a digital cranial endocast from CT imagery of the only known skull of *Hadrocodium wui*, a mammaliaform from the Lower Jurassic of China. This endocast is

the most complete and least distorted from a non-mammalian mammaliaform. As such, it is significant for reconstructing endocranial character states for the most recent common ancestor of mammals. We compared the endocast of *H. wui* with a number of cranial endocasts from fossil and extant mammals with the purpose of mapping the phylogenetic evolution of brain-related endocast characters and the structure of the endocranial cavity in the context of recent published hypotheses about mammal phylogeny. The lateral expansion of the cerebral hemisphere casts under the parietal in *Hadrocodium* is much better developed than in other non-mammalian cynodonts. The endocast confirms that presence of lissencephalic (smooth) cerebral hemisphere casts and presence of relatively large olfactory bulb casts are plesiomorphic for Mammalia. The endocast of *Hadrocodium* possesses small casts of the parafloccular lobes of the cerebellum unlike a number of basally diverging mammals and non-mammalian cynodonts. The midbrain, cerebellar hemisphere, and vermis casts are not clearly visible on the endocast due to damage to the skull roof. A rhinal fissure is not visible on the endocast. The endocast of *Hadrocodium* also provides valuable new data for the study of the evolution of brain size near the base of Mammalia. A comparison of relative endocranial volume size of a number of fossil and extant mammals and non-mammalian cynodonts shows that an increase in brain size occurred in the most recent common ancestor between *Hadrocodium* and crown mammals. The laterally expanded cerebral hemisphere casts, and large relative endocranial volume correlated with the detachment of the inner ear ossicles from the mandible in *Hadrocodium* suggests that the neocortex is a synapomorphy for a more inclusive clade than Mammalia.

Technical Session XV, Friday 1:30

### NEUROCRANIAL ANATOMY OF A MICROSOURIAN LEPOSPONDYL, *CARROLLA CRADDOCKI*, EXTRACTED VIA HIGH-RESOLUTION COMPUTED TOMOGRAPHY

MADDIN, Hillary, University of Calgary, Calgary, AB, Canada; ANDERSON, Jason, University of Calgary, Calgary, AB, Canada

Studies of amphibian braincases and internal ear morphology are experiencing a renaissance as the search for new morphological characters becomes increasingly important in investigations into lissamphibian origins, and as non-destructive methods (e.g. CT) become increasingly accessible and affordable. To date, focus has been on members of Temnospondyli. As a result, the corresponding anatomy of the alternatively hypothesized ancestral lineage, Lepospondyli, has remained largely unknown and several putative temnospondyl-lissamphibian synapomorphies pertaining to the braincase have remained untested. We herein describe the braincase, braincase endocast, and otic capsule endocast of *Carrolla craddocki*, a brachystelechid microsauro, extracted using high-resolution CT, representing the first data of its kind for a lepospondyl tetrapod. The anatomy of *C. craddocki* is compared to that of derived temnospondyls and representative lissamphibian taxa. Several features considered to be exclusively shared between lissamphibians and fossil temnospondyls, including those relating to the inner ear such as the presence of the lissamphibian-type perilymphatic duct system, are shown to be present in this microsaurian lepospondyl, suggesting a wider distribution of certain traits across non-amniote tetrapods than previously thought. In contrast, several features appear to be different in *C. craddocki* from that of temnospondyls, such as the presence of a separate ossification in the sphenethmoid region in addition to the sphenethmoid ossification, and these observations will undoubtedly contribute to clearer understanding of variation in braincase and related morphology in early tetrapods. These data will be valuable points of reference for future studies on the origin and evolution of Recent amphibians. This work underscores the importance of broader comparative samples; studies including support for temnospondyl origins of lissamphibians in the absence of data from lepospondyls and other Paleozoic tetrapods should be approached with caution.

Poster Session IV (Saturday)

### PREDICTED DISTRIBUTIONS OF EQUINES IN THE GREAT PLAINS DURING THE MIOCENE BASED ON ENVIRONMENTAL VARIABLES

MAGUIRE, Kaitlin Clare, Ohio University, Athens, OH, USA; STIGALL, Alycia, Ohio University, Athens, OH, USA

Geographic distributions of Miocene equine species are predicted from the Great Plains using ecological niche modeling (ENM). The Equinae underwent a dramatic radiation as climate changed from warm and humid in the middle Miocene to cooler and more arid conditions during the late Miocene. Predicted distributions of individual species from ENM are analyzed in relation to this climate change. The ENM modeling system employed is GARP (Genetic Algorithm using Rule-set Prediction). This method predicts the geographic extent of a species' fundamental niche based on environmental variables coupled with known species occurrence points and provides a means to quantify a species' geographic range. Species ranges are predicted for two successive time slices during the Miocene that span from the Mid-Miocene Climatic Optimum into the early Pliocene (14.5–8.5 Ma and 8.5–2 Ma). During the initial cooling phase, species with larger predicted ranges were more likely to survive between the Barstovian and Clarendonian North American Land Mammal Ages (NALMA) than species with smaller ranges. As climate continued to cool and became increasingly arid in the late Miocene, range size and survival from one NALMA to the next appear independent, with increased extinction rates observed across all taxa. Equine diversity has been attributed to niche partitioning, resulting in various feeding morphologies among species as climate changed. Species more commonly exhibit disjunct (“patchy”)



geographic distributions than continuous geographic distributions in the middle Miocene, a time characterized by the onset of a colder, more arid climate. Disjunctions likely facilitated peripheral isolates speciation, promoting development of novel skeletal adaptations to new feeding strategies resulting in the observed increased speciation rate. During the late Miocene, continuous ranges are more common, which correlates with lower speciation rates. This is the first use of ENM and GARP in the continental fossil record. Its use here demonstrates the potential for future biogeographic studies aimed at assessing the impact of ecological variables relative to taxon-specific distribution and morphological data.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 9:00

#### **CLADOSELACHE: AN ICONIC DEVONIAN SHARK**

Maisey, John, American Museum of Natural History, New York, NY, USA

Late 19th century descriptions of the late Devonian shark *Cladoseleche* had an immediate impact upon contemporary theories concerning the origins and early evolution of jawed vertebrates, coming a mere decade after another influential discovery; the living frilled shark *Chlamydoselachus*, whose teeth resembled those of extinct *Cladodus*, *Didymodus*, and *Pleuracanthus* so closely that it was considered a relic of some ancient, Paleozoic selachian lineage. *Cladoseleche* still occupies a critical position in modern phylogenetic analyses, and is widely depicted in popular books and on the internet, has been discussed in creationist literature, and has even featured in a series of “collectible” Japanese toy figures! But despite *Cladoseleche*'s iconic status, we are still woefully ignorant about many aspects of its anatomy and relationships. The view that modern *Chlamydoselachus* is pertinent to the discussion has also proven to be remarkably resilient, revealing the insidious seductiveness of symplesiomorphy. Scientific understanding of *Cladoseleche* has developed erratically; strong early 20<sup>th</sup> century interest at the American Museum of Natural History was followed by a mere handful of highly informative but spasmodic investigations, especially in London, Cleveland, and Stockholm. Recent phylogenetic studies have proposed a relationship between *Cladoseleche* and symmoriform sharks but, because of uncertainty surrounding symmoriform relationships, the phylogenetic position of *Cladoseleche* seems as murky as before. A major revision of cladoselechan sharks was initiated by the late Michael Williams at the Cleveland Museum of Natural History, but following his untimely death that project was disrupted and his findings remain unpublished. Williams strongly advocated that Cleveland Shale *Cladoseleche* specimens actually represent two genera, and was in the process of differentially diagnosing them at the time of his death. A synthesis of his unpublished findings will hopefully help resolve many of the mysteries still surrounding cladoselechan sharks, and a resuscitation of his project is therefore planned.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 10:30

#### **BIOGEOGRAPHY OF CHARACIFORMES: AN EVALUATION OF THE AVAILABLE INFORMATION OF FOSSIL AND EXTANT TAXA**

MALABARBA, Luiz, UFRGS, Porto Alegre, Brazil; MALABARBA, Maria, MCP-PUCRS, Porto Alegre, Brazil

The order Characiformes has long been considered a terrestrial group of relevance in understanding earth history due to their exclusiveness to freshwater. The phylogenetic history of the group, however, is still poorly understood, preventing the formulation of a reliable biogeographical hypothesis. The accepted cladistic hypothesis of relationships to other ostariophysan orders and even its monophyly have been challenged in recent molecular studies. However, most of these studies are based on very low numbers of characiform and other ostariophysan representatives, and may be affected by long branch attraction artifact. Previous hypotheses to explain current distribution of the Characiformes are re-evaluated. Compared to the tremendous diversity of the living forms, the characiform fossil record is still meager, being reported from South America, Africa, Europe and Arabian Peninsula from Cenozoic and Mesozoic. The occurrence of marine fossils characiforms is discarded based on the stratigraphic information. The characiform occurrences in the European Ypresian are explained by a connection between Southwest Europe and North Africa in the Lower Eocene, allowing the immigration of characiforms taxa from Africa. Uneven present day distribution and diversity of characiforms in South America and Africa has been tentatively explained based on centers of origin or cladistic vicariance theories, associated with different scenarios (e.g. extinction or marine dispersal). Marine origin or marine dispersal, and massive extinction of characiforms in Africa are considered not supported hypotheses. We propose that the absence of some lineages and the lower diversity of characiforms in Africa may be the result of predrift vicariance and distribution patterns of ancient characiform lineages inside the Gondwana.

Poster Session III (Friday)

#### **MESOZOIC CONTINENTAL VERTEBRATE COMMUNITY FROM PAKISTAN-AN OVERVIEW**

MALKANI, M., Geological Survey of Pakistan, Quetta, Pakistan

Indo-Pakistan subcontinent has critical position in Gondwanan paleobiogeography due to long migration, and consequent collision with Asia. From 1864-1999, India was the only source of Mesozoic vertebrates but its Late Cretaceous fauna is inadequate for assessing paleobiogeography and phylogeny. Since 2000, tracks and remains of a large number of

continental vertebrates were found from the Mesozoic of Pakistan. Trackways representing interaction among a theropod and a group of sauropods were found from the middle Jurassic Samanask Limestone of upper Indus (Kohat and Pothwar) Basin. A few poorly preserved fossils of *Brohisaurus kirthari* titanosaurs were found from the latest Jurassic Sembar Shale of lower Indus (Kirthar) Basin. Three thousand bones/pieces of bones (articulated, associated and mostly fragmentary but well preserved) were found from the two red mud horizons (alternated with sandstone) of latest Cretaceous Vitakri (10-35m thick) Member of upper Pab Formation of middle Indus (Sulaiman) Basin include the following biodiversity: *Pakisaurus balochistani*, *Sulaimanisaurus gingerichi* and *Khetranisaurus barkhani* of Pakisauridae, *Marisaurus jeffi* and *Balochisaurus malkani* of Balochisauridae Titanosauria were coined on the basis of most diverse caudal centra. *Marisaurus* and *Balochisaurus* bear the partial skull and postcranial elements. *Vitakridrinda sulaimani* Abelisauridae Theropoda is based on a partial skull and some postcranial elements. *Pabweshi pakistanensis* Baurusuchidae Mesoeucrocodylia represents the most diagnostic Crocodyliform remains from the Indo-Pakistan subcontinent and it is the first baurusuchid known outside South America. A stem cross section of a gymnosperm was also found. There are many localities which have produced articulated and associated assemblages and have a great potential for excavating the preserved articulated skeletons of these exceptional animals. Recent discoveries from the Mesozoic of Pakistan broaden the spatial distribution of its biota and provide further an opportunity for the solution of scientific enigma like phylogeny, paleobiogeography, paleoclimate, paleobiology and extinction of dinosaurs, due to well preserved fossils, and wide and extensive exposures of their host rocks.

Poster Session III (Friday)

#### **NEW INFORMATION ON TWO CHASMOSAURINE CERATOPSIDS FROM THE HORSESHOE CANYON FORMATION (LATE CRETACEOUS) OF ALBERTA, CANADA**

MALLON, Jordan, University of Calgary, Calgary, AB, Canada; HOLMES, Robert, University of Alberta, Edmonton, AB, Canada; ANDERSON, Jason, University of Calgary, Calgary, AB, Canada; FARKE, Andrew, Raymond M. Alf Museum of Paleontology, Claremont, CA, USA; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA

An examination of undescribed cranial material attributed to the chasmosaurines *Anchiceratops* and *Arrhinoceratops* from the Horseshoe Canyon Formation (Late Cretaceous) of Alberta reveals variation and new anatomical information not previously recognized in these genera. Where preserved, all *Anchiceratops* skulls bear the characteristic six large epiparietals and paired horn-like epi-ossifications at the caudal margin of the parietal, but vary considerably in the expression of the episquamosals. These range in shape from being large, triangular and indistinguishably fused to the squamosal to being small and rounded, or absent entirely. A single preserved mandible also exhibits a coronoid process offset further laterally than in most other ceratopsids, and a distinctive lip of bone immediately ventral to this. Interestingly, some undescribed specimens attributed to *Arrhinoceratops* exhibit a similar but exaggerated morphology of the mandible, possibly attesting to the sister-group relationship of these two taxa recovered in recent phylogenetic analyses. In fact, a reexamination of the holotype reveals that many of the characters used to diagnose *Arrhinoceratops* (e.g., size and orientation of the facial horn cores, length of the rostrum, size of the rostral bone, presence of premaxillary flanges, size and orientation of the epijugals, shape of both the lateral temporal and antorbital fenestrae, and size and shape of the frill) are variable within several other ceratopsid genera, and some of the supposed autapomorphies of the genus (e.g., large, ventrolaterally-directed epijugal; subtriangular lateral temporal fenestrae; oval parietal fenestrae) are also shared with *Anchiceratops*. In light of these findings, we present new reconstructions and revised diagnoses of these two familiar but poorly understood taxa.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

#### **ENVIRONMENTAL ASSOCIATIONS OF SAUROPOD DINOSAURS AND THEIR BEARING ON THE EARLY LATE CRETACEOUS “SAUROPOD HIATUS”**

MANNION, Philip, UCL, London, United Kingdom

Sauropod dinosaurs apparently inhabited a range of environments, including inland and coastal settings, as demonstrated by both the body fossil and trackway record. Sauropod trackways show two distinct ichnotypes: “narrow-gauge” and “wide-gauge”, which are thought to relate to non-titanosaurs and titanosaurs respectively. A quantitative analysis of a large dataset of both sauropod body fossil and trackway occurrences reveals a positive association between non-titanosaurs and coastal environments in comparison to titanosaurs. The strong statistical support for this association suggests that this is a genuine signal and that non-titanosaur sauropods did preferentially live in coastal environments in relation to titanosaurs. It is possible that titanosaurs radiated as a result of an increase in inland environments in the Early Cretaceous and that the “sauropod-hiatus” in the early Late Cretaceous of North America and Europe may be a preservational artefact, with the lack of titanosaurs found between the Cenomanian-Campanian potentially a result of a dearth in inland deposits preserved during this time. This scenario has better support than the “austral immigrant scenario”, which posited reinvasion of titanosaurs from southern continents in the Campanian, following a sauropod extinction at the end-Albian. The analysis also supports the hypothesis that “wide-gauge” trackways are produced by titanosaurs as the trackway and body fossils show similar environmental associations, whereas when the analysis is expanded to include all titanosauriformes, the signal is lost.

Technical Session XVII, Saturday 11:00

**A SAMPLE-STANDARDIZED MACROEVOLUTIONARY HISTORY OF THE UNGULATES OF WESTERN NORTH AMERICA**

MARCOT, Jonathan, University of Illinois at Urbana-Champaign, Urbana, IL, USA

The taxonomic evolution of North American ungulates has played a central role in the narrative of mammalian evolution and its response to Cenozoic environmental change. For example, the radiations of groups such as horses have been considered bellwethers of the spread of grassland ecosystems, and artiodactyls and perissodactyls have been the subject of studies of competitive interactions. However, evolutionary patterns from the fossil record can be altered by many factors, and distort our perception of Cenozoic evolution and environmental changes. In this study, I estimate time-series of taxonomic richness and rates of origination and extinction for perissodactyls and artiodactyls from western North America using occurrence data from the Paleobiology Database. The number of collections and their geographic distribution varies among intervals, and this can bias perceived evolutionary patterns. Therefore, I address these two sources of bias by standardizing interval-to-interval variation in numbers, and geographic range among the collections. The overall pattern shows two maxima of taxonomic richness in the Middle to Late Eocene and the Early to Middle Miocene, which were separated by an interval of relatively low richness in the Oligocene. Rates of origination were high early in the group's history, including a peak in origination at 38Ma. This is followed by relatively low rates throughout most of the Oligocene. The early Neogene is characterized by four increases in origination rate at around 22, 18, 10-12 Ma and 4Ma. Each peak is either preceded or accompanied by a peak in extinction rate, suggesting large-scale taxonomic turnovers. While all peaks in origination are evident in both clades, some appear to be driven predominantly by artiodactyls (e.g., 22Ma), while others by perissodactyls (e.g., 18Ma). This might suggest clade-specific responses to environmental stimuli. As in previous studies, neither taxonomic richness nor rates appear to be correlated with estimates of global temperature, suggesting that environmental influences on taxonomic evolution are manifested at more restricted geographic scales.

Technical Session XV, Friday 3:45

**DATING THE ORIGIN OF LISSAMPHIBIA BY THREE TECHNIQUES SUGGESTS A PERMIAN, MONOPHYLETIC ORIGIN**

MARJANOVIĆ, David, CNRS UMR 7179, Paris, France; LAURIN, Michel, CNRS UMR 7179, Paris, France

The origin of extant amphibians is controversial. Most phylogenies suggest a monophyletic origin from either temnospondyls or lepospondyls, but a few suggest a polyphyletic origin from both groups. Recent molecular studies have argued that Lissamphibia originated in the Mississippian or Late Devonian, and that this date favors a monophyletic origin from temnospondyls. Such an early origin is more coherent with polyphyly. We reassess the date of origin of Lissamphibia using three independent techniques. First, we use a time-calibrated supertree of 223 lissamphibian species older than Pliocene and several extant ones. This tree shows a highly significant stratigraphic fit, suggesting that the fossil record yields reliable information about divergence times. Some divergences are even fit for use as calibration points for molecular dating. Fourteen combinations of minimal branch length settings and ten random resolutions for each polytomy show that our results tend to overestimate the age of cladogeneses compared to fully resolved trees. Second, we use four internal calibration dates from the time-calibrated supertree, along with up to three external calibration dates, to estimate the time of origin of Lissamphibia using mtDNA. We investigate the effect of internal vs. external calibration dates, evolutionary model, smoothing factor used in penalized likelihood, and use of minimum and maximum ages for some calibration points. The choice of calibration dates and the use of maximum ages have by far the largest impact on the date obtained. Third, we try to establish a confidence interval on the lower bound of the stratigraphic range of this clade. This is phylogeny-independent; it is based on the stratigraphic distribution of 1207 localities that have yielded lissamphibian fossils, the relative area of sedimentary rocks from various periods exposed on the continents, and ten exponential growth models of lissamphibian diversity that differ by the assumed effects of three mass extinctions and the starting times of lissamphibian diversification obtained from molecular studies. All results suggest a Permian origin of Lissamphibia, and lissamphibian monophyly.

Technical Session I, Wednesday 9:15

**IMPROVING CONGRUENCE BETWEEN MORPHOLOGICAL AND MOLECULAR DATA USING IMPLIED WEIGHTING**

MARTIN, Jessica, Georgia Southern University, Statesboro, GA, USA; GEISLER, Jonathan, Georgia Southern University, Statesboro, GA, USA

There has been significant debate on the best methods for phylogenetic analyses. Unweighted parsimony, which is the predominant method used for paleontological data, has been heavily criticized for its tendency to attract long branches. We are investigating a method developed by Pablo Goloboff (i.e. implied weighting) for its ability to recover "accurate" phylogenies. Implied weighting applies character weights during an analysis, with less weight given to more homoplastic characters. The severity of down-weighting is determined by a constant  $k$ , where lower  $k$  values indicate greater down-weighting. To date, only limited research has been done on the influence of  $k$  values on phylogenetic results. In this study we are using 26 published morphological mammalian data sets. All datasets

include extant taxa, whose relationships have also been determined using nuclear DNA sequences and/or rare genomic events. Each dataset is being analyzed with 12 different  $k$  values (i.e. 0.001, integers 1-10, and 1000) as well as with unweighted parsimony using the computer application TNT (Tree Analysis using New Technology). While "accuracy" could not be directly measured, congruence between implied weighting analyses and a consensus molecular tree could be measured by calculating the difference in tree scores, which is the complement to "fit" as determined in implied weighting. The differences in scores were standardized because the magnitude of the score is inversely proportional to the  $k$  value employed. Preliminary results based on detailed analyses of 4 of these datasets show that implied weighting, with  $k$  values between 1 and 10, yielded results that were more congruent than did unweighted parsimony. The value of  $k$  that yielded the greatest congruence varied, indicating there is not a universal, ideal value of  $k$ . In some cases, there was more than value of  $k$  that maximized congruence with the molecular tree. Incongruence greatly increased as  $k$  values approached 0 (i.e. clique analysis). Ongoing work aims to compare the measure of congruence used here with topological measures as well as whether the  $k$  value that maximizes congruence can be determined prior to the analysis.

Poster Session IV (Saturday)

**COOKIE-CUTTER CATS; ANOTHER SABER-TOOTHED MORPHOTYPE**

MARTIN, Larry, University of Kansas, Lawrence, KS, USA; NAPLES, Virginia, Northern Illinois University, DeKalb, IL, USA; BABIARZ, John, BIOPSI, Mesa, AZ, USA

L. D. Martin proposed that all cat-like carnivorans could be placed in one of three morphotypes: conical-toothed, dirk-toothed and scimitar-toothed. All modern cats are conical-toothed. The other two types have blade-like canines (saber-teeth). The dirk-tooths had shorter legs than do ordinary cats, while the legs of the scimitar-tooths are more elongated. Dirk-toothed forms ambushed their prey, while scimitar-tooths must have engaged in pursuit. We think that the dirk-toothed forms killed using a highly specialized throat bite, but that scimitar-toothed forms may have bitten prey in a variety of locations. Their canines were shorter, broader, more coarsely serrated and nearly continuous with the incisor arcade. These features are most prominent in *Xenosmilus*, a newly described Pliocene form that breaks the paradigm by combining scimitar sabers with the short limbs of an ambush predator. In *Xenosmilus*, the sharp, prognathous incisor arcade coupled with the canines could have cut out a lump of flesh about as big as the cat could swallow. Such terrible bites would have quickly put the prey into shock. Death might have resulted from multiple wounds rather than through a directed killing bite, although these cats could make such a bite if the opportunity presented itself. This bite would resemble the action of a cookie cutter taking out a section of dough, and we have used that example to provide a name for this unusual saber-tooth adaptation.

Technical Session VII, Thursday 1:45

**MOSAIC EVOLUTION IN THE DENTITION OF THE ARCHAIC PLIOCENE VOLE *OGMODONTOMYS* FROM THE MEADE BASIN OF SOUTHWESTERN KANSAS**

MARTIN, Robert, Murray State University, Murray, KY, USA; MARCOLINI, Federica, Universita Roma Tre, Rome, Italy

Thirteen characters and four indices from nine stratigraphically superposed samples of *Ogmodontomys* first lower molars (m1s) from the Meade Basin of southwestern Kansas, spanning an interval of approximately 2.0 million years of the early and middle Pliocene, were measured and analyzed by a variety of statistical techniques. The proportion of enamel atolls on the m1 were also examined. There were no statistically significant changes in eight measurements and one index. Although statistically significant differences were found for five of the variables and three indices during the sampling period, two of these variables and the three indices were interpreted as displaying an overall pattern of stasis within which statistically significant changes occurred. Three occlusal measurements displayed directional trends. Two of these represented changes in widths of dentine fields between triangle pairs (T1-T2, T3-T4) and the third was the deepening of a buccal reentrant angle (BRA3), initially as the result of loss of the enamel atoll in the anteroconid between Fallen Angel B and Fox Canyon time, presumably as the result of a speciation event from *O. sawrockensis* to *O. poaphagus*. A second significant deepening of BRA3 occurred during the late middle Blancan, within the species *O. poaphagus*. Significant widening of the dentine field between T1-T2 also occurred at this time, whereas significant decrease of the field between T3-T4 occurred twice; once at the *O. sawrockensis* - *O. poaphagus* speciation event and once again from Deer Park to Paloma time in *O. poaphagus*. When we include data from the schmelzmuster (microhistological enamel banding pattern), the summary indicates a punctuated pattern of change in occlusal morphology and schmelzmuster pattern, concentrated at the *O. sawrockensis* - *O. poaphagus* speciation event and again within *O. poaphagus* at various points in the Pliocene. The linea sinuosa (enamel-dentine junction), on the other hand, displays significant changes occurring throughout the history of both species. The most significant changes in m1 shape occur at the *O. sawrockensis* - *O. poaphagus* transition, but both phyletic change and "punctuated gradualism" (stairstep evolution) are also recorded in *O. poaphagus*.

Preparators' Session, Thursday 11:30

**TINY TEETH: CRETACEOUS MAMMAL TEETH MOLDED AND CAST WITH STORAGE IN MIND**

MASON, Jane, Florida Museum of Natural History, Gainesville, FL, USA

The fossil teeth from Cretaceous mammals are small, fragile, and rare. Molding and casting them in multiple copies ensures safe study by the wider paleontological community and permits a deeper understanding of these uncommon animals. When thirty teeth on loan from the Geological Survey of India were presented for reproduction and collection storage containment, a system had to be devised that allowed continued safe handling and a means for organizing these casts. Using traditional mold design and materials presented problems when the small size and fragility of these teeth were considered. Casting technique, as well as future archival storage, were studied in this light. Preparation of a tooth required using colored carbowax to plug all holes and gaps to ensure safety of the tooth while in a vacuum chamber and colored for easy removal later. The teeth were left on the original mounting pins that acted as handles through the whole procedure. Often less than a millimeter long after preparation, a silicone glove mold was painted on a tooth embedded in warm clay using a microscope and compressed air. The specimen number was inscribed backwards on the collar of the mold close to the tooth. These molds were comprised of several thin layers, and cusps were reinforced with nylon mesh. A thin mold was necessary to allow flexibility and the complete inversion of the mold during demolding and casting to reduce stress on the fragile structure. Differential coloring of the area in the mold where the tooth sits, or the first detail coat, permitted easier casting. The uniform size and shape of the casts was determined by using a hole-punch that exactly fits the internal diameter of a standard collections storage vial to make the mold's outside form. This tool also makes perfect-fit spacers of ethafoam so that multiple casts of the same tooth can be stacked and stored in the same vial for shipping and or collection purposes. Using these techniques, I was able to process four copies of each tooth while keeping track of the progress of the project. Once all the teeth had been molded and cast, the collection storage format was already accomplished.

Poster Session IV (Saturday)

**AN ICHTHYOSAUR SKULL FROM THE SUNDANCE FORMATION (JURASSIC) OF CENTRAL WYOMING**

MASSARE, Judy, Earth Sciences Dept., SUNY Brockport, Brockport, NY, USA; WAHL, William, Wyoming Dinosaur Center, Thermopolis, WY, USA

We report on a fairly complete skull of *Ophthalmosaurus natans* (UW 24216) from the upper Redwater Shale (Oxfordian) of the Sundance Formation of northern Natrona County, WY. The meter-long skull is preserved in three dimensions, along with most of the palate and articulated jaws. The skull roof is complete but flattened posteriorly and damaged on the left side. Fusion of several skull bones suggests that this is an adult. The skull morphology shows some differences from the well-known reconstruction by Gilmore, including smaller and more rounded temporal fenestra, less robust postfrontals, and a more complex nasal-lacrimal suture. The occipital region is roughly rectangular, wider than high, similar to previous reconstructions. The sclerotic ring is complete for both eyes and the circular shape suggests that it is not deformed. The sclerotic plates themselves are unusual in that the outer 40% of each plate is bent inward by about 90°. All but the last few centimeters of the snout is preserved, and it is fractured into several pieces that allow a view of the internal structure. Loose teeth are present between the upper and lower jaw from at least the middle to the tip of the snout. This indicates *O. natans* had teeth as an adult, in contrast to what has been suggested for the closely related *O. icenicus* from the Oxford Clay of England.

Poster Session II (Thursday)

**A BRIDGERIAN RODENT (SCIURAVIDAE) FROM THE PARACHUTE CREEK MEMBER OF THE GREEN RIVER FORMATION IN THE PICEANCE CREEK BASIN, NORTHWESTERN COLORADO**

MASTERS, Simon, Intermountain Paleo-Consulting, Vernal, UT, USA; SANDAU, Stephen, Intermountain Paleo-Consulting, Vernal, UT, USA; TEMME IV, Thomas, Intermountain Paleo-Consulting, Vernal, UT, USA

A primitive rodent skull was discovered during the paleontological monitor of a pipeline in the Piceance Creek Basin, northwestern Colorado. The individual is represented by a mostly complete skull, ulna, radius, and a partial vertebra. The skull is reasonably well preserved, yet shows some signs of crushing prior to or soon after shallow deposition. The skull also exhibits transverse compression mainly of the sinistral frontal element and zygomatic arch. The crown of P<sup>1</sup> along with portions of the roots of M<sup>1</sup>-M<sup>2</sup> are sheared off and deposited distal-buccally from the skull, with the distal portion of the dextral maxilla missing. The extreme wear of the occlusal surface shown on M<sup>1</sup>-M<sup>2</sup> of the sinistral maxillary molars suggests the individual was in the advance stages of life. The rodent is identified to the genera (*Sciuravus*), of the Bridgerian Land Mammal Age (BLMA). The BLMA age supports the age of the sediment in the monitor area as late Early Eocene to early Middle Eocene. The specimen was recovered in an arkosic to sub-arkosic, coarse sandstone lens in the uppermost Parachute Creek Member of the Green River Formation. During the late Early and early Middle Eocene, the Uinta and Piceance Creek Basins were connected by a single lake extending across parts of northwestern Colorado and northeastern Utah. The matrix around the specimen consists of quartz grains, mica flakes, white and black calcite grains, feldspar, and chert grains and calcium carbonate cement. The stratigraphic column as exposed by trenching, in ascending order, consists of a white, well indurated limestone, gray-white shale, and the tan, medium to coarse grain arkosic sandstone in which the fossil material was discovered.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**QUANTIFICATION OF EVOLUTION OF LEPTOMERYX ENAMEL ACROSS EOCENE-OLIGOCENE TRANSITION**

MATHIS, Julie, University of Florida/Florida Museum of Natural History, Gainesville, FL, USA

The Eocene-Oligocene transition (~33Ma) has recently been demonstrated to be one of the most pronounced climate changes of the Cenozoic, with the continental mean annual temperature dropping ~8°C over a span of ~400,000 years. *Leptomeryx* is a small, ruminant artiodactyl found commonly from before the transition (late Eocene, Chadronian NALMA) to after the transition (early Oligocene, Orellan NALMA). Significant changes would be expected in response to the dramatic climatic shift, particularly an increase in the amount of enamel as the animal dealt with harsher, more abrasive cold-climate plants. Previous research on *Leptomeryx* has shown qualitative differences in cusps, ridges, and folds in premolars, but no quantitative data are known for the potential increase of enamel in later species. To test this hypothesis, 11 specimens of *Leptomeryx* from both the Chadronian and Orellan of northwestern Nebraska were divided into similar wear stages (Juvenile, Adult, Senior). Specimens from the Juvenile wear stage representing the largest sample size (Chadronian n=6, Orellan n=7) were chosen to conduct analyses on. Photographs of the occlusal surface of each specimen were taken, carefully controlling the orientation to minimize the amount of non-occlusal surface enamel shown. ArcGIS software was used on the photographs to isolate the occlusal-surface enamel into polygons. The software was then used to calculate the area of the polygons, thus giving the area of occlusal surface enamel for each tooth. The m1 and m2 molars were determined to be similar enough in size to include together in statistical analysis. The Orellan population showed an increase in enamel versus the Chadronian population. This increase is determined to be a significant difference in both the Mann-Whitney U test (p=0.036) and the Two Independent Samples Comparison (p=0.029). Future work on this hypothesis will be done by increasing the sample size and using ImageJ software.

Poster Session III (Friday)

**PALEOENVIRONMENTS OF THE LATEST CRETACEOUS OLDMAN FORMATION OF SOUTHERN ALBERTA**

MATSON, Christopher, University of Calgary, Calgary, AB, Canada; THERRIEN, François, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; ZELENITSKY, Darla, University of Calgary, Calgary, AB, Canada; EBERTH, David, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Rapid turnover of dinosaur faunas have been previously recognized in the late Campanian Oldman and Dinosaur Park formations of southern Alberta in Dinosaur Provincial Park (DPP). Although this faunal turnover has been attributed to climatic and environmental changes, no study attempting to correlate them has been conducted. To test this hypothesis, paleosols of the upper Oldman Formation exposed in DPP were studied to reconstruct the environmental and climatic conditions in which dinosaurs lived. Five distinct types of paleosols (pedotypes) are recognized: (1) blue-gleyed paleosols with rare root traces, (2) poorly-developed gray paleosols with rare clay coatings and slickensides, (3) weakly-developed dark gray paleosols with sideritized horizons, (4) well-developed green paleosols with abundant slickensides and clay coatings, and (5) well-developed green to gray paleosols with an albic horizon and abundant clay coatings. Three pedotypes (2, 4, and 5) contain morphological and geochemical features indicative of well-drained habitats subjected to alternating wet and dry periods. One pedotype (5) contains a light gray, leached (albic) horizon that preferentially developed on wide, shallow channel scours suggesting that sandier parent material may have facilitated its development. The gleyed and sideritized pedotypes (1 and 3) denote local ponding and saturation of soils by a fluctuating watertable. Pedogenic features observed in the various pedotypes (clay coatings, leached horizons, gleyed horizons) testify to periods of abundant precipitation and high watertables, an interpretation consistent with paleoprecipitation estimates of 733-1176 mm/year calculated from paleosol geochemistry. This sub-humid climate of the upper Oldman Formation in DPP contrasts with the semi-arid climate inferred from the presence of caliches in coeval deposits in southernmost Alberta and in Montana. Future study will focus on the paleosols of the Dinosaur Park Formation in DPP to gain further insight into the relations between environment/climate and dinosaur faunal turnover during the Late Cretaceous.

Poster Session I (Wednesday)

**SKULL FUNCTION AND SUTURE MORPHOLOGY IN CHORISTODERA**

MATSUMOTO, Ryoko, University College London, London, United Kingdom; EVANS, Susan, University College London, London, United Kingdom

Choristodera is a group of extinct Laurasian freshwater reptiles. The Late Cretaceous to Eocene neochoristoderes *Simoedosaurus* and *Champsosaurus* are characterised by flat elongated snouts, dorsally directed orbits, and enlarged temporal fenestrae, although *Champsosaurus* differs from *Simoedosaurus* in having a much narrower, gavial-like rostrum. Because of their snout morphology and aquatic lifestyle, neochoristoderes are often likened to crocodiles, but detailed functional comparisons have not been made between the two groups. Skull sutures are integral to skull function, and their study can shed light on the level and direction of strains experienced during feeding. Suture patterns were analysed in disarticulated material of *Champsosaurus* and *Simoedosaurus*, and compared with those of

narrow and broad-snouted crocodiles. These comparisons reveal differences, most notably between midline joints and between those of the medial and lateral cranial series. For example, in neochoristoderes, the paired frontals and parietals meet at deep ridged butt joints (massive between the posterior parietals); in crocodiles, the frontals and parietals are single, and the latter bone is relatively shallow. In the rostrum, crocodile nasals are paired with a relatively shallow midline joint, whereas neochoristoderan nasals are fused and partially replaced by elongated, strongly sutured prefrontals. In the anterior palate the median sutures are relatively deeper in neochoristoderes than in crocodiles, but the posterior sutures have less depth, unlike crocodiles where the bones are fused. There are also differences in the articulations between the median roofing bones and those of the postorbital and temporal series. In crocodiles these articulations are strong, deeply interdigitated 'plug-in' contacts. In neochoristoderes they are shallow scarf joints. These differences must be considered in the context of a broader study of the choristoderan skull, but they demonstrate that the skulls of crocodiles and neochoristoderes are adapted to withstand different forces, reflecting differences in feeding strategy and lifestyle despite superficial similarity.

Poster Session III (Friday)

**THE MOCCASIN MOUNTAIN TRACKSITE, UTAH; WHERE SCIENCE, TECHNOLOGY, AND RECREATION MEET PALEONTOLOGICAL RESOURCE MANAGEMENT**

MATTHEWS, Neffra, Bureau of Land Management, Denver, CO, USA; LOCKLEY, Martin, University of Colorado at Denver, Denver, CO, USA; BREITHAUP, Brent, University of Wyoming, Laramie, WY, USA; TITUS, Alan, Bureau of Land Management, Grand Staircase-Escalante National Monument, Kanab, UT, USA; NOBLE, Tommy, Bureau of Land Management, National Operations Center, Denver, CO, USA

In the fall of 2007, the occurrence of dinosaur tracks was reported to the BLM Kanab Field Office by a group of hunters. The tracks are located near Coral Pink Sand Dunes State Park, a popular off-highway vehicle (OHV) area. Upon investigation by the BLM, a spectacular vertebrate paleontological resource was brought to light. The Moccasin Mountain Tracksite (MMT) reveals multiple track levels in the Navajo Formation (age ~185 million years) in a slickrock sandstone area covering about 1,000 m<sup>2</sup>. This site provides an ideal opportunity for the successful synergy of management, science, technology, interpretation, and recreation. OHV recreational activity is extremely popular in southern Utah, with Coral Pink Sand Dunes State Park and nearby areas experiencing a rapid increase in use. OHV activity has impacted the track surface at the MMT necessitating the closure of the track-bearing area to vehicular traffic to protect this significant paleontological resource. Scientifically the site contains a high ichno-diversity and important preservation features. At least six different track types have been observed, including tridactyl (*Grallator* and *Eubrontes*) and tetradactyl forms (*Batrachopus* and *Otozoum*). Tracks occur on both the dune foreset beds and the interdune bounding and truncation surfaces and are preserved as underprints, in convex hyporelief, and more rarely in concave epirelief. The morphology varies from the distinct preservation of anatomical features, such as pads and claw impressions, to areas of undifferentiated dinoturbation. This unique faunal assemblage found in the midst of a vast Navajo dune field warrants a high level of study and documentation. One mode of documentation will include close-range photogrammetry. In the spring of 2008 an overall strategy for capturing the entire surface was devised and preliminary 3D image models were created. The digital virtual representations provide an effective tool for presenting the uniqueness of the site to OHV enthusiasts, land managers, and the scientific community, as well as, interpreting this unique site to the public and increasing the awareness and concern for such natural treasures.

Technical Session XVIII, Saturday 1:45

**RECOVERING PALEOENVIRONMENTAL DATA HIDDEN IN BIOAPATITES: GEOCHEMISTRY OF FISH REMAINS FROM THE UPPER DEVONIAN ESCUMINAC FORMATION (MIGUASHA, QUEBEC)**

MATTON, Olivier, Université du Québec à Montréal and Parc national de Miguasha, Montréal, QB, Canada; CLOUTIER, Richard, Chaire de recherche en paléontologie et biologie évolutive and Université du Québec à Rimouski, Rimouski, QB, Canada; STEVENSON, Ross, Université du Québec à Montréal, Montréal, QB, Canada

For more than 125 years, the diverse and well-preserved Frasnian fish assemblage from the Escuminac Formation has released invaluable information on the evolution, anatomy and paleoecology of lower vertebrates, not to mention the insight it provides on the transition between fishes and tetrapods. But, despite this major scientific interest, no unequivocal paleoenvironmental framework has been established. Conflicting data from paleontological, sedimentological and geochemical studies have led to an array of interpretations ranging from lacustrine to marine, with a recent consensus for a transitional, brackish estuarine paleoenvironment. Among the evidences used by authors, Sr isotopic composition and rare earth elements (REE) have only been measured on a single bony fragment of the placoderm *Bothriolepis canadensis* without stratigraphic data. This long-standing debate is addressed through a broader geochemical study using these valuable proxies. Bioapatites from five fish species (acanthodian *Homalacanthus concinnus*, actinopterygian *Cheirolepis canadensis*, placoderm *Bothriolepis canadensis*, dipnoan *Scaumenacia curta*, osteolepiform *Eusthenopteron foordi*) collected from the base to the top of the Escuminac Formation (ca. 119 m) were analyzed. The isotopic analyses were performed by Thermal Ionisation Mass Spectrometry (TIMS) and REE abundances were measured by laser ablation ICP-MS.

REE patterns are similar to those described in most marine Paleozoic bioapatites. Some Sr ratios are consistent with Late Devonian seawater composition, though most of the biogenic apatites analyzed show a variable drift from marine value toward a more radiogenic continental signature. This trend is likely owing to Sr exchange between fossils and host sediments during burial. Tooth material appears more resistant to alteration than bone and scales. These results suggest that fish remains have experienced diagenesis but not enough to completely overprint their original paleoenvironmental signatures. These signatures are suggestive of a brackish to marine water environment for the Escuminac Formation, with no clear interspecific variation in terms of paleosalinity.

Poster Session II (Thursday)

**ASTRAGALUS MORPHOLOGY AND EVIDENCE OF SPECIATION IN THE GROUND SLOTH *MYLODON* (MAMMALIA: XENARTHRA: MYLodontidae) MCAFEE, Robert, Doane College, Crete, NE, USA**

Investigations to redefine the morphological characters of the astragali of various South American Mylodontidae sloths have produced novel character states overlooked by prior workers. Specimens belonging to *Mylodon* are now defined by the additional characterization of having a contoured tibial plateau, due to a rise in the anterior portion, and an elongated C-shaped excavation of the anterior articular surface of the odontoid process. Examination of *Mylodon* astragali also reveals a unique morphology that is thought to represent a new species, for which resurrection of the name *M. domesticum* is recommended. Both morphs share the new *Mylodon* characters, along with the historic characters of an obtuse angle between the odontoid process and tibial plateau, and in the continuous articular facet for the calcaneus, which is often separate in other mylodontid subfamilies. Based on the association of these morphs with known cranial material, it is suggested that the species-level characters of *M. darwini* be redefined as having an S-shaped lateral border of the tibial plateau and by the astragalar head being more anteriorly positioned with regard to the anteriormost edge of the tibial plateau. The former descriptions of *M. darwini* are now assigned to *M. domesticum* in which there is no indentation to the border of the tibial plateau to produce the S-shape and the astragalar head is evenly oriented with the anterior edge of the plateau. Given the nature of these changes, a more thorough review of the characters relative to the skulls associated with these astragalar morphs is needed to further establish the proposed taxonomy.

Technical Session III, Wednesday 4:00

**BODY SIZE OF THE GIANT EOCENE SNAKE *PALAEOPHIS COLOSSAEUS* (SERPENTES: PALAEOPHIIDAE) ESTIMATED FROM RECENTLY COLLECTED MATERIAL FROM MALI**

MCCARTNEY, Jacob, Stony Brook University, Stony Brook, NY, USA; KLEY, Nathan, Stony Brook University, Stony Brook, NY, USA; O'LEARY, Maureen, Stony Brook University, Stony Brook, NY, USA

*Palaeophis* is an extinct genus of marine snakes with a Pan-Tethyan distribution, and known to vary widely in body size. One of the largest species, *P. colossaeus*, is considered by some to be the largest snake known. A recent expedition to Mali in 2003 resulted in the collection of many vertebrae of this species, as well as those from possibly one other species; intracolumnar variation is poorly understood in *Palaeophis*, complicating precise identification of some of the smaller material. The specimens range in size from about 10 mm to about 35 mm in centrum length. The largest of the vertebrae can be positively ascribed to *P. colossaeus*; these vertebrae are larger than those of any extant snakes. We attempt to estimate the length of *P. colossaeus* from these isolated vertebrae. A number of measurements were made on the largest mid-trunk vertebrae within a phylogenetically and ecologically broad sample of extant snakes of various body lengths (from about 0.25 m to more than 6 m). The geometric mean of several measurements was regressed on body size for the extant taxa sampled, and the length of *P. colossaeus* was estimated based on the same measurements taken from the three largest vertebrae recovered. Whereas individual measurements regressed on body size gave estimates in excess of 11 m for *P. colossaeus*, a geometric mean of several measurements yielded a slightly lesser estimate of about 10 m (total length). The preservation of the material was such that all of the measurements that comprised the geometric mean could not be taken on the largest specimen; however, the more complete specimen used for this estimation was not significantly smaller. These length estimates place *P. colossaeus* near the uppermost size limit for Serpentes, including both extant and extinct taxa. Also included in the collections are two pathological specimens in the form of fused vertebrae. The larger of the two is on par with the previously mentioned specimens (measurements were not made on this specimen, however, because of the pathology). In both, the centra are fused extensively, and boundaries between them are difficult to observe.

Technical Session VII, Thursday 2:15

**QUANTIFYING THE EXTENT OF TIME-AVERAGING INTRODUCED BY RODENT BIOTURBATION IN MAMMAL-BEARING CENOZOIC SEDIMENTS**  
MCGUIRE, Jenny, University of California at Berkeley, Berkeley, CA, USA; BLOIS, Jessica, Stanford University, Palo Alto, CA, USA; TOMIYA, Susumu, University of California at Berkeley, Berkeley, CA, USA; SHERRON, Brian, University of Washington, Seattle, WA, USA; BARNOSKY, Anthony, University of California at Berkeley, Berkeley, CA, USA

Time-averaging is a common problem in reconstructing communities from fossil deposits, but it is seldom possible to quantify how much time is actually represented in a given fossil assemblage. We radiocarbon-dated multiple specimens from an apparently cohesive community sample recovered from a Quaternary loess deposit in the Sand Hills Coulee Soil exposed in Sagebrush Trench in the Saddle Mountains of eastern Washington. Taxa sampled for radiocarbon dating came from throughout the 2 meter stratigraphic range of the deposit and from across the range of ecomorphs and taphonomic types represented at the site. Resulting dates revealed that the locality in fact contains specimens from two distinct time periods often in close physical proximity and stratigraphic association. The younger specimens had excellent taphonomic preservation and dated to 1200-4700 <sup>14</sup>C years before present (ybp); whereas the older specimens from 15000-15600 <sup>14</sup>C ybp demonstrated poorer preservation. Closer inspection revealed that the younger specimens were dominated by species utilizing burrows including *Spermophilus* and *Thomomys* likely collected from the burrows that trace through the deposit, while the older specimens were larger, non-burrowing species including a juvenile bison. The resulting time differential between neighboring specimens associated through bioturbation is greater than 10,000 years, the same order of magnitude as the age of the site. These results highlight that (a) closely associated taxa apparently from the same kind of habitats can be of significantly different ages; and (b) the effects of such time-averaging can be ascertained with careful sedimentological analyses in tandem with even sampling of specimens for dating. These results reveal the potential extent of time-averaging in other bioturbated deposits that are common throughout the Cenozoic, and indicate that care should be taken in assuming contemporaneity of taxa from such fossil assemblages.

Technical Session V, Wednesday 3:00

**PREY-KILLING ADAPTATIONS IN THE FORELIMBS OF SABER-TOOTHED CATS AND NIMRAVIDS**  
MEACHEN-SAMUELS, Julie, UCLA, Los Angeles, CA, USA

The cranial morphology of saber-toothed cats and nimravids has been well-studied, but less attention has been paid to their postcranial morphology. For predatory animals like felids the forelimbs are an important part of the prey-killing apparatus. The morphology of saber-toothed cats and nimravids suggests they also used both the skull and forelimbs to catch and kill prey, making living cats a good proxy for studying their ecology. A previous comparative multivariate study of extant felids that kill predominantly large prey and those that kill smaller prey elucidated important differences in the forelimbs that relate to these disparate prey-killing strategies. Extant large prey specialists tend to have larger olecranon processes of the ulnae, more robust humeri and radii, larger humeral epicondyles, and wider proximal paws. All of these characters are functionally important for coping with the large, unpredictably directed forces encountered when subduing struggling prey. In this follow-up study, I compared the morphology of saber-toothed cats and nimravids to extant cats using linear regressions and univariate analysis of variance. Additionally, radiographic images of the humeri were taken of 29 species of extant felids and compared with the humeri of *Hoplophoneus*, *Smilodon fatalis*, and *Homotherium crenatidens* to determine whether there is a difference in cortical thickness of the humerus as well. Results show that all of these functionally important morphological features were significantly larger in the saber-toothed morphs than in extant conical-toothed cats of similar size. These differences translate into relatively more robust, powerful forelimbs in saber-tooth morphs than in extant felids. Additionally, when saber-toothed nimravids and felids were compared, significant differences were only found in the proximal paw width. This suggests that nimravids and saber-toothed felids converged upon similar forelimb morphologies. This convergent morphology was most likely due to a greater need to immobilize prey with the forelimbs before administering a precisely directed killing bite, which would minimize the risk of canine tooth fracture.

Poster Session II (Thursday)

**PSEUDALLOMYS (RODENTIA, APLODONTIDAE) FROM THE CYPRESS HILLS FORMATION, SASKATCHEWAN, DEMONSTRATES THAT PSEUDALLOMYS IS NOT A JUNIOR SYNONYM OF ANSOMYS**  
MEYER, Taran, University of Calgary, Calgary, AB, Canada; BELL, Sean, Can-Am Geomatics, Swift Current, SK, Canada; BRYANT, Harold, Royal Saskatchewan Museum, Regina, SK, Canada

Two new species of *Pseudallomys* are recognized from two localities within the Cypress Hills Formation of Saskatchewan, the Orellan-aged Fossil Bush Locality and the Whitneyan Rodent Hill Locality. These new species form a significant part of the aplodontid fauna at both localities, with about 20 specimens from Fossil Bush and 30 from Rodent Hill, and include the first known upper molars for the genus. The new species are similar in morphology to *Pseudallomys nexodens*, sharing the complex lophules in the talonid basin,

compressed metaconid, complete hypolophid, large shelf buccal to the mesoconid, and double mesostylid. They differ from *P. nexodens* in their smaller size, and from each other in tooth proportion and minor details. The upper molars closely resemble the uppers of *Allomys storeri*, having a complete ectoloph with a narrow mesostyle, and small second metaconule, but have more complex lophules in their valleys. Although all the new specimens are isolated teeth, the uppers are strongly associated with the lowers based on similar size and frequency and the distinctive network of lophules found in the basins of the teeth. There is no other sample of uppers present at either locality which could be associated with the *Pseudallomys* lowers, and no other lowers which could match the uppers. Cladistic analysis of *Pseudallomys* has placed it within the genus *Ansomys*. The uppers described from the new Cypress Hills material cannot be included within the usual definition of *Ansomys* as they lack the distinctive "handle shaped" ectoloph. As result, pending a re-examination of the relationships of these taxa, we consider *Pseudallomys* as a distinct genus.

Poster Session III (Friday)

**A CONUNDRUM OF PTEROSAUR ICHNOSPECIES IN WYOMING: PTERAICHNUS STOKESI OR PTERAICHNUS SALTWASHENSIS?**

MEYERS, Vicki, Geological Museum, University of Wyoming, Laramie, WY, USA; BREITHAUPT, Brent, Geological Museum, University of Wyoming, Laramie, WY, USA; MATTHEWS, Neffra, USDOI-Bureau of Land Management, Denver, CO, USA

The occurrences of Late Jurassic pterosaur tracks can be found at several locations in Wyoming, including Alcova, Glendo, and Seminoe reservoirs, and the Bighorn Canyon Recreation Area. The Seminoe Reservoir Tracksite, the focus of this study, is in the Windy Hill Sandstone Member (Oxfordian-Kimmeridgian) of the Upper Sundance Formation. The pterosaur tracks are about 1 meter below a layer containing dozens of sauropod tracks. The preserved pterosaur casts and impressions occur on multiple-bedding planes and are exposed on the underside of overhanging ledges and on float blocks. To date over 225 tracks and over twelve trackways have been found. Multiple, well-preserved, trackways display paired pes and manus prints, supporting a quadrupedal mode of locomotion. The pterosaur tracks from the Seminoe Reservoir Tracksite were documented and analyzed during 2007 and 2008 using a combination of conventional measurement techniques, sketches, and photography. Documentation of 165 tracks included individual track measurements of length, width, depth, with description of morphological characteristics. Pes and manus trackway pace, stride, straddle, and gait width were measured, while pace angulation, outward rotation and *in situ* trackway orientation were also documented. Digital photography was used for photogrammetric analysis, track location, and a permanent, non-destructive method of assessment. The abundant collection of data allows for taxonomic identification. Based on this in-depth morphological study, these are the first pterosaur tracks of Wyoming to be assigned the ichnospecies *Pteraichnus saltwashensis* and question the assignment of *P. stokesi* to tracks elsewhere in the state. In addition, the Seminoe Reservoir trackways show disparity in pterosaur movement, due to the animal's size, speed, and the substrate consistency. Varying size and number of tracks suggest different sized animals walking along the shoreline in a marginal marine environment. This study adds to our understanding of pterosaur size distribution, terrestrial quadrupedal locomotion, and behavior, as well as the Upper Jurassic paleoecology of south-central Wyoming.

Technical Session XVII, Saturday 9:15

**THE EARLY EOCENE ASIAN PERISSODACTYL DANJIANGIA PINGI AND THE ORIGIN OF BRONTOTHERIIDAE**

MIHLBACHLER, Matthew, New York College of Osteopathic Medicine, Old Westbury, NY, USA; HOLBROOK, Luke, Rowan University, Glassboro, NJ, USA

Investigations into the phylogeny of the order Perissodactyla have brought little consensus on the position of the Brontotheriidae. Classically, brontotheres are placed in the suborder Hippomorpha. However, hypotheses of brontothere origins range from having arisen within the Palaeotheriidae, to being closer relatives of tapirs and rhinos in the Ceratomorpha, or as the sister taxon of all other perissodactyls. To date, little attempt has been made to incorporate brontotheres into analyses of perissodactyl relationships, with authors often including only a single primitive brontothere, such as *Palaeosyops*, or only including a taxon assumed to be related to brontotheres, such as *Lambdotherium* from the early Eocene of North America. An early Eocene Chinese perissodactyl, *Danjiangia pingi*, bears remarkable similarity to *Lambdotherium* and has more recently been considered the sister taxon of Brontotheriidae, thus implying an Asian origin. However, the relationships of Brontotheriidae, their postulated sister taxa, and other Perissodactyla have not been simultaneously included in an analysis. Here we investigate these relationships with 60 cranial, dental, and postcranial characters, coded for *Lambdotherium*, *Danjiangia*, a variety of basal and derived brontotheres, nineteen other early perissodactyls, and outgroup taxon *Phenacodus*. The six resulting trees group three extinct groups, Palaeotheriidae, Chalicotherioidea, and Brontotheriidae into a single clade outside of the crown perissodactyl clade. *Danjiangia* is positioned as the sister of Brontotheriidae, while *Lambdotherium* nests more closely with Chalicotherioidea and Palaeotheriidae. These preliminary findings suggest that Brontotheriidae may have stemmed from an Asian ancestor, while *Lambdotherium* might actually have had closer ties to chalicotheres and palaeotheres. The early and early-middle Eocene record of brontotheres, beginning with *Eotitanops*, is stronger in North America. Although there are a few fragmentary occurrences of relatively primitive brontotheres from middle Eocene faunas of Asia, an early Eocene Asian brontotheriid more primitive than *Eotitanops* has not been found.

Poster Session IV (Saturday)

**NEW ANTHRACOTHERES (MAMMALIA, ARTIODACTYLA) FROM WADI MOGHRA, EARLY MIOCENE, EGYPT**

MILLER, Ellen, Wake Forest University, WINSTON SALEM, NC, USA; GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA; EL-BARKOOKY, Ahmed, Cairo University, Cairo, Egypt

Wadi Moghra, early Miocene, Egypt, has yielded an array of fossil mammals, including four different anthracotheres (Anthracotheriidae, Artiodactyla). Anthracotheres are widespread in the northern continents and Africa from the late Eocene through the Miocene. Moghra is important for understanding the evolutionary history of this group because there is a higher abundance and diversity of anthracotheres there than at any other early Miocene African locality. Moreover, all of the anthracotheres recovered from Moghra are unique to that locality. Of the four anthracothere species known from Moghra, *Afromeryx africanus* and *Sivameryx moneyi*, have clear relatives in Eurasia, and likely entered Africa as part of a well-documented immigration event that began in the early Miocene. The other anthracotheres, *Brachyodus depereti* and "*Brachyodus*" *mogharensis*, represent forms with a much longer history in Africa, as both species were probably derived from the earlier occurring *Bothriogenys*, best known from late Eocene and early Oligocene deposits in the Fayum Depression, Egypt. Of particular interest is the taxon "*Brachyodus*" *mogharensis*, which was originally assigned to the genus *Brachyodus* but new specimens demonstrate the distinctiveness of this species and require that it be placed in a new genus. Among primitive features distinguishing this species from *Brachyodus* are retention of three lower incisors, lack of fused mandibular symphysis, and lack of enlarged upper and lower third incisors - derived characters include presence of an anterior mandibular flange supporting i3 and c1, and the proliferation of mental and mandibular foramina. Not only are there a greater number of mental and mandibular foramina, but many of them are expanded in size suggesting that the anterior portion of the muzzle was either highly mobile, highly sensitive, or both. These features are likely to represent adaptations for feeding on aquatic plants in shallow water. It has yet to be determined whether these animals fed predominately on marine or freshwater plants. Given the deltaic depositional setting of Moghra and the occurrence of both marine and terrestrial biota, both possibilities exist.

Romer Prize Session, Thursday 11:45

**TESTING THE ECOLOGICAL FIDELITY OF YELLOWSTONE NATIONAL PARK'S LARGE-MAMMAL DEATH ASSEMBLAGE: PALEOECOLOGICAL IMPLICATIONS AND CONSERVATION APPLICATIONS**

MILLER, Joshua, The University of Chicago, Chicago, IL, USA

Paleoecological interpretations of fossil deposits rely on a detailed understanding of the taphonomic biases associated with skeletal assemblages - but the processes of surficial terrestrial skeletal accumulation, the characteristic differences in ecological sampling of various depositional environments, and the quality of ecological data available in bone assemblages remain largely unexplored. Here, I use the well-studied animal community of Yellowstone National Park, WY (YNP) to test the fidelity with which modern surficial bone accumulations mirror the population structure and habitat utilization of a living community in a temperate environment. Forty transects were used to survey the death assemblage of four habitats (grasslands, forests, river margins, and lake margins). Species representative of all body-size classes and nearly all taxonomic groups found in YNP are documented in bone remains - of the known YNP vertebrate diversity, only bats and reptiles are missing from the death assemblage. For ungulates (the group with the largest sample size and highest statistical power), the death assemblage accurately reflects the living community; all native ungulates are present and comparisons between the living community's rank-order abundances and their representation in the dead remains are strongly positive (Spearman rho ~0.7-0.9). The sampled habitats show quantitative differences in live-dead agreement - habitats with higher fossilization potentials (lakes and rivers) show higher landscape-scale ecological fidelity than environments less likely to yield fossil deposits (forests). Examination of carcasses with known dates of death, and radiocarbon dating of bones across the landscape, find time-averaging durations to be at least decadal. Finally, the fidelity with which modern surficial death assemblages reflect large-mammal communities not only speaks to the paleoecological potential of fossil accumulations, but suggests that multigenerational death assemblages may be used to complement traditional biological surveys and provide historical contexts to better interpret the stability of modern populations and track their changes over ecological time.

Poster Session IV (Saturday)

**NEW SPECIMENS OF TANAOCROSSUS (ACTINOPTERYGII, PERLEIDIFORMES) FROM THE LATE TRIASSIC CHINLE FORMATION OF THE WESTERN UNITED STATES**

MILNER, Andrew, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; SPEARS, Sarah, Department of Geology, University of Kansas, Lawrence, KS, USA; OLSEN, Paul, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA

*Tanaocrossus kallioikoskii* is a fusiform palaeonisciform "subholostean" with an elongate dorsal fin known only from the holotype (AMNH 5700), an impression lacking the anterior half of the skull and the pectoral fins, from the "upper portion" of the Chinle Formation in

Montrose County, Colorado. A 2005 excavation of "Walt's Fish Quarry" in the Owl Rock Member of the Chinle Formation of San Juan County, Utah, yielded three new specimens of *T. kallioikoskii*, two of which have complete skulls and pectoral fins. The "Walt's Fish Quarry" site is geographically close to the type locality of *Tanaocrossus*. Three more specimens from the lower part of the Bull Canyon Formation in Quay County, New Mexico are well-preserved and three-dimensional, unlike the flattened Utah specimens. The new material reveals *Tanaocrossus* to be a perleidiform based on the presence of an antero-dorsally expanded preopercular, a vertical suspensorium, among other characters. *Tanaocrossus* has sometimes been placed within the Family Scanilepidae along with *Scanilepis* and *Fukangichthys*; however, the new specimens demonstrate that this cannot be the case, and the placement of the latter taxa is in question as well. Detailed study of the three-dimensional Bull Canyon specimens will allow for a clearer understanding of this hitherto enigmatic fish.

Technical Session I, Wednesday 11:15

**NEW DENTAL AND POSTCRANIAL REMAINS FROM A SINGLE POPULATION OF PALAEOSTYLOPS FROM THE LATE PALEOCENE OF THE FLAMING CLIFFS IN MONGOLIA**

MISSIAEN, Pieter, Ghent University, Ghent, Belgium; ESCARGUEL, Gilles, Université Lyon 1, Lyon, France; HARTENBERGER, Jean-Louis, Université Montpellier 2, Montpellier, France; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Bruxelles, Belgium

The famous Flaming Cliffs area in Mongolia has long been known to yield abundant Cretaceous (Djadohka Fm.) and early Paleogene (Khashat Fm.) fossil vertebrates. This region was revisited in 1999 with D. Dashzeveg. During fieldwork at the Gashato locality, a small fossiliferous sandy lens (<1 m<sup>2</sup>) in Member 1 of the late Paleocene Khashat Formation was completely excavated and screen-washed. Except some rare mixodont remains, the mammal fossils in this lens consist of remains of the arctostylopid *Palaeastylops*. Over 250 upper and lower jaw fragments are recorded, representing both described species of *Palaeastylops*, with a minimum number of 24 individuals for *P. iturus* and 15 for *P. macrodon*. The finding of such a concentration of individuals may have important implications for the ecology of arctostylopid. The high number of dental remains from a single lens allows to illustrate the morphometric and morphological variability of both forms from a single population. Documenting the variability in both forms is important because they have been variously suggested to represent one sexually dimorphic species, two separate species or even two separate genera. Study of these new fossil specimens will therefore provide a test of these different taxonomical interpretations. Until recently, the Asian and North American Arctostylopidae were only known by dental remains, and they were generally allied with the endemic South American Notoungulata. A recent study of the first unambiguously identified arctostylopid tarsals however suggested that arctostylopid are not notoungulates, but instead are a family of non-gliroid Gliiriformes, and moreover characterised *Palaeastylops* as a moderately specialised cursorial or saltatorial form. The arctostylopid fossils reported here not only include fossil teeth and tarsals, but also previously unknown other postcranial remains, including a distal part of a humerus, a proximal part of a femur and a distal part of a tibia. These new elements can therefore give additional insights in both the phylogeny and the locomotory habits of the poorly known arctostylopid.

Poster Session II (Thursday)

**QUANTIFYING THE BENEFITS OF A HEAVY LIQUID (SODIUM POLYtungSTATE) SEPARATION TECHNIQUE ON MICROVERTEBRATE FOSSIL RECOVERY**

MITCHELL, Jonathan, Appalachian State University, Boone, NC, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA; SCHNEIDER, Vince, North Carolina Museum of Natural Sciences, Raleigh, NC, USA

The extraction of microvertebrate fossils from similar sized clasts (via picking) is by far the most time consuming and daunting aspect of microvertebrate study. The thought of picking many kg of matrix one grain at a time is rather discouraging, but the process can be expedited. The use of a heavy liquid to facilitate the sorting process is not new, nor is the use of the safe (if expensive) salt known as sodium polytungstate (SPT). However, we have attempted to identify the ideal procedures and quantify the benefits of SPT separation, and we made several innovations. Thus we have: 1. Approximated the densities of various fossil types (bone, teeth, fish scales, etc.) 2. Identified the ideal working density (2.73-2.78g/ml) to minimize sand in the sink, and also minimize the chances of SPT evaporating to a solid. 3. Timed the rates of descent through the SPT of these same fossil types (0.5-13mm/sec). 4. Quantified the time saved by using SPT over the more traditional picking (474 hours are saved per kilo at an assumed picking rate of 1000 grains per hour). 5. Found that covering the working surfaces with plastic wrap greatly reduces the loss of the very valuable SPT. 6. Discovered that a nylon mesh net, weighted down with sealed plastic vials containing steel shot, greatly facilitates recovery of "heavies" (fossils and heavy sand). Our methodology was fairly straight forward. Picking through a site (a clay rich deposit from the Newark Supergroup), we counted the occurrence of fossils versus that of concentrate (sand), and then weighed known amounts of fossils and sand to find both a mass percentage (1%) and a count percentage (1%) of fossils. We then performed simple density tests on various fossil types to determine the ideal density to work with the SPT. We then processed in excess of 12

kg in ~24 working hours. Picking through the heavies, we again counted the occurrence of fossils versus sand (20% fossil), weighed them (17% fossil), and compared those results to the unfiltered data. We also examined the “float,” in an attempt to see how many fossils were lost, and we report that nearly none were (<0.01% by count).

Poster Session III (Friday)

**TWO PREVIOUSLY UNDESCRIBED SKELETONS OF *LEPTOCERATOPS* (ORNITHISCHIA, NEOCERATOPSIA) FROM THE LATEST CRETACEOUS OF SOUTHERN ALBERTA**

MIYASHITA, Tetsuto, University of Alberta, Edmonton, AB, Canada

*Leptoceratops* is stratigraphically the youngest basal neoceratopsian (non-ceratopsid neoceratopsian) in North America. An articulated postcranial skeleton (TMP 82.11.1) from the Willow Creek Formation and an associated skull and postcranial skeleton (TMP 93.95.1) from the Scollard Formation are new additions to the list of well-preserved *Leptoceratops* specimens. The two specimens reveal variation among the specimens previously assigned to *Leptoceratops gracilis* and highlight potential importance of postcranial anatomy in taxonomy of basal neoceratopsians. TMP 82.11.1 was previously considered to have occurred from the Belly River Group (Campanian), but it is almost certainly from the Willow Creek Formation (Maastrichtian), based on the matrix associated with the specimen and documentation of the locality. The specimen is the first associated basal neoceratopsian material from the formation and expands the distribution of *Leptoceratops* westward. Several differences in the postcranial skeleton from other *Leptoceratops* specimens include a straight ischial shaft, a poorly developed head of femur lower in position than the greater trochanter, and probably a higher count of dorsal vertebrae. TMP 93.95.1 allows a three-dimensional description of the vertebral morphology. Its syncervical consists of three vertebrae, but the fourth cervical has a suture with the syncervical, supporting that the ceratopsid syncervical consists of the first four cervical vertebrae. Postcranial anatomy is variable from specimen to specimen in *Leptoceratops*, partly as discussed for TMP 82.11.1. A conservative approach is to attribute all the variation in postcranial skeletons of *Leptoceratops* to individual differences, but it is interesting that the morphological variation is consistent with geographical distribution of the specimens. The specimens from the Scollard Formation of southern Alberta are more similar to each other than to those from elsewhere. A few additional diagnostic characters may be identified in the postcranial skeletons of *Leptoceratops*, including the relative length of an ischium.

Technical Session III, Wednesday 2:00

**THE ROLE OF CRANIAL SUTURES IN A LIZARD SKULL: A FINITE ELEMENT ANALYSIS INVESTIGATION**

MOAZEN, Mehran, Department of Engineering, University of Hull, Hull, United Kingdom; CURTIS, Neil, Department of Engineering, University of Hull, Hull, United Kingdom; EVANS, Susan, Research Department of Cell & Developmental Biology, UCL, University College London, London, United Kingdom; JONES, Marc, Research Department of Cell & Developmental Biology, UCL, University College London, London, United Kingdom; FAGAN, Michael, Department of Engineering, University of Hull, Hull, United Kingdom

The role and function of cranial sutures has been a fascinating topic of research for many years among evolutionary and craniofacial biologists. It has been shown that sutures affect the mechanical loading of skulls and also contribute to differences in skull shape; however, there is still much debate as to what is the main function of sutures. Here we investigate in more detail the function of cranial sutures, using finite element analysis (FEA) to model the skull of the lizard *Uromastyx hardwickii* (Diapsida: Lepidosauria: Squamata). In a series of FEA studies we loaded the *Uromastyx* model using data obtained from a previous multibody dynamics analysis (MDA) study, which provided load data for bilateral biting. Initial results, which looked at a skull with no modelled sutures, revealed elevated levels of stress in locations that corresponded to cranial sutures in the living animal. Therefore, in a second high resolution finite element model all the cranial sutures were modelled within the skull and their effect on the stress distributions was assessed. Our results showed that individual sutures relieve the strain (and stress) locally in the skull, but at the same time elevate the strain in other regions. These findings suggest that sutures work in groups, or at least that the function of sutures is not simply to reduce the global stresses in the skull. This detailed investigation also revealed that the frontal-parietal suture of the *Uromastyx* skull plays a substantial role in relieving strain, which raises interesting questions about the role and evolution of squamate mesokinesis.

Technical Session XI, Friday 8:30

**A NEW PARAREPTILE FROM THE MIDDLE PERMIAN *TAPINOCEPHALUS* ASSEMBLAGE ZONE, KAROO BASIN OF SOUTH AFRICA**

MODESTO, Sean, Cape Breton University, Sydney, NS, Canada; REISZ, Robert, Department of Biology, University of Toronto at Mississauga, Mississauga, ON, Canada

A small skull with associated postcranial fragments from Middle Permian strata of South Africa represents a new kind of small parareptile. Although somewhat damaged by weathering of the skull table, much of the skull roof, the palate, and the occiput are preserved together with the occluded mandible. Assigned originally to the genus *Owenetta*, the skull is owenettid-like in its general shape and in the presence of a postfrontal-

supratemporal contact. However, distinctive ornamentation is present on preserved skull-roof elements, relatively large lathanosuchoid-like lateral temporal fenestrae are present, and unequivocal procolophonoid synapomorphies are absent. Phylogenetic analysis positions the new parareptile as the sister taxon of ankyramorphs (i.e., the clade of lathanosuchoids, bolosaurids, and procolophonians). The tree topology indicates that the ancestor of this clade (*Ankyramorpha* + new taxon) evolved lateral temporal fenestrae, and that this character was modified and/or lost in some of its descendants (procolophonoids, pareiasaurs, some nycteroleterids). Optimization of geographic distributions onto the phylogeny supports the hypothesis that parareptiles diversified first in Gondwana and subsequently dispersed into Laurasia. This is in strong contrast to the patterns of synapsid and eumetatherian patterns of initial diversification in Laurasia. This divergent interpretation of parareptilian history, however, remains tempered by the observations that the earliest parareptiles (*Bolosaurus*, *Eudibamus*, *Acleistorhinus*, and *Colobomycter*) are Laurasian, and that the most basal parareptiles (mesosaurids, millerosaurs, and the new taxon, all Gondwanan) are characterized by extensive ghost lineages. Accordingly, the known pattern of early parareptilian evolution indicates that the biogeography of these reptiles is difficult to decipher, and new, yet-to-be described forms should help resolve this complex evolutionary history.

Poster Session II (Thursday)

**EVOLUTIONARY STASIS OF GOLDEN EAGLES OVER THE LAST GLACIAL-INTERGLACIAL CYCLE (35 KA TO PRESENT)**

MOLINA, Sarah, Occidental College, Los Angeles, CA, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA

Pleistocene fossils from Rancho La Brea represent 26,000 years of morphology and lived during a period of dramatic climate change. According to classic evolutionary theory, the effects of this instability should be seen as morphological changes in the most commonly preserved bird, the golden eagle, *Aquila chrysaetos*, over the last 35,000 years. Five variables each were measured on over 600 well-preserved tarsometatarsi from the Page Museum at Rancho La Brea, and the same measurements were taken from a sample of 63 extant golden eagle bones. Samples from each radiocarbon-dated pit at Rancho La Brea were then compared across time, using pairwise univariate and bivariate statistics. Interestingly, the data shows no significant change in size between 35,000 to 9,000 years b.p. or over the entire 35,000 years. Data analysis suggests that *Aquila chrysaetos* experienced evolutionary stasis even during the irregular climatic changes of the most recent glacial-interglacial cycle.

Poster Session I (Wednesday)

**LATE PLEISTOCENE VERTEBRATE FAUNA FROM THE DEPRESSION CENTRAL OF CHIAPAS, MEXICO**

MONTELLANO, Marisol, Instituto de Geología, UNAM, Mexico, Mexico; CARBOT-CHANONA, Gerardo, Museo de Paleontología Eliseo Palacios, Instituto de Historia Natural, Tuxtla Gutiérrez, Chiapas, Mexico; DOMINGUEZ-VAZQUEZ, Gabriela, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, Mexico; ISLEBE, Gerald, Departamento de Ecología y Sistemática, Colegio de la Frontera Sur, Chetumal, Quintana Roo, Mexico

The Pleistocene vertebrate fauna from the tropical latitudes of Mexico is poorly known. During the last years systematic field work had been carried on in the Pleistocene sediments in the “Depression Central” of the State of Chiapas, México, by staff of the Museo de Paleontología of the Instituto de Historia Natural. As a result ten fossil localities were found yielding a diverse vertebrate fauna; pollen was recovered from one site and screenwashing for microvertebrates was done in another. The identified megafauna taxa includes: *Glyptotherium* sp., *Eremotherium laurillardii*, *Mammuthus columbi*, *Cuvieronius tropicus*, *Equus conversidens*, *Odocoileus* cf. *O. virginianus*, *Bison* sp., *?Stoiceros*, and *Panthera leo atrox*. Among the microvertebrates, the rodents *Sigmodon* cf. *S. hispidus*, and *?Reithodontomys* were recognized; remains of an unidentified colubrid snake and lizard were collected; also scutes of the turtles *Kinosternon* sp. and *Trachemys* cf. *T. scripta* were recovered. The faunal association suggests a Rancholabrean age (Late Pleistocene). The cervid, rodents and turtles continue living in the Central part of the State. *Bison* sp. changed its geographic range and the rest of the megafauna went extinct at the end of the Pleistocene. The only carnivore recovered is *Panthera leo atrox*, its presence documents its southernmost distribution in America. The identified pollen belong to the Compositae, Graminaeae, Solanaceae, Mimosoideae and Pinaceae families; it was collected from the same site where the cervid, horse, ground sloth and glyptodont were found. It suggests an open plain dominated by grasses with shrubs, and a pine forest was close by. This kind of vegetation is not present anymore in the area, now a tropical deciduous forest is covering the area. These preliminary results provide information for understanding since when the current conditions prevailed in the area.

Technical Session IV, Wednesday 3:45

#### **IDENTIFYING TAPHONOMIC PATHWAYS IN MODERN BONE ASSEMBLAGES USING ORDINATION ANALYSIS**

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Data regarding the formation of modern bone assemblages can be of great use in interpreting patterns of bone occurrence and distribution in fossil assemblages. During February 2004, a herd of 38 cows were drowned after falling through ice on the Yellowstone River in Montana. The cow carcasses were interred until the ice melted during early April after which they were transported downstream by the spring melt waters. On five occasions between May 2004 and September 2006 (approximately every 6 months), the 20km stretch of the Yellowstone River where the carcasses were deposited was revisited. The location, bone abundances, taphonomic and sedimentological characteristics of each of the carcasses that could be relocated were recorded, providing an approximately 1000-day time-series describing the taphonomic modification of the measured carcasses. Twelve carcasses were relocated frequently to be statistically analysed. Assuming no *a priori* knowledge of the geomorphology and sedimentology of each of the carcass localities, NMDS ordinations were carried out comparing the bone abundance data from each visit to each carcass with the aim to determine whether patterns of bone abundance change were indicative of particular sedimentary environments or other taphonomic factors. Three distinct taphonomic pathways were differentiated by Q-mode NMDS analysis based on channel proximity and nature of the confining sediment. R-mode analysis of the same data demonstrates the importance of fluvially mediated transport on the studied bone assemblages – bones are broadly separated by ease of transport, although with several notable exceptions, namely ribs, scapulae and sacra. The results of this study are of particular interest from a palaeontological standpoint as they imply that bone abundances in single source bone assemblages from large taxa in fluvial systems have a distinct, measurable taphonomic signature relating to their taphonomic pathway. This signature should be recoverable from fossil assemblages allowing the independent estimation of the exposure time and primary sedimentological/geomorphological environment for the formation of such assemblages.

Poster Session III (Friday)

#### **PORTILLA: A DINOSAUR NESTING SITE FROM THE UPPER CRETACEOUS OF THE CUENCA PROVINCE (SPAIN)**

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The Portilla dinosaur eggshell site is located in the Barranco de la Hoz (Portilla municipal district, Cuenca province, Spain) and it belongs to the Villalba de la Sierra Formation (Upper Cretaceous, Maastrichtian in age). The sediment is mainly composed of massive marls probably deposited in a palustrine environment with several arid episodes responsible of the presence of some gypsum levels. Portilla locality has yielded about 2,000 dinosaur eggshell fragments. No complete eggs neither nidification structures have been found by the moment. The external surface of the eggshell shows a nodular aspect, with relatively high and large sub-rounded tubercles belonging to the compactituberculata morphotype. The external pore openings are located between the nodes and they are rounded in shape. In radial view, the eggshell shows a spherulitic pattern constituted by high and narrow crystal units. The pore canals are located between the shell units, and they are relatively straight, showing a constant diameter of about 0.1 mm. Both shell units and pore canal morphologies can be included within the tubo-spherulitic morphotype. However, the vertical pore canals are sometimes transversely united by oblique or sub-horizontal secondary canals connecting the main ones. The described morphology of the Portilla eggshells (general eggshell thickness, shell unit morphology, and pore canal pattern) indicate that they belong to the oospecies *Megaloolithis siruguei* that are attributed to sauropod dinosaurs, and more precisely, titanosaurs. Some pathological eggshells showing a double eggshell layer have been also collected. The shell units of the outer layer grow up from the corresponding units from the inside layer. As a consequence, the pore canals continue through both layers, and connect the inner and the outer surfaces of the shell. The Portilla eggshell material is very similar to that collected from other egg-sites of similar age from Spain (Burgos province and Tremp Basin) and that from the southern France (specially the area near Aix-en-Provence).

Poster Session III (Friday)

#### **TAPHONOMY AND VERTEBRATE FAUNA OF THE CAMPANIAN NORTHUMBERLAND FORMATION, HORNBY ISLAND (BRITISH COLUMBIA)**

MORRISON, Kurt, Roburn 3-8, Hornby Island, BC, Canada; DYKE, Gareth, University College Dublin, Dublin, Ireland

The sedimentary sequences exposed on the rocky beaches that form the western fringes of the small gulf island of Hornby (Strait of Georgia, British Columbia) document the top two-thirds of the Campanian Northumberland Formation. Encapsulated within the Nanaimo Group of marine sediments, this is the most fossiliferous unit on the Canadian west coast: fossils of birds, sharks, mosasaurs, crocodiles, turtles and fish have been collected, often in large numbers, from a series of sites at Collishaw and Manning points on Hornby Island. Dinosaur bones are known from the underlying Cedar District Formation, on Denman Island. However, despite having been picked over by collectors since the 19th Century (regularly since the 1980s) few Northumberland Formation fossil vertebrates are documented in the literature.

Based on recent field mapping and cataloguing of one large collection (ca. 5000 specimens) from Hornby, we interpret the taphonomy of the Northumberland Formation, placing the known fossils into geological and stratigraphic context for the first time. Fossiliferous bands form typically as lenses within the sequence, and are not laterally continuous. Sediments at Collishaw are deep marine (> 100 m) turbidite lenses and gravity flows; a large proportion of fossils (ca. 65 percent) were rolled by these flows and were deposited by slumping into concavities on the sea floor. Other less abraded fossils (including birds) provided centers for mud-ball accretion or settled in the water column while others were embedded at speed into sediment, emplaced at oblique angles to flow bedding. Preservation size varies but all classes, from minute teeth up to associated mosasaur skull material, have been collected from Hornby.

A taxonomic review of the fossil vertebrates from the Northumberland Formation has enabled us to reconstruct this deep marine depositional environment. One constituent of this fauna, the diversity of sharks and rays is particularly striking: we have synthesized more than 600 teeth to document 18 species comprising nine selachian families. Three taxa are new and augment this unique Pacific rim Cretaceous marine ecosystem.

Technical Session XIII, Friday 2:45

#### **FIRST TERTIARY LAND MAMMAL FROM SCANDINAVIA: PALEONTOLOGY AND ISOTOPE FINGERPRINTING**

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Terrestrial mammalian paleofaunas are well known from the European Tertiary, with the exception of Northern Europe. For the Miocene, the northernmost terrestrial faunas in Europe are known from northwest Germany and from central Poland, only exceeded by a single *Hippotherium* molar, which was found on the North Sea island of Sylt. The gomphothere tooth presented in this paper was discovered south of Lake Mälaren in central Sweden, approximately 100 km southwest of Stockholm. The find extends the paleobiogeography of Miocene terrestrial mammals 1000 km farther North and represents the first Tertiary land mammal of Scandinavia. The molar was found in Pleistocene fluvioglacial deposits, embedded in a reworked, conglomeratic sandstone pebble. The well preserved specimen can be attributed to a trilophodont gomphothere. The lower molar could be either an m1 or m2 since size and morphology varies considerably in gomphothere molars. Even the generic assignment of this single molar is difficult, since it could represent either *Gomphotherium* or *Amebelodon*. To determine the provenance of the gomphothere, the isotope composition (C, O, Sr, Nd) of the tooth enamel and the embedding sediment were analyzed. Isotopic signatures of the tooth were compared to those of Miocene gomphothere teeth from central Europe as well as to bones of extant moose from different areas of Sweden with different bedrock types. The enamel of the Swedish gomphothere tooth has a mean  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio typical for old crustal rocks. It is more radiogenic than those of Miocene gomphothere teeth from continental Europe south of Scandinavia. Intra-tooth enamel  $\delta^{18}\text{O}_{\text{CO}_3}$  values display two seasonal cycles. The enamel mean  $\delta^{13}\text{C}$  value is similar to gomphothere molar specimens from the Lower Miocene of Central Europe. U/Pb isotope analysis of detrital zircons from the embedding sediment is in progress to determine the age of the source rocks. This multi-isotope provenance approach proves the existence of Miocene terrestrial mammal fauna and sediments on the Fennoscandian shield.

Poster Session IV (Saturday)

#### **MORPHOLOGY AND FUNCTION OF THE NECK OF PLATEOSAURUS**

MOSER, Katrin, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; WITZEL, Ulrich, Institut für Konstruktionstechnik, Ruhr-Universität Bochum, Bochum, Germany

To understand the evolution of gigantism in sauropodomorph dinosaurs, an understanding of the evolution of the sauropod body plan is essential. One of the hallmarks of sauropodomorph dinosaurs is the long neck, but the morphofunctional evolution of this structure has not been analysed in detail yet. We use the basal sauropodomorph *Plateosaurus* as a model organism for understanding neck design and mechanics in a basal sauropodomorph. Based on excellently preserved specimens, the neutral pose of the neck (with maximal overlap of the zygapophyses) and maximal dorsoventral and lateral movements between single elements was evaluated. In the neutral pose, the neck forms a slight S-curve, flexing downwards at the base, then somewhat upwards and downwards again towards the neck. Dorsoventral flexibility was limited and less than lateral movability. For a biomechanical analysis with Finite Element Structure Synthesis (FESS), the cervical musculature of *Plateosaurus* was reconstructed, using the Extant Phylogenetic Bracket approach (EPB). In comparison with the osteological cervical characters of crocodiles, birds and iguanas and their associated soft tissue, a model of cervical musculature in *Plateosaurus* was reconstructed. The cervical musculature is composed of the most dorsally situated transversospinalis group for stretching and dorsal flexion, the lateral longissimus group for lateral movement, the ventral iliocostalis group for lateral and ventral movement, and the hypaxial muscles for ventral flexion. FESS furthermore helps to identify forces that played a role in shaping the cervical vertebrae, and thus helps to refine the reconstruction of the musculature, especially for muscles that might not have osteological correlates. Preliminary results indicate that the neck of *Plateosaurus* was held horizontally in a slight S-curve and allowed more lateral than dorsoventral flexion. Given a horizontal or even downsloping (in



case of quadrupedal locomotion) anterior part of the dorsal vertebral column, this indicates rather low-browsing habits for *Plateosaurus*, in a type of adaptation that is consistent with low-browsing behaviour as reconstructed for several sauropod taxa.

Technical Session XVI, Saturday 8:15

#### EVOLUTION OF U-SHAPED CLAVICLE COMPLEX AND EARLY RADIATION OF ICHTHYOPTERYGIA

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It has been known since the 19th Century that fish-shaped ichthyopterygians (Parvipelvia; Late Triassic – early Late Cretaceous) had a pair of clavicles that formed a robust U-shaped complex. This is a derived condition among ichthyopterygians—the basal ichthyosaur *Utatusaurus* (Early Triassic) had clavicles that did not meet along the midline, as in many basal amniotes. The functional evolution of the U-shaped clavicle complex in ichthyopterygians has been a puzzle. Given the reminiscence with the bird furcula, the clavicles could have helped underwater flight with pectoral flippers. However, parvipelvians were typical tail-propelled swimmers and not underwater fliers, with large caudal flukes and small flippers with short humeri. The same is true for Mixosauridae (Middle Triassic), which had thus far been the most basal ichthyopterygians with U-shaped clavicles. We report new specimens of *Chaohusaurus* from the Spathian (Lower Triassic) of China that finally shed light on this long-held question of shoulder evolution. The specimens clearly reveal U-shaped clavicles in this oldest genus, unlike in *Utatusaurus* that also lived in the Spathian. *Chaohusaurus* is known for its disproportionately large pectoral flippers in adults, suggesting that pectoral propulsion was important in its daily life. It also had a long humerus that resulted in higher mechanical advantage of arm muscles than in most ichthyopterygians. It therefore seems that the U-shaped clavicles evolved very early in ichthyopterygian evolution in a lineage that used pectoral propulsion, and was retained by its descendants that eventually gave rise to Parvipelvia. The plesiomorphic clavicle design seen in *Utatusaurus* is also found in cymbospondylids, such as *Cymbospondylus* and *Xinminosaurus*. The implication is that the Early Triassic *Chaohusaurus* was phylogenetically more derived than cymbospondylids of the Middle Triassic. A phylogenetic analysis based on a modified published data matrix supports this relationship.

Technical Session III, Wednesday 2:30

#### A BURROWING, LACERTID-LIKE SQUAMATE FROM THE EOCENE OF MESSEL, GERMANY

MUELLER, Johannes, Humboldt-Universität Berlin, Museum fuer Naturkunde, Berlin, Germany; WUTTKE, Michael, Generaldirektion Kulturelles Erbe, - Erdgeschichte -, Mainz, Germany; KARDJLOV, Nikolay, Hahn-Meitner-Institut, Department of Materials Science (SF3), Berlin, Germany; HILGER, André, Hahn-Meitner-Institut, Department of Materials Science (SF3), Berlin, Germany

Recent molecular investigations have dramatically challenged the traditional view of squamate phylogeny. Among the many changes in paradigm, the hypothesis of a monophyly of amphisbaenians and lacertids figures among the most prominent, as it has significant implications for the proposed relationship between amphisbaenians and snakes. However, so far there has been no morphological or fossil support for an amphisbaenian-lacertid grouping, questioning the validity of this new hypothesis. Here we describe a new genus and species of Eocene lizard from the famous fossil locality of Messel, Germany, consisting of a completely articulated specimen of which only a few parts of the tail and the shoulder girdle are missing. The new taxon is characterized by a spatula-like snout with a modified premaxilla and maxilla, notably small and anteriorly positioned orbits, the lack of a tympanic crest, a low tooth count, and reduced manus and pes, which together strongly suggest burrowing life habits and a head-first digging behavior. In a phylogenetic analysis including both morphological and molecular characters as well as extant and fossil taxa, the new taxon groups consistently with amphisbaenians and lacertids, showing the tendency to fall in a sister position to Amphisbaenia. Snakes, on the other hand, group with anguimorphs and marine lizards, showing no support for a fossorial origin. Our study emphasizes once again that fossils are crucial for testing hypotheses of phylogenetic relationships, because extant taxa often reveal only a relatively restricted picture of their evolutionary history.

#### MICROMAMMAL REMAINS FROM THE PLESIORYCTEROPUS ULNA SITE, ANJOHIBE CAVE, NW MADAGASCAR

MULDOON, Kathleen, Dartmouth Medical School and Dartmouth College, Hanover, NH, USA; BURNEY, David, National Tropical Botanical Garden, Kalaheo, HI, USA

A recent renaissance in subfossil research in Madagascar has greatly augmented the subfossil record of microvertebrates, and allows for the comparative analysis of these paleoecologically-important assemblages. In light of this growing database, we report on the subfossil micromammal fauna from the *Plesiorcyteropus* ulna site, Anjohibe Cave, northwestern Madagascar. Anjohibe is an extensive cave system in the Eocene limestone plateau, northeast of Mahajanga. Within the cave system, several localities have been discovered, ranging in age from approximately 70 kyr BP to younger than 10 kyr BP. These localities have yielded the remains of large extinct animals, including giant lemurs (*Babakotia*, *Palaeopropithecus*, *Archaeolemur*), the extinct carnivorous *Cryptoprocta spelea*, and the bizarre aardvark-like endemic mammal *Plesiorcyteropus madagascariensis*, in

association with abundant remains of small vertebrates. The *Plesiorcyteropus* ulna locality has yielded at least 9 species of micromammals. It is likely these remains were brought into the cave by roosting owls and other carnivores. While not concentrated into bone breccias, most individual specimens are coated in flowstone, and must undergo chemical preparation prior to study. Skeletal remains in the microfaunal assemblage demonstrate a high quality of preservation, and include largely complete crania, jaws, isolated teeth, and postcranial elements. Chiropterans (*Hipposideros* and *Eidolon*) are the most abundant order represented. Rodents are represented by at least four taxa, including endemic (*Eliurus* and *?Nesomys*), and introduced (*Rattus* and *Mus*) forms. Interestingly, at this locality, primates are rare, and only represented by two taxa: *Eulemur* and *Lepilemur*. One specimen of an introduced soricid (*Suncus*) has been recovered. Comparisons among the fossil localities within the Anjohibe Cave system suggest variation in the structure of the micromammal communities. Species diversity is much lower at the *Plesiorcyteropus* ulna site than at other localities within the cave system. Given the isotaphonomic setting, such discrepancies likely relate to microhabitat differences sampled within the cave system.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

#### THE MOST PRIMITIVE PORPOISE (CETACEA: DELPHINOIDEA) FROM THE UPPER MIOCENE WAKKANAI FORMATION, HOKKAIDO, JAPAN

MURAKAMI, Mizuki, Waseda University, Tokyo, Japan

A small porpoise, (NMV-7) housed in the Nakagawa Museum of Natural History, which was delivered from the Wakkanai Formation (10.0-9.2 Ma), located in Hokkaido, Northern Japan. NMV-7 is composed of a partial skull with right periotic and tympanic, lacking rostrum, right facial portion and vertex. The postcrania include all the cervicals, 5 thoracics, and a rib. The apex of the anterior process of the periotic thickened and triangular, and ventrally developed transverse process of the atlas suggest that NMV-7 belongs to the Delphinoidea. The most remarkable character of NMV-7 is the ascending process of the premaxilla that significantly elevated above maxilla without swelling and projects strongly laterally. The overhanging ascending process of the premaxilla is considerably over a line with the anterior maxillary foramen. This structure corresponds to “the premaxillary eminence”. It is used for an abruptly raised elongate structure comprising most of the premaxillary fossa in the Phocoenidae and the extinct Albireonidae, but the Monodontidae, the Iniidae, the Pontoporidae, the extant delphinoid *Grampus*, and the extinct kentriodontid “*Lophocetus*” *reppeningi* show a swelling that could be considered a premaxillary eminence. Therefore, I subdivided character of the premaxillary eminence into some characters in order to obtain meaningful results from the phylogenetic analyses. A cladistic analysis was carried out with PAUP, version 4.0 with a matrix of 78 characters for 28 taxa. These taxa include 13 modern and fossil phocoenids, and above mentioned taxa. *Platanista* was used as an outgroup. While the monophyly of the Phocoenidae is supported, the phylogenetic analysis indicates the family is closer to the Delphinidae + the Monodontidae than the Albireonidae. NMV-7 shares following characters with primitive phocoenids *Australithax*, *Piscolithax*, and *Lomacetus*: 1) The premaxilla overhang the maxilla laterally, 2) lateral part of the premaxilla from posterior the premaxillary triangle to anterior the external nares convex dorsally. However, all phocoenid except NMV-7 has a basin lateral to the external nares on the maxilla indicates that NMV-7 is most primitive phocoenid.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 9:00

#### THE CENOZOIC FOSSIL RECORD OF OSTARIOPHYSANS IN AFRICA

MURRAY, Alison, University of Alberta, Edmonton, AB, Canada; WILSON, Mark, University of Alberta, Edmonton, AB, Canada

Three major clades of ostariophysan fishes are found in the Cenozoic record of Africa: catfishes (Siluriformes), characins (Characiformes) and minnows (Cypriniformes). All three taxa have played important roles in biogeographic hypotheses involving African isolation. Recognition of isolated elements as belonging to catfishes is uncontroversial for the most part, as crania, spines, and vertebrae are distinctive in this group. However, determining the relationships of these fossils can be difficult. Catfishes are found in a number of Cenozoic African deposits, including the Paleocene of Niger and Nigeria, and Eocene deposits of Egypt and Tanzania. Catfish elements are found throughout younger deposits of Africa. Recognition of fossils as belonging to characiforms has been more controversial. Lack of a well-preserved Weberian apparatus in articulated remains has been used to justify excluding some fossils (e.g., *Mahengecharax carrolli*) from the Characiformes, whereas other fossils with similar preservation are accepted as representatives of the group (e.g., *Arabocharax baidensis*). However, it is more parsimonious to accept these fossils as characiforms rather than to assume that they belong to an unrecognized clade. Isolated teeth and jaws, by contrast, have been accepted as characiforms with less controversy, but it is difficult to assign such elements to particular lineages. The fossil record of characins stretches back to the Late Cretaceous, with molariform teeth found in a number of African deposits. Characins are represented in the Cenozoic by both articulated and isolated remains from Paleocene and younger deposits. Cypriniform fishes are not known from Africa prior to the middle Miocene, and it is believed that they are relatively new to the continent, only arriving after a Miocene connection formed between Africa and Asia. Most cypriniform fossils are isolated teeth and pharyngeal bones that have been assigned to only two different genera, *Barbus* and *Labeo*. While it may be difficult to assign ostariophysan remains to a particular clade, these freshwater fishes provide important evidence about the timing and extent of African biogeographic isolation.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**GROWTH STRATEGY IN EARLY ICHTHYOSAURS: AN OSTEOHISTOLOGICAL STUDY**

NAKAJIMA, Yasuhisa, the University of Tokyo, Tokyo, Japan

Bone microstructure of derived ichthyosaurs is characterized by following two specializations: presence of rapid growing bone tissues (woven bone tissue and fibrolamellar complex) rarely seen in extant reptiles; and osteoporotic-like state indicating a light body mass advantageous for fast and maneuverable swimming. In order to look into the evolutionary process of these interesting features, I conducted a detailed histological study of four individuals of basal ichthyopterygians including two *Utatsaurus hataii* from the Osawa Formation (Upper Spathian, northwestern Honshu of Japan). The cortex is generally composed of vascularized cancellous bone. Spongy inner cortex has thin trabeculae with secondary endosteal bone. On the other hand relatively compact outer cortex has resorption bays, but very little evidence of redeposition. All proximal limb elements and some other bones have fibrolamellar complex or woven-fibered bone as the dominant bone tissue in the primary periosteal cortex, although slow-growing bone tissue (lamellar-zonal bone) may be dominant in cortex of ribs of some individuals. Most bones have external fundamental system (EFS) which is a thin layer of the most peripheral region consist of lamellar-zonal bone. The evidence of endosteal bone remodeling suggests dominance of resorption through the remodeling process in cortex of basal ichthyopterygians. The bone tissue types suggest that these elements had grown rapidly in earlier stage and reduced growth rate dramatically in later stage. Although the "lizard-like" appearance of basal ichthyopterygians, bone growth strategy indicated by microstructure is similar to "fish-like" more derived ichthyopterygians. These are significantly different from bone microstructure reported on a basal non-marine diapsids such as captorhinids.

Poster Session III (Friday)

**LATE MIOCENE PALEOENVIRONMENTAL CHANGE OF HOMINOID EVOLUTION IN SUB-SAHARAN AFRICA - MESOWEAR ANALYSIS OF HIPPARION (EQUIDAE, PERISSODACTYLA) CHEEK TEETH FROM KENYA**  
NAKAYA, Hideo, Kagoshima University, Kagoshima, Japan; UNO, Kevin, University of Utah, Salt Lake City, UT, USA; FUKUCHI, Akira, Okayama University, Okayama, Japan; KUNIMATSU, Yutaka, Kyoto University, Inuyama, Japan; NAKATSUKASA, Masato, Kyoto University, K, Japan

The tooth mesowear method is a new approach of reconstructing ungulate diets and their paleoenvironments. We analyzed mesowear of *Hipparion* upper and lower cheek teeth (P4 – M3) from the Late Miocene Nakali (9.9-9.8 Ma) and Namurungule (9.6 Ma) Formations from Northern Kenya to evaluate diet and compare paleoenvironments at these two sites. The distance between sites is approximately sixty kilometers and the geologic age of the formations is similar. Both sites have yielded important Late Miocene hominoid fossils. *Samburupithecus kiptalami* was found from the Namurungule Formation, and *Nakalipithecus nakayamai* and several catarrhine taxa were recently discovered from the Nakali Formation. For tooth mesowear analysis, the occlusal relief of the buccal side is scored as high or low. Cusp shape is classified as "sharp", "round" or "blunt". For occlusal relief, 52 % of upper and 68% of lower cheek teeth from the Namurungule Formation were scored "low". From the Nakali Formation, 88% of upper and 65% of lower cheek teeth were scored "low". For cusp shape, the majority of upper cheek teeth from the both formations were classified as "round" to the top. 25% of upper and 68% of lower cheek teeth from the Namurungule Formation were classified as "blunt", but almost none of them as "sharp". However, 25% of upper and 10% of lower cheek teeth from the Nakali Formation were classified as "sharp" and very rarely as "blunt". The following conclusions are reached: The paleoenvironment of the Nakali Formation may have been a woodland environment, while the Namurungule Formation may have been an openland environment. This environmental difference between the Namurungule Formation and Nakali Formation probably indicates the environmental change through geological age and/or the topographic difference between highland and lowland at the similar age. This result is supported by stable isotope analysis of *Hipparion* tooth enamel and pollen analysis from both formations.

Poster Session I (Wednesday)

**RECONSTRUCTION OF THE FORELIMB MUSCULATURE AND FUNCTION IN XENOSMILUS HODSONAE: AN ATYPICAL SCIMITAR-TOOTHED FELID**  
NAPLES, Virginia, Northern Illinois University, DeKalb, IL, USA; SPEARING, Kurt, Northern Illinois University, DeKalb, IL, USA

*Xenosmilus hodsonae* has been recognized as a scimitar-toothed saber-tooth although it does not fit the typical pattern of having relatively short, coarsely serrated sabers and long legs, making it a pursuit predator of large prey. Instead, this animal diverges from previously described scimitar-tooth morphology, having the short legs characteristic of members of the dirk-toothed saber-tooth group proposed initially by Kurten and later presented in current form by L. D. Martin. *X. hodsonae* is the only known scimitar-toothed sabercat that shows convergence to the postcranial body form of *Smilodon fatalis*, although the limbs are even more robust than the felid from Rancho La Brea. Specifically, the scapula elements that have been recovered for *X. hodsonae* show a degree of freedom of movement at the glenohumeral articulation reminiscent of *Smilodon*. The humerus of *X. hodsonae* is more robust than is that of *Smilodon*, as indicated by bone shaft thickness, and increased prominence of the greater trochanter, deltopectoral crest and other processes. The humero-ulnar joint is more robust, and allows great freedom for pronation

and supination. Muscle scars on the radius and ulna reflect marked ability to rotate the forepaw medially, presumably for grasping prey, as can also be reconstructed from the large digits, especially the thumb, which possesses a large, recurved claw. These features contribute to the unique combination of structure and function presently described as the new saber-tooth category of "cookie-cutter cat."

Preparators' Session, Thursday 11:15

**A NEW "STREAMLINED CRADLE MAKING OPERATION" FOR MAXIMUM PROTECTION OF FOSSILS WHILE ALLOWING FOR EASY ACCESS FOR RESEARCH NEEDS**

NELSEN, Thomas, Utah Field House of Natural History State Park Museum, Vernal, UT, USA; MADSEN, Scott, Utah Geological Survey, Salt Lake City, UT, USA; GRAY, Dale, Utah Friends of Paleontology / Utah Field House of Natural History State Park Museum, Vernal, UT, USA

Dinosaur National Monument is currently undergoing many changes due to the closure of the Quarry Visitor Center. Due to these changes, many of the collections that were housed at the quarry visitor center had to be relocated to alternate storage facilities (housing garages and a semi trailer) located in the park. This meant that some very important and extremely fragile fossils needed to be transported about a half mile down hill from the qvc to the housing / maintenance area by way of fork-lifts and trucks. To accomplish this, we were tasked with developing and providing a safe means by which the fossils could be transported. The three of us collectively researched, designed and built individual bone cradles that provided maximum protection by being strong, light weight, completely concealed and at the same time providing easy access for researchers. Our design and methods incorporated some of the techniques and ideas previously used by the Smithsonian Institute. Due to time and budget constraints we had to design a more quick, efficient and cost effective method in comparison to some of the other designs that we had researched. The result was an excellent "streamlined" design that utilized less material, stronger material, less man hours and produced a lighter weight cradle. This was also a very cost effective operation that solved our budget concerns. The cradles are designed to be a "clam shell" housing that can be opened from either side. This allows for the specimen to be studied while maintaining a molded, bed-like support structure for the specimen to set in. Our design incorporates the use of sand tables for molding the cradle to the specific fossils, FGR 95 plaster, double bias fiber glass cloth, 1/16" ethifoam and a host of low cost supporting materials and tools. The end result was approximately 20, light weight, protective bone cradles that made the move much easier and safer to maintain the integrity of the fossils during the move.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**THE EVOLUTION OF THE SACRUM: IDENTIFYING HOMOLOGOUS SACRAL VERTEBRAE ACROSS AMNIOTA**

NESBITT, Sterling, American Museum of Natural History, New York, NY, USA

The number of sacral vertebrae ranges from zero to over thirty in tetrapods and is often phylogenetically informative throughout Amniota; it is clear that many disparate clades increase their number of sacral vertebrae independently. Within Reptilia, the plesiomorphic sacral count is two whereas some archosaur clades (suchians, pterosaurs, dinosaurs) increase sacral vertebra count to three or more. Two strategies have been implemented to homologize the number of sacral vertebrae in phylogenetic analyses: 1) scoring absolute number of sacral vertebrae (sometimes ordered); and 2) breaking the sacrum into components (e.g. the addition of a dorsosacral or a caudosacral). The second strategy requires that primordial sacrales one and two are clearly identified, and all authors using this method have assumed that primordial one and two are always adjacent. Here, I demonstrate that not only are vertebrae added to the sacrum from the dorsal series and caudal series but also are inserted between primordial one and two in some suchians (e.g., *Arizonasaurus*) and in neotheropods (e.g., *Allosaurus*). I determined this by comparing the morphology of the sacral ribs and the attachment sites of the sacral ribs to the ilium in basal archosauriforms with two sacral vertebrae to archosaurs with three or more sacral vertebrae. The results indicate that the homology of sacral vertebrae can be partitioned into the presence/absence of 1) a dorsosacral, 2) a caudosacral, and/or 3) an insertion of a sacral between primordial one and two. The identity of the sacral vertebrae in taxa with seven or more sacral vertebrae remains difficult to determine. An insertion of a sacral vertebra between the primordial sacrales may also be present in some synapsids. The recognition of an insertion of a sacral vertebra between the primordial sacrales is important because it indicates that new vertebrae can be added to the sacrum and not simply incorporated from other portions of the vertebral series. Sacral vertebrae homologies can then be used in phylogenetic hypotheses more accurately.

Poster Session II (Thursday)

**ADDITIONAL MATERIAL OF THE MIOCENE CHACHALACA BOREORTALIS LAESSLEI (NEORNITHES, CRACIDAE) AND ITS IMPLICATIONS FOR THE THOMAS FARM FOSSIL LOCALITY AND THE EVOLUTION AND BIOGEOGRAPHY OF CRACIDS**

NESTLER, Jennifer, Florida Museum of Natural History, Gainesville, FL, USA; STEADMAN, David, Florida Museum of Natural History, Gainesville, FL, USA

The modern distribution of the family Cracidae is from southern Texas to northern Argentina. Several Neogene cracids have been described from the northern United States, suggesting that cracids originated in North America (or at least the Northern Hemisphere)

and entered South America during the Great American Biotic Interchange around 3 Ma. The genus *Boreortalis* was described by Pierce Brodkorb based on the distal end of a tibiotarsus from the Thomas Farm fossil locality in Florida in 1954. Since then, a partial humerus from the same site has also been attributed to *Boreortalis*, and several other Neogene species from Kansas, Nebraska, and South Dakota, originally placed in the *Ortalis*, have been tentatively referred to *Boreortalis* as well. Much new material of *Boreortalis* has been recovered recently at Thomas Farm, allowing for a comprehensive description that will lead to a better understanding of the evolution and phylogeny of cracids. The purpose of this project is to describe those elements, and to compare them to the modern genera *Ortalis*, *Penelope*, and *Penelopina*. We find *Boreortalis* to be distinctive, but probably most closely related to *Ortalis*. The presence of *Boreortalis* at Thomas Farm supports the tropical environment that has been proposed for the site from studying other taxa of birds and mammals.

Technical Session XVIII, Saturday 4:00

#### **PALEOLATITUDINAL RESPONSE OF CHARACIFORMES (TELEOSTEI: OSTARIOPHYSI) TO CENOZOIC CLIMATE CHANGE**

NEWBREY, Michael, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; MURRAY, Alison, University of Alberta, Edmonton, AB, Canada; WILSON, Mark, University of Alberta, Edmonton, AB, Canada; BRINKMAN, Donald, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; NEUMAN, Andrew, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Living characiforms have a limited geographic distribution in Africa, South America, and southern North America and yet during three different times in the Mesozoic and Cenozoic, characiforms are reported much further north in Europe. Here we test the hypothesis that temperature plays a role in limiting the distribution of extant and extinct characiforms by examining three testable predictions: 1, extant characiforms have a limited thermal distribution; 2, the geographic distribution of extinct characiforms has changed with changing climates; and 3, characiforms are found in Europe during extreme highs in global temperature. Thermal comparisons are made from the extant range data for the various ostariophysans. The published literature provided 192 Mesozoic and Cenozoic characiform taxa/localities from Europe, Africa, and South America for analysis. Our analysis shows that extant characiform distribution was limited by cold temperatures, with characiforms absent when coldest mean monthly temperatures dropped below 1.8°C. For comparison, cypriniforms and siluriforms have larger geographic ranges that extend into much colder temperature zones. The latitudes for 162 latest Cretaceous and Cenozoic characiform fossil localities are significantly correlated with paleotemperature for the last 67 million years. During warmer times, characiforms occurred at significantly higher latitudes. Moreover, characiforms are only reported from Europe during the two warmest times in the Cenozoic: the Early Eocene Thermal Maximum and the Miocene Thermal Optimum. Characiforms have a long history of responding to climate change and are thermally limited today, suggesting that climate change and particularly cooler times could have limited characiform distribution and dispersal in the past.

Preparators' Session, Thursday 9:30

#### **UTILIZATION OF CYCLODODECAN AS A STABILIZER DURING PREPARATION OF CRANIATA**

NIXON, Deborah, Southern Methodist University, Dallas, TX, USA; VINEYARD, Diana, Southern Methodist University, Dallas, TX, USA

The application of cyclododecan, a volatile binding medium, was utilized as a stabilizer during air scribe preparation of fossil turtle skulls. The specimens represent a new basal Eucryptodira recovered from the Early Cretaceous Glen Rose Formation Trinity Group, Texas. Four complete skulls and one partial cranium required preparation of the interior regions and the exposed neurocranial structures and foramina, respectively. Two of the four complete skulls were well preserved while two were poorly preserved, brittle, and missing bone. The skull bone was thin on the two poorly preserved specimens. The matrix consisted of dense limestone with calcite veins and thin calcite deposits between the matrix and bone. Based on the specimens representing a new taxon, preservation without loss of bone during preparation was of the utmost importance. The application of cyclododecan involved two simple steps. Step 1: melting cyclododecan crystals to a liquid state at a temperature of 130 degrees. Step 2: Applying the liquid cyclododecan utilizing a small brush. The cyclododecan cools instantly upon application. The cyclododecan was applied to a thickness of approximately 3 - 4 mm or until the cyclododecan was opaque. The skulls were then prepped using ARO air scribes to remove the matrix. Cyclododecan sublimates from a solid to a gas at room temperature, depending on thickness, within 15 - 30 days without discoloring or altering bone and leaving no residues. During the preparation process, the skulls were kept refrigerated to slow sublimation. Once the preparation was complete, the cyclododecan was allowed to sublimate off the specimens. Although air scribes, even the smaller units, can fracture delicate bone, cyclododecan used as a temporary stabilizer is essential in providing strength to the bone as well as retaining broken parts in situ so they may be permanently reattached. Preparation of the fossil turtles resulted in zero bone loss and exposure of interior skull regions that may not have been possible without damaging other areas of the skulls if cyclododecan were not utilized as a stabilizer.

Poster Session II (Thursday)

#### **THE USE OF URETHANE RESIN AS A NOVEL APPROACH TO THE STABILIZATION OF A LARGE NEARLY INTACT LAND TORTOISE FROM THE LATE PLIOCENE OF NEW MEXICO**

NORTON, J., New Mexico Museum of Natural History, Albuquerque, NM, USA; RINEHART, Larry, New Mexico Museum of Natural History, Albuquerque, NM, USA; MORGAN, Gary, New Mexico Museum of Natural History, Albuquerque, NM, USA

After encountering great difficulties in maintaining stability in a fragile 1 m tortoise fossil using standard techniques, it was decided that an entirely new approach should be considered so that this nearly complete fossil shell could be studied and displayed to greatest advantage. The specimen (*Hesperotestudo sp.*) was found partially exposed in Gila Group sediments in Hidalgo County, in the southwestern corner of New Mexico. The fossil shell was found packed solidly with matrix and was transported in a classic plaster jacket. Conventional wisdom would have dictated leaving the matrix in the specimen to stabilize it. The presence, however, of numerous girdle and limb elements along with important small vertebrate fossils necessitated its removal. As the matrix and multiple skeletal remnants were removed, it became apparent that the plastron (now in superior position) was too fragile to be supported by the bridges of the shell. Cyanoacrylate products did not adequately penetrate the entire thickness of shell structures and wooden supports were required as matrix was removed. After preparation of the inner surfaces a clear urethane resin (Crystal Clear 202<sub>sm</sub>) was applied in multiple coats to achieve an eventual thickness of 3 to 5 mm. Metal struts were installed for further support once the interior preparation was completed. The resin (ordinarily used as a casting compound) cures as a very hard, clear plastic and provides support while still allowing excellent views of underlying details. A test performed on a carapace fragment showed that the resin penetrated the fossil much more deeply than cyanoacrylate penetrant, thus providing excellent stabilization. We have no data on which to gauge the life expectancy of this resin but are confident that without it this large specimen could not be prepared and displayed as effectively.

Technical Session I, Wednesday 8:15

#### **A TEAM-BASED APPROACH YIELDS A NEW MATRIX OF 4,500 MORPHOLOGICAL CHARACTERS FOR MAMMALIAN PHYLOGENY**

NOVACEK, Michael, American Museum of Natural History, New York, NY, USA; ATOL MAMMAL MORPHOLOGY TEAM, USA; MAMMAL ATOL MORPHOLOGY TEAM, USA

The NSF-sponsored Mammal AToL (Assembling the Tree of Life) project provides an unprecedented level of coverage of taxa for both morphological and molecular characters—including the largest data matrix of morphology to date—in order to test interordinal and interfamilial relationships among living and fossil mammals. This requires a new collaborative approach to team-based phylogenetics research. Twenty-one investigators in the morphology team (including students and postdocs) have collaborated in MorphoBank via the web to assemble the matrix. Rather than working in Nexus files on traditional desktop software, MorphoBank allows all researchers to view the same matrix in a database live at any time and stores comments, contributions, labeled images, and citations. The current first draft of the matrix contains more than 4,500 informative morphological characters, documented with 8,500 images grouped in cranial (28%), dental (33%), postcranial (21%) and soft tissue (18%) partitions. The size of the morphological matrix is the first within range of the largest molecular data sets for mammals (less than 10,000 informative characters). Each partition began as a raw assembly of published matrices on different mammal groups that was then edited, managed and organized by one member of the team who assembled comments and additions from all team members. This process has clarified homology issues in all partitions, and has identified redundant and confusing terminology. For example, there is a much clearer basis for the homology of dental loci in different groups, including five premolars as the basal condition in eutherians and the homology of the eutherian DP5 with the marsupial M1. In addition, certain complexes of dental characters that seemingly covary (and co-evolve) in one group comprise components that show independent evolution when the full range of mammals are considered. Such patterns are evident with respect to molar characters at different tooth positions, necessitating separate coding and expansion of the matrix. This global sampling of characters provides a critical framework for any arguments concerning character independence or covariance.

Poster Session I (Wednesday)

#### **PRELIMINARY REPORT ON LIZARDS FROM THE GOLER FORMATION (PALEOCENE) OF CALIFORNIA**

NYDAM, Randall, Midwestern University, Glendale, AZ, USA; LOFGREN, Donald, Raymond Alf Museum of Paleontology, Claremont, CA, USA

The Goler Formation includes a roughly 3 km thick series of mostly terrestrial sediments that outcrop throughout the El Paso Mountains in the Northern Mojave Desert. The Goler Formation is not particularly fossiliferous, but does represent the only series of exposures of Tiffanian (Paleocene) strata west of the Rocky Mountain region that yield a diverse nonmarine vertebrate fauna. Taxa recovered to date include turtles, mammals, crocodylians, amphibians, lizards, sharks, and marine and non-marine invertebrates. Lizard specimens consist of isolated osteoderms and fragmentary jaws. Osteoderms include three distinct morphotypes. The first includes small rectangular, non-keeled, imbricating osteoderms

with a subtle ornamentation of shallow pits and grooves. A partial frontal has a similar ornamentation on the fused osteoderms. This pattern is commonly attributed with small anguils (e.g., *Odocoileus*, *Proxostops*, *Elgaria*). The second morphotype includes rectangular, keeled, imbricating osteoderms with a pronounced pit and ridge ornamentation. This is similar to the anguid *Ophisaurus*, but keeled osteoderms are also common in armored scincomorphans. The third morphotype is rectangular to oval, non-imbricating, with tubercles separated by deep grooves. Some specimens have a distinct longitudinal groove along the dorsal surface near one edge. These osteoderms are similar to some anguils, xenosaurids, and helodermatids. The lizard jaws recovered include an anguimorph (lack of subdental gutter and shelf), a possible xantusiid (closed dentary tube, laterally expanded dentary; ?*Paleoxantusia*), a large scincomorph with massive teeth, and a scincomorph with blunt, striated teeth. Although the material is limited, it appears that the lizards of the Goler Formation are similar in morphotypic/taxonomic diversity (anguils, xantusiid, scincomorphans) to other Paleocene-aged faunas of North America.

Technical Session VIII, Thursday 2:45

**THE EVOLUTION OF MAMMAL-LIKE CROCODYLIFORMS (CROCODYLIFORMES; NOTOSUCHIA) IN GONDWANA: NEW EVIDENCE FROM THE MIDDLE CRETACEOUS GALULA FORMATION, RUKWA RIFT BASIN, SOUTHWESTERN TANZANIA**

O'CONNOR, Patrick, Ohio University, Biomedical Sciences, Athens, OH, USA; SERTICH, Joseph, Stony Brook University, Anatomical Sciences, Stony Brook, NY, USA; STEVENS, Nancy, Ohio University, Athens, OH, USA; GOTTFRIED, Michael, Michigan State University, East Lansing, MI, USA; ROBERTS, Eric, University of Witwatersrand, Johannesburg, South Africa

Discoveries of fossil crocodyliforms have revealed a stunning morphological and presumed ecological diversity not exhibited by extant members of the group, particularly in Cretaceous taxa recovered from southern landmasses. Divergent dental morphologies in notosuchian crocodyliforms provide the basis for inferring mammal-like feeding adaptations in small-bodied members of this clade. Recent expeditions conducted in the middle Cretaceous Galula Formation, Rukwa Rift Basin, southwestern Tanzania, have recovered numerous specimens of crocodyliform and other continental vertebrates. Among the former is a putative notosuchian that was previously identified based on a single specimen consisting of a partial dentary and maxilla preserving an incomplete, but distinctly heterodont dentition. Several additional specimens, including a near-complete rostrum with upper and lower teeth, were collected in 2006/07, and for the first time allow an explicit functional and phylogenetic assessment of this taxon. The Tanzanian form deviates significantly from typical crocodyliform cranio-dental morphologies, exhibiting an abbreviated snout, robust lower jaw, and an extremely heterodont dentition. Moreover, the presence of complementary upper and lower molariform teeth suggests an unparalleled degree of crown-crown interaction during jaw adduction relative to all known crocodyliforms, even among notosuchians, similar to the condition observed only in mammals. A cladistic analysis including selected protosuchians and mesoeucrocodylians was conducted to assess the relationship of the new taxon among Mesozoic crocodyliforms. In all most parsimonious trees the Tanzanian form occupies a position among a derived clade of notosuchians that includes *Adamantina* and *Mariliasuchus*. Notosuchian diversity peaked during the middle Cretaceous in West Gondwana, where a number of forms experimented with various types of molarization. The presence of yet another mammal-like crocodyliform from the Cretaceous of Gondwana is significant in that it suggests alternative niche partitioning, with notosuchians inhabiting eospace similar to that occupied by mammals on northern continents.

Technical Session II, Wednesday 9:45

**POPULATION-LEVEL RESPONSE OF THE DIRE WOLF, *CANIS DIRUS*, TO CLIMATE CHANGE IN THE UPPER PLEISTOCENE**

O'KEEFE, Frank, Marshall University, Huntington, WV, USA

Due to recent interest in climate change, very detailed climate records are now available for many areas, including the Los Angeles Basin, home to the La Brea tar pits. When combined with recent advances in La Brea <sup>14</sup>C dating, these records allow the analysis of the correlation between climate variables and parameters derived from tar pit carnivore populations. In this study, essentially complete dire wolf (*Canis dirus*) crania (N=73) were sampled for 27 3-D morphometric landmarks using a microscribe. These data were analyzed using Procrustes superimposition followed by principal components analysis for the derivation of relative warps, followed by canonical variates analysis to investigate shape variation among samples. The wolf crania originate from four different samples of broadly different ages: pit 13 is datable to the termination of the last glacial maximum, pit 61 to the Pleistocene-Holocene boundary, Pit 91 to the OIS interglacial, and the UCMP sample to the last glacial maximum. Analysis of centroid size reveals that *C. dirus* is significantly smaller in pit 13, at the termination of the last glacial maximum, and then rebounds to a larger size in pit 61. Subsidiary analyses show that body size in recent wolves (*C. lupus*) is inversely correlated with temperature, so the finding that dire wolves from the warmest and driest period are larger than the pit 13 sample is surprising. Pit 13 animals also have a reduced anterior dentition and a relatively robust P4-M1 complex, as well as other cranial changes possibly indicative of increased bone processing. Climate was extremely variable at the termination of the last glacial maximum, and these findings may indicate increased nutrient stress in the *C. dirus* population at this time. This hypothesis is testable by an

analysis of tooth wear and breakage across the four pits, as these parameters are known to reflect nutrient stress in carnivore populations. Another morphometric finding is significant differences in the rostrum during the last glacial maximum, probably interpretable as a response to low ambient temperature.

Technical Session XX, Saturday 1:45

**INSTABILITY OF PIVOTAL FOSSIL CLADES IN CETARTIODACTYLAN PHYLOGENY AND EVOLUTION OF THE EAR REGION AND ANKLE**

O'LEARY, Maureen, Stony Brook University, Stony Brook, NY, USA; SPAULDING, Michelle, American Museum of Natural History, New York, NY, USA; PARENT, Sara, Stony Brook University, Stony Brook, NY, USA; GATESY, John, University of California, Riverside, Riverside, CA, USA

New skulls of the raoellid cetartiodactylan, *Indohyus*, document the first known occurrence of a classic terrestrial cetartiodactylan feature (quadritubercular teeth) with a classic cetacean feature (pachyostotic bulla) in the same specimen. Establishing the phylogenetic position of raoellids is key for understanding whether the pachyostotic bulla evolved twice or whether quadritubercular teeth reappeared in a close relative of cetaceans. The first published phylogenetic tree to include these new skulls was, however, based on a relatively small subset of taxa and characters, including few extant taxa, limited morphological data, and no molecular data. Similarly, the position of extinct Mesonychiids as nested within Cetartiodactyla has been tested with combined data from large samples of ungulates, but not with the inclusion of large samples of carnivorans, which have broad dental similarities to mesonychiids. Such a test is important for determining whether the double-trochleated astragalus exhibited homoplasy. We combined the new *Indohyus* data with the largest existing matrix of cetartiodactylan phylogeny, which has over 600 morphological characters and over 40 kilobases of molecular sequence data. We also added to this matrix seven carnivorans (extant and extinct) and creodonts for a total of 77 taxa. Analysis of all data produced trees in which the positions of extant taxa are congruent with trees found from evaluation of molecular data alone as follows: (((Cetacea + Hippopotamidae) + Ruminantia) + Suina) + Camelidae). Analysis of morphology alone, even with *Indohyus* and carnivorans included, however, did not return a tree that was topologically congruent with the molecule-based tree. Evaluation of morphological data alone indicated that the pachyostotic bulla of *Indohyus* is convergent to that of cetaceans. The positions of key fossil clades like *Indohyus* and Mesonychia are highly volatile and change only a few steps away from the shortest trees in the combined data analysis. Despite the relatively distant phylogenetic positions of Carnivora and Cetartiodactyla, inclusion of carnivorans has a strong impact on the position of Mesonychia.

Poster Session III (Friday)

**THE FIRST DISCOVERY OF FOSSIL COLOBINE MONKEYS FROM THE EARLY PLEISTOCENE OF TAIWAN**

OGINO, Shintaro, Primate Research Institute, Inuyama, Japan; OTSUKA, Hiroyuki, Kagoshima Univ. Museum, Kagoshima, Japan

In this study we report the first discovery of fossil colobines from the Early Pleistocene Neritic sediments near Chochen village, West Taiwan. The vertebrate fauna from the deposit consists of more than ten kinds of animals such as monkeys, tigers, rhino, wild boars, elephants, deer, wild ox, water buffalo, and whales. The fossil specimens of monkeys are three isolated teeth; two isolated molars, M<sup>1</sup> and M<sub>3</sub>, which clearly belong to *Macaca*, whereas the other M<sub>3</sub> is referred to Colobinae, the leaf monkeys. The M<sub>3</sub> is a relatively hypsodont tooth with long and sharp shearing crests. Four main cusps are sharp and high, and positioned marginally. Transverse width of the distal lobe (heel) is wide, and three small marginal cusps are observed between the hypoconulid and the 6th cusp. The configuration of the M<sub>3</sub> demonstrates that the tooth belong not to Cercopithecinae but to Colobinae. The size of the M<sub>3</sub> is close to that of large modern colobine monkeys such as *Nasalis*, *Rhinopithecus*, and *Semnopithecus*. This fauna shows a similarity to the Pleistocene fauna of southern China, so called *Stegodon - Ailuropoda* fauna (sensu stricto). Although some members of the Taiwanese fauna including colobines became extinct during the Pleistocene in Taiwan as did the *Stegodon - Ailuropoda* fauna in the main land, *Macaca* is still living in this Island. More detailed analysis of the faunal specimens would make clear the causes of extinction of the Early Pleistocene land mammals in Taiwan.

Technical Session IX, Thursday 3:30

**ENDOCRANIAL ANATOMY OF AEPYORNITHIDAE BIRDS**

OHASHI, Tomoyuki, Institute of Industrial Science, The Univ. of Tokyo, Tokyo, Japan; MANABE, Makoto, National Museum of Nature and Science, Tokyo, Japan; YOSHIDA, Akira, The Research Institute of Evolutionary Biology, Tokyo, Japan; RASOAMIARAMANANA, Armand, Université d'Antananarivo, Antananarivo, Madagascar; SUWA, Gen, The University Museum, The Univ. of Tokyo, Tokyo, Japan

The largest bird ever known to science is the extinct elephant bird *Aepyornis* from the Pleistocene of Madagascar. In this study, we CAT scanned seven braincases of Aepyornithidae, and reconstructed three dimensional endocranial models. The specimens vary in size: the largest endocast is 2.4 times larger than the smallest one in the estimated brain mass. The largest braincase can be identified as *Aepyornis maximus* by its large

size. The second smallest specimen can be identified as a species of *Mullerornis* body according to a previous study because it has an anteroventrally projected pituitary. Other five specimens may include other species of *Aepyornis* and *Mullerornis*. These reconstructed endocasts have some common features: relatively large pituitary body, weakly developed flocculus, large maxillomandibular foramen and distinct wulst at the anterior cerebrum hemisphere. These characters exhibit some similarities to *Struthio* and *Dinornis*. There are some differences among seven specimens: for example, optic lobe of larger endocasts is less developed than those of smaller endocasts, and pituitary body differs in shape between larger and smaller endocasts. The flexion of endocranial cavity is similar to that of *Struthio*, and it does not show any differences in the seven specimens examined. The differences among the specimens studied here might have exhibited inter-specific variations in Aepyornithidae, but some may be a result of intra-specific variations.

Poster Session I (Wednesday)

#### **CROCODYLOMORPH EGGS AND EGGSHELLS FROM THE BAURU GROUP, UPPER CRETACEOUS OF BRAZIL**

OLIVEIRA, Carlos Eduardo, Fundação Educacional de Fernandópolis-FEF/Instituto de Geociências e Ciências Exatas, UNESP-Rio Claro, Fernandópolis, Brazil; SANTUCCI, Rodrigo, Departamento Nacional de Produção Mineral-DNPM, Brasília, Brazil; ANDRADE, Marco, Department of Earth Sciences, University of Bristol, Bristol, United Kingdom; FULFARO, Vicente, Departamento de Geologia Aplicada, Instituto de Geociências e Ciências Exatas, UNESP-Rio Claro, Rio Claro, Brazil; BENTON, Michael, Department of Earth Sciences, University of Bristol, Bristol, United Kingdom

The record of fossil crocodyloid eggs is rather limited and poorly understood, not matching the wide diversity of crocodylomorph skeletal taxa known to date, especially regarding non-eusuchian mesoeucrocodylians and other basal lineages. This absence in the fossil record has been partially attributed to the proportionally thin eggshell of extant crocodylians. A remarkable new association of well preserved eggshells, eggs and egg clutches from the Adamantina Formation (Bauru Group, Upper Cretaceous) is reported, characterized by a particularly thin eggshell (0.15-0.25 mm), one of the most delicate seen in any crocodyloid eggs. The outcrop supplied several associations of eggs distributed in a relatively small area and different horizons. The new Adamantina Formation eggs also show basic characteristics of other typical crocodyloid eggs. These eggshells have elliptical or drop-shaped pore openings (30-80 micrometers in length) and a tightly packed arrangement of the basic units. These features contrast with other known types of fossil crocodyloid eggshells, which always possess well-developed interstices and usually subcircular pore openings (e.g. *Krokolithus wilsoni*, *K. helleri*, Glen Rose Formation eggshells). In the new Adamantina eggs, at least two egg clutches were associated with articulated remains of *Baurusuchus pachecoi*, a highly predaceous notosuchian mesoeucrocodylian. The Bauru Group has already yielded another type of crocodyloid egg, associated with remains of the notosuchid *Mariliaesuchus*, and is the only geological unit to show two distinctive types of crocodyloid eggshells, as well as dinosaurian eggs. As the Bauru Group includes no fewer than seven different mesoeucrocodylian genera, most of them notosuchians, the occurrence of two crocodyloid oospecies is expected and is a valuable source of information for paleobiological studies. However, specific information on Bauru Group eggs and eggshells is still scarcely documented and, therefore, is poorly understood.

Poster Session I (Wednesday)

#### **THE FIRST PODOCNEMIDIDAE TURTLE FROM THE SÃO JOSÉ DE ITABORAÍ BASIN (PALEOCENE), RIO DE JANEIRO, BRAZIL**

OLIVEIRA, Gustavo, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; CAMPOS, Diogenes, Museu de Ciências da Terra/DNPM-RJ, Rio de Janeiro, Brazil

The São José de Itaboraí Basin, situated in Rio de Janeiro State, is known worldwide for the Early Paleocene mammalian fauna. However, this deposit has also yielded several reptilian remains, most still unstudied. Here we report the first occurrence of a podocnemid turtle from this basin. The specimen (DGM 518-R) consists of an isolated skull, and a preliminary phylogenetic placement, using PAUP\* 4b10 for Windows, of the new specimen was based on the re-analysis of published morphological data matrix. This analysis indicates that DGM 518-R is a member of the Podocnemididae, a group composed of extant and fossil taxa. We obtained one most parsimonious tree with 63 steps. Although the knowledge on a Podocnemidinae phylogeny is poorly understood and the phylogenetic relationships of DGM 518-R with other *Podocnemis* spp. could not be accessed, the resulted tree - (*Araripemys* (Pelomedusidae (Bothremydidae (*Brasilemys* (*Hamadachelys* (*Portezueloemys* (Erymnochelinae (*Bauruemys* (Podocnemidinae plus DGM 518-R))))))))) - indicates that Itaboraí specimen is close related to Podocnemidinae. This relationship is supported by two synapomorphies: (1) parietal-jugal contact and (2) short postorbital with parietal-jugal contact. These characteristics are considered by several authors to be diagnostic for *Podocnemis*. Therefore, a review of this taxon to establish the relationships of the species of *Podocnemis* genus is very important for the better understood of the affinities in clade formed by Podocnemidinae.

Technical Session XV, Friday 1:45

#### **POSTCRANIAL OSSIFICATION SEQUENCE AND MORPHOGENESIS OF MICROBRACHIS PELIKANI (LEPOSPONDYLI: TETRAPODA)**

OLORI, Jennifer, The University of Texas at Austin, Austin, TX, USA

Ontogeny has become a critical source of new data for phylogenetics and now plays a major role in sorting out the relationships between early tetrapods and modern taxa. Despite the continuous increase in information on temnospondyl ontogeny, the growth and development of 'lepospondyl' taxa remains a little-studied subject. In a step toward rectifying this, I describe the ontogeny of the postcranium of the microsaur *Microbrachis pelikani*. A total of 67 specimens of *Microbrachis* with skull lengths ranging from 8.2 to more than 30mm were surveyed for changes in postcranial ossification sequence, morphogenesis, and limb allometry. Previous views of *Microbrachis* as a direct developer were supported. Even the smallest individuals exhibit a fully formed and sutured skull roof with a complete circum-orbital series. Sclerotic plates are visible in a specimen of skull length 11mm. In the postcranium, dermal pectoral girdle elements are present in individuals with a skull length smaller than 13mm. These elements could not be located in the two smallest animals, possibly due to poor preservation. An ossified scapula is first present in specimens with a skull length of 17mm. In the pelvic region, the ilia are visible in specimens of all sizes, the ischia are clearly ossified in an individual with a skull length of 11mm, and the pubes ossify at a skull length around 16mm. The pes matures earlier than the manus, with tarsals (skull length 16mm) appearing before carpals (skull length 19mm). The ossification sequence of major processes is more variable than that of the bones themselves and morphogenesis may not be consistent in a single individual. Overall, the development of the appendicular skeleton in *Microbrachis* differs little from that of most temnospondyls and probably further demonstrates a plesiomorphic pattern of limb and girdle development. However, late ossification of the scapula after the tarsals is noteworthy because this pattern is not known in any temnospondyl. Ossification of the pubis at small body size may also be important because this bone fails to ossify in many temnospondyls and lissamphibians.

Technical Session XIII, Friday 2:15

#### **MIOCENE CLIMATE CHANGE AND MAMMAL BODY SIZE EVOLUTION IN THE NORTHWESTERN UNITED STATES**

ORCUTT, John, University of Oregon, Eugene, OR, USA

Geographic body size trends have long been recognized within most extant mammal taxa. The classical model holds that geographic body size variation is driven primarily by mean annual temperature, with larger individuals in cooler climates. Recently, ecologists have proposed several alternative hypotheses positing that other climatic variables (e.g. precipitation, seasonality) or biotic interactions (e.g. competition, migration) more strongly influence body size evolution. While highly relevant in the face of anthropogenic global warming, the question of causality has not yet been answered. Paleontological data can be used to gain a unique perspective on the debate by allowing observations of body size changes through time as well as space. The Miocene is a particularly interesting interval in which to assess the influence of climate on biotic change, as it encompasses periods of both global warming (early-mid Miocene) and global cooling (late Miocene). The excellent fossil and climatic records of the northwestern United States (Oregon, Washington, and northern Nevada) make them an ideal natural laboratory for studying the biotic effects of climate change. Within this region, body mass was estimated through the Miocene for taxa within three ecologically distinct and well-represented families: canids, equids, and sciurids. For most taxa, an increase in body mass was observed from the Barstovian to the Hemphillian, while preliminary data suggest a general decrease in size during the Arikareean and Hemingfordian. These trends closely track changes in climate: warm, wet, and less seasonal intervals tend to favor small individuals, while cold, arid, and seasonal intervals tend to favor large individuals. As such, the data presented here are consistent with the hypothesis that climate plays an important role in driving body size evolution in mammals.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 9:30

#### **MOLECULES AND PHYLOGENETIC RELATIONSHIPS OF OSTARIOPHYSANS**

ORTI, Guillermo, University of Nebraska, Lincoln, NE, USA; LI, Chenhong, University of Nebraska, Lincoln, NE, USA

Phylogenetic relationships among families of ostariophysans have been notoriously difficult to resolve with confidence in spite of significant effort to synthesize evidence from morphological and DNA data. The most widely accepted hypothesis based on morphological characters supporting the monophyly of Ostariophysans and the phylogenetic relationships of ostariophysan subgroups was published over 20 years ago. More recent molecular studies show very different results, even questioning the monophyly of the group as well as the monophyly of some of the subgroups. Thus, there are disagreements between morphological and molecular evidence, and also among the recent molecular studies. We present new evidence from DNA sequences of ten nuclear genes currently being used for broad-scale phylogenetic studies of euteleosts, sampled from a large sample of representative taxa of all ostariophysan subgroups. Maximum likelihood and Bayesian analyses of these sequences alone and in combination with previously published data confirm the monophyly of Ostariophysans as well as a sister group relationship with Clupeomorpha, but result in a new hypothesis for the evolution of this large group of teleostean fishes. Available fossil data are used to calibrate the molecular clock for the new genes and establish upper and lower bounds for the diversification of the ostariophysan lineages under a Bayesian framework of molecular dating.

Technical Session X, Friday 9:00

### THE EARLY EVOLUTION OF ARCHOSAUR STANCE AND GAIT

PADIAN, Kevin, University of California, Berkeley, CA, USA; LI, Cheng, University of California, Berkeley, CA, USA

For some decades, the paradigm for the evolution of stance and gait in archosaurs has been a transition from sprawling to “semi-erect” to erect posture. Yet no living animals appear to walk in a “semi-erect” posture or gait, which is a poorly defined functional complex. We suggest a separation of terminology related to stance vs. gait so as not to entail different processes: “sprawling” and “erect” should refer to stance; “rotatory” and “parasagittal” are more appropriate descriptors of gait. The “high walk” of crocodiles uses an erect stance that was apparently also used by various extinct pseudosuchians, according to evidence from functional morphology and trackways. We compared the reconstructed skeletons of various pseudosuchians to Triassic trackways, in order to determine the plausibility of various trackmakers and to assess possibilities of stance and gait. We show that the trackway *Apatopus* could have been made by either a phytosaur or an aetosaur, but in either case the animal was performing the high walk (erect stance, parasagittal gait). A phytosaurian trackmaker would imply that the common ancestor of archosaurs could perform the high walk, so erect stance and parasagittal gait would not have evolved independently in pseudosuchians and ornithosuchians. An aetosaurian trackmaker would imply independent origins. In either case, so far only ornithosuchians have been shown to have evolved obligate erect stance and parasagittal gait.

Poster Session IV (Saturday)

### DESCRIPTION AND PALEOBIOLOGY OF AN EOCENE SHARK FAUNA FROM BANKS ISLAND, ARCTIC CANADA

PADILLA, Aspen, University of Colorado Museum of Natural History, Boulder, CO, USA; EBERLE, Jaelyn, University of Colorado, Department of Geological Sciences, Boulder, CO, USA; CUMBAA, Stephen, Canadian Museum of Nature, Ottawa, ON, Canada; HUTCHISON, J., University of California Museum of Paleontology, Berkeley, CA, USA

Although shark teeth are the most abundant vertebrate fossil in the marine record, they are not well documented from polar regions. Here, we report a shark fauna from Banks Island, Canada’s westernmost Arctic island, based upon discovery of over 8,000 isolated shark teeth in unconsolidated sands of the Eureka Sound Group cropping out in Aulavik National Park (~74° N. latitude). Based upon palynological and lithologic studies of others, the fossil shark-bearing sediments are considered Eocene in age and representative of a nearshore, deltaic environment. The fauna is dominated by two genera of sand tigers *Striatolamia* and *Carcharias*, while the only non-Lamniform shark is the extinct sharpnose shark *Physogaleus*. Also recovered at fossil localities are the teeth and bones of teleost fishes, fragments of turtle shell, and rarer fossils of a warm water ray and ratfish. The trace fossil *Ophiomorpha* is locally abundant. Modern sand tigers are known to inhabit warm, shallow coastal waters world-wide. Consequently, their presence in Eocene sediments on Banks Island indicates warmer Arctic ocean waters than at present, an interpretation that is consistent with paleoclimate data from similar-aged strata in Canada’s eastern High Arctic. Although sand tigers are documented from other Eocene localities in the northern hemisphere such as Belgium, Kazakhstan and the eastern United States, the Banks Island shark fauna represents the northernmost known occurrence of sand tigers. The low diversity of the fauna may reflect reduced salinity in a nearshore deltaic environment. Additionally, the predominance of smaller teeth (< 2 cm in length), which we interpret as belonging to juveniles, may suggest a sand tiger pupping ground, as today’s sand tigers give birth in reduced-salinity nearshore environments to avoid predation.

Poster Session I (Wednesday)

### A REEXAMINATION OF THE SHOTWELL METHOD OF FOSSIL COMMUNITY RECONSTRUCTION FOR USE IN TAPHONOMIC AND PALEOECOLOGICAL INTERPRETATIONS

PAGNAC, Darrin, Museum of Geology, Rapid City, SD, USA

J. Arnold Shotwell proposed a statistical/graphic method for determining community structure among large fossil vertebrates. He utilized Number of Specimens per Individual (NSI) values, which are derived from Minimum Number of Individual (MNI) values. MNI values which are represented by a larger number of skeletal elements equate to higher NSI values. As such, higher NSI values theoretically represent a higher concentration of specimens from individuals of a given taxon. Shotwell suggested that high NSI values represented taxa from a proximal community immediately adjacent to the site of deposition, those with low values, from distal communities away from the area of deposition. Subsequent research showed that NSI values were the result of taphonomic processes and preferential preservation of more durable skeletal material rather than actual concentrations of taxa or community structure. Shotwell’s method is reexamined using the original methods combined with Voorhies taphonomic groups. A graphical representation of NSI values broken into Voorhies taphonomic groupings is produced. Two examples from localities from the Miocene Barstow Formation are presented. RAM 94026, from the unnamed middle member of the Barstow Formation, was deposited under typical fluvial/alluvial conditions. RV 5201, from the unnamed upper member, was deposited under typical lacustrine conditions. Analysis and graphical representation of each locality reveals taphonomic preservation typical of each respective depositional regime. Taphonomic and paleoecological

interpretations are presented based on the results. The use of this method is not intended for community reconstruction as was originally proposed by Shotwell. Rather, it serves as a simple graphic tool for representing the taphonomic overprint of a given assemblage. It can be further utilized to make additional interpretations, such as confirming field diagnoses of taphonomic overprint or identifying higher or lower concentrations of individual taxa suggesting gregarious or solitary behavior.

Poster Session II (Thursday)

### HOW DID SAUROPODS BREATHE? RIB DIMENSIONS AND HISTOLOGY IN CAMARASAURUS

PAJOR, Nadine, University of Bonn, Institute of Zoology, Bonn, Germany; BREUER, Thomas, Institute of Zoology, Bonn, Germany; PERRY, Steven, Institute of Zoology, Bonn, Germany

To answer the above question, we used morphometric estimations and histological techniques to reconstruct the rib dimensions and thorax of *Camarasaurus*. 3D laser scans of the ribs show us the shape and assumed muscle attachment sites on the ribs. Furthermore we found Sharpey’s Fibers in ground sections. Sharpey’s Fibers are structures in bone, that can be found in recent as well as in fossil material and define muscle attachments or tendon insertions in bone. They can be visualized by polarized light microscopy in ground sections. To get an idea of the structure of intercostal muscles in *Camarasaurus* and other sauropods, we generate a map of muscle insertions along the rib profile. This is possible because the fibers let us draw conclusions about muscle insertions and the forces that acted on the ribs. The shapes of the ribs are also important, they show us how the forces are distributed over the thorax. The results lead us to the maximum possible movement and swingaxes of the ribs to estimate a thoracic volume and “let the dinosaur breathe”.

Poster Session IV (Saturday)

### THE OSTARIOPHYSAN FOSSIL RECORD OF THE INDIAN SUBCONTINENT

PAMAR, Varun, Department of Geology, University of Jammu, Jammu, India; ARRATIA, Gloria, Biodiversity Research Center, The University of Kansas, Lawrence, KS, USA; KRIWET, Jürgen, Museum für Naturkunde, Berlin, Germany; PRASAD, Guntupalli, Department of Geology, University of Jammu, Jammu, India

In the Indian subcontinent, ostariophysan fishes have been recovered mainly in two major areas, the Deccan traps and Siwaliks. The Deccan Province of India is one of the most important and largest flood basalt provinces of the earth that covers an area of 500,000 sq. km. The Deccan intertrappean beds were deposited under fluvio-lacustrine conditions, occasionally shallow marine, and contain well-preserved faunas and floras. Vertebrates include fishes, amphibians, reptiles, and mammals. A Late Maastrichtian age is currently assigned to the infra- and intertrappean beds. The Neogene to Quaternary terrestrial sedimentary deposits of the Sub Himalaya are known as Siwaliks (~ 18.3 to ~0.5 Ma). The fossil record of ostariophysans includes an isolated cyprinid scale from the Inter-Trappean at Deothan, a tooth assigned to *Arius* from the Infra-trappean beds of Pisdura, and a pectoral spine assigned to *Siluriformes* indet. from the Upper Cretaceous Inter-Trappean beds of Andhra Pradesh, which represents the oldest record of Asia. We report new findings of numerous well-preserved siluriform pectoral and dorsal spines that were recovered at the Kisalpuri intertrappean site, and dorsal spines recovered at Naskal (intertrappean site) and Marepulli (infratrappean site). The spines are few mm in length but heavily ossified; the proximal region of all spines is well-preserved but the distal end is damaged. Pectoral spines represent two distinct morphotypes that are interpreted as belonging to different catfish taxa. In morphotype A the pectoral spine bears denticulations only at its posterior margin, whereas in morphotype B denticulations are present in both anterior and posterior margins. No other bony elements were recovered associated with the spines. Disarticulated and articulated ostariophysans have been recovered in Siwaliks deposits, including cypriniforms (e.g., *Tor*, *Cyprinus*), siluriforms, and gonorynchiforms. Among catfishes, a gigantic one was assigned to *Bagarius*, a palatal series to *Arius*, and isolated bones to the Bagridae, Chacidae, and Clariidae. Siwaliks deposits contain chaniid gonorynchiforms, which are not present in the modern Indian subcontinent.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

### DON’S GOOSEBERRY PIT, BLACK HILLS, SOUTH DAKOTA: A SITE BASED TAPHONOMIC STUDY OF NON-ANALOG FAUNAL ASSEMBLAGES ACROSS THE PLEISTOCENE-HOLOCENE BOUNDARY

PARDI, Melissa, Department of Geosciences, The Pennsylvania State University, University Park, PA, USA

The occurrence of non-analog mammalian faunas in the late Quaternary has strong implications for understanding past environments as well as predicting species responses to future climate change. One of the unknowns in the study of non-analogs is the degree to which taphonomy contributes to their origin. Non-analogs lack biological relevance if they are a taphonomic artifact. To this end, the analysis of non-analog faunas from a pit cave, Don’s Gooseberry Pit in the Black Hills of South Dakota, provides an opportunity to constrain many taphonomic processes. In particular this includes excavation technique, depositional pathways, faunal sampling, and time averaging within samples. Don’s Gooseberry Pit contains a rich micro-mammal record that spans the late Pleistocene and

Holocene. If taphonomy generates non-analog faunas, they should be present throughout the entire sequence. If they relate to climate conditions, they should correlate to major climate perturbations, such as those occurring during the end Pleistocene transition. The Holocene contrasts to this transition because, as shown by ice and deep sea cores, it was relatively more stable. My results show that 1) Pleistocene non-analog assemblages are not a result of time averaging or other taphonomic biases and 2) non-analog assemblages are absent from the Holocene. Some areas of sympatry I have identified do not exist today in North America, suggesting habitat regimes that disappeared late in the Quaternary. Additionally, biogeographic ranges of species appear to have shifted individually across the landscape throughout the Pleistocene and Holocene. The results of this research have implications for paleoecology and conservation biology. Non-analogs represent a unique time in history, and should be treated accordingly. Non-analogs provide information about habitat change during rapid climate fluctuations. If faunal assemblages are continually emergent and geologically short lived, then predicting how communities will adjust to future climate change becomes more complicated.

Technical Session XI, Friday 8:00

**BIOTIC RESPONSES TO CLIMATE CHANGE IN THE PERMO-CARBONIFEROUS TRANSITION, PART I: VERTEBRATE FAUNAL DISTRIBUTIONS AND REGIONAL PROVINCIALISM**

PARDO, Jason, University of Illinois at Urbana-Champaign, Urbana, IL, USA; HUTTENLOCKER, Adam, University of Washington, Seattle, WA, USA; SMALL, Bryan, Denver Museum of Nature and Science, Denver, CO, USA; MILNER, Andrew, The Natural History Museum, London, United Kingdom

Three major vertebrate faunal provinces have been recognized for the Late Pennsylvanian and Early Permian; the Edaphosaur-Nectridean (E-N) Province of Euramerica, the Mesosaur Province in Gondwana, and the Kazakhstan Plate Province in Central Asia. Regional faunas within these greater provinces have been proposed on the basis of qualitative data, but few quantitative assessments of regional provincialism have been attempted. The Permo-Carboniferous (C/P) transition within the E-N Province is worthy of particular interest, as these sediments record dramatic shifts in Paleozoic climate regimes along a paleoequatorial west-east transect, running from New Mexico, USA, to Czechoslovakia. This drastic climatic event is recorded in observable changes in lithology and paleoflora. Such observations suggest that quantitative investigation into the distribution of C/P vertebrates in the E-N province in context of this change in climate may be more lucrative than attempts to infer a series of province-wide faunal replacements and/or catastrophic mass extinctions. In doing so, we revisit hypotheses proposed by Vaughn and Olson, concerning physical and biological barriers to vertebrate dispersal. As part of an ongoing collaborative effort to quantify the dynamics of the C/P transition, we assessed C/P vertebrate faunas from continental deposits in North America and Europe for patterns of provincialism similar to those recently described for Peri-Tethys floras. We analyzed over 100 vertebrate collections with comprehensive occurrence data from the C/P transition of North America and Europe. Localities were binned by global stage and analyzed using a sliding window to account for minimal collection effort in certain regions and intervals. We assessed dissimilarity between localities and used a clustering algorithm to compare faunas, assessing regional bins for statistically significant fidelity to faunal clusters. Results suggest that faunas were regionalized along the west-east climatic cline, possibly representing contemporaneous vertebrate communities which varied more with paleogeography than geological stage.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**A DECONSTRUCTION OF THE ARTIODACTYL ASTRAGALUS AND ITS IMPLICATIONS FOR RECONSTRUCTING PHYLOGENY**

PARENT, Sara, Stony Brook University, Stony Brook, NY, USA

The artiodactyl ankle has historically been considered an "ordinal trait" by some morphologists and systematists because of its continued description as being relatively invariant in its general form throughout the clade. A few authors have attempted to break down the artiodactyl ankle into a collection of separate morphological characters but have not reported the comparative results in detail. Observations that I have made on the astragalus of several extant and extinct genera suggest that the artiodactyl ankle is actually a suite of numerous independent characters, several of which vary within the order and/or are shared with taxa from other clades. Several highly variable features of the artiodactyl astragalus are described and used along with other observations on the morphology of the artiodactyl tarsus to create new morphological characters for phylogenetic analysis. These characters include variations in the depth of the trochleation of the navicular facet, the width of the cuboid facet, a hook-like process on the ventral surface of the tibial trochlea, a variably present medial curvature of the borders of the tibial trochlea, asymmetry in the heights of the lateral and medial borders of the tibial trochlea, and the presence of a lateral process distal to the ectal facet. In this study I used the matrix of O'Leary and Gatesy, with the addition of several astragalar characters, to assess the phylogenetic relationships of artiodactyls, whales and mesonychids. The resulting new analysis with added tarsal data recovered a single fully resolved most parsimonious tree that places mesonychids sister to whales and nests both within a paraphyletic Artiodactyla. Character optimizations performed show that hallmark traits considered unique to artiodactyls are actually shared with other taxa and that none of the tarsal characters scored were unique to Artiodactyla, although one astragalar character was shared by cetaceans and artiodactyls.

Poster Session IV (Saturday)

**HOW MANY VALID AETOSAUR SPECIES ARE THERE? REVIEWING THE ALPHA-TAXONOMY OF THE AETOSAURIA (ARCHOSAURIA: PSEUDOSUCHIA) AND ITS IMPLICATIONS FOR LATE TRIASSIC GLOBAL BIOSTRATIGRAPHY**

PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA

Since 1844, 30 species of aetosaurs have been named, and nearly half of these were published since 1985 when the taxonomic utility of osteoderm ornamentation was first emphasized. Subsequent, often conflicting, studies have either lumped or split generic taxa depending on the focus of the study (e.g., developing a global biostratigraphy). A reinvestigation of the alpha taxonomy of the Aetosauria suggests that only 13 of these taxa are currently unambiguously valid, with the majority of the rest comprising *nomina nuda*, *nomina dubia*, or junior synonyms. Furthermore several taxa such as *Adamanasuchus eisenhardtae* and *Typhorax antiquum* may be valid but have not been properly diagnosed using discrete autapomorphies or unique character combinations. Unequivocally valid taxa include *Acaenasuchus geoffreyi*, *Aetosaurus ferratus*, *Aetosauroides scagliai*, *Coahomasuchus kahleorum*, *Desmatosuchus spurensis*, *Desmatosuchus smalli*, *Heliocanthus chamaensis*, *Longosuchus meadei*, *Lucasuchus hunti*, *Neoetosaurioides engaeus*, *Paratyphorax andressorum*, and *Tecovasuchus chatterjeei*. The type materials of classic taxa such as *Stagonolepis robertsoni* and *Typhorax coccinarum* are not diagnostic to the species level and will need designation of neotype specimens to conserve their taxonomic names. Taxa such as *Desmatosuchus haplocerus* and *Calyptosuchus (Stagonolepis) wellsi* are also well known; however, the former is a nomen dubium whereas previous diagnoses of the latter are based mainly on synapomorphies from incorrectly referred material. Recent recognition of increased aetosaur taxonomic diversity suggests that paramedian osteoderm ornamentation may be indicative of more inclusive clades rather than specific genera or species. This recognition, in concert with the reinvestigation of the alpha taxonomy and phylogeny of the clade, indicates that aetosaur taxa are more endemic than previously hypothesized (with only one taxon, *Paratyphorax*, having an unambiguously cross-continental correlation) and are therefore not useful for global correlation of Late Triassic non-marine strata, though they might support regional correlations. This has implications regarding the proposed timing of archosaur clade appearance and diversification in the Late Triassic, especially of Dinosauria.

Poster Session III (Friday)

**DIFFERENTIATING BETWEEN SAUROPELTA EDWARDSORUM (ORNITHISCHIA, THYREOPHORA) AND A NEW ANKYLOSAURID, BOTH FROM THE EARLY CRETACEOUS CLOVERLY FORMATION OF CENTRAL MONTANA**

PARSONS, William, Buffalo Museum of Science, Buffalo, NY, USA; PARSONS, Kristen, Buffalo Museum of Science, Buffalo, NY, USA

This current analysis of a newly discovered dinosaur has resulted in its recognition as the second ankylosaur, and the first member of Ankylosauridae, to be recovered from the Early Cretaceous Cloverly Formation of central Montana. The initial determination that it was in fact a new taxon resulted from a differential comparison between the cranial elements of this new taxon and the cranial elements of the nodosaurid *Sauropelta edwardsorum*, the only other ankylosaur from the Cloverly Formation. Here we present the detailed character comparisons that differentiate this new taxon from *Sauropelta*. Although only a few fragmentary cranial elements of *Sauropelta* have thus far been recovered, their comparison with the cranial material of this new taxon has revealed several distinctly contrasting features. The differentiating characters in this new taxon include a frontoparietal dome, an expanded nuchal ridge that obscures the occipital region, a circular orbit, ventral curvature in the caudolaterally directed paroccipital processes, a caudoventrally directed foramen magnum, a comparison between the relative proportions of the basiptyergoid processes and the basal tubera, and a number of features of the braincase. Another consequence of this comparative study has been a more detailed examination of the cranial characters of *Sauropelta*. This has contributed some newly coded characters for *Sauropelta*, as well as some editing of the coding of previously known characters. Further analysis of all these features presents some clues as to the earlier stages within the evolutionary development of what would become the more extravagant cranial characters possessed by later members of Ankylosauridae. Some interpretative speculations regarding the function of the few key unambiguous synapomorphies that define the two major clades within Ankylosauria suggest possible differing behaviors that may have led to the development of these two clades.

Technical Session IV, Wednesday 2:15

**GEOCHEMICAL AND CRYSTALLOGRAPHIC VARIATIONS IN FOSSIL BIOAPATITE**

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The primary constituent within modern and fossilized bone is the mineral bioapatite (Ca<sub>5</sub>(PO<sub>4</sub>)<sub>3</sub>(F, OH, Cl)). Because there are four different types of crystallographic positions in the bioapatite, cations and anions can be substituted into these various sites through elemental exchange. During diagenesis, substitutions into the bioapatite structure affect the chemical composition and control changes in the Unit Cell Dimensions (UCD). In a comparison of

lattice parameters between modern and fossil bioapatite, there is a significant change in the bioapatite unit cell parameters like the a and c axes, and the unit cell volume. Since substitutions are dependent on what species are available during diagenesis, the depositional environment will ultimately determine the fossil apatite structure. A representative sampling of bioapatite from the marine deposits of the late Campanian and Maastrichtian of the Pierre Shale in central South Dakota was used for this research. Samples of fossil vertebrate material were collected with tight stratigraphic control. The precise stratigraphic measurements paired with the geochemical signatures and UCD of the bioapatite from the analyzed material identified geochemical units or packages within the study area. Results of our geochemical analysis of the bioapatite samples show that the composition directly controls the variations seen in the UCD. For example, an enrichment of Light-Rare Earth Elements (REE) has a greater effect on the stretching of the a-axis as compared to Middle or Heavy REE enriched samples. Fossil bioapatite samples that have relatively high concentrations of Sr or Mn, show the greatest variations of the UCD. Geochemical signatures and UCD of fossils vertebrates are consistent within individual lithologic units but are significantly different between these units. These variations in fossil bioapatite are unique for a particular lithostratigraphic subdivision and can be used to discriminate between the units or packages. The variations in the composition and the UCD also reflect what was available for substitution into the bioapatite and identify changes in the paleoenvironment.

Poster Session III (Friday)

#### PALEODIET RECONSTRUCTION USING STARCH GRANULES FROM MARINE ANGIOSPERMS

PEEK, Stephanie, University of Wyoming, Laramie, WY, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA

Starch granules are a ubiquitous component of plants that can be used in tandem with phytoliths, pollen, and macrofossils to reconstruct past floral diversity. Application of this tool to paleobotanical studies in aquatic environments has been lacking. Seagrasses are rarely preserved as macrofossils and lack phytoliths, thus the study of starch granules can greatly improve their identification in the fossil record. Unaltered starch granules have been found in sediments approximately 180 kyrs old and the odds of preservation are greatly improved when granules are protected in cracks in archaeological materials or in scratches or pits in the occlusal surface of fossilized tooth enamel. Examination of the starch granules recovered from fossilized teeth could be used to infer the paleodietary preferences of extinct species, specifically large aquatic herbivores (e.g., sirenians). To evaluate the efficacy of this method, we examined the starch granules from living species of seagrasses and assessed whether the starch granules were sufficiently distinct for species identification. The seagrasses of the Caribbean are dominated by three species, *Thalassia testudinum*, *Halodule wrightii* and *Ruppia maritima*. *T. testudinum* starch granules are relatively large (15-30 µm diameter), round to conical with centered, straight, extinction crosses, and have a hilum that is centered with a particle and radiating fissures. *H. wrightii* has smaller granules (5-20 µm) that are elliptical to subangular with wavy figure-eight extinction crosses. The starch granules of *R. maritima* are relatively small (2 to 15 µm), generally round with centered, straight extinction crosses, and have a center hilum without a particle or fissures. There are significantly different morphological features between seagrasses (i.e. shape, presence or absence of particle or fissures, extinction cross morphology) that allow for positive identification of starch granules from an unknown seagrass. Examination of starch granules extracted from aquatic herbivore teeth would facilitate the identification of the types of seagrasses the animal consumed, a technique that could be applicable within the fossil record.

Technical Session X, Friday 12:00

#### HISTOLOGY, TAXONOMY, AND SYSTEMATIC POSITION OF BASAL NEORNITHISCHIAN DINOSAURS FROM THE LOWER CRETACEOUS YIXIAN FORMATION, WESTERN LIAONING, CHINA

PEI, Rui, Peking University, Beijing, China; BOYD, Clint, North Carolina State University, Raleigh, NC, USA

Study of three new neornithischian dinosaur specimens from the Lower Cretaceous Yixian Formation provides important insights into the anatomy, ontogeny, histology, and taxonomic diversity of basal neornithischians from the Jehol Biota. Two almost complete specimens (specimens A and B) referred to *Jeholosaurus* allow nearly the entire skeletal anatomy of this taxon to be described for the first time. The taxonomic status of a third specimen (specimen C) was difficult to interpret, prompting phylogenetic and histological analyses of these specimens. The phylogenetic analysis, based on 238 characters coded for 40 terminals (taxa/specimens), placed specimen C as the sister taxon to all other *Jeholosaurus*; this clade of Jehol neornithischians is positioned between two clades of North American neornithischians represented by *Orodromeus* and *Thescelosaurus*, respectively. Histological thin sections from the shaft of tibia and/or humerus were examined for all three specimens. Each specimen displays parallel-fibered microstructure, simple vessel canals, and no lines of arrested growth. The absence of both secondary remodeling and an external fundamental system suggests that these were relatively young individuals. The orientation of the vessels indicates specimen A and B were beginning to slow their growth, while specimen C was still actively growing at death. However, specimen C displays morphological features (different presacral vertebrae count and a pronounced scapular spine) that are difficult to explain as ontogenetic or individual variants: these changes have not been recognized in ontogenetic

series of other neornithischians such as *Orodromeus* and *Dryosaurus*. Thus, despite being ontogenetically younger, specimen C likely represents a previously undescribed species. Differences in the dental and postcranial anatomy between this species and *Jeholosaurus* indicate these two species exploited different dietary and ecological niches. These results underscore the importance of utilizing both histological data and observations of ontogenetic variation in closely related taxa when doing taxonomic study of new specimens.

Poster Session III (Friday)

#### A POSTCRANIAL DESCRIPTION OF THE BASAL EUPELYCOSAUR *AEROSAURUS WELLESI*

PELLETIER, Valerie, California State University, San Bernardino, San Bernardino, CA, USA; SUMIDA, Stuart, California State University, San Bernardino, San Bernardino, CA, USA

*Aerosaurus wellsi* is a basal eupelycosaur in the family Varanopseidae from the Lower Permian Abo/Cutler Formation of New Mexico. The skull has been described in detail, and although the postcranial skeleton has been addressed by some authors, little of it has been described in detail and even less of it illustrated. Careful examination of the postcranial skeleton of *Aerosaurus* shows features that differentiate it from the closely related varanopseid, *Varanops brevirostris* as well as other eupelycosaurs. The relative sizes and shapes of the vertebrae and ribs of the two eupelycosaurs are very similar, however the limbs bear some notable differences. The deltopectoral crest of the humerus is much more pronounced on that of *Aerosaurus*. Posteriorly, the tubercle for the latissimus dorsi is also more prominent. The distal dorsal surface appears squared off compared to *Varanops* most notably in the area of the longitudinal ridge for attachment of the flexor muscles. The ectepicondyle is smaller and less pronounced. Unlike *Varanops*, the humerus is only slightly shorter than the femur. The femur of *Aerosaurus* is more concave posteriorly because of the more posterior position of the surface of articulation with the acetabulum. The internal trochanter is also larger than that of *Varanops*. Of the more distal limb elements, the ulna is similar to that of *Varanops* though the olecranon process is relatively more prominent. The radius of *Aerosaurus* is slightly more robust. The tibia is less robust and slightly longer than the fibula. The latter being more slender than that of *Varanops*. One pes is well preserved and not significantly different from that of other eupelycosaurs.

Technical Session XVII, Saturday 8:15

#### DIETARY DIVERSITY AMONG PALEOCENE AND EOCENE NORTH AMERICAN CONDYLARTHRA (MAMMALIA: EUTHERIA)

PENKROT, Tonya, Marshall University, Huntington, WV, USA

The Condylarthra was one of the most abundant and diverse groups of Paleocene-Eocene mammals in North America, yet their paleobiology remains incompletely known. As archaic ungulates, condylarths have been presumed to be primarily herbivorous, but this hypothesis has only been tested on a limited number of taxa. Causes of the decline and disappearance of North American condylarths have also not been rigorously investigated, especially regarding the global warming event at the Paleocene-Eocene boundary (PETM). A combination of three-dimensional (from laser scanning) and linear dental morphometrics was used to test: 1) if Torrejonian through Wasatchian condylarths (Arctocyonidae, Hyopsodontidae, Mioclaenidae, Phenacodontidae) were primarily herbivorous or omnivorous; and, 2) if changes occurred in the diets of these families through the Paleocene and Eocene, correlating with regional or global environmental changes. The results indicate that arctocyonids and mioclaenids included the most omnivorous condylarths in this study; most hyopsodontids were likely frugivores or folivore-frugivores; and phenacodontids were the most nearly specialized for folivory. No simple pattern of changing dietary diversity is discernible through the Paleocene-Eocene of North America across the families included in this study, but the most pronounced changes in dietary diversity occurred at the Torrejonian-Tiffanian and Clarkforkian-Wasatchian (Paleocene-Eocene) boundaries. Dietary shifts in some condylarthran families corresponded to environmental disruptions (i.e., the PETM); these shifts suggest a gradual decline in condylarth ecological diversity leading up to their complete disappearance later in the Eocene. Apparent dietary changes within genera were rare, but a shift within *Thryptacodon* towards increased omnivory occurred between the Tiffanian and Wasatchian NALMAs.

Poster Session III (Friday)

#### LATEST CRETACEOUS IBERIAN HADROSAUROIDS (DINOSAURIA)

PEREDA-SUBERBIOLA, Xabier, Universidad del País Vasco/EHU, Facultad de Ciencia y Tecnología, Dpto. Estratigrafía y Paleontología, Bilbao, Spain; CANUDO, José Ignacio, Universidad de Zaragoza, Ciencias de la Tierra, Paleontología, Grupo Aragosaurus, Zaragoza, Spain; COMPANY, Julio, Universidad Politécnica de Valencia, Valencia, Spain; CRUZADO-CABALLERO, Penélope, Universidad de Zaragoza, Ciencias de la Tierra, Paleontología, Grupo Aragosaurus, Zaragoza, Spain; RUIZ-OMENACA, José Ignacio, Museo del Jurásico de Asturias (MUJA), Colunga, Spain

A review of the hadrosaurid record from the Latest Cretaceous of Spain indicates a greater diversity than previously thought, with at least three Late Maastrichtian taxa. These include a member of the Lambeosaurinae clade from the Blasi sites in Arén (Huesca), a basal hadrosaurid from La Solana site in Tous (Valencia), and a possible non-hadrosaurid



member of Hadrosauroida from Fontllonga (Lleida). The only genera and species described to date in the Latest Cretaceous of the Iberian Peninsula are *Pararhabdodon isonenensis* and *Koutalisaurus kohlerorum*, both from the Early Maastrichtian to early Late Maastrichtian of the Tremp-Isona area (Lleida). The membership of *Pararhabdodon* in Lambeosaurinae has been questioned, but its relationships within Hadrosauridae are not yet fully resolved. The phylogenetic position of *Koutalisaurus* (a possible junior synonym of *Pararhabdodon*) is uncertain. The hadrosauroid assemblage from the Late Maastrichtian of the Iberian Peninsula is very different from those known in North America and Asia, which are dominated by euhadrosaurians: lambeosaurines in eastern Asia and hadrosaurines in western North America. By contrast, the Iberian faunas (and those of Europe as a whole) consist of both derived and basal forms, which could be the result of the complex European palaeobiogeography. In this context, the primitive character of some European hadrosauroids (e.g., the Fontllonga taxon; *Telmatosaurus transylvanicus* from the Early Maastrichtian to the early Late Maastrichtian of Romania) could be explained in terms of geographical isolation during the Late Cretaceous, whereas the occurrence of derived euhadrosaurians (such as lambeosaurines) could be consequence of a late dispersion from Asia or North America.

Poster Session III (Friday)

#### FIRST CRANIAL MATERIAL OF A JUVENILE MONKEY FROM THE TERTIARY OF SOUTH AMERICA: CRANIAL ANATOMY AND DENTAL ERUPTION SEQUENCE

PERRY, Jonathan, Stony Brook University, Stony Brook, NY, USA; KAY, Richard, Duke University, Durham, NC, USA; VIZCAÍNO, Sergio, Museo de La Plata, La Plata, Argentina; BARGO, M., Museo de La Plata, La Plata, Argentina

We report on a partial cranium of a juvenile monkey from the Santa Cruz Formation at Puesto Estancia La Costa (=Corriegen Aike), Southern Patagonia coast of Argentina. The material is of early Miocene age (~16.5 Ma). This locality has yielded most of the specimens attributed to *Homunculus patagonicus*, including the neotype. This new specimen likely belongs in *H. patagonicus*; if so, it is the ontogenetically youngest specimen known for its species. The orbits are intact, but most of the cranium posterior to the orbits is lost. The palate and parts of the upper face are well-preserved. There is a complete post-orbital septum. The optic canal diameter is relatively great, similar to that of an adult individual of *Killikaika blakei*, also from the Santacrucian. Orbit size suggests diurnality; optic canal size confirms that this species had high visual acuity. Computed tomographic scans of the cranium and observations of the degree of wear on the erupted teeth reveal some details of the dental eruption sequence. The M1 and M2 are erupted and unworn with three open roots each, the incisors are lost but were likely fully erupted, the deciduous premolars are in occlusion and heavily worn, the canine is in the cap stage, the M3 is also in the cap stage and lacks a root. Platyrrhines vary considerably in dental eruption sequence (P2, P4, P3). The new *Homunculus* specimen has an unusual premolar eruption sequence (P2, P4, P3). The dental eruption sequence in *Homunculus* is similar to that of the Oligocene paratithecoid *Apidium phiomense* from the Fayum Basin of Egypt, although in the latter, M3 erupts before P4. Unlike the extant owl monkey (*Aotus*), the earliest known platyrrhine (*Branisella boliviana* from the late Oligocene of Bolivia), and *Apidium*, but like most extant platyrrhines, *Homunculus* clearly had a late-erupting M3. An early-erupting M3 may be primitive for platyrrhines. If so, a late-erupting M3 would characterize the clade *Homunculus*+extant platyrrhines, and *Aotus* evolved an early-erupting M3 from a late-erupting ancestor. An alternative hypothesis is that *Homunculus* and most extant platyrrhines acquired a late-erupting M3 independently.

Poster Session II (Thursday)

#### BIRD SKULL FROM THE GREEN RIVER FORMATION (MIDDLE EOCENE) OF GARFIELD COUNTY, COLORADO

PERRY, Michael, Museum of Western Colorado, Grand Junction, CO, USA; FOSTER, John, Museum of Western Colorado, Grand Junction, CO, USA

The skull of a bird, found by Jim Kirkland near the "Radar Dome" locality (Grande's U-2) in the Bridgerian Parachute Creek Member of the Green River Formation (Lake Uinta), appears to be different from other Green River bird skulls and may represent a new genus. The skull (MWC 5943) is 67.1mm in total length; the bill length is 36.1mm; the cranium length is 29.8mm; and the height of the skull is 25.0mm. Preservation is poor so few individual bones of the skull can be distinguished, but the shapes of the bill, cranium, lower jaw, and orbit are clear. The skull is the same size and overall shape as the modern sage-grouse *Centrocercus urophasianus*. In particular, the long, tapered bill without premaxillary overhang differs from other modern and fossil galliforms. Also, there is essentially no dorsal indentation at the bill/cranium juncture, unlike what is seen in the Green River galliform *Gallinuloides* and most modern Galliformes. *Gallinuloides* also has a relatively shorter and less gradually tapered bill with a more down-curved premaxilla than the new skull. The bill of MWC 5943 is relatively longer, more gradually tapered, and the premaxilla less curved, than in the Green River bird *Foro*. The bill is not as elongate as in modern Corvidae.

Poster Session I (Wednesday)

#### RESOURCE PARTITIONING AMONG LATE PLEISTOCENE UNGULATES IN THE BLACK PRAIRIE OF MISSISSIPPI AND ALABAMA

PHILLIPS, George, Mississippi Museum of Natural Science, Jackson, MS, USA; FERANEC, Robert, New York State Museum, Albany, NY, USA

Carbon and oxygen isotope analysis of tooth enamel has become valuable for examining resource use among fauna in ancient ecosystems. One ecosystem of the southeastern United States of recent interest is the Black Prairie district of Mississippi and Alabama. The Black Prairie is a distinctive geological and ecological region within the inner Gulf Coastal Plain possessing an agricultural history intimately tied to the "Old South." The indigenous botanical composition of the Black Prairie is mixed forest and woodland intermittently broken by small insular prairies. In this study we aim to understand resource use among herbivores present in the Black Prairie during the Late Pleistocene. Specifically, we will test the hypothesis that hypsodont taxa were strict grazers of C<sub>4</sub> grasses, while brachydont taxa concentrated feeding only on C<sub>3</sub> browse. To test this hypothesis we serially sampled individuals of seven species for stable carbon and oxygen isotope values. Species included: *Bison antiquus*, *Equus* sp., *Mammuthus jeffersonii*, *Mylohyus fossilis*, *Mammuthus americanus*, *Odocoileus virginianus*, and *Tapirus veroensis*. The oxygen isotope results from the 135 serial samples show sinusoidal curves suggestive of ingesting water from one to three years. The carbon isotope results reveal resource partitioning among the sampled taxa. Further, the herbivore diets appear consistent during enamel formation. The data generally support the hypothesis. The hypsodont taxa, *Bison* and *Mammuthus*, had isotope values typical of feeding entirely on C<sub>4</sub> grasses, while the brachydont taxa had diets typical of feeding entirely on C<sub>3</sub> browse. One interesting result is from *Equus*, a hypsodont, grazing taxon, which possesses a signature typical of a C<sub>3</sub> feeder. While not consistent with the hypothesis, horses have previously been shown to be more generalized feeders, including grasses, forbs, and browse in their diets. Natural swards in the modern Black Prairie contain a large proportion of C<sub>3</sub> forbs, which would lighten carbon isotopic signatures of non-selective grazers. These results highlight our ability to understand the ecology of ancient mammals of the Mississippi-Alabama Black Prairie.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

#### VARANUS GIGANTEUS SKULL MECHANICAL BEHAVIOR REVEALS A CLOSE RESEMBLANCE TO CERATOSAURID DINOSAURS

PINO-OLIVARES, Andrea, Computational Biomechanics Research Group, University of New South Wales, Sydney, Chile

*Varanus giganteus* (perentie) and *V. komodoensis* (Komodo dragon) are among the largest living lizards in the world. Although varanids are considered to be morphologically conservative, *V. giganteus* reveals a considerably taller and narrower cranium than *V. komodoensis* and its feeding behavior is based on inertial feeding rather than the characteristic hold- and pull- defleshing technique of Komodo dragons. Consequently, mechanical differences should exist between them. Understanding these differences could be of considerable use in the identification of feeding behaviors among extinct reptiles, particularly with respect to carnivorous dinosaurs. Here, using high resolution 3D Finite Element Analysis (FEA) we examine the mechanical behavior of a *V. giganteus* skull under a wide range of gape angles (0 to 45 degrees) using modeling and loading protocols previously applied to *V. komodoensis*. Our results show that in the perentie, maximal distal and mesial bite forces are much weaker than the Komodo dragon. The perentie skull develops high stress in the fronto-parietal region shifting the stress distribution from frontal to parietal toward a larger gape angle. This stress distribution could not be observed in the Komodo model, but has been described in earlier 2D FEA for *Allosaurus* and *Coelophysis*. Our findings suggest that, contrary to previous assumptions, the cranial mechanics and perhaps the feeding techniques of these dinosaurs are more similar to those of *V. giganteus* than *V. komodoensis*.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 8:00

#### MODELING EARLY HOMINID BEHAVIORAL EVOLUTION

PLAVCAN, J., University of Arkansas, Fayetteville, AR, USA; LOCKWOOD, Charles, University College, London, United Kingdom

Sexual dimorphism is arguably the only direct morphological correlate of social behavior preserved in the fossil record. While many accept that early hominids were strongly dimorphic, others disagree, and dimorphism has been used to support a variety of sometimes conflicting behavioral inferences. But dimorphism is a function of changes in both male and female traits. Here, we review how phylogenetic analysis of changes in size in extant and extinct species provides evidence for changes in behavior in the fossil record, based on an extant primate model that focuses on a combination of correlates of dimorphism in extant species, and basic principles of socio-ecological behavior that should impact changes in male and female size. We evaluate craniodental and postcranial evidence for dimorphism and size changes in early hominids, and evaluate several alternative models that can be tested in the fossil record. Given the pattern of modern human life-history and behavioral traits, we suggest that a gorilla-like model might serve as a more appropriate analogue to hominid mating systems. If so, early hominids would have retained a skewed operational sex ratio and strong male competition. Later changes in female size that some suggest produced a loss of dimorphism would in fact indicate changes in grouping patterns that altered female

monopolization potential. However, we stress the likely uniqueness of early hominid social behavior, and underscore that interpretations of the fossil record are better based on first principles of the primate socio-ecological model, rather than simple analogies to humans, chimpanzees, and gorillas.

Technical Session XVI, Saturday 8:00

**BRAINCASE EVOLUTION IN PLIOPLATECARPINE MOSASAURS**  
POLCYN, Michael, Southern Methodist University, Dallas, TX, USA

A 27 million year evolutionary sequence of mosasaurs including *Tethysaurus*, *Russellosaurus*, *Selmasaurus*, *Ectenosaurus*, *Platecarpus*, and *Plioplatecarpus* is compared with successively more plesiomorphic forms, *Halisaurus* and *Varanus*. CT scanning was employed to study internal structures. A progressive increase in the contribution of the basilar artery to cranial circulation culminates in the basilar artery providing the majority of the blood supply in some derived forms and suggests adaptation for extended submergence, deep diving, or both. Variation in contemporaneous species may reflect differential diving ability or habitat segregation. Loss of kinesis and increasingly robust support of the parietal by the braincase facilitates increased bite force and allows access to larger prey items through their evolutionary history. Early forms such as *Tethysaurus* and *Russellosaurus* retain the plesiomorphic varanoid condition of the alar process of the prootic being ligamentously bound to the parietal, allowing mobility of the braincase below the parietal. *Platecarpus* and *Plioplatecarpus* have a reduced and extremely robust alar process, abutting a reinforced parietal and forming a largely immobile structure. *Ectenosaurus* and *Selmasaurus* possess the intermediate condition, but also have a uniquely derived and immobile contact of the supraoccipital and the parietal. The supratemporal plays a significant role in intracranial immobilization in mosasaurs. A varanoid-like, vertically oriented, supratemporal contact with the parietal is retained in *Halisaurus*. *Tethysaurus* possesses an oblique contact, and *Russellosaurus*, a derived horizontally oriented contact. Increasing complexity and overlap in the sutural contact with the parietal increase immobilization in *Ectenosaurus*, *Selmasaurus*, *Platecarpus* and *Plioplatecarpus*. The semicircular canals in derived mosasaurs are markedly reduced in size and radii compared with extant terrestrial varanoids. Reduction in the size and radii of the semicircular canals in cetaceans has been interpreted as a means of reducing sensitivity to rapid rotational motion of the body during agile swimming. A similar pattern is shared by mosasaurs.

Technical Session V, Wednesday 4:00

**LOCOMOTION AND CLIMATE: COMMUNITY-LEVEL STRUCTURE OF DIGITIGRADY IN NORTH AMERICAN MAMMALIAN CARNIVORES**  
POLLY, P. David, Indiana University, Bloomington, IN, USA

Locomotor specializations are closely related to the environment in which a species lives. Cursorial specializations should logically be associated with open environments, arboreal specializations with forested environments, and natatorial specializations with riparian environments. The average locomotor specialization of entire communities (and ecological guilds within those communities) should thus be influenced by the geographic distribution of environments on a continental scale. This hypothesis was tested by looking at the correlation between mean digitigrady of species of Carnivora (Eutheria, Mammalia) and environmental factors across the whole of North America. Digitigrady was measured from the calcaneum as a ratio of the length of the calcaneum over the distance between the anterior margin of the sustentacular facet and the posterior end of the calcaneum. This index is significantly related to a three-level categorization of digitigrady, which is one of the main indicators of locomotor specialization ( $P < 0.001$ ,  $N=128$ ). The digitigrady index was then measured in 38 of the 48 North American species (the 10 missing species were concentrated in Central America). The continent was divided into 9,699 fifty-kilometer grid cells and mean digitigrady was calculated across all the species in each cell. The association between mean digitigrady and several environmental factors was then tested. Digitigrady was highly correlated with Bailey's ecological provinces, categorizations based on annual rainfall and temperature distributions ( $R = 0.84$ ), with mean annual temperature ( $R = 0.77$ ), and vegetation cover ( $R = 0.72$ ). Digitigrady had little association with number of carnivorous species present in a fauna ( $R = 0.31$ ), with altitude ( $R = 0.25$ ) or with mean annual precipitation ( $R = 0.22$ ). The strong association between mean digitigrady and ecological province, temperature, and vegetation cover suggests that digitigrady can be used as a taxon-free morphological indicator of these three environmental factors.

Poster Session III (Friday)

**PALEOASYS: AN APPLICATION FOR HIGH-RESOLUTION TRACKING, REPORTING, AND ANALYZING PALEONTOLOGICAL RESEARCH ACTIVITIES WITHIN THE HELL CREEK STUDY SYSTEM**

POLTENOVA, Michael, Denver Museum of Nature & Science, Denver, CO, USA;  
WILSON, Gregory, University of Washington, Seattle, WA, USA; CARTER, Grace, Denver Museum of Nature & Science, Denver, CO, USA

An increasing wealth of published and unpublished paleontological data are being compiled in databases. The paleontological data contained are often restricted based on taxon, time period, project, or geography and seldom contain details of research and collection activities, previous taxonomic assessments, or multimedia, such as videos, animations, and images.

Paleontological database websites are typically managed by one person and lack user-friendly interfaces and features of community driven websites. These databases may be either non-database managed systems (non-DBMS) or database-managed systems (DBMS). DBMS more efficiently handles the access, creation, and modification of data. PaleOasys is a new community driven website application for paleontological research activities with a relational DBMS back-end. It integrates collection activities, lab work, curatorial tasks, locality details, geologic data, specimen information, GIS operations, research analyses, and multimedia into a single one-touch platform. The application design is ideal for high-resolution tracking, reporting, and analyzing of paleontological research activities. Our research group is using PaleOasys to address questions regarding biotic changes near the Cretaceous-Paleogene boundary in northeastern Montana. The system may capture data during each phase of research into one or more of 128 related tables. The user interface uses a community driven architecture that allows many people to interact easily with each other and the system. Statistics, reports, and charts may be generated for numerous permutations or subsets of the data and may be easily and quickly modified. In sum, PaleOasys uniquely combines the ability to track research and collection activities through a variety of multimedia, run quantitative analyses on subsets of the data, and generate easily modifiable reports with the user-friendly community features. As such, it is ideal for use in broad, collections- and field-based research collaborations, such as ours based within the Hell Creek study system.

Poster Session II (Thursday)

**A NEW SPECIES OF PACHYARMATHERIUM (XENARTHRA: CINGULATA) FROM THE LATE PLEISTOCENE OF NORTHEASTERN BRAZIL AND ITS PHYLOGENETIC AFFINITIES**

PORPINO, Kleberston, Universidade do Estado do Rio Grande do Norte, Mossoró, Brazil;  
FERNICOLA, Juan, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina;  
BERGQVIST, Lilian, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

*Pachyarmatherium* is an enigmatic cingulate genus formerly recognized as a Dasypodoidea, but tentatively assigned to the poorly known subfamily Glyptatelinae (Glyptodontidae) by later authors. *Pachyarmatherium* remains are only known from the late Pliocene-late Pleistocene of United States and Costa Rica so far. Here we describe a new species belonging to this genus from the Late Pleistocene of northeastern Brazil. The specimens studied comprise several isolated osteoderms, carapace fragments and miscellaneous postcranial material. The new species differs from the North American *Pachyarmatherium leiseyi* in being larger and in having osteoderms with pentagonal, hexagonal and heptagonal shape (instead of only pentagonal and hexagonal), main figures with oblong and subrounded outline, in contrast to the typical polygonal pattern observed in *P. leiseyi*, and a larger number of peripheral figures. The several well-preserved postcranial elements assigned to this new taxon allowed testing the affinities of *Pachyarmatherium* within cingulates. Therefore, we conducted a cladistic analysis of 48 morphological postcranial characters scored for eleven cingulates (*Pachyarmatherium*, four dasypodids, one pampatherid and five glyptodontids) and two pilosans used as outgroup taxa. In the most parsimonious topology obtained, *Pachyarmatherium* is the sister-group to a clade including Pampatheriidae and Glyptodontidae. This result contradicts the previous tentative allocation of *Pachyarmatherium* within Glyptodontidae, and indicates that the glyptodont-like characters of the carapace and osteoderms of *Pachyarmatherium* (thick osteoderms and lack of movable bands) are homoplasies shared with glyptodonts. Finally, we note that the morphological evidence from the external ornamentation of osteoderms does not offer support for the placement of *Pachyarmatherium* within Glyptatelinae.

Technical Session X, Friday 11:45

**ACCURACY IN FINITE ELEMENT MODELING OF EXTINCT TAXA: SENSITIVITY ANALYSES IN HETERODONTOSAURUS TUCKI**

PORRO, Laura, University of Cambridge, Cambridge, United Kingdom

Finite element analysis (FEA) is an engineering technique that predicts the mechanical response of a structure under specified loads. Over the past decade, FEA has become the tool of choice for quantitative assessment of deformation, strain, and stress in biological structures during function. Because skulls are complex structures and experience strong selective pressure, the majority of finite element (FE) studies have focused on the cranium across a wide taxonomic range including mammals, crocodylians, dinosaurs, and birds. Advances in imaging specimens and FE software have made it possible to rapidly generate detailed models. However, realistic results demand realistic material properties, forces, and constraints. When modeling extinct taxa, these input parameters are estimates, leading some to question the accuracy of FEA results. Sensitivity analyses were carried out on a FE model of the skull of *Heterodontosaurus tucki* (an early ornithischian dinosaur) to determine the degree to which variables including material properties, muscle force and direction, bite force and direction, and constraints influenced model behavior. Model deformation, principal stress orientation, and stress/strain distributions were unaffected by changes in material properties, muscle and bite force magnitude, although these variables did change peak stress/strain values. In contrast, variations in the direction of muscle and bite forces and model constraints had a larger impact on model behavior. While sensitivity analyses do not prove absolute accuracy, they identify which variables significantly affect model behavior, allow the placement of error bars on FEA results, and increase confidence in model predictions.

Poster Session II (Thursday)

**THE METHODS AND DATA COLLECTION IN FOSSIL BONE PREPARATION PROCESS: TURNING SCRAP MATERIAL INTO PREMIUM SCIENTIFIC, EDUCATIONAL, AND EXHIBIT RESOURCES**

POTAPOVA, Olga, The Mammoth Site of Hot Springs, Inc., Hot Springs, SD, USA

The proposed strategy of data collection of the fossils going through the preparation process is suggested based on the performed preparation of the Woolly mammoth molars collected along with other bones in the Long Hollow Creek two miles northwest of Sisseton, Roberts County, SD. The very few fossil bones and fragments were remnants of the second complete mammoth skeleton found east of Missouri River in SD, most of which were in too poor of condition to save and preserve. These bones have been owned and stored by the Heritage Museum of the Coteau des Prairies and Sisseton School District 54-2, Sisseton, SD since their discovery in early 1940's. It is planned for the restored materials to be exhibited in the Museum; also displayed will be the "behind the scenes" preparation records, conservation methods used, and photo-documentation. The Mammoth Site was contacted by both organizations regarding the restoration and the specimen exhibits. During the restoration and conservation of the fossils the following procedures were developed to capture the data and preserve the scientific integrity of the specimens; photo documentation of every major step in reconstruction, daily records of the preparation activities and material use in record forms, and image-mapping of the reconstructed areas of each prepared specimens. Based on completed reconstructions, identification of teeth generation, analyses of the wear patterns, approximate individual age of the mammoth, recommendations on long-term storage or exhibit, and specimen samplings for AMS and other analyses were provided. The paper materials, supplemented by images, will provide the in-depth conservation methods and data collection of the prepared material.

Technical Session IX, Thursday 3:45

**LANDSCAPE TAPHONOMY OF BIRD BONE AND ITS UTILITY AS A PALEOENVIRONMENTAL INDICATOR**

PRASSACK, Kari, Center for Human Evolutionary Studies at Rutgers University, New Brunswick, NJ, USA; BLUMENSCHINE, Robert, Center for Human Evolutionary Studies at Rutgers University, New Brunswick, NJ, USA

This study uses neo-taphonomic observations of bird bone survivorship in the field and under controlled conditions to test the utility of fossil birds for reconstructing paleolandscapes. It addresses 1) the depositional environments in which bird bone is most likely to be deposited, buried and fossilized, 2) whether avifaunal death assemblages reflect living communities in terms of species richness and diversity and 3) explores how landscape-specific taphonomic profiles may provide data for reconstructing the paleolandscape. Field data collection consisted of bone surveys in a range of northern Tanzanian lake basin systems. Experimental neo-taphonomic observations included feeding bird carcasses to carnivores, exposing bird bone to sub-aerial weathering processes, and submersion of bird bone in soils and water from many of the surveyed landscape facets. Results thus far suggest that bird bone is not uniformly distributed across the landscape, that the major taphonomic agent affecting bird bone survivorship is carnivore feeding activity, and that the depositional habitat may affect the taphonomic history of bird bone assemblages in expected and identifiable ways.

Romer Prize Session, Thursday 10:30

**PHYLOGENY AND HISTORICAL BIOGEOGRAPHY OF HADROSAURID DINOSAURS**

PRIETO-MARQUEZ, ALBERT, FLORIDA STATE UNIVERSITY, TALLAHASSEE, FL, USA

Hadrosaurids were the most diverse and abundant Late Cretaceous dinosaurs. However, their phylogenetic relationships are still contentious since previous analyses have been non-global and have generally utilized the same character data. I conducted the most comprehensive phylogenetic and biogeographic analysis of Hadrosauridae using extensive taxonomic sampling at the specific level and first hand examination of material from nearly every known species. Primary homology was assessed using traditional methods and morphometrics (analysis of planar curves using geodesic paths—a landmark-free method that models the continuous non-linear geometry of bone shapes). 299 characters were deemed informative including many new cranial and postcranial traits. Parsimony and Bayesian analyses (Mk model with equal and variable rates of change) were implemented. Ancestral areas were reconstructed using Fitch parsimony and dispersal-vicariance biogeography. The parsimony analysis resulted in 41 MPITs of 971 steps each (C.I. = 0.44, R.I. = 0.76, 37% missing data). Bootstrap proportions, decay indices and Bayesian posterior probabilities were greater for the most inclusive clades outside Hadrosauridae and the most exclusive hadrosaurid clades. Hadrosauridae was redefined as the clade stemming from the most recent common ancestor of *Hadrosaurus* and *Parasaurolophus*. Species from Eastern North America were the closest outgroups to hadrosaurids. Hadrosaurines comprised "saurolophs" and the "kritosaur-maiasaur" clade. Lambeosaurines comprised "parasaurolophs" and "amurosaurs" (= "hypacrosaur" + "corythosaurs"). The genesis of Hadrosauridae occurred in the late Santonian of Eastern North America with subsequent dispersal to Asia, the ancestral area for the major Hadrosaurinae-Lambeosaurinae (euhadrosaurian) divergence. Hadrosaurines and lambeosaurines dispersed to North America and experienced major cladogenesis. "Maiasaur" and "saurolophs" returned to Asia, while "kritosaur" colonized South America. "Tsintaosaurs" dispersed to Europe, while members of "hypacrosaur", "parasaurolophs" and "corythosaurs" invaded Asia.

Technical Session XVII, Saturday 11:15

**THE EARLY EVOLUTION OF NORTH AMERICAN PECCARIES (TAYASSUIDAE) PROTHERO, Donald, Occidental College, Los Angeles, CA, USA**

The systematics of the earliest North American peccaries has long been confused, and no comprehensive taxonomic monograph has ever been published. However, large collections with many excellent undescribed specimens (especially in the Frick Collection) are now available to address many of the issues. Contrary to previous literature, the White River (mostly Whitneyan) taxon *Perchoerus probus* is distinct in many ways from the John Day Arikarean taxon, *Thinohyus lentus*. Although both have almost identical cheek tooth dimensions and morphology, the skulls are very different. Both male and female *Thinohyus* specimens show much greater robustness and overall larger size, with a more elongate muzzle and a diastema between the canine and first premolar. Unfortunately, the type specimen of *Thinohyus lentus* is based on a badly broken juvenile skull, so many of the alleged diagnostic differences between *Thinohyus* and *Perchoerus* are not valid when adult specimens are considered. Only one White River taxon, *Perchoerus probus*, is valid, with many junior synonyms. The sole exception to this rule is the tiny taxon *Perchoerus nanus* (senior synonym of *P. minor*), which is now known from a complete skull from the Chadronian, and many other partial specimens. Likewise, there have been many different names applied to the John Day specimens of *Thinohyus*, but most seem to be junior synonyms of *T. lentus* exhibiting a continuous distribution of robustness that may be attributable to sexual dimorphism.

Romer Prize Session, Thursday 9:15

**CARCASSES ON THE COAST AND A BONEBED IN THE VALLEY: INTEGRATING TAPHONOMY AND ECOLOGY TO MEASURE CETACEAN DIVERSITY IN THE FOSSIL RECORD**

PYENSON, Nicholas, University of California Museum of Paleontology, Berkeley, CA, USA

To understand how well fossil assemblages represent original communities, paleoecologists seek comparisons between modern death and living assemblages. For large marine vertebrates like cetaceans, measuring their diversity in ocean ecosystems is difficult and expensive. Cetacean strandings, if viewed as death assemblages, provide an alternative means for measuring cetacean diversity. Using sample-based rarefaction methods, I generated collector's curves for strandings along the US Pacific Coast and compared this death assemblage with live surveys of adjacent waters. At large spatiotemporal scales (>10 years, >1000 km of coastline), the stranding record recovers similar rank order abundances as live surveys, but the former are richer than the latter, with live-dead ratios between 1.1-1.3, especially at higher taxonomic levels. The high fidelity of these live-dead comparisons provides a baseline for measuring diversity in fossil assemblages, like the Middle Miocene Sharktooth Hill (STH) bonebed. The STH bonebed is distributed over 30 km<sup>2</sup>, and it preserves a diverse, time-averaged marine vertebrate assemblage that accumulated over 1ky-100ky. Although strandings and bonebeds are not homologous phenomena, they measure cetacean diversity in analogous ways because they sample diversity at similar spatiotemporal scales. In this view, the STH bonebed provides an adequate sample of Middle Miocene cetacean diversity. STH cetacean generic richness (>20 genera) is comparable to modern richness, although STH cetaceans are mostly unrelated to those currently in the eastern North Pacific Ocean. In terms of relative abundance, delphinoids dominate both modern and fossil assemblages, although physeteroids were more abundant in the past than today. Cranial proxies of body size show that extinct odontocetes occupied the same size categories as today; by contrast, the majority of extinct mysticetes were smaller than living mysticetes and occupied a much smaller size range. These region-specific comparisons indicate that many components of cetacean community structure (generic richness, relative abundance and certain size classes) were already established by 16 Ma.

Poster Session I (Wednesday)

**EARLY LATE PALEOCENE CARNIVORANS FROM THE ROCHE PERCÉE LOCAL FAUNA, SOUTHEASTERN SASKATCHEWAN, CANADA**

RANKIN, Brian, University of Alberta, Edmonton, AB, Canada; FOX, Richard, University of Alberta, Edmonton, AB, Canada

The occurrence of vertebrate fossils from the Ravenscrag Formation in the vicinity of Roche Percée, southeastern Saskatchewan, Canada, documents the presence of a large and diverse assemblage of early late Paleocene (late Tiffanian Land Mammal Age) mammals. Previous studies of the Roche Percée localities have described the multiuberculates, plesiadapiforms, a cyriacotheriid pantodont, and an erinaceid lipotyphlan; however, the vast majority of taxa from these localities remain undescribed. In this research, work centered on the identification and description of carnivoran dental and gnathic fossils from the Roche Percée local fauna. Discoveries, to date, include four previously unknown species of viverravid carnivorans. Significantly, three species most closely resemble *Raphictis*, a previously monotypic genus from the Fort Union Formation of northwestern Wyoming, and are referred here to that genus. Specimens from the Roche Percée localities preserve the first known elements of the upper dentition of *Raphictis* and suggest that the genus may have been highly specialized for slicing and piercing. In addition, a new species of *Didymictis*, most closely resembling *D. dellensis*, is described. This research provides an improved understanding of carnivoran diversity and evolution in the northern part of the Western Interior during the early late Paleocene.

Technical Session XIX, Saturday 1:45

**CRANIAL ANATOMY AND SYSTEMATIC POSITION OF THE MIDDLE JURASSIC THEROPOD DINOSAUR *PROCERATOSAURUS* FROM ENGLAND**  
RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; MILNER, Angela, The Natural History Museum, London, United Kingdom

The theropod dinosaur *Proceratosaurus bradleyi* from the Middle Jurassic (Bathonian) Forest Marble of Gloucestershire, England is based on a single, well-preserved skull, missing most of the dorsal skull roof. Originally described as a new species of *Megalosaurus*, the taxon was later thought to be closely related to *Ceratosaurus* or to *Ornitholestes*. Recent cladistic analyses have indicated that *Proceratosaurus* might be the oldest known coelurosaur, making it a potential key taxon for understanding the early evolution of this group. The cranial anatomy of *Proceratosaurus* is quite distinctive, and it can be diagnosed by a number of autapomorphies: anterior nasal process of the premaxilla inclined slightly anterodorsally and nasal horn core overhanging the premaxillary internarial bar anteriorly, internarial bar of the premaxilla bifurcating posteriorly into a posteriorly directed ramus and a dorsally directed ramus, anterior end of the maxillary antorbital fossa placed considerably anterior and ventral to the promaxillary foramen, and anteriormost dentary tooth curved anteriorly and with the carinae oriented labiolingually. Other important characters of the skull include the presence of a hollow median horn or crest on the nasals and a very elongate external nares that extends over more than 20% of the skull length. CT images of the skull revealed a relatively short and high braincase, with a highly pneumatic basisphenoid, including anterior tympanic recesses, pneumatic pockets associated with the entrance of the internal carotids, and basipterygoid recesses. The teeth of *Proceratosaurus* are noteworthy in that several premaxillary teeth show longitudinal striations, and distal denticles of the serrations are distinctly larger than mesial denticles. *Proceratosaurus* shows several characters that indicate that this taxon represents the oldest known tyrannosaurid, including a short premaxilla, a well-developed jugal recess, a steeply sloping basisphenoid, premaxillary teeth that are considerably smaller than the maxillary teeth, and D-shaped anteriormost premaxillary teeth.

Poster Session I (Wednesday)

**DEVELOPMENTAL CONSTRAINTS AND COMPARATIVE VARIABILITY OF DERMAL VS ENDOCHONDRAL BONES IN PLEISTOCENE MAMMALS**  
RAYMOND, Kristina, Occidental College, Los Angeles, CA, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA

Study of the embryology and ossification of modern bones predicts that fossil dermal bones (which ossify from connective tissue) will exhibit greater size variability than endochondral bones (which are formed from embryological cartilaginous precursors), because dermal bones are less tightly constrained by joints and articular surfaces. To evaluate this hypothesis, we measured multiple dimensions of over 900 dermal bones (patellae and other sesamoids) of the sabertoothed cat *Smilodon fatalis*, the Ice Age lion *Panthera atrox*, the bison *Bison antiquus*, the horse *Equus occidentalis*, the camel *Camelops hesternus*, the mylodont ground sloth *Paramylodon (=Glossotherium) harlani* and the nothrothere ground sloth *Nothrotheriops shastensis* from Rancho La Brea and from the late Pleistocene San Josecito Cave in Nuevo Leon, Mexico. These were compared to measurements of over 700 endochondral bones (such as the astragali) of comparable size. Through statistical analyses (coefficients of variation, ANOVA, and t-tests) we found slight but statistically significant evidence of higher variability in the dermal bones of these taxa. As predicted, dermal bones are not as tightly constrained by growth and by adjacent tissues as are endochondral bones. This evidence of relative variability is important in assessing how much variability is typical of a single species, and thus has taxonomic implications.

Poster Session II (Thursday)

**EVIDENCE OF HUMAN PREDATION ON JEFFERSON'S GROUND SLOTH (*MEGALONYX JEFFERSONII*) FROM EASTERN NORTH AMERICA**  
REDMOND, Brian, Cleveland Museum of Natural History, Cleveland, OH, USA; MCDONALD, H., National Park Service, Fort Collins, CO, USA

The nature and extent of early human (Paleoindian) predation on Late Pleistocene megamammals of North America has been vigorously debated. Until recently, direct evidence of such behavior has been restricted to mammoth, *Mammuthus* spp., and mastodon, *Mammuth americanum*, kill and butchering sites in the west and possible meat-caching localities in the east. While humans have been implicated in the extinction of ground sloths in both North and South America, evidence of butchering and human utilization of ground sloths has been limited to *Mylodon darwini* in South America. No previous finds of any of the North America genera of sloths have displayed evidence of human hunting or butchering. The recent identification of stone tool cut marks on bones of an individual of the extinct Jefferson's Ground sloth, *Megalonyx jeffersonii*, provides the first evidence for North America that members of this group may have been part of the Paleoindian diet and promises to widen the debate on the impact of humans on this part of the Pleistocene megafauna. The sloth remains, a left femur, right tibia, patella, and astragalus, two unguals, two thoracic and one lumbar vertebrae, and one rib, along with associated botanical and sediment samples were recovered from a bog in southwestern Huron County, Ohio, sometime prior to 1915. However, the precise locality remains unidentified. The complete left femur bears 52 stone tool cut marks on the anterior surface. A sample of XAD purified

bone collagen from the femur (UCIAMS-38250) returned an AMS 14C radiocarbon age of 11,740 ± 35; 700 years earlier than the current dates for the Clovis culture dated from 11,050 to 10,800 14C years. The cut-marked femur provides the first definitive evidence for human exploitation of *Megalonyx* in North America and supports the idea of humans being present in North America prior to the Clovis culture.

Technical Session IX, Thursday 1:30

**WHAT ARE APPROPRIATE EXTANT MODEL ORGANISMS FOR DINOSAUR DISEASE?**  
REGA, Elizabeth, Western University of Health Sciences, Pomona, CA, USA

The analysis of disease in extinct animals hinges in large part upon the selection of an appropriate animal model. The holotype of *Chasmosaurus irvinensis* (CMN 41357) is a largely mature individual manifesting multiple pathologies. Among these are an extensive florid osteoproliferative mass affecting cervical vertebrae C5-C9, with fusion of cervical ribs 6 and 7 and intervertebral disc space obliteration. The differential diagnosis includes many neoplastic conditions; chondrosarcoma possibly arising from multiple prior osteochondromas at this location is most likely cause. Osteochondromas are a hereditary developmental cartilage defect which is part of the dyschondroplasia spectrum extremely prevalent in many bird species. An additional complete specimen of *Chasmosaurus belli* (ROM 843) also displays multiple osteoproliferative lesions attributable to osteochondroma, suggesting that this condition may be prevalent in this clade and that an avian model of etiology is appropriate. However, other degenerative conditions in *C. irvinensis* are best understood with mammalian analogues. The question of what constitutes an appropriate animal model in paleopathology is best addressed by examining histological indicators of bone dynamics which best match the affected animal and skeletal region.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**A CUTTING ANALYSIS: TOOTH SERRATIONS IN THEROPOD DINOSAURS AND THEIR BIOMECHANICAL IMPLICATIONS**  
REICHEL, Miriam, University of Alberta, Edmonton, AB, Canada

Tooth serrations are common structures among theropod dinosaurs and have been widely studied for taxonomic purposes. These structures are also found in other taxa, such as crocodylians, squamates, sharks and even synapsids. Such a wide taxonomic distribution indicates the efficiency of these structures, but very little is known about their mechanics and genesis. In this study, I analyzed the mechanical implications of serrations in different taxa (Late Cretaceous theropods, *Mosasaurus hoffmanni* and the shark *Squalicorax falcatus*), by constructing finite element (FE) models of their teeth based on photographs. FE analyses tested the effects of different forces applied to each tooth. The composition of individual serrations was taken into consideration, because the percentage of enamel and dentine varies among different taxa and their differential densities play an important role in stress bearing. The distribution of stress levels generated by forces applied along the tooth indicated how serration morphology and composition is related to tooth function. In all specimens analyzed, the serrations showed very little stress when pressures close to their estimated bite forces were applied. In most specimens, the curved carina carried more stress, with the exception of *M. hoffmanni*, in which the opposite occurred. Ultimately, this study will aid more detailed paleoecological interpretations of feeding habits in theropod dinosaurs.

Fossils and the Evolutionary Patterns of Ostariophysans, One of the Largest Vertebrate Clades, Saturday 8:30

**OSTARIOPHYSAN OTOLITHS AND THEIR STRATIGRAPHIC AND SYSTEMATIC VALUE**

REICHENBACHER, Bettina, Department for Earth and Environmental Sciences, Palaeontology, Ludwig Maximilians-University, Munich, Germany; SCHULZ-MIRBACH, Tanja, Department of Earth and Environmental Sciences, Palaeontology, Ludwig Maximilians University, Munich, Germany; KLUG, Stefanie, Natural History Museum, Humboldt University, Berlin, Germany

Otoliths are aragonitic mineralizations in the membranous labyrinth of the teleost fishes. They are arranged in three pairs on each side of the skull and play an important role in the senses of hearing and balance. According to their position in the membranous labyrinth, they are named saccular, lagenar, and utricular otolith, or *sagitta*, *asteriscus*, and *lapillus*. In the Ostariophysa, the *sagitta* is tiny, whereas the *lapillus* and *asteriscus* are large (up to some millimeters in size). In contrast, the *sagitta* is the largest otolith in all other teleosts. As a result, otolith size relations can be considered as an additional synapomorphy supporting the Ostariophysa. Interestingly, the tiny size of the *sagitta* is also a conspicuous character in the Clupeomorpha and may serve as an additional synapomorphy supporting the Ostarioclupeomorpha or Otocephala. The fossil record of the Ostariophysa consists of skeletons, otoliths, and pharyngeal teeth. Among the ostariophysan otoliths, one of them (*lapillus*) appears abundantly in Oligocene and Neogene brackish and freshwater sediments, even if no skeletal remains can be found. Generally, the taxonomic determination of isolated fossil otoliths (i.e. without co-occurring skeletal remains) is based on comparative morphological studies with otoliths of Recent fishes. The morphology of the *sagitta* is species-specific in most teleosts, however, the *sagitta* is not preserved as a fossil in the Ostariophysa. Also, due to the scarcity of appropriate investigations, it is not certain whether

the *lapillus* and *asteriscus* are species-specific in Ostariophysi. Therefore, fossil *lapilli* can be identified only at the genus level, with a few exceptions, e.g. in *Tinca* and †*Tarsichthys*. Nevertheless, studies of fossil *lapilli* have greatly contributed to first appearance data, faunal turnovers and provincialism of Ostariophysi in the Oligocene and Neogene of Europe. Fossil *lapilli* have also been used for oxygen and carbon isotopic measurements for deciphering the fish's environmental parameters such as temperature and salinity. Future studies will provide such data also for other regions of the world.

Technical Session XI, Friday 9:15

**THE ANATOMY AND RELATIONSHIPS OF THE ENIGMATIC DIAPSID REPTILE *LANTHANOLANIA IVAKHNENKOI* FROM THE MIDDLE PERMIAN OF NORTHERN RUSSIA**

REISZ, Robert, Department of Biology, University of Toronto at Mississauga, Mississauga, ON, Canada; MODESTO, Sean, Department of Biology, Cape Breton University, Sydney, NS, Canada

Diapsid reptiles were the most common terrestrial vertebrates of the Mesozoic. However, they were exceedingly rare in the Paleozoic. The oldest known diapsids are araeoscelidians, which first appeared during the Late Carboniferous, but did not last beyond the Early Permian. Other Permian diapsids, referred to as either 'neodiapsids' or 'eosuchians,' include the younginiforms, most of which are known from the uppermost Permian of Madagascar and Africa. Other Paleozoic taxa, formerly considered to be diapsids, have now been reidentified as small varanopid synapsids. The recent description *Lanthanolania ivakhnenkoi*, a small reptile from the Middle Permian of Russia, introduced a significant new element into this problematic period of diapsid evolution. Based on the incomplete data provided by the holotype and only known specimen (a single, fragmentary skull), we suggested that this small reptile may be the oldest known crown diapsid. The discovery of a nearly complete skeleton of this rare and enigmatic reptile allows us to test this controversial hypothesis. The skull confirms anatomical details that were only hinted at by the original specimen, including the absence of the quadratojugal, a poorly developed subtemporal bar of the jugal, the absence of the tabular and the postparietal. The morphology of the postcranial skeleton also supports the interpretation that *Lanthanolania* is the oldest known crown diapsid reptile, indicating that archosauriform/lepidosauriform split occurred well before the end of the Permian.

Technical Session XVI, Saturday 11:00

**FUNCTIONAL ADAPTATIONS IN THE FORELIMB OF MAMENCHISAURID SAUROPODS**

REMES, Kristian, University of Bonn, Steinmann Institute, Division of Paleontology, Bonn, Germany

Mamenchisauridae is a unique group of probably endemic East Asian Jurassic sauropods that are characterized by their exceptionally long neck. A detailed examination of the forelimb osteology of this group, in combination with muscle reconstructions based on the Extant Phylogenetic Bracket approach, revealed that also their pectoral extremity exhibits unique adaptations that are not found in other sauropod groups. These include a dorsolateral extension of the glenoid joint, specialized attachment sites of the shoulder musculature, asymmetric accessory condyles of the humerus, and elongate proximal processes of the ulna. All these modifications are functionally linked. The form of the glenoid allowed the humerus to rotate cranio-laterally around the coracoid, which enforced adaptations in the musculature to maintain the ability to effectively retract the humerus. Moreover, transformations in the elbow region were necessary to keep the manus pronated, in spite of changing orientations of the distal end of the humerus during retraction. Due to the configuration of the sauropod shoulder girdle with a cranially placed coracoid, other sauropods that lack these adaptations were significantly limited in their forelimb step length, and in theory consequently could reach only a distinctly lower maximum velocity. However, the adaptations observed in mamenchisaurids might also correlate to the exceptionally elongate neck, because the forces exerted on the torso during movement of this long cantilever need to be compensated by specialized props that support the body laterally. Nevertheless, it remains unexplained why other sauropod groups with strongly elongate necks lack comparable modifications.

Poster Session II (Thursday)

**ALTERATION OF BONE MICROSTRUCTURE RELATED TO GROWTH RATE IN THE GIANT RATITE *DINORNIS***

RENSBERGER, John, University of Washington, Seattle, WA, USA

Lamellar bone tissue functions as a fracture-resisting mechanism in which fiber directions change across lamellae and individual lamellae extend with uniform thicknesses over considerable distances, like layers of finely crafted plywood. In mature bone of taxa with this type of tissue, osteocyte processes (canaliculi) run in parallel in the direction of growth. In rapidly growing tissues, such as woven bone, this regularity is absent and fibrillar organization is irregular and canaliculi are randomly directed. In birds, lamellar bone is irregular and osteocyte processes branch profusely in random directions, prompting the hypothesis that this irregularity represents a tradeoff of tissue strength in favor of more rapid development. Isolation from predation over a long period of time would test this hypothesis which, under those conditions, predicts reduced selection for rapid bone growth, loss of

these distinctive microstructural organizations and restoration of the primitive vertebrate structures supporting stronger tissues. Observations and measurements of microstructural features of bone tissue in *Dinornis*, the extinct moa of New Zealand, reveal changes from the specialized tissue structures characteristic of birds to those more characteristic of mammals and other vertebrates. This, the moa's history of isolation from predation, its loss of wings and exceptionally slow growth, together with evidence that growth rates in modern birds scale positively with mortality rates, indicates that the derived microstructure in birds and extinct theropods has been sustained by selection for elevated rates of osteogenesis to allow early attainment of efficient locomotion.

Technical Session XVIII, Saturday 2:30

**CTENACANTHID SHARK REMAINS (CHONDRICHTHYES) FROM THE LOWER PERMIAN PEDRA DO FOGO FORMATION, STATE OF TOCANTINS, BRAZIL**

RICHTER, Martha, Natural History Museum, London, United Kingdom

Abundant surface-laying remains of sharks, among which are large fin spines, isolated teeth and segments of calcified cartilage, were collected in Guaraf, north Brazil. The Pedra do Fogo Formation, where these fossils come from, represents marginal deposits of an epicontinental sea in the Parnaíba Basin. The rock matrix contains hard cement with diagenetic, ferruginous ooliths, probably formed in arid climate conditions. The specimens described herein have been recovered after long acid and mechanical preparation. Most teeth are indistinguishable from those of *Glikmanius occidentalis*, which occur in the Pennsylvanian-Lower Permian of USA, the Late Carboniferous of England and Carboniferous of Russia. Dorsal and posterior fin spines have been identified and are identical to *Ctenacanthus amblyxiphias* from the Lower Permian of Kansas. The concurrence in Brazil of abundant 'cladodont' teeth together with ctenacanth spines gives support to the growing evidence that *Glikmanius occidentalis* (= *Cladodus occidentalis*) and the Brazilian teeth material, as well as other dentitions and fin spines from elsewhere do indeed belong to ctenacanthid sharks. Unfortunately, the Brazilian ctenacanthid fin spines and all the available *Ctenacanthus amblyxiphias* spines are known only from isolated remains. It is suggested that *C. amblyxiphias* is probably a junior synonym of *Glikmanius occidentalis*, given recent discoveries of associated teeth and fin spines in the USA. *Glikmanius* sharks survived for about 30 million years and, having initially been reported from fully marine rocks, they seem to have been able to adapt to more restrictive environments of epicontinental seas during the Lower Permian, when they apparently became extinct. The palaeogeography and palaeoclimate of the Parnaíba Basin and other regions of occurrence of similar Late Carboniferous and Lower Permian shark faunas is discussed.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursdays 9:15

**GROSS ANATOMICAL BRAIN REGION APPROXIMATION (GABRA): A NEW TECHNIQUE FOR ASSESSING BRAIN STRUCTURE IN DINOSAURS AND OTHER FOSSIL ARCHOSAURS**

RIDGELY, Ryan, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

Tracking brain evolution through the fossil record has proven difficult, because a cast of the bony endocranial cavity is the only proxy available for study. A cranial endocast is a fair representation of brain size and form for some groups (mammals, birds), but for many reptile groups the brain does not completely fill the cranial cavity, and an endocast is a poor proxy. Thus, quantitative studies of relative brain size or qualitative studies of brain region evolution often require untested assumptions. We present a new technique called Gross Anatomical Brain Region Approximation (GABRA) which addresses these problems by using 3D digital analysis to estimate brain size and morphology in fossil taxa based on a variety of comparative anatomical criteria. Based on hundreds of virtual endocasts of extant and extinct archosaurs generated from our CT data, we have identified a large suite of homologous endocast features (neurovascular canals, dural sinuses, fossae produced by the brain itself, etc.) that have highly conserved relationships to the regions of the brain. These criteria provide limits on the location and size of major brain regions (e.g., cerebral hemispheres, cerebellum, optic lobes, olfactory bulbs) in fossil taxa, and allow the production of a 3D model of the inferred brain morphology. As examples, the digital endocasts of *Euoplocephalus*, *Pachyrhinosaurus*, *Camarasaurus*, and *Majungasaurus* were imported into modeling software (Maya). Virtual models of the underlying brain regions were produced within the endocast using 3D ellipsoids constrained by the anatomical criteria noted above. The reconstructed brains are credible and testable hypotheses, revealing, among many other things, that the sauropod had much more extensive venous sinuses than did either ornithischian, with the theropod being intermediate. GABRA allows moving beyond studying the endocast as a singular entity to studying the evolution of the brain and its different parts, allowing hypotheses of neurological mosaic evolution to be better tested. Moreover, revised estimates of brain (and brain region) size will put quantitative analyses on a better footing.

Poster Session I (Wednesday)

**SECOND OCCURRENCE OF NANOCURIS (THERIA: NANOCURIDAE) FROM THE LATEST CRETACEOUS LANCE FORMATION OF WYOMING, USA**

RIEDEL, Jeremy, University of Washington, Seattle, WA, USA; WILSON, Gregory, University of Washington, Seattle, WA, USA

An incomplete lower right dentary preserving two molars represents the second occurrence of the unusual therian mammal *Nanocuris* and extends its known geographic range from southwestern Saskatchewan to northern Wyoming. This specimen was recovered from the Lance Formation of Wyoming (Lancian; latest Maastriatian), which is temporally equivalent to the Frenchman Formation of the holotype specimen. The specimen exhibits a derived variation on the primitive mammalian tribosphenic molar condition, containing strongly laterally compressed lower molars that decrease in size posteriorly. In both preserved molars, the entoconid and hypoconid are highly reduced or absent altogether. The trigonid of m2 is largely missing, while the talonid is well preserved. Although showing wear to the occlusal surface, remnants of the metaconid, paraconid, and protoconid, as well as the hypoconulid are evident. The bifurcated roots and pulp cavities of m2 are clearly visible in cross-section from the ventral margin of the jaw. Although much of the m3 crown has broken away postmortem, the mesial base of the crown and the talonid remain. While morphological details are relatively few, preservation of coronal features in the m2 of this specimen extends our knowledge of this highly derived dentition from one of North America's most unusual Late Cretaceous mammals. Additionally, the damaged ventral margin of the jaw allows a look into the internal structure of the dentary not readily visible on the type; relatively thick cortical bone of the specimen indicates a robust nature to *Nanocuris*. Previous workers have placed *Nanocuris* within Eutheria, but the paucity of morphological characters along with its uniqueness among Lancian taxa preclude meaningful phylogenetic analyses, leaving its phylogenetic affinities uncertain.

Technical Session VII, Thursday 2:00

**RIDGED ENAMEL ON THE TEETH OF GIANT BEAVERS: FUNCTION OR PHYLOGENY?**

RINALDI, Caroline, Univ. of Missouri-Kansas City School of Medicine, Kansas City, MO, USA; MARTIN, Larry, Univ. of Kansas Natural History Museum and Biodiversity Research Center, Lawrence, KS, USA; TIMM, Robert, Univ. of Kansas Natural History Museum and Biodiversity Research Center, Lawrence, KS, USA; COLE, Theodore, Univ. of Missouri-Kansas City School of Medicine, Kansas City, MO, USA

Incisor enamel of rodents is generally smooth, but in some lineages, there are distinct patterns of ridges on the labial surface. These patterns distinguish phylogenetic lineages at the generic or species level, and arose independently in widely separated clades, including cricetids, sciurids, and castorids. The most striking examples occur in Pleistocene giant beavers, where two parallel lineages can be distinguished on the basis of their enamel ridging, as well as numerous cranial features. In the lineage including *Castoroides leiseyorum*, enamel of the upper incisors is pinnately ridged. The cutting edge of the upper incisors is worn to a "V"-shaped margin. In a second lineage including *Castoroides ohioensis*, the ridging is parallel and the upper incisor edge straighter. The two different patterns of ridges and wear can be explained within a functional context. While the morphology of the ridges differs in the two lineages, in both, the ridges are oriented such that they meet the occlusal margin at a right angle, producing a serrated cutting edge. Although ridging may increase strength of the enamel, the resultant serrated edge is important in the mechanics of food acquisition and processing. In both lineages, lower incisors wear on their contacting surfaces and come to a common point at their occlusal tip. This point fits into a depression worn into the occlusal (lingual) surface of upper incisor dentin. In most rodents, upper incisors are used as an anchor while lower incisors are used for the gnawing power stroke. As a result, in most rodents, lower incisors grow and wear faster than uppers. We examined incremental growth rates within the two giant beaver lineages and results indicate that lowers grow more slowly than upper incisors, a relationship presently undocumented for any other rodent species. A 3-D model is presented to illustrate how giant beavers may have used the serrated edge of the upper incisors to process vegetation. The development of ridged enamel may be a parallel adaptation that reflects dietary preferences, with an influx of fibrous food including grassy plants, and changes in food acquisition and processing mechanics.

Poster Session IV (Saturday)

**GROWTH, ALLOMETRY, AND AGE/SIZE DISTRIBUTION OF THE LATE TRIASSIC THEROPOD DINOSAUR COELOPHYSIS BAURI: PRELIMINARY RESULTS**

RINEHART, Larry, New Mexico Museum of Natural History, Albuquerque, NM, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; CELESKEY, Matthew, New Mexico Museum of Natural History, Albuquerque, NM, USA

We statistically extracted size (= age) classes from *Coelophysis bauri* metrics. Using these size classes, we generated a hypothetical growth curve for *C. bauri* based on femur lengths (N=37). This curve is similar in shape to that of some birds (e.g., *Gallus gallus*) with the differences largely in time scale, and also to previously reported histologically derived growth data for *C. kayentakate*. Age and mass distributions were then calculated based

on the number of individuals in each age class and on femur dimensions. Hypothetically, *Coelophysis*' growth rate was very high for the first year. Sexual dimorphism apparently onset between years one and two. After one or two years, growth slowed in the gracile morph whereas the robust morph is first apparent and grew aggressively for another year; slow growth then continued in both morphs. Robust and gracile morphs probably represent males and females respectively, based on their sexual dimorphism index (SDI = robust size / gracile size = 1.34). Both age and mass distributions are of hyperbolic form. Very small ~ one-year-olds weighing ~2 kg and ~1.4 m long comprise 40 % of the population, ~11 % are adults weighing ~14 kg and ~2.7 m long, ~2 % reach 25 kg and 3.1 m length. Our allometry study, based on 15 suitably complete specimens, agrees with previous studies showing that orbits and hind limbs show negative allometry whereas skull and neck lengths are positive. Allometric growth constants (this study) relative to total length are: skull length, 1.62; cervical series, 1.31; sacrum, 1.26; caudal series, 0.78; forelimb inc. hand, 1.3; hand, 1.52; hindlimb inc. foot, 0.92; foot, 0.91. Relative to skull length: orbit diameter, 0.28; height at quadrate, 0.22; height at prefrontal, 0.32. The cervical series shows complex allometry (log-transformed data are better fit by a polynomial than linear regression); growth rate being high in juveniles and progressively lower in adults. Thus, relative to adult proportions, juveniles had very short, high faces with large orbits, very short necks, short torsos, long tails, short arms, very small hands, long legs and large feet.

Technical Session II, Wednesday 8:30

**UNGULATE DIETARY ADAPTATIONS AND DIVERSITY IN THE MIDDLE AND LATE PLEISTOCENE OF WESTERN EUROPE: VARIATION THROUGH TIME AND SPACE**

RIVALDS, Florent, ICREA and Institut Català de Paleoecologia Humana i Evolució Social (IPHES), Tarragona, Spain; SCHULZ, Ellen, Biocenter Grindel and Zoological Museum - University of Hamburg, Hamburg, Germany; KAISER, Thomas, Biocenter Grindel and Zoological Museum - University of Hamburg, Hamburg, Germany

Dental wear patterns of Pleistocene ungulates (Equidae, Rhinocerotidae, Suidae, Cervidae, and Bovidae) were analyzed as a paleoenvironmental and paleoclimatic proxy for climatic changes and habitat diversity. The mesowear and microwear analysis includes 763 specimens from seven localities. The material belongs to nine archaeological levels corresponding to Neanderthal activities in Western Europe, and four different marine isotopic stages (MIS) 8 to MIS 3. The sites are located in two main geographic areas in Western Europe. The three German localities, Salzgitter Lebenstedt, Taubach, and Wallertheim are located in the Northern part of Western Europe and correspond to open-air sites. The localities Payre, Portel-Ouest, Ermitons, and Abric Romaní are caves located in the southern Mediterranean area of France and Spain. Those sites were selected to analyze changes through time and space. (1) We compared changes through time during two glacial and two interglacial phases. Interglacial phases (MIS 5 and 3) are characterized by a high diversity in dietary adaptations of the ungulate fauna, whereas during glacial periods (MIS 8 and 4) dietary diversity decreased significantly. The variations observed through time are certainly related to a reduction in diversity of the available vegetation during the cold and dry periods of the Pleistocene. (2) We compared geographical changes in dietary adaptations during interglacial periods when Northwestern Europe was not covered by ice sheets and Neanderthals colonized the area. During MIS 5 and 3, there is a significant increase in abrasiveness of the diet from Northwestern to Southern Europe, corresponding to an increase towards more grazing. This corresponds to a latitudinal gradient in vegetation from an evergreen forest in North-Western Europe to temperate grassland in the Mediterranean area evidenced by pollen data. Dental wear analyzes reveal significant changes on both temporal and geographical scales in relation to climate and vegetation changes.

Poster Session III (Friday)

**FIRST REPORT OF THE GENUS EDMONTONIA (THYREOPHORA: NODOSAURIDAE) FROM MEXICO**

RIVERA-SYLVA, Hector, Museo del Desierto, Saltillo, Coahuila, Mexico; GUZMAN-GUTIERREZ, Jose Ruben, Centro para la Conservacion del Patrimonio Natural y Cultural de Mexico A. C., Aguascalientes, Ags., Mexico; LOPEZ-ESPINOSA, Jose, Museo del Desierto, Saltillo, Coahuila, Mexico; DE LA PEÑA-OVIEDO, Ileana, Museo del Desierto, Saltillo, Coahuila, Mexico; PALOMINO-SANCHEZ, Francisco, Instituto Nacional de Estadística, Geografía e Informática, Aguascalientes, Ags., Mexico

The first research team to discover dinosaur remains in northwest Coahuila, Mexico, was the Department of Paleontology and Petrography of the National Institute of Statistics, Geography and Informatics (INEGI for its acronym in Spanish) who in 1996 discovered some interesting localities. They contacted and took us to these sites in 2007. In the locality named Las Jicoteas, northwestern Coahuila, Mexico, biostratigraphic correlation using marine invertebrates gives an Upper Cretaceous, Late Campanian age, and equivalent to the lower part of the Aguja Formation of the Texas Big Bend. It was a paralic system with a thin prodelta with marshes, lagoons, and near shore marine deposits. Previous discoveries of nodosaurids in Mexico came only from the Late Cretaceous (Campanian) of Baja California, which consisted of fragmentary material not assignable to any genus in particular. The dinosaur material found during 2007 and 2008 are osteoderms, vertebrae, distal and proximal portions of the limbs, and portions of the ribs. The material can be attributed to the genus *Edmontonia* sp. based on the tall conical spike and the thick, strong osteoderms, with an external massive, compact and cancellous bone on the basal side. Nodosaurid osteoderms are

thus derived in the thickening of the osteoderm brought about by the infilling of the concave base and the loss of the basal cortex plesiomorphically present in Ankylosauridae and Polacanthidae. These remains provide further data on its geographical distribution being this the southernmost report for the genus. In the same site we have found fossils of associated fauna, including gar fish scales, turtle osteoderms of the Trionychidae family, as well as additional dinosaur remains belonging to the families Tyrannosauridae and Hadrosauridae.

Poster Session IV (Saturday)

**PALEONTOLOGY AND TAPHONOMY OF A SPECTACULAR LATE TRIASSIC-EARLY JURASSIC THEROPOD BONE BED (“SYNTARSUS” RHODESIENSIS) FROM THE ZAMBEZI VALLEY, ZIMBABWE.**

ROBERTS, Eric, University of the Witwatersrand, Johannesburg, South Africa; MGDODI, Kudzanayi, University of the Witwatersrand, Johannesburg, South Africa; BRODERICK, Tim, Chisipite, Harare, Zimbabwe; YATES, Adam, University of the Witwatersrand, Johannesburg, South Africa; O’CONNOR, Patrick, Ohio University, Athens, OH, USA

In 2006, following extensive flooding in Mozambique and Zimbabwe, a spectacular new cliff-face exposure of hundreds of delicate “*Syntarsus*” *rhodesiensis* (*Megapnosaurus rhodesiensis* / *Coelophysus rhodesiensis*) bones was discovered in the Forest Sandstone along the Chitake River in Mana Pools National Park, Zimbabwe. A preliminary expedition was conducted to recover the most exposed portion of the bone bed and stabilize the rest. Detailed mapping of the bone bed suggests a close stratigraphic and spatial association with Dr. Mike Raath’s 1972 *Syntarsus* bone bed in the Chitake River, which yielded 26 associated to partially articulated individuals. Periodic observations over the last 30 years indicate that the original bone bed was completely devoid of skeletal material by the 1980’s, and that extensive erosion occurred even since then. We interpret the new *Syntarsus* bone bed to be a discrete extension of the 1972 locality, indicating that the accumulation is much larger than originally thought, and with many more individuals. Initial preparation of the new material demonstrates many similarities with the original accumulation, including densely packed, mono-specific concentrations of exquisitely preserved, partially articulated to disarticulated bones from all portions of the skeleton. The most significant findings from the new excavation include the first articulated neck and skull of *Syntarsus*, along with multiple other series of articulated cervical vertebrae and isolated cranial material. The articulated skull is significant in that it will provide novel data for resolving the taxonomic affinities of “*Syntarsus*” *rhodesiensis* and addressing its putative synonymy with *Coelophysus*. Concurrent with the ongoing study of the new theropod materials are a reexamination of the original *Syntarsus* collections and both taphonomic and sedimentological investigations of the site. Synthesizing data from the new and original bone beds, coupled with improving age control and depositional environments for the Forest Sandstone will permit a better understanding of the relationships between extensive coelophysoid mass mortality concentrations in Africa and North America.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 10:15

**THE PETROSAL LOBES, SUBARCUATE FOSSA AND SEMICIRCULAR CANALS IN *MONDELPHIS DOMESTICA*: IMPLICATIONS FOR EXTINCT METATHERIANS**

RODGERS, Jeri, Jackson School of Geosciences, Austin, TX, USA

Digital endocasts can inform functional morphologists about the workings of the vestibular system and its relationship with functional centers in the brain. Membranous labyrinths contained within the bony semicircular canals of the petrosal send signals relaying head orientation and movements to be processed by the cerebellum. The parafloccular lobe (or petrosal lobe of the paraflocculus) of the cerebellum has been identified as a center for processing that afferent information. Petrosal lobes are accommodated by the subarcuate fossa of the petrosal. Given that the subarcuate fossa is bordered by the posterior and lateral semicircular canals and opens medially beneath the anterior semicircular canal circumference into the endocranial cavity, the size of the petrosal lobes housed in that space could be an important determiner of semicircular canal size. Size ratios of the semicircular canal radii of curvature have been related to mammalian locomotor strategies in previous studies, having been studied via histology and digital endocasts from nondestructive X-ray computed tomography. Endocasts of the subarcuate fossa have not been made, however, because initial studies of the petrosal lobes in preserved mammalian soft tissue indicated that the lobes do not fill the subarcuate fossa and thus could not influence semicircular canal growth. We recently acquired MRI scans of both live and freshly euthanized *Monodelphis domestica* specimens. These specimens were then scanned by high resolution X-ray computed tomography (HRXCT). Segmentation of the MRI scans combined with digital endocasts of the subarcuate fossa from HRXCT to show that the petrosal lobes of *M. domestica* fill the subarcuate fossa, and thus may influence attenuation of its semicircular canals. This information allows a direct comparison of radii of curvature from the semicircular canals to the volume of the subarcuate fossa in *M. domestica* skulls, and may have important implications for evaluating sensory processing and locomotor strategies in early mammalian fossils.

Poster Session IV (Saturday)

**VERTEBRATES LIMB GEOMETRY IN THE SIMPLEX SPACE - SAUROPODOMORPHS APPENDICULAR SKELETON ANALYSIS**

RODRIGUES, Luis, Museu Nacional de Historia Natural/Universidade de Lisboa, Lisbon, Portugal; DAUINS-I-ESTADELL, Josep, Universitat de Girona, Girona, Spain; MATEU-FIGUERAS, Gloria, Universitat de Girona, Girona, Spain; THIÓ-HENESTROSA, Santiago, Universitat Girona, Girona, Spain

355 specimens belonging in various taxa of Dinosauria (Sauropodomorpha, Theropoda, Ornithischia and Aves) and Mammalia (Protheria, Metatheria and Eutheria) were analyzed under the Compositional Data Analysis (CDA) methodological framework. A novel metric comparison of the appendicular skeleton of both fore and hind limb proportions of different vertebrates using the CDA methodology is presented – Aitchinson Distance (A.D.). Morphospaces occupation patterns of the different limb elements are described and quantified. Different approaches have been previously proposed for describing and quantifying compositional data in vertebrate studies. Until now none of those referred methodologies has taken into account the specificities of compositional data, i.e., the unit sum constraint which invalidates the usual interpretation of covariances and also of correlations. The CDA, proposed twenty years ago by Aitchinson, offers a resolution to most of the problems in compositional data. A special focus has been put on Sauropodomorpha dinosaurs and the A.D. has been used as a measure of disparity in limb elements proportions of that group in order to infer some aspects of functional morphology, namely the bipedal-quadrupedal locomotion transition that occurred among sauropodomorphs. This episode constituted a major evolutionary transition, which is reflected on the appendicular skeleton. Additionally, a review of previously published compositional morphospaces of different vertebrates and associated methodologies is performed and compared with the CDA.

Poster Session III (Friday)

**HOW DO NEW DISCOVERIES AFFECT PTEROSAUR PHYLOGENY?**

RODRIGUES, Taissa, Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

It is usually expected that new species can affect our knowledge of a group’s phylogeny, and this has already been tested for euornithopods, merychippine horses and hominids. Regarding pterosaurs, in the last decades their relationships have begun to be investigated using cladistic methods. Here we examine the influence of the discovery of new taxa in the first testable pterosaur phylogenetic hypothesis published. We began with the first three named species of the data matrix and added new ones following the year of their description. Results showed that some taxa collapsed branches, while others solved some relationships. The initial cladogram consisted of a trichotomy. Most added species just nested into it, either in sister-taxon relationships or adding to the initial polytomy. The addition of “*Ornithocheirus*” *compressirostris* and *Germanodactylus rhamphastinus* affected the resolution negatively, collapsing most nodes. By 1984, the strict consensus tree consisted of *Anurognathus* + *Batrachognathus* as the sister group to all other species, displaced in a large polytomy. The addition of *Anhanguera blittersdorffi* and *A. santanae* (described in 1985) brought great resolution to the entire Pterosauria, even to non-pterodactyloids. Addition of each species at a time showed that *A. santanae*, the more complete of the two, provides more resolution. The addition of *Tupuxuara leonardii* (Iwaki specimen) and *Zhejiangopterus linhaiensis*, described in 1994, further solved the relationships of their immediate inclusive group, the Azhdarchoidea, bringing *Azhdarcho* and *Zhejiangopterus* as sister groups and the Azhdarchoidea as sister group to the Tapejaridae, changing previous results (e.g., Tapejaridae closer to Dsungaripteridae). Finally, the last important addition was *Feilongus youngi* described in 2005, that solved several relationships within the Archaeopterodactyloidea. As expected, those preliminary results indicate that species can affect phylogeny in different ways. However, the fact that most pterosaur taxa are incomplete and the presence of tremendous gaps in their fossil record suggest that new discoveries have potential to provide more significant changes in the future.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**AN UNUSUAL SPECIMEN OF *BAURUEMYS ELEGANS* AND ITS IMPLICATIONS FOR THE TAXONOMY OF THE SIDE-NECKED TURTLES FROM BAURU BASIN (UPPER CRETACEOUS OF BRAZIL)**

ROMANO, Pedro, Museu Nacional, UFRJ, Rio de Janeiro, Brazil

Five podocnemid species from the Bauru Basin were named: *Roxochelys harrisi*, *Bauruemys brasiliensis*, *R. wanderleyi*, *B. elegans*, and *Cambaremys langertoni*. The former is a *nomen dubium* which holotype is lost; the second is an *incertae sedis* known only by a nearly completed plastron; the third is represented by fragmentary carapace and plastron as holotype and few other specimens never reported on literature; the fourth is represented by several well preserved specimens including skulls; and the latter might correspond to a juvenile form of *B. brasiliensis* and is represented only by a single fragmentary specimen. Besides those, several nearly completed topotypes of *B. elegans*, including 19 almost completed shells, have been collected by the researchers from Museu Nacional in the last years. One of those specimens (MN 7017-V), which is still under preparation, calls attention by possessing a supposed diagnostic feature of *C. langertoni*, i.e.: a seventh neural plate. However, MN7017-V shows other distinctive characters which enable its attribution to *B.*

*elegans*: moderated thickness of the carapace (differing from *Roxochelys*) and first costal plate contacting only the elongated neural I (differing from *Roxochelys* and *Cambaremys*). In order to investigate if MN 7017-V shows significant differences to the other 18 almost completed post-cranium topotypes of *B. elegans* collected, it was included on a matrix of 24 quantitative characters of the carapace to perform a morphometric analysis. The covariance matrix was explored via Principal Component Analysis (PCA) and two searches were carried out: one with only the total length and width measurements (2 characters) and other with the comprised measurements of the carapace (22 characters). Both PCAs indicated no significant difference in the sample, which might confirm the hypothesis of MN 7017-V being a *B. elegans*. This is the first explicit report of phenotypic plasticity in this species and raises our attention to the fragility of some characters used to diagnose the three genera described from the Bauru Basin.

Poster Session I (Wednesday)

#### REPRODUCIBILITY BETWEEN PATHOLOGIES IN RECENT AND FOSSIL CROCODYLIANS AND CROCODYLIAN ECOMORPHS

ROTHSCHILD, Bruce, University of Kansas, Lawrence, KS, USA

Application of the scientific approach to a validated data base and phylogeny-independent pathology recognition criteria form the basis for systematic review of crocodylomorph osseous pathology. Isolated occurrence of jaw fractures in Triassic phytosaurs *Myrstriosuchus*, *Mahajangasuchus*, *Phytosaurus buceros* and *Leptosuchus imperfecta* and puncture wounds in Cretaceous *Brachychoapsa sealeyi* and Eocene *Tilemsisuchus lavocati* suggests intraspecific conflict. That behavioral interpretation is confirmed in contemporary *Alligator mississippiensis* and *Crocodylus americanus*. It contrasts with frequent gastralia fractures in Late Paleocene *Leidyosuchus* (= *Borealosuchus*) *formidabilis*, not recognized in contemporary crocodylians. Alterations compatible with infection are noted in distal elements of *Machimosaurus mosae* and *Leidyosuchus formidabilis*, similar to infections in contemporary *Alligator mississippiensis* (4/88), *Caiman latirostris*, *Crocodylus siamensis* and *Crocodylus acutus* (2/26). Late Paleocene *Leidyosuchus formidabilis* and Lower Miocene *Tomistoma downsoni* and *Leidyosuchus* (= *Borealosuchus*) *formidabilis* have ossification of anulus fibrosus characteristic of the inflammatory arthritis 'spondyloarthropathy,' as have 2/88 contemporary *Alligator mississippiensis*, 1/26 *Crocodylus acutus*, 1/5 *Crocodylus moreletii* and 1/22 *Palaeosuchus palpebrosus*. Benign neoplasia, in the form of button osteoma and a probable chondroma, are found in an Eocene *Crocodylus*, and an osteochondroma in contemporary *Caiman yacare*. Isolated cases of articular gout were observed in *Alligator sclerops* and *mississippiensis*; *Tupinambis*; *Crocodylus americanus*, *niloticus*, *novaeguineae*, *porosus* and *johnsonii*; *Caiman crocodiles*; *Tomistoma schlegelii* and *Gavialis gangeticus*, but gout has yet to be identified in the fossil record. Analogous to suggestion that crocodylomorphs have not changed greatly during much of their history, neither has the osseous pathologies with which they were afflicted. Gastralia fractures appear to be Cretaceous phenomenon, while gout may be a more recent disease. The consistency of pathology in crocodylian ecomorphs may reflect a similar consistency between disease and host habitat.

Technical Session I, Wednesday 10:00

#### THE SOUTH AMERICAN MAMMALIAN MESOZOIC RECORD: A BIOGEOGRAPHIC REEVALUATION

ROUGIER, Guillermo, University of Louisville, Louisville, KY, USA; PAEZ, Natalia, University of Louisville, Louisville, KY, USA; GAETANO, Leandro, Universidad de Buenos Aires, Buenos Aires, Argentina

The first record of South American Mesozoic mammals is barely 20 years old and our understanding of relationships and biogeography precarious. In recent years a variety of new localities have been discovered that range in age from Middle Jurassic to latest Cretaceous preserving several distinct mammalian lineages. The Jurassic forms are so far represented by two australosphenidan taxa, a peculiar lineage of triconodonts, one as-yet-undetermined allotherian, and an incertae sedis mammal known by footprints. The Early Cretaceous record consists solely of *Vincelestes*. The Late Cretaceous is more richly represented; dryolestoid mammals form the bulk of the sample, including highly derived endemic taxa from the Cenomanian and Campanian-Maastrichtian alongside more generalized dryolestoids not unlike some of the Jurassic members of the group. Mesungulatis are the most often found mammals of the Late Cretaceous and, together with their close relatives reigtheriids and pelagrotheriids, illustrate an herbivore adaptation of the dryolestoid dental pattern. Multituberculates and gondwanatheres complete the list of known Late Cretaceous taxa. The phylogenetic positions of the South American Mesozoic taxa point to a big discontinuity between the Jurassic and Cretaceous faunas with a distinctive provincialism of southern Pangea or early Gondwana. *Vincelestes* has no clear links to any other South American form. The Cenomanian dryolestoids are basal members of some Late Cretaceous lineages, but the most distinctive Late Cretaceous forms are not known from any other age, and with the sole exception of the mesungulatis-like *Pelagrotherium*, they are not known beyond the K-T boundary. A calibrated global phylogeny suggests a Jurassic root for all the Cretaceous lineages, hinting at the Pangea break up as a likely cause for the highly distinctive South American mammalian assemblage during the Mesozoic. The broad geographical distribution of gondwanatheres agrees with such a paleogeographic scenario, although the absence of the ubiquitous dryolestoids in non-South American localities is puzzling.

Technical Session II, Wednesday 11:45

#### GROWTH INCREMENT AND STABLE ISOTOPE ANALYSES OF A JUVENILE AFRICAN ELEPHANT TUSK: AN INTERPRETIVE REFERENCE FOR STUDIES OF JUVENILE WOOLLY MAMMOTH TUSKS

ROUNTREY, Adam, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; HAYNES, Gary, University of Nevada, Reno, Reno, NV, USA

Structural and compositional analyses of proboscidean tusks can provide high-resolution records of diet, climate, nutritional status, and life history events. Though much of the previous work using tusks to reconstruct life histories has focused on tusks of adults, which usually lack material formed in the first few years of life, recent studies on the tusks of juveniles have begun to shed light on this early portion of life. In previous work on juvenile woolly mammoths, all individuals over one year of age showed a pattern of decreasing collagen- $\delta^{15}\text{N}$ , consistent with decreasing relative importance of milk in the diet. In addition, seasonal-scale cycles in both  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  were observed. To test some of our interpretations based on these data, we have obtained a historically collected tusk of a juvenile African elephant (*Loxodonta africana*) that retains enamel on its tip. The presence of enamel indicates that the first-formed dentin, which is laid down near the time of birth, is present. As the conditions in which this individual lived, and the circumstances of its death, are to some extent known, this analysis serves as a means of assessing the responses of structural and compositional characteristics of the tusk, such as weekly growth increment thicknesses or  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  of collagen, to environmental conditions and life history events. The elephant died at an age of approximately 3.5 years, probably due to starvation along with many other juveniles, during a dry season at the Shabi Shabi seep in Hwange National Park, Zimbabwe. This individual lived through one of the driest years on record in the park as well as some years with closer-to-average precipitation, allowing us to observe responses to differing conditions. Although the effect of drought on a nursing calf might be less than would be expected in an adult, signs of nutritional stress, such as elevated  $\delta^{15}\text{N}$ , should be passed from the mother to the calf via the composition of milk. This study is one of the first to test the methods used to extract paleobiological information from tusks by applying them to a Recent relative of mammoths from a known environmental context.

Poster Session I (Wednesday)

#### ALABAMA AS A DISPERSAL PATHWAY IN THE PLEISTOCENE

RUEZ, JR., Dennis, University of Illinois at Springfield, Springfield, IL, USA

The abundant Pleistocene fossil localities of Florida show a high degree of faunal interchange with the western United States. However, dispersal pathways between these regions were few. During times of peak glacial advance, the inhabitable latitudinal span of North America was tightly constricted. Although glacial intervals would have corresponded to lower sea levels, the narrow continental shelf between the Mississippi-Alabama Shelf and West Florida Shelf means that most dispersal would have occurred across what is currently exposed land in Alabama. The relatively high elevation of the Appalachians would have been an additional dispersal barrier to the low-elevation adapted mammals of Florida. Therefore, analysis of Alabama Pleistocene mammals may reveal insight into the ecologic dynamics of rapid dispersal rates during times of climate instability. Ice-Age (Pleistocene) terrestrial mammals are known from at least 16 localities in Alabama, based on published records. This includes 29 species, 10 of which are extinct, and 11 of which are extant, but currently do not occur in Alabama. The localities cluster in the extreme northern part of the state, where the fossils are found in caves, and the southern third of the state, where fossils are exposed by rivers. Notable occurrences include some of the earliest discoveries of the Columbian mammoth (*Mammuthus columbi*) and American mastodon (*Mammuth americanum*), one of the largest collections of the ground sloth *Megalonyx jeffersonii*, and the southernmost record of reindeer (*Rangifer tarandus*). The Pleistocene fauna of Alabama contains a unique combination of cold-adapted taxa (*Clethrionomys gapperi*, *Microtus pennsylvanicus*, *Erethizon dorsatum*, *Martes americana*, *Martes pennanti*, *Rangifer tarandus*) and warm-adapted taxa (*Panthera onca*, *Dasyurus bellus*, *Mylohyus nasutus*, *Tapirus veroensis*).

Technical Session XII, Friday 10:15

#### DO INTERNAL CRANIAL FEATURES REFLECT ADAPTATIONS IN "WOODPECKING" MAMMALS?

RUF, Irina, Steinmann-Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Bonn, Germany; GINGERICH, Philip, Museum of Paleontology and Department of Geological Sciences, University of Michigan, Ann Arbor, MI, USA; KOENIGSWALD, Wighart, Steinmann-Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Bonn, Germany

Three mammalian orders have convergently occupied the ecological niche of woodpeckers: (1) fossil apatemyids, (2) the primate *Daubentonia*; and (3) the marsupial *Dactylopsila*. Previous authors have interpreted prominent chisel-like incisors and elongation of certain fingers as adaptations for arboreal foraging on xylophagous insects. Here we investigate internal cranial features such as brain size, the bony labyrinth, and nasal turbinates, which may also reflect the requirements of this special mode of life. Skulls of a new European apatemyid from the Eocene of France were compared with those of *Daubentonia* and *Dactylopsila* by using micro-CT. Apatemyids and *Daubentonia* have significantly larger brains than related species. The brain endocast of the apatemyid has the proportions and



morphology typical for basal extant mammals. Cerebellum morphology indicates adaptation to fast and complicated movements and postures as required for an arboreal lifestyle. The relative size of the brain in the apatemyid is equivalent to that expected for an average living terrestrial mammal, and it is thus larger than the brain of most contemporary mammals. Bony labyrinth morphology in the apatemyid is comparable to that of small extant mammals in having almost two turns of the cochlea. Mammalian “woodpeckers” require a highly developed sense of smell, which can be inferred from the morphology of turbinals. In *Dactylopsila* the nasal skeleton is comparable to that of *Monodelphis*, whereas *Daubentonia* shows a highly derived and complex nasal capsule with an increased number of turbinals compared to other mammals. This pattern in *Daubentonia* might reflect the evolutionary history of the olfactory system in this highly specialized primate, but seems not to be necessarily related to “woodpecking”. The apatemyid has the number of turbinals found in most extant small macrosmatic mammals, a condition that might be related to body size. It is exceptional that the turbinals of a fossil mammal could be investigated to such a detailed extent. However, we found no clear links to “woodpecking” in the internal cranial features studied here.

Technical Session XI, Friday 10:15

**ANOMODONT DIVERSITY AND DISPARITY AND THE END PERMIAN EXTINCTION**

RUTA, Marcello, University of Bristol, Bristol, United Kingdom; BENTON, Mike, University of Bristol, Bristol, United Kingdom; SURKOV, Mikhail, University of Saratov, Saratov, Russia

Phylogeny-based approaches to analysis of morphological diversity (i.e. disparity) are applied to anomodonts, a speciose clade of herbivorous synapsids and a dominant component of terrestrial ecosystem guilds during the Permian and Triassic. We use published analyses and a new phylogeny that combines the majority of Permian and Triassic genera. Several disparity metrics (including variance- and range-based indexes) are used to evaluate diversification patterns according to stratigraphic age, biozone provenance, phylogenetic grouping, and cladogenetic rank. Overall, disparity increases throughout the Permian, when either age or biozone successions are examined. An invariable drop in disparity occurs at the Permo-Triassic boundary. Throughout the Triassic, disparity fluctuates slightly around a threshold value comparable to the disparity in the Capitanian (Permian), and is remarkably lower than the values attained by the group in the latest Permian. When cladogenetic rank is used, disparity profiles rapidly achieve a plateau in the Permian, although a slight decrease in the Triassic is observed. We further discuss disparity in relation to ecological adaptations, particularly feeding strategies. The low-feeder middle Triassic taxa exhibit overall disparity that is comparable to that of other Triassic taxa, but lower than that of Permian taxa. Permian and Triassic anomodonts are examined also in an empirical character-state space and their rates of character accumulation are compared.

Technical Session VIII, Thursday 3:15

**PHENOTYPIC PLASTICITY IN THE EVOLUTION OF ALLIGATORINAE**

SADLEIR, Rudyard, Univ Chicago & Field Museum, Chicago, IL, USA

During ontogeny, organisms can display different phenotypes as a result of living under different environmental conditions. Recent research suggests such environmentally induced phenotypic plasticity can promote evolutionary diversification among populations. The growing *Alligator mississippiensis* agroindustry provides a unique opportunity to investigate whether different environmental conditions through ontogeny can induce cranial shape variability and whether the magnitude of variability corresponds to or exceeds species boundaries. In various species of crocodylians, captive-raised populations have been casually recognized to have cranial morphologies very different from wild populations. Geometric morphometric analysis shows such differences are statistically significant between wild and captive populations of *A. mississippiensis*. In an analysis of extant crocodylian variation, farm-raised specimens cluster closer to *A. sinensis* suggesting that differences in shape due to ontogenetic environment transcend species morphospace boundaries. Inferential power critically improves when fossil taxa are included. Results reveal the morphospace range of wild and captive *A. mississippiensis* is nearly inclusive of its taxonomically closest extinct taxa *A. olseni*. Captive *A. mississippiensis* occupy a novel region of morphospace orthogonal to the wild population's ontogenetic shape change. This suggests the phenotypic plasticity in *A. mississippiensis* is large enough to account for the scale of evolutionary differentiation among *Alligator* species back to the Miocene. Surprisingly, the position of the extinct *A. mefferdi*, the putative direct ancestor of *A. mississippiensis*, is situated at the large end of the wild *A. mississippiensis* ontogenetic shape change vector suggesting heterochronic change could underlie the species' evolution. This hypothesis is explored at higher analytical resolution using a greater fossil sample, and a sample of 16 farm-raised *A. mississippiensis* of known age and ontogenetic environmental condition compared to a post-hatchling size range of 22 wild specimens from the same geographic range.

Poster Session IV (Saturday)

**A TITANOSAURIFORM SAUROPOD (DINOSAURIA: SAURISCHIA) AND MICROVERTEBRATES FROM THE LOWER CRETACEOUS OF HYOGO PREFECTURE, SW JAPAN**

SAEGUSA, Haruo, University of Hyogo, Sanda, Japan; IKEDA, Tadahiro, Museum of

Nature and Human Activities, Sanda, Japan; KUSUHASHI, Nao, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; TANAKA, Satoshi, Kyoto University of Education, Kyoto, Japan; MATSUBARA, Takashi, Museum of Nature and Human Activities, Sanda, Japan

Two new terrestrial vertebrate fossil assemblages were found from the Lower Cretaceous Sasayama Group of Hyogo Prefecture in the years 2006 and 2007. The Sasayama Group is composed of fluvial sediments, and several tuff beds intercalated in the group yielded zircon fission track ages of ca 120 Ma to 140 Ma. From the red mudstone of the group in Sasayama City, Hyogo Prefecture, microvertebrates such as mammalian lower jaws, small ornithischian teeth, and lepidosaurian postcranial elements and lower jaws were collected. The red mudstone of paleosol origin exposed on the bank of the Sasayama River in Tamba City, Hyogo Prefecture yields skeletal elements of an individual of a sauropod (the Tamba sauropod), shed teeth of theropods and ornithopods, and microvertebrates. Teeth, a brace, an atlas, dorsal ribs, dorsal vertebrae, a pubis, an ilium, caudal vertebrae and chevrons of the Tamba sauropod were discovered during the excavation in the winter of 2007 and 2008. The excavation and the preparation of the sauropod are still in progress but the prepared elements of the sauropod show following diagnostic features: the absence of 'crus' bridging dorsal margin of haemal canal, plank-like anterior dorsal ribs, the presence of proximal pneumatocoel on dorsal ribs, and the spongy presacral bone texture. The sacral vertebrae are badly damaged but judging from the sacral ribs, there may have been six sacral vertebrae. The combination of these features suggests that the Tamba sauropod can be allocated to Somphospondyli. The absence of the forked chevrons and the presence of ventral longitudinal hollow on anterior and middle caudal vertebrae suggest that the skeleton can be assigned to titanosaurid, whereas the features such as the shallow haemal canal and the amphiplatyan anterior caudal vertebrae contradict this assignment. The combination of titanosaurid and non-titanosaurid plesiomorphic features may suggest that the Tamba sauropod occupies proximal phylogenetic position to the titanosaurid among primitive titanosauriform sauropods.

Poster Session II (Thursday)

**A NEW COMPLETE SKELETON OF *NOTHROTHERIUM MAQUINENSE* FOUND IN AN UNDERWATER LIMESTONE CAVE FROM BAHIA (BRAZIL)**

SALLES, Leandro, Museu Nacional UFRJ, Rio de Janeiro, Brazil; PERINI, Fernando, Museu Nacional UFRJ, Rio de Janeiro, Brazil; MORAES NETO, Carlos, Museu Nacional UFRJ, Rio de Janeiro, Brazil

As part of the outcome of a recent expedition carried on by the Brazilian National Museum to explore Quaternary deposits associated to limestone caves located at the Chapada Diamantina's karst, northeast of Brazil, a complete skeleton of *Nothotherium maquinense* was found. This cave, named Impossiveis, is situated in the interior of a doline 60 meters deep, where on the bottom is placed the opening of the cave, and the skeleton was recovered in an underwater condition at approximately 300 meters from the cave's entrance. This finding is the third complete skeleton of this poorly known small ground sloth, so far only reported in Brazil. This skeleton consists of a juvenile with the basicranium almost intact, missing only the right squamosal and the right bulla tympanica. There were also recovered two maxillae, the left nasal, and six isolated teeth. From the mandibles, only an articular process of the left mandible was found. The axial skeleton is represented by five of the seven cervical vertebrae, missing the atlas and the fifth cervical, all fifteen thoracic and three lumbar vertebrae, plus the complete sacrum, and nine of the caudals. Thirty ribs were recovered. The pectoral girdle and front limbs are almost complete, represented by one clavicle and both scapulae, humeri, ulnae and radii. The blade portions of the scapulae are fragmented, but their proximal region are complete. The pelvis is almost complete, the left hip bone being nearly intact, while the right one is broken in three pieces. Both femora, the two tibiae and one fibula are present. Many of the bones of the hands and feet are missing, being recovered four carpal bones, four tarsal bones, five phalanges, both calcaneus and one astragalus. Being a young animal, both the distal and proximal articular extremities of the long bones of the limbs are separated from the shaft, but present. Numerous bone fragments associated to the skeleton were also recorded. In all, approximately 55% of the skeleton was recovered and by all means the other parts are there lain, immersed in clay sediments waiting to be found.

Romer Prize Session, Thursday 11:15

**PALEOECOLOGY AND MORPHOLOGICAL EVOLUTION OF BEAVERS (FAMILY CASTORIDAE)**

SAMUELS, Joshua, University of California, Los Angeles, Los Angeles, CA, USA

Beavers are among the largest living rodents and as ecosystem engineers they have dramatic impacts on other species. Despite their importance, beavers have been largely overlooked in paleoecological reconstructions due to a lack of data on their ecomorphology. Here I use a combination of linear and geometric morphometric techniques to examine locomotor and dietary adaptations in the cranial and postcranial skeletons of a wide array of extant rodent species. These proxies were used to create a comprehensive ecomorphological framework to examine the morphological and ecological evolution of beavers. Results demonstrate that living rodents with similar locomotor and dietary habits have convergent morphology, despite independent evolutionary histories. Application to extinct beavers reveals diverse ecologies, with some species occupying very different niches than extant beavers. Extinct

beavers show two primary locomotor specializations, fossoriality in the Paleocastorinae and Migmastorinae and semi-aquatic habits in the Castorinae and Castoroidinae. The craniodental structure of the burrowing beavers reveals adaptations for chisel-tooth and head-lift digging behaviors, an ecology more similar to living gophers and blind mole-rats than living beavers. Craniodental structure of both burrowing and semi-aquatic beavers suggests that most species had highly specialized herbivorous diets. The inferred ecologies of extinct beavers were then mapped onto their phylogeny to examine morphological evolution through time. Burrowing beavers display increased specialization for fossoriality and herbivory over time, corresponding with the expansion of more open habitats and a radiation of grasses in the early Miocene. They also diverge into specialized chisel-tooth and head-lift digging forms, which may have allowed sympatric taxa to partition resources. The semi-aquatic beaver lineages both show increased specialization for semi-aquatic life and herbivory over time, as well as a progressive increase in castoroidine beaver size after the immigration of *Castor* to North America in the late Miocene.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 8:15

**THE ENDOCRANIAL ANATOMY OF THE DOMED-SKULL CHALICOTHERE TYLOCEPHALONYX UCMP 115867 WITH EMPHASIS ON THE PARANASAL SINUSES AND TURBINATES**

SANDERS, Richard, University of Utah SOM, Salt Lake City, UT, USA; WEDEL, Mathew, University of California, Merced, CA, USA

The domed-skull nature of the Split Rock Miocene chalicothere, *Tylocephalonyx* UCMP 115867, from Fremont County, Wyoming was speculated on by Munthe and Combs. Aided only by examination of the skull's external morphology and glimpses of the internal structures afforded by fractures in the specimen, they developed an extensive list of possible functions of the calvarial dome that typified domed skulled chalicotheres. We revisit this subject with the aid of computed tomography to describe the internal anatomy of the skull with particular attention to the paranasal sinuses and nasal turbinates. Based on our analysis of the skull's internal anatomy, we further refine the speculated possible functions of the dome. With CT, any well-preserved skull can be potentially evaluated with respect to the endocranial anatomy as well as the paranasal sinus anatomy. With the domed skull chalicothere *Tylocephalonyx*, the paranasal sinus anatomy is particularly relevant to the nature of the domed calvarial architecture of the skull in that, as we now know through our investigation, the dome is an extension of the frontal sinus into the parietal plates. Furthermore, the entire volume of the dome above the dural covering of the brain is in fact pneumatized. The endocranium is well preserved including gyral impressions and calcified dural remnants. As the internal matrix is undisturbed, there are also traces of differential infilling of the endocast possibly reflecting a taphonomic sequence of brain material mummification and later replacement. Distinct crystalline replacement of preserved turbinate molds reveals the surprisingly complex sinonasal turbinate anatomy.

Preparators' Session, Thursday 10:30

**RESTORATION AND THREE-DIMENSIONAL ASSEMBLY OF A NEARLY COMPLETE, ARTICULATED EOCENE PROTOCID WHALE SKELETON FROM PAKISTAN**

SANDERS, William, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; GRAF, John, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; ZALMOUT, Iyad, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; UL-HAQ, Munir, Geological Survey of Pakistan, Quetta, Pakistan; GINGERICH, Philip, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA

A Geological Survey of Pakistan-University of Michigan team working on the western side of the Sulaiman Range in Balochistan, Pakistan has recovered a diverse marine mammal assemblage, including an articulated protocetid whale skeleton (GSP-UM 3551), from middle Eocene (mid-Lutetian) sediments. GSP-UM 3551 is valuable for understanding the transformation of terrestrial to aquatic lifeways in cetaceans because it is the most complete protocetid skeleton known, with all elements of the head and body represented, including the tail and fore- and hind-legs and feet. We detail the technical procedures of field recovery, preparation, and replication used to comprehensively reconstruct the skeleton of this individual. During excavation, bone was consolidated with PVAc, and the specimen was removed in blocks in plaster jackets. Elements were initially prepared within these blocks using airscribes, and molded in articulation. Molds were made of layered silicone rubber, to capture maximum detail, and done in multiple pieces to protect the integrity of original bone. Casts of the blocks were assembled and elements numbered to ensure correct association of bones throughout the process. Elements were then manually prepared out of blocks, and remolded. Next, casts of individual bones were used to restore broken segments and cut apart and reset to correct for plastic distortion and step fracturing. An internal latticework was constructed to rebuild the anterior dentaries, in close alignment with the cranium, permitting precise occlusion of the teeth. Paste epoxy was used for reconstruction, because it is easy to sculpt and retains its shape over time. Reconstructed elements were then remolded and hollow cast in laminar polyester mixed with talc and lined with fiberglass, for dimensional accuracy, stability, and strength. Heating cast copies and bending them into serial alignment with unaffected ribs, directly on the mount, removed rib deformation. The finished mount of GSP-UM 3551 is morphologically accurate, lightweight and internally supported, facilitating placement in dynamic exhibit postures and visual assessment of its amphibious locomotor abilities.

Technical Session XVI, Saturday 8:45

**OSTEOLOGY OF YUNGUISAURUS (SAUROPTERYGIA, PISTOSAUROIDEA)**  
SATO, Tamaki, Tokyo Gakugei University, Tokyo, Japan; CHENG, Yen-nien, National Museum of Natural Sciences, Taichung, Taiwan, ROC; WU, Xiao-chun, Canadian Museum of Nature, Ottawa, ON, Canada; LI, Chun, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

A large number of species and specimens of basal sauropterygians are known exclusively from the Triassic, whereas the Plesiosauroidea are the only but very successful sauropterygians in the Jurassic and Cretaceous. Triassic pistosauroids are important to understand this transition, but the paucity of well-preserved specimens has been a major obstacle for research. *Yunguisaurus liae* from the Late Triassic of China, described in 2006, was the first pistosauroid represented by a nearly complete skeleton. Further preparation of the holotype and a detailed comparison with other sauropterygians including two recently reported pistosauroids (Late Triassic *Bobosaurus* from Italy, and *Yunguisaurus* sp from the Middle Triassic of China) revealed additional characteristics of this taxon, filling the stratigraphic and morphological gaps at the transition. The long neck of *Yunguisaurus* consists of more than 40 vertebrae, and this is within the range of Early Jurassic plesiosaurs but well over those of basal sauropterygians, which typically have 20 to 30 cervical vertebrae. Cervical neural arch is wider than the centrum because of the large zygapophyses, and presence of zygosphen-zygantrum articulation is suggested. Neural spines in dorsal region are not so tall as in *Bobosaurus*. The scapula is comparable to *Corosaurus* in having a long dorsal blade with moderately expanded tip and in lacking the ventral flat surface. Unlike the short and hourglass-shaped ilia of basal sauropterygians and *Bobosaurus*, those in Chinese pistosauroids have a small acetabular portion and wide dorsal (sacral) end, and thus approach the plesiosaurian condition in which the ilium is essentially a rod. There is no trace of an obturator foramen in the pubis. Mosaic of primitive and derived characters in *Yunguisaurus* indicates some of the plesiosaurian characteristics appeared before the latest Triassic from which the earliest known plesiosaurs occur.

Poster Session III (Friday)

**THREE DIMENSIONAL TRAUMA ANALYSIS USING X-RAY MICROTOMOGRAPHY IN TENONTOSAURUS TILLETI, CLOVERLY FORMATION (MONTANA, USA)**

SCHACHNER, Emma, University of Pennsylvania, Philadelphia, PA, USA; MANNING, Phillip, University of Manchester, Manchester, United Kingdom

The study of disease and injury in the fossil record dates back to Moodie's early 19th century descriptions of abnormalities preserved in the fossilized remains of extinct animals. The identification and classification of pathological bone allows for a more complete understanding of the biology and physiology of extinct taxa. Extrapolating inferences of dinosaurian behavior is more difficult, however pathological bones give insight into predator-prey relationships, intraspecific interactions, and disease or trauma experienced by an animal. While pathological bones are being increasingly documented for the Dinosauria, the identification of the underlying cause of many pathological conditions remains equivocal until the basic physiological responses of archosaur bone to disease are better understood. Accurate descriptions of pathological bones in both extinct and relevant extant taxa are essential in order to better understand the complex nature of osteological responses to injury and disease in archosaurs. This study provides a detailed anatomical description of both external and internal pathological bone in a new specimen of *Tenontosaurus tilletti* (UMM LL.12275), housed at The Manchester Museum (University of Manchester). The macroscopic mechanical properties of trabecular bone are related to both the 3D architecture and properties of individual trabeculae. In this study, X-ray microtomography has been used to determine the internal 3D architecture of a number of trabecular structures and develop meshes for finite-element analysis. A distinct osteophyte projecting from the lateral surface of the terminal phalanx of digit II (left manus) is consistent with exostosis as a function of a tendon avulsion, resulting in the observable trauma. The x-ray microtomography supports this interpretation and provides an additional internal, 3D microstructural marker in the trabecular bone that is directly related to the external avulsion pathology (osteophyte). The response of the bone to the trauma can be quantitatively assessed for the first time in three dimensions and compared with similar trauma observed within extant species.

Poster Session I (Wednesday)

**TRANSGRESSIVE LAG OR CONDENSED SECTION?: TAPHONOMIC EVIDENCE FROM THE LATEST CRETACEOUS-EARLIEST TERTIARY BASAL HORNERSTOWN FORMATION (NEW JERSEY, U.S.A.)**

SCHEIN, Jason, New Jersey State Museum, Trenton, NJ, USA; LACOVARA, Kenneth, Drexel University, Philadelphia, PA, USA; GALLAGHER, William, New Jersey State Museum, Trenton, NJ, USA; POOLE, Jason, Academy of Natural Sciences of Philadelphia, Philadelphia, PA, USA

Despite a lengthy history of investigation, the sedimentological nature of the fossil-rich latest Cretaceous – earliest Tertiary basal Hornerstown Formation remains contentious. Several investigators interpret the Main Fossiliferous Layer (MFL) as representing a transgressive lag, with all of the fossils essentially reworked out of the underlying latest Maastrichtian Navesink Formation. However, this interpretation ignores abundant and overwhelming taphonomic evidence: it does not explain the numerous articulated and associated partial

and nearly complete vertebrate skeletons collected from the MFL for more than a century. These remains include crocodile and turtle skeletons, shark vertebral columns, a partial articulated bird wing, and delicate teleost remains, some of which are complete and include articulated scales. The taphonomic data clearly require an alternative hypothesis to explain the exceptionally high density of vertebrate remains in the MFL. We believe a condensed-section model more parsimoniously explains the formation of the MFL, with a time-averaged faunal assemblage accumulating in a sediment-starved glauconitic depositional environment. In addition to latest Cretaceous faunas, including ammonites, isolated mosasaur elements, *Squalicorax* teeth, and well-preserved and closely-associated *Enchodus* remains, the MFL also contains taxa that range upward into the Paleogene sections, including crocodiles, turtles, and lamnid sharks. This model better explains the mixture of more taphonomically mature remains with associated skeletons and extremely delicate specimens.

Technical Session XIV, Friday 3:30

**A DEBRIS FLOW-HOSTED BONEBED OF JUVENILE LAMBEOSAURINES IN THE TWO MEDICINE FORMATION OF MONTANA**

SCHERZER, Benjamin, Montana State University, Bozeman, MT, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA

The partially excavated Sun River Bonebed in the Two Medicine Formation of north-central Montana yielded the remains of several (MNI=8) unidentified juvenile lambeosaurines, nearly to the exclusion of other taxa. Sedimentologic and taphonomic data collected during excavation indicate the individuals perished in a catastrophic mass mortality event, with the remains ultimately entrained and deposited in a cohesive debris flow. Elements are predominantly unweathered, show a moderate frequency of abrasion, fracture styles indicative of fresh breaks, near complete disarticulation, a lack of tooth marks, and inferred "wet rot" common to epiphyses and other spongy bone. The bonebed is preserved as a 45 cm-thick massive, poorly sorted, normally graded, clast- to matrix-supported conglomerate with clasts dominated by lambeosaurine elements and occasional pebble- to cobble-sized calcareous clasts. A deficiency of small, light bones suggests winnowing of the assemblage, and elongate elements show a preferred orientation in trend, but random plunge. The clay-rich matrix lacking in invertebrate fossils, and local strata indicative of an ephemeral stream environment, suggest initiation of a debris flow through a seasonal flood flow bulking overbank fines. The dominance by lambeosaurine elements lends credence to the hypothesized age-class segregation of hadrosaurids in the Late Cretaceous of Montana. Among the restricted number of documented debris-flow hosted bonebeds, the Sun River Bonebed is unique in its preservation of an interpreted monotoxic mass mortality assemblage.

Technical Session XVI, Saturday 9:15

**BONE HISTOLOGICAL AND DEVELOPMENTAL ASPECTS OF THE TURTLE SHELL: COMPARISON WITH PLACODONT ARMOR AND AN ASSESSMENT OF *PRISCOCHELYS HEGNABRUNNENSIS* (MIDDLE TRIASSIC, SOUTHERN GERMANY)**

SCHEYER, Torsten, Paleontological Institute and Museum, University of Zurich, Zurich, Switzerland

Turtles are unique among modern reptiles in that they encase their trunk and shoulder girdle completely in a rigid shell, with some placodont reptiles (Sauropterygia) from the Triassic showing remarkable convergence to the turtle shell. Morphological differences and phylogenetic analyses have led to the confirmation that turtles and placodonts are not closely related. Recently, reviews of turtle shell bone and placodont armor plate histology, microstructural and microanatomical data became apparent that unambiguously distinguish both groups. New developmental data on the shell of pleurodiran taxa, including a series of *Emydura subglobosa*, indicate how costals and neurals may form through a bimodal mode of growth. An alternative structural hypothesis, based on heterochrony and lack of epidermal, dermal and musculoskeletal interaction is proposed for complete neural reduction in the genus *Emydura*. Unlike osteoderms of other tetrapods, that develop without cartilaginous preformation, a cartilaginous tissue, 'postcranial fibro-cartilaginous bone' tissue, was further found in placodont armor plates. Based on these new available data, as well as the fragmentary nature and accompanying scarcity of diagnostic features, *Priscochelys hegnabrunnensis* was revised. New morphological, histological and neutron tomographical (NT) data relating directly to the bony microstructure of the specimen itself are now available that question the previous assignment of the specimen as the oldest turtle. The specimen was found to share several distinctive features (i.e. bone sutures congruent with scute sulci, absence of a diploe structure with interior cancellous bone, thin vascular canals radiating outwards from distinct centers in each field and rugose ventral bone surface texture consisting of mineralized fiber bundles) with cyamodontoid placodonts and few with stem turtles (i.e. depth of scute sulci). *P. hegnabrunnensis* proposedly represents a cyamodontoid armor fragment consisting of fused conical plates. This project was funded by 'Fonds zur Förderung des akademischen Nachwuchses' (FAN), University of Zurich.

Technical Session XVI, Saturday 8:30

**A NEW SPECIES OF POLYCOTYLID PLESIOSAUR FROM THE EARLY TURONIAN OF UTAH: EXTENDING THE STRATIGRAPHIC RANGE OF NORTH AMERICAN *DOLICHORHYNCHOPS***

SCHMEISSER, Rebecca, University of Nebraska, Lincoln, NE, USA

Polycotyloid plesiosaurs are relatively well known in the Cretaceous Western Interior Seaway of North America. *Dolichorhynchops* and *Trinacromerum*, two closely related genera, are recognized from two distinct stratigraphic intervals in these marine sediments. *Trinacromerum* is the older of the two and is typically found in Cenomanian and Turonian sediments whereas *Dolichorhynchops* is found in Campanian sediments. Given their distribution into two distinct time ranges, it has been suggested that these genera may have biostratigraphic potential for North American marine sediments. A nearly complete specimen representing a new species of polycotyloid plesiosaur from the Tropic Shale of southern Utah excavated from Glen Canyon National Recreation Area in 2005 is well preserved, though disassociated. The skeleton is a subadult and has been identified as *Dolichorhynchops* sp. based on the presence of several morphologic characters. The characters that allow the placement within the genus *Dolichorhynchops* include, but are not limited to: gracile, lightly striated teeth; wide, short temporal fenestra; robust, laterally trending ectopterygoid; and vertical suspensorium. The specimen also has several unique morphologic characters that allow the recognition of a new species within *Dolichorhynchops*. This new specimen has been placed in a stratigraphic context within the Tropic Shale and is Early Turonian in age. This greatly extends the known stratigraphic range of North American *Dolichorhynchops* by approximately ten million years. This suggests the lack of biostratigraphic utility of *Dolichorhynchops* and *Trinacromerum* in North America and provides further information on the occurrence of *Dolichorhynchops*.

Romer Prize Session, Thursday 8:00

**INFERENCE OF DIEL ACTIVITY PATTERN SUGGESTS COMPLEX TEMPORAL RESOURCE AND HABITAT PARTITIONING AMONG MESOZOIC ARCHOSAURS**

SCHMITZ, Lars, Department of Geology, University of California, Davis, CA, USA

Diel activity pattern (DAP) is an important behavioral characteristic of vertebrates that influences niche partitioning and resource use. Despite the complexity observed in the extant biosphere, our knowledge of vertebrate DAPs in the Mesozoic has been sparse. I remedied this problem with a threefold approach that is based on physiologic optics and eyeball morphology. First, I established that osteological features (orbit length, OL; external scleral ring diameter, EXT; internal scleral ring diameter, INT) are correlated with optically relevant eyeball soft-tissue structures (eyeball diameter, ED; axial length, AL; lens diameter, LD). These structure-function relationships are evident in both avians and squamates, based on data that I collected for a total of 102 avian and 21 squamate species. Second, I showed that groups of different DAP among extant terrestrial amniotes can be separated with discriminant analysis of both eyeball soft-tissue and osteological dimensions. I measured ED, AL, and LD for 35 mammalian, 15 avian, and eight squamate species, and OL, EXT, and INT for 68 avian and 45 squamate species. I also investigated if a classification into different DAPs is possible by solely using EXT and INT, which I measured for 251 terrestrial avian species (n=1502). Third, I used discriminant analysis to infer the diel activity pattern of 33 fossil archosaurs, including *Euparkeria*, *Proterosuchus*, nine pterosaur, and 22 dinosaur (including four avians) species. My analysis revealed that a variety of DAPs existed among Mesozoic archosaurs, encompassing diurnal, nocturnal, and cathemeral or crepuscular patterns. The previous assumption of a dichotomous split of temporal habitat and resource use among terrestrial amniotes in the Mesozoic, with archosaurs being diurnal and mammals being nocturnal, needs to be re-evaluated. While quantitative inferences of the DAP of Mesozoic mammals are not available yet, my results demonstrate that many Mesozoic archosaurs were active both day and night. The results provide the first concrete evidence that the complex partitioning of temporal habitat and resources already existed in the Mesozoic.

Poster Session I (Wednesday)

**A NEW BASAL CROCODYLIFORM FROM THE LATE TRIASSIC OF NORTH CAROLINA**

SCHNEIDER, Vincent, North Carolina Museum of Natural Sciences, Raleigh, NC, USA; CLARKE, Julia, North Carolina State University/NCMNS, Raleigh, NC, USA; NESBITT, Sterling, American Museum of Natural History, New York, NY, USA; BRINKMAN, Paul, North Carolina Museum of Natural Sciences, Raleigh, NC, USA

A nearly-complete, articulated skeleton of a basal crocodylomorph was recovered from the Pekin Formation of the Deep River Basin (Newark Supergroup), which also produces specimens of traversodontid cynodonts, dicynodonts, aetosaurs, phytosaurs, and semionotid fish as well as several other pseudosuchians. The new specimen lacks only the rostral portion of the skull and the tip of the tail and is one of the first basal crocodylomorph specimens with an articulated manus and pes. It represents one of the oldest crocodylomorph occurrences in North America and conclusively shows that Crocodylomorpha was present by the Carnian. It shares at least three apomorphies with other crocodylomorphs: 1) a medially directed process of the prefrontal; 2) a supratemporal fossa that extends onto the frontal; and, 3) the absence of a postfrontal. Although the new specimen is approximately the same size as *Dromicosuchus grallator*, a crocodylomorph from slightly younger deposits from

the Durham Basin (Newark Supergroup), it has a pelvis that is about 20% longer. The new specimen's elongate and slender ilium differs from the shorter, more robust ilia of other crocodylomorphs. It possesses posteriorly expanded posterior cervical ribs in comparison to other crocodylomorphs. Differentiation between this specimen and other more fragmentary North American basal crocodylomorphs such as *Hesperosuchus agilis* is more difficult. The new specimen possesses two small phalanges on digit five of the pes, a feature not previously observed in Late Triassic crocodylomorphs. Additionally, it adds to the growing taxonomic diversity of crocodylomorphs prior to the end of the Triassic. However, the general body size and shape of North American basal crocodylomorphs remains conservative among all of the taxa. The monophyly of, and character optimizations across, basal crocodylomorph taxa remain controversial. This specimen should add new insights into the relationships of the basal members of this group.

Poster Session III (Friday)

**ANATOMY AND SYSTEMATICS OF *COLEPIOCEPHALE LAMBEI* (ORNITHISCHIA PACHYCEPHALOSAURIDAE) REVISED**

SCHOTT, Ryan, University of Toronto, Toronto, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; WILLIAMSON, Thomas, New Mexico Museum of Natural History, Albuquerque, NM, USA; CARR, Thomas, Carthage College, Kenosha, WI, USA; GOODWIN, Mark, University of California Museum of Paleontology, Berkeley, CA, USA

The systematics of pachycephalosaurid dinosaurs is poorly resolved, due in part to the incomplete nature of their remains, which often consist of fragmentary cranial domes. Recent studies differ significantly with regards to the morphological interpretation and phylogenetic placement of several pachycephalosaurid taxa from the Late Cretaceous of North America. *Colepiocephale lambei* (originally *Stegoceras lambei*) from the Foremost Formation of Alberta is particularly problematic. It has recently been recognized as 1) synonymous with *S. validum*, 2) a distinct species within the *Stegoceras* clade, and 3) an unusual taxon more derived than *Stegoceras*. Conflict between the latter hypotheses arises from different interpretations of the parietosquamosal region of the dome. Re-evaluation of the morphology of *C. lambei* on the basis of all known material from Alberta indicates that the posteromedian extension of the parietal is broken off at its base in all known specimens, and what has been interpreted as the posterior margin of the dome actually represents the anterior margins of large supratemporal fenestrae. The squamosals are not preserved in any specimen, but the form of the parietal suggests that they were present in the typical pachycephalosaurid configuration. *Colepiocephale lambei* is considered to be a distinct taxon based on several autapomorphic features and stratigraphic segregation from *S. validum*. Phylogenetic analyses that include new anatomical data confirm that *C. lambei* occupies a basal position within domed pachycephalosaurids and is most likely within the *Stegoceras* clade. This interpretation is more consistent with its stratigraphic position as one of the oldest known members of this clade. This study also results in the recognition of the first material referable to this taxon from the Judith River Formation of Montana. This occurrence results in a southerly geographic range extension for this taxon, and indicates for the first time that its stratigraphic range extends above the Taber Coal Zone and into the equivalent of the lower Oldman Formation in Alberta.

Poster Session I (Wednesday)

**DENTAL EVOLUTION IN NORTH AMERICAN SHORT-FACED BEARS**

SCHUBERT, Blaine, Department of Geosciences and Don Sundquist Center of Excellence in Paleontology, East Tennessee State University, Johnson City, TN, USA

The osteology and dentition of North American short-faced bears (genus *Arctodus*) was reviewed and discussed by Björn Kurtén in the late 1960s. Although general size differences were noted in the two species, *A. pristinus* and *A. simus*, their temporal and evolutionary relationship to one another was not resolved. Here, a review of currently known *Arctodus* specimens and their dental measurements establishes a framework for changes in dental proportions between species and through time. *Arctodus pristinus* first appears in the late Blancan, extends to the late Irvingtonian, and is not known from the Rancholabrean. *Arctodus simus* appears in the middle Irvingtonian and goes extinct at the end of the Rancholabrean. Overall, *A. simus* is larger and had a shorter face with more crowded teeth. The most obvious difference in the dentition between these two species is a trend toward larger premolars and anterior molars in *A. simus*. This trend can be tracked chronologically, and thus it seems apparent that *A. pristinus* is the ancestor of *A. simus*.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 11:00

**THE CHEEK REGION OF THE ACTINOPTERYGIAN *DIALIPINA***

SCHULTZE, Hans-Peter, University of Kansas, Natural History Museum, Lawrence, KS, USA

The osteichthyan *Dialipina* possesses a skull roof pattern and scales with ganoin that are typical for primitive actinopterygians. The triphycercal tail is unique within actinopterygians, but occurs in parallel within different sarcopterygian groups. In contrast, the cheek region is different from that of actinopterygians and sarcopterygians in its division into many bones. The teeth of upper and lower jaw sit on 'naked' tooth-bearing elements; there is neither a

maxilla nor dentary/dentalosplenic. The lower jaw is formed by seven bones: one anterior bone followed by a long dumb-bell shaped bone. Five bones lie between the posterior part of the dumb-bell shaped bone and the tooth-bearing element. The upper jaw is formed by many small bones followed posteriorly by a few larger bones. The cheek is covered by many small bones; a preoperculum cannot be identified. A large operculum can be identified, followed dorsad by small bones below the skull roof. Such a bone arrangement on the lateral side of the skull is unknown in any other osteichthyan. A division of the cheek region in many bones is found in primitive dipnoans, but the arrangement is quite different. It seems at present most parsimonious to interpret the bone composition of the lateral side of the skull as unique and autapomorphic for the actinopterygian *Dialipina*.

Technical Session II, Wednesday 9:15

**TOOTH WEAR SIGNATURES OF EXTANT EQUIDS CORRELATE WITH HABITAT PARAMETERS - A TOOL TO INFER PLEISTOCENE HOMINID ENVIRONMENTS**

SCHULZ, Ellen, Biocenter Grindel and Zoological Museum, University of Hamburg, Hamburg, Germany; KAISER, Thomas, Biocenter Grindel and Zoological Museum, University of Hamburg, Hamburg, Germany

Modern members of the genus *Equus* (zebras, horses and asses) are employed as indicators for the structure of their habitats and habitat parameters of Pleistocene equid populations associated with Palaeolithic human occupation. Dietary traits of extant *Equus* species were ranked in a continuum reflecting the relative proportions of abrasion and attrition in dental wear (dental mesowear). GIS-mapping was used to correlate dental wear signatures of 790 individuals of extant *Equus africanus*, *E. ferus*, *E. grevyi*, *E. hartmannae*, *E. hemionus*, *E. khur*, *E. kiang*, *E. quagga* and *E. zebra* from the Holarctic, Palaeotropical and Capensis with climate data. Mesowear signatures are demonstrated to reflect climate related environmental parameters as rainfall and climatic water balance on the species level. The established extant database is applied to Late Pleistocene *Equus ferus* and *E. hydruntinus* populations which are sympatric in some OIS 5 profiles from Southern Germany, where they are associated with human occupation levels. GIS-mapping indicates that extant equids inhabit three major climate zones: The equatorial, the arid and the warm temperate zone. Based on mesowear signatures both fossil species relate to extant species from arid climates only. In *E. ferus* a shift towards more abrasive diets is observed between OIS 5 and OIS 3 environments. This shift is interpreted as to reflect the climatic cooling which lead to more arid environments. The variability in the dietary signal also indicates the remarkable flexibility of *E. ferus* during the Middle Palaeolithic period. This flexibility distinguishes *E. ferus* as a highly sensitive indicator of Pleistocene habitat structure. *E. hydruntinus* had a less abrasive diet than the sympatric *E. ferus*. The species was thus most likely associated with floodplains as independently indicated by the fluvial sedimentology. The presence of both indicates a diverse composition of the Middle Palaeolithic hominid environments including a shift towards more arid habitats at the transition between the Middle and the Upper Palaeolithic period.

Poster Session IV (Saturday)

**MORPHOLOGICAL VARIATION IN OTOLITHS OF *CYPRINUS CARPIO* LINNAEUS, 1758**

SCHULZ-MIRBACH, Tanja, Ludwig-Maximilians-University Munich, Munich, Germany

Like other teleost fishes, the Ostariophysi possess three types of otoliths in the membranous labyrinth on each side of the skull. However, in ostariophysan fishes, only the *lapilli* are large and robust and thus have a good fossil preservation potential. A terminology for the *lapillus* morphology has recently been introduced. The lack of detailed studies on extant *lapilli* with regard to intra-specific variability and morphological changes during ontogeny renders classification of fossil *lapilli* a difficult task. In order to evaluate these changes, I chose the extant *Cyprinus carpio* (Cyprinidae) to carry out a detailed investigation of *lapilli*. Thirty-six captive-bred specimens from Southern Germany differing in size (standard length, SL) respective age were investigated. The standard length of the individuals ranged from 29 mm to 300 mm. The shape of the *lapilli* is round and oval with smooth margins in small fish (SL < 30 mm). With increasing fish length, the contour of the *lapilli* becomes more elongate, showing a pronounced posterior tip and crenulated margins. *Lapilli* of fish with SL < 120 mm display small crystals on their ventral side, which is oriented to the sensory epithelium. In fish larger than 170 mm, these crystals vary in size and reveal a rosette-like pattern. In five individuals (SL > 170 mm), aberrantly developed *lapilli* were observed, which are characterized by an exceptionally thin and transparent posterior portion or medial margin. Further investigations may show whether these aberrant developments are an artifact of selective breeding or a naturally occurring phenomenon. In summary, the results of this study may allow for a more precise differentiation between (i) juvenile and adult *lapilli* belonging to the same fossil species, or (ii) two different morphotypes representing two distinct species.

Poster Session I (Wednesday)

**WILL THE REAL POLYCOTYLUS PLEASE SWIM UP**

SCHUMACHER, Bruce, Sternberg Museum of Natural History, Hays, KS, USA

The first valid polycotylid plesiosaur named from the North American Cretaceous, *Polycotylus* is poorly understood, in part due to inadequacy of the holotype specimen which consists of twenty-one vertebrae, a partial ilium, distal end of a propodial, and various proximal podials and phalanges (USNM 27678, AMNH 1735). Williston declared another nearly complete skeleton with skull parts (YPM 1125) the paratype. Hallmark characters of the genus as compared to other polycotylids include a higher cervical count, shorter vertebral centra with deeply scalloped margins, chevron facets formed equally by adjacent caudals, propodials with expanded distal ends bearing four distinct facets for epipodial bones, and markedly elongate ischia. Recent works have suggested other diagnostic characters, including larger size, more robust teeth, strongly sigmoidally curved humeral shaft, epipodial bones much broader than long, subquadrate and shorter phalanges, and compressed and recurved ilia. From this list of characters the genus would seem to be a distinct morphotype more easily divisible from the other classically known and also confused polycotylids, *Trinacromerum* and *Dolichorhynchops*. However, skeletons attributable to *Polycotylus* have been misidentified as both *Trinacromerum* and *Dolichorhynchops*. In particular, UNSM 50133 was reported as consisting of a skull assignable to *Dolichorhynchops osborni*. However, UNSM 50133 includes a substantial portion of the post-cranial skeleton including cervical, dorsal, and caudal vertebrae, partial girdles, and articulated front and hind limbs. UNSM 50133 possesses many of the hallmark characters for *Polycotylus*, including a strongly sigmoidally curved humeral shaft, humerus and femur bearing four distinct epipodial facets, short vertebral centra, compressed and recurved ilium, and chevrons facets formed equally by adjacent caudals. Given this, UNSM 50133 is more likely assignable to *Polycotylus* and the complete skull of this specimen should be used to characterize the genus. The type specimen of *Trinacromerum bonneri* (KUVP 40002) exhibits many of these same post-cranial characters and should also be examined in this regard.

Poster Session II (Thursday)

**THE LAST SUPPER: MOLAR MICROWEAR FEATURES OF PHASCOLARCTUS CINERUS AND THE EFFECTS OF AGE, SEX AND SEASON**

SCHWARTZ, Leah, Faculty of Arts and Science, New York University, New York, NY, USA; GRIFFITH, Joanna, Koala Infectious Disease Research Group, Faculty of Veterinary Science, University of Sydney, Sydney, Australia; FLANAGAN, Cheyne, Koala Hospital, Port Macquarie, Australia

Dental microwear is widely used by paleontologists to evaluate the diet and environment of extinct animals. This study examined the microwear of an extant Australian marsupial, the koala (*Phascolarctus cinerus*), using a sample for which the last few meals were known. The purpose of this study was to associate the microwear features observed with the diet of an individual animal and to determine the effects on microwear features of variables such as age, sex and season. Twenty-six koalas were entered into this study. All were wild animals from the Port Macquarie area of New South Wales admitted to a wildlife hospital for treatment. Eating habits of the animals while in captivity were recorded, and gut content collected. Microwear features were examined at 70x magnification in accordance with the method used for a larger microwear 'library' of extant Australian marsupials under preparation for use in paleoecological studies. No significant difference was found ( $p > 0.05$ ) between the average numbers of pits, large pits and scratches for koalas of different sex or age classes. The effect of age on microwear may be negated in this species by an increase of rumination like mastication behavior in older koalas. There were also no significant differences in microwear features between koalas entered into the study that died in different years, months or seasons. The last meal items the koalas consumed did have a significant impact on microwear, with *Eucalyptus nicholii*, the narrow-leaved peppermint, increasing the number of pits observed. This study confirms that the largest effect on microwear is the last few meals consumed by the individual animal and that, at least for animals feeding on evergreen species in a temperate environment, season has little effect.

Technical Session XIV, Friday 3:45

**EXCEPTIONAL PRESERVATION OF BRACHYLOPHOSAURUS CANADENSIS (CAMPANIAN, JUDITH RIVER FORMATION, USA)**

SCHWEITZER, Mary, North Carolina State University, Raleigh, NC, USA; ORGAN, Chris, Harvard University, Cambridge, MA, USA; ZHENG, Wenxia, North Carolina State University, Raleigh, NC, USA; ASARA, John, Beth Israel Deaconess Medical Center, Boston, MA, USA; CLELAND, Timothy, North Carolina State University, Raleigh, NC, USA

The presence of apparently original soft tissues in demineralized *Tyrannosaurus rex* bone (MOR 1125) was unexpected. We demonstrated the persistence of these components (transparent vessel-like structures, two populations of cell-like microstructures, and flexible, fibrous matrix) in a variety of fossils spanning several continents, time periods, and taxa, and we showed, using immunochemistry, amino acid sequence data, and a variety of other methods, that collagen fragments were preserved in matrix tissues and chemical extracts of bone fragments in extremely low concentrations. Recently we showed that sufficient molecular signal was retained in these sequences to generate phylogenetic hypotheses that are consistent with other lines of evidence supporting the close relationship of birds and

dinosaurs. Here, we present the results of multiple analyses conducted on the femur of an ~80 Ma hadrosaur (*Brachylophosaurus canadensis*, MOR 2598). Hind limb elements of this dinosaur were collected specifically for molecular analyses, using a protocol designed to optimize the chances of such recovery, while minimizing introduction of contamination or artifact. We show preservation of the above endogenous components in skeletal elements of this dinosaur, and present evidence for the presence of proteins, including collagen, osteocalcin, hemoglobin, and elastin. Multiple phylogenetic analyses of amino acid sequence data place this hadrosaur well within Archosauria, closer to birds than crocodylians.

Technical Session I, Wednesday 10:30

**MULTITUBERCULATES (MAMMALIA, ALLOTHERIA) FROM THE LATE CRETACEOUS (CAMPANIAN) BELLY RIVER GROUP OF SOUTHERN ALBERTA, CANADA**

SCOTT, Craig, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; FOX, Richard, University of Alberta Laboratory for Vertebrate Paleontology, Edmonton, AB, Canada; BRINKMAN, Donald, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Strata of the Belly River Group exposed in south central and southeastern Alberta are renowned for documenting vertebrate fossils of Late Cretaceous (Campanian) age. Although mammals from the Belly River Group have long been recognized, much of their taxonomy, systematics, and paleoecological significance remains undescribed, with one group in particular, the multituberculates, being poorly documented. Previous and ongoing fieldwork in southern Alberta has resulted in an enormous collection of Campanian multituberculates that includes dental, gnathic, cranial, and postcranial specimens that document taxonomically diverse assemblages spanning the Belly River Group. Twenty multituberculate taxa are recognized from the Belly River Group. The basalmost Foremost Formation documents, among others, two archaic species of the cimolodontid *Cimolodon*, and possibly six cimolomyids, including two species of *Meniscoessus*, as well as a new species of *Cimolomys*. The stratigraphically higher Oldman Formation records a taxonomically diverse assemblage dominated by *Cimexomys judithae* and a new genus of large-bodied cimolomyid; the Oldman Formation notably documents the first Canadian occurrence of the *Paracimexomys*-grade *Cedaromys*, two archaic species of *Cimolodon*, two neoplagiulacids, and an incomplete skull of a *Cimexomys*-like multituberculate. Eighteen taxa are known from the overlying Dinosaur Park Formation, most of which are also known from the Oldman Formation. Notable other occurrences in the Dinosaur Park Formation include *Cimolodon electus*, a species of *Cimolodon* similar to *C. foxi*, and possibly as many as eight cimolomyids. Multituberculates greatly increase in taxonomic diversity in the Oldman Formation, concomitant with a major regression of the Western Interior Seaway and a presumed increase in inland habitat. Although the Belly River multituberculate assemblages bear closest resemblance to other northern Judithian faunas, several taxa are shared with assemblages from the Kaiparowits Formation of southern Utah, suggesting that some of the differences between northern and southern multituberculate assemblages may be owing, at least in part, to sampling error.

Technical Session VI, Thursday 3:00

**LOW MAGNIFICATION MICROWEAR: QUESTIONS OF PRECISION AND REPEATABILITY**

SCOTT, Robert, Rutgers, The State University of New Jersey, New Brunswick, NJ, USA; SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, USA; GRINE, Frederick, Stony Brook University, Stony Brook, NY, USA; TEAFORD, Mark, Johns Hopkins University, Baltimore, MD, USA

Since dental microwear analyses began thirty years ago, researchers have used various image-based techniques to reconstruct the diet of extinct vertebrates. These methods involve the subjective recognition of apparent features on two-dimensional images of three-dimensional wear fabrics. Recognized limitations of these traditional methods include: (1) moderate to high levels of intra- and inter-observer error in feature recognition, (2) time consuming protocols for quantifying features, and (3) expenses associated with imaging technology such as scanning electron microscopy (SEM). Recently, a low magnification, light microscopy microwear technique has become popular among vertebrate paleontologists as a less time intensive, low-cost alternative to traditional SEM image-based methods. Dental microwear surfaces can vary greatly even within a single species and thus some precision with respect to quantification of microwear is required. This is especially true in the case of fossil teeth where post-mortem wear effects may leave only small samples available for analysis. It is not clear that low magnification light microscopy offers a sufficient level of precision or repeatability. A series of double-blind tests indicate that inter-observer error rates for categorizations of microwear features are higher than those for traditional microwear analyses. Moreover, our experience demonstrates that even after significant training, new investigators are not always able to apply the technique. We urge caution with respect to the use of low magnification light microscopy for quantifying dental microwear surfaces that are often quite variable.

Poster Session II (Thursday)

**PRELIMINARY SYSTEMATIC AND PALEOENVIRONMENTAL ANALYSIS OF THE AVIFAUNA FROM ROLAND SPRINGS RANCH, WEST TEXAS**

SCULLEY, Julie, Sam Houston State University, Huntsville, TX, USA; JOHNSON, Eileen, Museum of Texas Tech University, Lubbock, TX, USA; LEWIS, Patrick, Sam Houston State University, Huntsville, TX, USA

The Plio-Pleistocene is of great interest in regard to avian evolution, as the climatic fluctuations of the Pleistocene impacted avian biodiversity significantly. By the late Pliocene, virtually all modern avian families and genera were present and species diversity had peaked in excess of 20,000. The glaciation events of the Pleistocene reduced this number to fewer than 10,000. As few described North American avifaunal assemblages are available, the overall pattern of avian systematics and biogeography is poorly understood. This research is focused on a systematic and paleoenvironmental analysis of the avifaunal component of a fossil assemblage from the Roland Springs Ranch of Snyder, Texas. This locality, RSR1, is in the Rolling Plains region of West Texas. Deposition appears to have occurred in a low-energy fluvial environment without apparent taphonomic bias resulting in the preservation of a diverse fauna. Preliminary biostratigraphic dating using non-avian taxa suggests this assemblage represents a transitional period between the Blancan and Irvingtonian North American Land Mammal Ages (ca. 1.8 mya). As such, the RSR1 avifauna should compare well with others from contemporaneous North American sites, and is hypothesized to be similar to those from localities located in the early to middle Blancan-age Rexroad Formation in the High Plains of Kansas. This avifaunal assemblage numbers over 30 specimens and consists of various elements representing at least two orders. The fauna fills an important spatial gap in the avifaunal record and will help to resolve avian systematic and biogeographical issues from the important period just prior to the Pleistocene.

Poster Session IV (Saturday)

**BASICRANIAL MORPHOLOGY AND PROTOCERATID RELATIONSHIPS**

SEALE, Brendon, University of Calgary, Calgary, AB, Canada; THEODOR, Jessica, University of Calgary, Calgary, AB, Canada

The phylogenetic placement of Protoceratidae within Artiodactyla has proven to be a challenging task. Early workers placed them within Ruminantia, but they had subsequently been moved into the Tylopoda, based on the putative synapomorphy of the arterial canal for the vertebral artery being inside the neural arch. CT studies of *Syndyceras*, a highly derived synthetoceratine, suggested that protoceratids lacked key tylopod synapomorphies in the ear region, such as the crista promontorii medioventralis (CPM) and an enlarged mastoid fossa. These studies and studies of the basal protoceratid *Leptotragulus* suggested that the periotic morphology of protoceratids more closely resembled ruminants. High resolution CT scans of the ear region of AMNH 53523, *Protoceras celer*, confirm that the morphological characteristics of the periotic of synthetoceratines and of the basal protoceratids are also found within the protoceratines. *P. celer* shows a large anteroposteriorly-oriented crest on the periotic, subdividing the braincase into distinctive cerebral and cerebellar cavities, a condition found among ruminants and not among tylopods. Likewise, the subarcuate fossa is reduced as in ruminants. In addition, the periotic projects laterally to the exterior of the skull. Unlike camelids, the occipital flanges are far less enlarged and there is no ventral flange covering the petrosal canal of the periotic (=CPM). In order to assess whether these characters had a significant effect on the phylogenetic reconstruction, a parsimony analysis of 220 characters was analyzed for 52 taxa. The resulting phylogeny placed *Protoceras* in a position basal to all ruminants. Despite the inclusion of several putative protoceratid synapomorphies (for example, a small facial vacuity and strong lingual cingula) *Heteromeryx*, *Leptotragulus* and *Leptoreodon* are not recovered with *Protoceras* in a monophyletic Protoceratidae. Although protoceratids are most likely monophyletic, additional characters are needed to clearly demonstrate the monophyly of this group, and clarify its placement within Artiodactyla.

Technical Session XI, Friday 11:45

**DECOUPLED TRENDS IN THE EVOLUTION OF UPRIGHT STANCE IN NON-MAMMALIAN SYNAPSIDS**

SEARS, Karen, University of Illinois, Urbana, IL, USA; DOROBÄ, Carolyn, University of Illinois, Urbana, IL, USA; BECK, Allison, Augustana College, Moline, IL, USA

The evolution of an upright stance in synsids has been linked to the evolution of many mammalian traits, such as increased respiratory rate, locomotor efficiency and agility. As such, understanding the mechanisms behind the evolution of stance has the potential to illuminate the driving forces of the transition from 'reptile' to mammal. Here we test three long-standing hypotheses concerning the transition to an upright posture: (1) the transition in the hind limb, which provides the main propulsive thrust for locomotion, was completed before the transition in the forelimb, (2) the transition occurred gradually, and (3) there was a strong, persistent selective pressure for an upright stance in Synsida. We reconstructed morphometric proxies for stance for the fore- and hind limb on a phylogeny of 75 non-mammalian genera then compared the numbers, magnitudes, and rates of evolutionary changes toward and away from an upright stance. The hind limb begins its transition with the first therapsids, while the forelimb does not begin until the appearance of cynodonts, ~15 my later. This lag hints at a decoupling of the developmental and genetic controls of the fore- and hind limb during synsoid evolution. The evolution of stance in

both limbs is not gradual, but rather shows early periods of stasis, followed by relatively high rates of change, then a slowing in Probainognathia, immediately prior to the origin of mammals. The transition to upright stance does not strictly coincide with an observed trend toward reduction in body size, suggesting that small body size was not a prerequisite for an upright stance. We find no strong evolutionary bias towards an upright stance among non-mammalian synsids in either limb, suggesting that it was not persistently selectively advantageous across the entire clade or within groups. However, along the lineage leading to mammals, changes are strongly biased toward upright stance for both limbs. This suggests that the forelimb, far from passively responding to changes in the hind limb, was also under selective pressure to become upright, and that the transitions of both limbs were critical to the evolution of a mammalian lifestyle.

Technical Session I, Wednesday 11:30

**THE FIRST NORTH AMERICAN EQUIDS: A HIGH RESOLUTION STRATIGRAPHIC STUDY IN THE PALEOCENE-EOCENE THERMAL MAXIMUM**

SECORD, Ross, University of Nebraska, Lincoln, NE, USA; CHESTER, Stephen, Yale University, New Haven, CT, USA; BLOCH, Jonathan, University of Florida, Gainesville, FL, USA; BOYER, Douglas, Stony Brook University, Stony Brook, NY, USA; KRIGBAUM, John, University of Florida, Gainesville, FL, USA

Perissodactyls first appear in North America during the Paleocene-Eocene Thermal Maximum (PETM), along with the first artiodactyls and euprimates. These taxa appear to have entered North America over high-latitude landbridges in response to global warming. Here we present a new, high-resolution stratigraphy from the Cabin Fork area of the southern Bighorn Basin, with emphasis on the lower part of the PETM. The PETM is recognized by the associated carbon isotope excursion (CIE), which is constrained in this area by stable isotopes in organic carbon, n-alkanes, and new data from mammal teeth. The main body of the CIE spans ~40 m of strata. The first in situ occurrence of equids is in the lowest intermittent red bed (LIRB), ~3 m above the beginning of the CIE (BCIE). Equids are by far the most abundant mammal in LIRB, with one locality yielding 131 teeth (MNI=10), but no other mammals. Previous studies suggest that two species occur in the PETM, the smaller *Hyacotherium sandrae* (= *Sifrhippus sandrae*) and larger *H. grangeri* (= *Arenahippus grangeri*). The former is a common species in the PETM, while the latter is common in post-PETM, early Wasatchian localities. We find that teeth (including m1s) from LIRB fall within the size ranges of both *H. sandrae* and *H. grangeri*, suggesting the presence of either two species or one highly variable species. The intermediate size and unusual abundance of equids in LIRB suggests a unique, transient habitat in the lower part of the CIE. Such a habitat is also suggested by the *Meniscotherium* zone in the northern Bighorn Basin, which may be temporally equivalent but contains a markedly different fauna. A decrease in body size occurs above LIRB, ~10 to 30 m above the BCIE. This decrease appears to coincide with peak PETM warming, based on correlation to the marine record. Thus, body size change may have resulted from an ecological response to climate change. We identify teeth in this interval as *H. sandrae*, although three m1s are smaller than any perissodactyl teeth previously reported, the smallest yielding a body mass estimate of only 2.4 kg. Teeth identified as *H. grangeri* occur ~40 m above the BCIE, in the waning part of the CIE.

Technical Session XII, Friday 11:15

**DENTAL MORPHOLOGY AND DIET OF A LARGE ADAPIFORM PRIMATE FROM THE EOCENE BIRKET QARUN FORMATION, EGYPT**

SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA; PERRY, Jonathan, Stony Brook University, Stony Brook, NY, USA; SIMONS, Elwyn, Duke University, Durham, NC, USA

Recent work at the ~37 million-year-old Birket Qarun Locality 2 in the Fayum Depression, Egypt, has yielded material representing a new large-bodied genus and species of adapiform primate. Several isolated teeth, representing all tooth positions, and four partial mandibles have been recovered. The new species is the largest adapiform known from Africa; however, the teeth are below the size range of the largest adapid (European *Leptadapis magnus*). Based on data on tooth size in extant strepsirrhines, reconstructed body size for the new adapiform is 3.6kg (95% C.I. = 3.2-3.9). The new species resembles late Eocene (~34 Ma) *Aframomius dieides* from the same area, but is much larger and more specialized. Distinct features of the new species include the loss of p2 and an enlarged and obliquely oriented p3 (a remarkable convergence with catarrhine anthropoids); large hypocones, distinct prehypocristae, and mesostyles on all upper molars; and the presence of a mesoconid on the cristid obliqua in some specimens. The new species appears to be closely related to *Aframomius*; among adapiforms both African taxa are most similar in morphology to *Caenopithecus* from the middle Eocene of Europe. Shearing quotients for the new adapid are the highest for any Old World adapiform and suggest a diet rich in leaves. The mandibular corpus is short and deep, which would help to reduce and resist bending moments while increasing masticatory leverage. With a diet of tough leaves, a very large number of chewing cycles was likely required per feeding bout (relative to primates that consume mainly fruits, for example). The mandibular symphysis is fused in the only specimen that preserves the anterior part of the mandible. Dietary reconstruction for this new species bolsters the claim that African adapiforms were specialized folivores. Therefore, an increase in aridity and seasonality through the Eocene is an implausible explanation for the extinction of these early primates.

Poster Session I (Wednesday)

**A PALEODIETARY ANALYSIS OF LATE EOCENE TO MIDDLE MIOCENE MERYCOIDODONTIDAE USING THREE TECHNIQUES OF MOLAR ANALYSIS**

SEMPREBON, Gina, Bay Path College, Longmeadow, MA, USA; DREWNIAC, Patricia, Bay Path College, Longmeadow, MA, USA

The paleodiets of late Eocene to middle Miocene oreodonts (Merycoodontidae) were reconstructed by comparing data from macroscopic facet development (mesowear analysis), microscopic enamel scar patterns (microwear analysis), and relative hypsodonty of molar teeth. While oreodonts have generally been considered to be mainly folivorous browsers, the results of this study indicate a much wider variety of dietary practices enjoyed by oreodonts than previously expected, including bark stripping, folivory, frugivory, and grass consumption. Results are suggestive of a pig-like dietary regime. From the late Eocene to the early Oligocene, oreodonts apparently enjoyed relatively low abrasion browsing. However, from the late Oligocene through the middle Miocene, there is a trend toward more abrasive diets (i.e., mainly “dirty” browsing and some hard fruit, bark, and grass consumption). Mesowear and microwear data suggest a fluctuation of diet over time without a concomitant change in crown height evolution. Oreodonts apparently had a generalist dietary strategy which may have allowed them to live in large numbers in a variety of habitats – a finding consistent with the large numbers of oreodonts found in the floodplain deposits of the later Eocene and Oligocene.

Technical Session X, Friday 8:15

**A COMPARATIVE FUTURE FOR MORPHOLOGY-BASED CLADISTICS**

SERENO, Paul, University of Chicago, Chicago, IL, USA

Morphological transformation provided the impetus for Darwinian narrative and, a century later, the birth of cladistic methodology. Morphology-based cladistic analysis, nonetheless, has been labeled by critics as hopelessly ambiguous and inevitably dispensable in a molecular era. Ambiguity in coding and scoring morphological characters is a serious concern with basic issues unresolved, such as the definition of a “character” or the meaning of “absence”. Locating relevant character data has become an arduous task, given that morphology-based analyses consider not only species within a clade but also basal radiations and lineages. A morphology-based tree of life is a patchwork of partially overlapping analyses. How to compare and synthesize? Supertree methods are removed from data-level issues at the heart of the problem. Greater “explicitness,” gated “supermatrices,” or images banks also do not directly address the problems, which are rooted in understanding and standardizing character structure, measuring characters origin and usage, and measuring variation in the scoring of character states. At present we compare phylogenetic results (cladograms) rather than the character data generating those results and thus do not address the root causes for incongruence. Morphological character statements are composed of only a few logical components arranged in a two stereotypical patterns based on two premises (character independence, mutual exclusivity of character states). Minimal standards for character data, a flexible character database, and simple similarity indices for data comparison will greatly facilitate data compilation, characterization and comparison. Equilibrating competing hypotheses by determining their shared “taxonomic scope” is key to isolating mutually relevant character data. Competing hypotheses for particular regions of the tree of life are analyzed to highlight the method of comparative cladistics. When the procedures outlined here are software-facilitated, morphology-based cladistic analysis seems poised to enter a comparative era that overcomes long-recognized limitations in data comparison and synthesis.

Poster Session I (Wednesday)

**DYROSAURID (CROCODYLIFORMIA: MESOEUCROCODYLIA) REMAINS FROM THE MAASTRICHTIAN INTERTRAPPEAN BEDS OF INDIA AND THE DISTRIBUTION OF THE DYROSAURIDAE**

SERTICH, Joseph, Stony Brook University, Stony Brook, NY, USA; KHOSLA, Ashu, Panjab University, Chandigarh, India; PRASAD, Guntupalli, Jammu University, Jammu, India; VERMA, Omkar, Jammu University, Jammu, India

Dyrosauridae is a well known and widespread clade of longirostrine crocodyliforms known from Upper Cretaceous to Eocene deposits of the Atlantic and Tethys margins. Dyrosaurid remains have been recovered from coastal, epeiric, and fluvial deposits of Afroarabia, Europe, South America, North America, and southern Asia with the group achieving its greatest taxonomic diversity during the early Paleogene. Despite considerable recent attention, the early evolution and Late Cretaceous distribution of dyrosaurids remains poorly understood. Nonetheless, the distribution of Late Cretaceous dyrosaurid localities has resulted in a number of hypotheses regarding the origin and subsequent dispersal of this mostly marine group. Of particular importance to this debate is the early history of dyrosaurids on the Indian subcontinent. While the presence of dyrosaurids has long been known from the Upper Cretaceous Deccan volcanic-sedimentary sequences, these remains are incomplete and have often been overlooked in reconstructions of dyrosaurid dispersal. We report here the first definitive dyrosaurid material from the Maastrichtian intertrappean beds of Kisalpur locality, Dindori District, Madhya Pradesh, central India. The Maastrichtian intertrappean beds have yielded a diverse flora and fauna including numerous vertebrates, mollusks, ostracodes, and plants. In spite of this diversity, crocodyliform remains have previously been restricted to isolated teeth and vertebrae of

indeterminate taxonomic affinity. The new material consists of unassociated cranial and postcranial remains, as represented by a partial mandible, frontal, and two vertebrae. In addition to representing the most complete crocodyliform materials yet recovered from the intertrappean beds of central India, these remains present conclusive evidence for the presence of dyrosaurid crocodyliforms in the Late Cretaceous of the Indian subcontinent and demonstrate that the clade achieved widespread distribution by the Maastrichtian.

Technical Session XII, Friday 11:45

**MUSCULOSKELETAL MODELLING OF A MACAQUE SKULL - SENSITIVITY STUDIES**

SHI, JunFen, Department of Engineering, University of Hull, Hull, United Kingdom; CURTIS, Neil, Department of Engineering, University of Hull, Hull, United Kingdom; FITTON, Laura, Hull-York Medical School, University of York, York, United Kingdom; O'HIGGINS, Paul, Hull-York Medical School, University of York, York, United Kingdom; FAGAN, Michael, Department of Engineering, University of Hull, Hull, United Kingdom

Biomechanical modeling is an important tool for investigating functional anatomy, where the effects of forces and motions can be analysed in detail through three dimensional computational simulations. Here we used advanced multibody dynamics analyses (MDA) to study the cranial loading of a macaque (*Macaca fascicularis*) during biting. The MDA macaque model included the major muscle groups involved in mastication (temporalis, masseter, medial and lateral pterygoids) and incorporated muscle wrapping of the anterior and posterior temporalis. Unconstrained contact was defined between the cranium and mandible at the temporomandibular joints (TMJ) during biting, with a feedback loop used to limit the anterior/posterior movement of the mandible through automatic muscle control. The MDA model calculates the bite force and joint forces in response to the applied muscle forces; however, the sensitivity of these forces to factors such as muscle position must be known to have confidence in the simulation and understand its limitations. Thus a series of sensitivity studies was performed on the macaque model to assess the effect of muscle position and assumed optimum muscle length on bite force and joint forces during biting. A range of bite positions and gape angles (e.g. canine to molar biting at gapes of 5° to 30°) was considered during the simulations. The sensitivity analysis revealed that a shift in muscle position of just 5 mm (the skull has a postorbital length of 65 mm) could alter the bite forces by up to 20%. The location of the temporalis muscle group had the greatest effect, whereas the position of the deep masseter was not as important. These sensitivity studies highlight the importance of accurate muscular representations when undertaking any modelling of skulls. How such variations affect the strain distributions in the macaque skull is now being investigated in a complementary finite element study.

Poster Session III (Friday)

**NEW IGUANODONTID DINOSAUR MATERIAL FROM THE LATE EARLY CRETACEOUS IN THAILAND**

SHIBATA, Masateru, Fukui Prefectural Dinosaur Museum, Fukui, Japan; PRATUENG, Jintasakul, Museum of Petrified Wood and Mineral Resources, Nakhon Ratchasima Rajabhat University, Nakhon Ratchasima, Thailand

The Fukui Prefectural Dinosaur Museum, Japan and the Museum of Petrified Wood and Mineral Resources, Thailand began a dinosaur excavation project in Nakhon Ratchasima, northeastern Thailand in 2007. Many vertebrate fossils have been collected from the late Early Cretaceous non-marine Khok Kruat Formation, which consists of reddish calcareous conglomerates and sandstones at the site. These include a new iguanodontid dinosaur material, which includes a complete maxilla, caudal part of dentary, jugal, and ishium. Several characters of these bones indicate that it belongs to a non-hadrosaurid iguanodontid. For example, the low angled triangular shape of maxilla in lateral view is different from that of an isosceles triangular shaped in hadrosaurids. *Probatrosaurus*-like iguanodontid was already known from vertebrae, limb bones, braincase, isolated teeth and maxilla. The newly found dentary in this project bears wide dentary teeth with a diamond-shape that is different from those of *Probatrosaurus*, which are narrower and lanceolate shaped. There is a tendency for miniaturization of maxillary teeth, which is common in hadrosaurids. Such features of our iguanodontid maxilla and dentary are different from, and primitive to, *Probatrosaurus*. Therefore, it might be a new non-hadrosaurid iguanodontid in Thailand.

Poster Session IV (Saturday)

**A NEW ANACORACID SHARK FROM THE UPPER CRETACEOUS NIOBRARA CHALK OF WESTERN KANSAS, U.S.A.**

SHIMADA, Kenshu, DePaul University, Chicago, IL, USA

KUVP 141876 is a specimen of the extinct shark genus *Squalicorax* Whitley (Neoselachii: Anacoracidae) from the Smoky Hill Chalk Member of the Upper Cretaceous Niobrara Chalk in western Kansas, U.S.A. (housed in the Museum of Natural History, University of Kansas, Vertebrate Paleontology collection, Lawrence). The specimen consists of 18 small teeth (up to ca. 4 mm in total tooth height) and fragments of calcified cartilage that apparently came from a single individual. It is significant because the fossil shark represents a new species of *Squalicorax*. The specimen indicates that the total range of morphological variation of teeth was relatively small in the species and that its dentition (like other species of *Squalicorax*) most likely exhibited monognathic heterodonty. The small size and morphology of teeth

suggest that the new species is phylogenetically related to *S. volgensis*. The new species represents the seventeenth chondrichthyan taxon known from the Smoky Hill Chalk, and is one of the smallest chondrichthyan taxa so far known from the Niobrara Chalk. It possibly measured less than 1 m in total body length and could have been an opportunistic feeder that frequently scavenged vertebrate carcasses like other *Squalicorax* species. Although polymorphic variations within the species cannot be examined from the single specimen, this study demonstrates that the ability to be able to assess the possible range of intraindividual dental variation from an associated tooth set provides powerful insights into the morphology of the original dentition that concomitantly helps the inferences about its paleobiology.

Poster Session IV (Saturday)

**MORPHOLOGICAL VARIATION OF TOOTHPLATES AND CLADISTIC ANALYSIS OF GENUS *EDAPHODON* (CHONDRICHTHYES, HOLOCEPHALI, CHIMAEROIDEA) WITH A NEW SPECIES FROM THE LATE CRETACEOUS OF VANCOUVER ISLAND, BRITISH COLUMBIA, CANADA**  
SHIN, Ji-Yeon, University of California, Davis, Davis, CA, USA

The fossil chimaeroid genus *Edaphodon* is a group of chondrichthyan fishes that first appeared in the Early Cretaceous (Aptian) and became extinct in the Pliocene. Species of this genus are mostly known from Europe and eastern North America, but several have been described from Australia and New Zealand. They are known from isolated toothplates that are strengthened in parts by hypermineralized pads called tritons. The number and configuration of these tritons have been used in classifying isolated fossil chimaeroid toothplates. I report a complete chimaeroid dentition from the Late Cretaceous Haslam Formation (early Campanian) on Vancouver Island, British Columbia, Canada which extends the geographical range of the genus *Edaphodon* to western North America. The toothplates belong to the genus *Edaphodon* based on absence of descending lamina but represent a new species given the difference in shape and configuration of tritons compared to previously described species. A cladistic analysis was used to examine the pattern of evolutionary change of morphological features of the toothplates in this group. The new species is the second most basal on the strict consensus tree using discrete characters of mandibular toothplates. I also performed a Linear Discriminant Analysis (LDA) of toothplate shape discrimination to examine whether the new species is phenetically different from the rest. Four Cretaceous North American *Edaphodon* species (*E. agassizi*, *mirificus*, *sedgwicki*, and *stenobryus*) were chosen for the analysis because of the similarity in temporal range and morphology. The clear separation of the new species from other *Edaphodon* species in LDA plot confirmed not only the significant statistical difference of the new species, but also the validity of the diagnostic characters used in classification.

Technical Session XVII, Saturday 10:15

**FUNCTIONAL MORPHOLOGY OF THE KNEE IN RHINOS AND THE EVOLUTION OF KNEE LOCKING MECHANISMS AMONG RHINOCEROTOID PERISSODACTYLS**

SHOCKEY, Bruce, Manhattan College and AMNH, New York, NY, USA;  
MIHLBACHLER, Matthew, New York College of Osteopathic Medicine, Old Westbury, NY, USA; SOLOUNIAS, Nikos, New York College of Osteopathic Medicine, Old Westbury, NY, USA; HAYES, Patrick, Manhattan College, New York, NY, USA

Both living and extinct rhinos possess an enlarged medial trochlear ridge (MTR) on the distal end of the femur and an ossified medial patellar "hook" that are presumably part of a locking mechanism, similar to that which evolved independently in the knees of horses and other large mammals such as some toxodontid notoungulates. We report osteological and soft-tissue characteristics of the knee of the rare Sumatran rhino (*Dicerorhinus sumatrensis*) based on a recently deceased Wildlife Conservation Society specimen. A functioning knee lock in the Sumatran rhino is suggested by manipulation and palpation of the fresh hind limb, MRI, and inspection by dissection. The medial patellar hook and the medial patellar ligament (the ligament that extends from the medial patellar hook to the medial aspect of the proximal tibia) cross over the dorsal margin of the MTR during hyperextension of the knee. Subsequently, tension in the patellar ligament is maintained without requiring flexion of the quadriceps as long as the patella is in the locked position, thus passively locking the knee into a semi-extended position. This knee lock is almost identical to that of horses, except that the "hook" of the horse patella is composed of fibrocartilage, whereas that of *Dicerorhinus* and other rhinos is ossified and thus preserved in fossils. The knee osteology of *Dicerorhinus* is similar to that of other living and extinct true rhinos (Family Rhinocerotidae); however, *Uintaceras*, the probable sister taxon of Rhinocerotidae, lacks an enlarged MTR and medial patellar hook. *Indricotherium*, a hyracondontid rhinocerotoid, also has the hypertrophied MTR and medial patellar hook. Mapping of the enlarged MTR and medial patellar hook onto a phylogeny of Perissodactyla suggests that these traits are possibly homologous among *Indricotherium* and "true" rhinos. However, the absence of this morphology in *Uintaceras* and the development of a modified, and possibly homoplasious, knee locking mechanism in amynodontid rhinocerotoids are inconsistent with a single origin of a rhinocerotoid knee locking mechanism.

Poster Session I (Wednesday)

**A RARE LARGE MAMMAL DISCOVERY FROM THE WASATCH FORMATION (EOCENE) RESULTING FROM PROPOSED COAL BED METHANE DEVELOPMENT IN THE POWDER RIVER BASIN OF NORTHEASTERN WYOMING**

SHOUP, Ben, ARCADIS U.S., Inc., Buffalo, WY, USA; CAVIGELLI, Jean-Pierre, Tate Geological Museum, Casper College, Casper, WY, USA

During the summer of 2006, while conducting a Class III Cultural Resource Inventory for a federal mineral coal bed methane development project in the Powder River Basin (PRB) of northeastern Wyoming, a field crew from ARCADIS U.S., Inc. (ARCADIS) discovered several bone fragments weathering out from a poorly exposed slough in the Wasatch Formation (Eocene) on a wide finger ridge. Subsequent investigations of the locality by ARCADIS identified numerous additional bones buried just below the surface. Bones uncovered as the result of a limited surface excavation were determined to be from *Coryphodon* sp. This specimen was considered very rare due to the paucity of large mammalian fauna represented from the Wasatch Formation in the PRB. Most large mammal specimens from the Wasatch Formation in the PRB have only been recognized from fragmentary teeth and isolated, badly weathered bone fragments. This specimen was determined to be approximately 40% complete with several relatively well-preserved elements. As the specimen was discovered on private surface land, no federal regulations existed under split estate laws which would protect it from potential damage associated with eminent federal mineral resource development. Recognizing the significance of this specimen, ARCADIS worked with the landowner, the Bureau of Land Management (BLM) and Anadarko Petroleum Corporation (APC) to arrive at a mutually acceptable resolution to preserve the specimen. APC agreed to reroute a proposed well pad access road and pipeline corridor to avoid direct impacts to the locality. The landowner owner opted to donate the specimen to the Tate Geological Museum at Casper College in Casper, WY. Field crews from the Tate Geological Museum began excavating and preparing the specimen for display during the spring of 2007. This specimen was initially discovered as the result of proposed coal bed methane energy development and due to the efforts of the scientifically responsible operator and cooperative landowner it has been salvaged and repositioned for future research opportunities.

Poster Session IV (Saturday)

**ECOLOGICAL IMPLICATIONS OF TYRANNOSAURID LOWER JAW ONTOGENY, BIOMECHANICAL SCALING AND BITE FUNCTION**

SHYCHOSKI, Lara, University of Alberta, Edmonton, AB, Canada; SNIVELY, Eric, University of Alberta, Edmonton, AB, Canada

Large adult tyrannosaurids developed the strongest skulls and most powerful bites among carnivorous dinosaurs, yet younger and earlier-occurring tyrannosaurids had more slender jaws. This allometry raises the question of how tyrannosaurid lower jaws responded to stresses of increasingly high bite forces, throughout growth and evolutionary increases in body size. To address this allometry and deconstruct mandible shape, we applied geometric morphometrics to 45 theropod lower jaws. Using an adult *Tyrannosaurus rex* (RSM P2523.8: "Scotty") as the reference specimen, comparative lower jaw morphology (robust versus gracile) was determined using thin-plate splines (TPS). To compare bite stress magnitude and distribution in theropod mandibles, we applied finite element analysis to lower jaws of an ontogenetic series of seven *T. rex* specimens, six other tyrannosaurids, and six large non-tyrannosaurid theropods. Geometric morphometric results: When size was removed as a factor, principal components analysis revealed that shapes of non-tyrannosaurid lower jaws associate with those of juvenile tyrannosaurids. Excluding oviraptorids, TPS deformations of non-tyrannosaurid lower jaws converge with those of slender tyrannosaurids, even at large body sizes. FEA results: Despite higher bite forces on larger lower jaws, bending stress diminishes with ontogeny in *T. rex* and with size increase in other tyrannosaurids. Stress distributions and magnitudes in subadult *T. rex* mirror those of adult theropods of similar body size, and magnitudes are low in adult *T. rex* unless very high forces are applied. Stress distributions in the dentary of *Giganotosaurus carolinii* are similar to those of young juvenile tyrannosaurids. Similar stress results in mandibles of young *T. rex* and adults of other taxa suggest parallels in biting style and ecology. This supports hypotheses that tyrannosaurids comprised "ontogenetic" guilds of predators over 100 kg, mirroring phylogenetic guilds of adult theropods in earlier formations.

Technical Session XI, Friday 10:30

**NEW VERTEBRATE FOSSILS FROM THE PERMO-TRIASSIC RUHUHU BASIN OF TANZANIA**

SIDOR, Christian, University of Washington, Seattle, WA, USA; ANGIELCZYK, Kenneth, The Field Museum, Chicago, IL, USA; HOPSON, James, University of Chicago, Chicago, IL, USA; NESBITT, Sterling, American Museum of Natural History, New York, NY, USA; SMITH, Roger, South African Museum, Cape Town, South Africa

Recent fieldwork in the Ruhuhu Basin of southern Tanzania has yielded the first collection of Permian and Triassic vertebrates from the region since 1963. Forty-three fossil-bearing localities, most unconnected to those of previous German or British workers, were discovered. Permian genera from the Usili (formerly Kawinga) Formation, including *Endothiodon*, *Kingoria*, *Pareiasuchus*, *Procnosuchus*, and *Rhachiocephalus*, establish



close faunal similarity to the Beaufort Group of South Africa. However, the presence of endemic taxa such as *Peltobatrachus* and *Ruhuhucerberus*, as well as at least one newly discovered dicynodont, suggest regional differentiation. Furthermore, field observations demonstrate the co-occurrence of genera with non-overlapping stratigraphic ranges in South African strata, complicating biostratigraphic correlation. Sedimentary environments of the Usili differ substantially from those of the coeval Karoo rocks, suggesting habitats not represented in the South African sequence. Importantly, little evidence was found for more than one Permian vertebrate assemblage. Middle Triassic vertebrates collected from the Lifua Member of the Manda Beds include previously known genera, such as the cynodonts *Aleodon*, *Cricodon*, *Scalenodon*, and *Luangwa* (previously known only from the N'taware Formation of Zambia), as well as the dicynodont, *Angoniasaurus*. Archosauromorphs include the rhynchosaur *Stenaulorhynchus*, a new pseudosuchian, and a new dinosauriform similar to *Silesaurus*. The sporadic nature of the outcrops of the Lifua Member hamper intrabasinal correlation, but at least two facies preserving vertebrate fossils were recognized. Aspects of the Lifua fauna overlap with those of the upper Omingonde of Namibia, the *Cynognathus* C-zone of South Africa, and the N'taware of Zambia, although in neither of the latter two are similar archosauromorphs preserved. Finally, coprolites were found to be relatively common in the Lifua, with a least two distinctive morphologies represented: bone-bearing with pinch-points and spiral. The former type was associated with collections of small cynodont bones bearing surface features suggesting acid-etching.

Technical Session XV, Friday 3:00

#### THE EVOLUTION OF THE AMPHIBIAN HUMERUS AND THE ORIGIN OF SALTATION IN FROGS

SIGURDSEN, Trond, McGill University, Montreal, QB, Canada

The Lower Triassic forms *Triadobatrachus* and *Czatkobatrachus* are the only basal salientians known, but whether or not saltation was an important part of their locomotion is uncertain. Whereas previous studies focused on the hind limb and the pelvic girdle, the humerus was chosen as the focus of this study, since it retains a relatively conservative morphology compared to most other parts of the highly derived anuran skeleton. During the landing phase of a jump, the humerus helps to direct the forces of impact to the pectoral girdle. Many of the features of the anuran humerus, such as the curvature of the bone, the anterior concavity of its proximal end and the elongated deltopectoral crest (crista ventralis) are best interpreted in this light. This view is supported by the fact that these features are less pronounced in the exclusively aquatic members of the Pipidae. In contrast, the general morphology of the humerus of *Triadobatrachus* is closely comparable to that of modern jumping anurans. This suggests that saltation was an important factor in the locomotion of this early salientian. Furthermore, the humerus of salientians shares numerous features with those of salamanders, the primitive caecilian *Eocaecilia*, and the Permian amphibamid *Doleserpeton*. These features include the presence of a very large radial condyle, an elongate shaft and the absence of an entepicondylar foramen. Although the two latter traits have evolved independently in a few microsaurs as well as in various amniote groups, the humerus of *Doleserpeton* is the one that shares the most features with lissamphibians. Adult specimens of other amphibamids generally have shorter and somewhat more robust humeri than *Doleserpeton*, even in small forms such as *Amphibamus grandiceps*. The similar structure of the limb bones of *Doleserpeton*, caudates and salientians supports the view that there are close affinities between frogs, salamanders and the Amphibamidae. Furthermore, the limb bones of the basal caecilian *Eocaecilia* resemble those of *Doleserpeton* and salamanders more than microsaurs, adding support to the monophyletic hypothesis of lissamphibian relationships.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 11:15

#### THE ENDOCAST OF *IGNACIUS GRAYBULLIANUS* AND BRAIN EVOLUTION IN EARLY PRIMATES

SILCOX, Mary, University of Winnipeg, Winnipeg, MB, Canada; DALMYN, Claire, University of Winnipeg, Winnipeg, MB, Canada; BLOCH, Jon, University of Florida, Gainesville, FL, USA

Extant primates are distinctive among mammals in having large brains and visual specializations. As stem primates, plesiadapiforms provide direct information relevant to the earliest stages in the evolution of these characteristics. Here we describe a virtual endocast produced from ultra high resolution X-ray computed tomography data for the paromomyid plesiadapiform *Ignacius graybullianus* (USNM 421608) from the early Eocene of Wyoming. This represents the most complete endocast known for a plesiadapiform, allowing for an unprecedented study of both size and fine details of anatomy. *Ignacius graybullianus*' cranial capacity was 2.14 cubic centimeters, yielding an encephalization quotient (EQ) of 0.34 (Jerison's equation) or 0.53 (Eisenberg's equation). While low compared to extant primates, *I. graybullianus*' EQ is higher than calculated for Paleocene *Plesiadapis cookei*, is relatively high for an early Tertiary mammal, and overlaps the bottom of the range for fossil euprimates. The neocortex is relatively unexpanded, however, so that the caudal colliculi are visible. Although the rhinal fissure is located further ventrally than in a primitive insectivoran, its position on the lateral surface of the cerebrum is more similar to a modern tree shrew than to a euprimate. *Ignacius graybullianus* had large olfactory lobes, accounting for 5.5 percent of the volume of the brain, while the cross-sectional area of the optic nerve is smaller than would be predicted from the cranial capacity for a euprimate. These findings

augment our understanding of the adaptive profile of paromomyids. Studies of postcrania and teeth show that paromomyids were claw-climbers and frugivore-exudativores, most similar among extant mammals to callitrichine primates. Our results show that *Ignacius graybullianus* was a less visually directed animal than extant primates, an observation in keeping with the absence of other bony proxies for euprimate visual specializations such as forward facing orbits. The data available for plesiadapiforms are consistent with them representing the beginning of a long and likely complex history of primate brain enlargement that started in the Paleocene.

Poster Session III (Friday)

#### LIMB AND CONTACT STRUCTURE MORPHOMETRICS IN EXTANT ANURANS: IMPLICATIONS FOR INTERPRETING FOSSIL FROG LOCOMOTOR MORPHOLOGY

SIMONS, Verne, Department of Biological Sciences, Ohio University, Athens, OH, USA; STEVENS, Nancy, Department of Biomedical Sciences, Ohio University, Athens, OH, USA

Functional interpretations of morphology preserved in the fossil record are often made by analogy based on observable behaviors of modern species. Despite a conserved Bauplan with relatively long hind limbs, anurans exhibit a remarkable diversity of postcranial morphologies. Confidently linking specific morphology with behavior in modern anurans allows one to constrain potential behaviors in fossil members of the group. Previous research has suggested that anuran limb lengths and contact structure dimensions may be linked with the habitual use of different locomotor behaviors. These studies have provided interesting insights from a limited sample of anurans, but to date, such observations have not been made within an explicit phylogenetic framework. Thus, before applying these findings to the entire clade it is necessary to test hypotheses about the existence of convergent patterns in limb length and contact structure size across a diverse sample of modern forms. This study examined anuran postcranial morphometrics using a sample of extant species of known habitual locomotor behavior. The sample was assembled to permit pairwise comparisons of postcranial morphology in multiple anuran clades containing members that utilize different habitual locomotor modes. Non-destructive radiographic methods for obtaining skeletal morphometric data were employed to collect whole limb, including articulated manal and pedal, morphology. Nine linear measurements were collected on 70 specimens representing 15 species. Analyses of covariance (ANCOVA) were used to examine interspecific variability in taxa of vastly different body size (SVL). Results from this study differ from previous findings, as patterns of anuran limb morphologies tend not to span the entire clade, but are restricted to selected phylogenetically focused comparisons. For example, arboreal natatanurans exhibited a longer and wider manus than did the strong jumpers within the clade. As another example arboreal bufonids exhibited longer fore- and hind limbs than walking members of the group. This study provides a framework for inferring behavior of fossil anurans, suggesting that functional interpretations of fossil frogs may require more specific taxonomic resolution than previously recognized.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 8:30

#### THE EARLY PLIOCENE HOMINID *ARDIPITHECUS RAMIDUS*: COMPARATIVE DENTAL ANATOMY AND ECOLOGICAL CONTEXT

SIMPSON, Scott, CWRU - School of Medicine, Cleveland, OH, USA; QUADE, Jay, University of Arizona, Tucson, AZ, USA; LEVIN, Naomi, University of Utah, Salt Lake City, UT, USA; SEMAW, Sileshi, Stone Age Institute, Gosport, IN, USA

Until recently, the 4.2-3.0 million year old early australopithecines (*Australopithecus anamensis* and *Au. afarensis*) have provided the most ancient evidence of characteristically hominid dental specializations. These taxa occupied river and lake margins with ready access to a heterogeneous mix of habitats. Here, we describe a recently collected sample of Early Pliocene (4.3-4.8 Ma) hominid *Ardipithecus ramidus* fossils from the Gona Project research area in the Afar State of Ethiopia. Dental remains from this species are characteristically different in size and morphology from the subsequent australopithecines by having smaller postcanine teeth with thinner enamel and larger canines. In addition, the lower degree of tooth crown size variation and the occupation of perhaps more closed habitats reconstructed for this species indicates a major shift in behavior and adaptive pattern in the transition to the australopithecines.

Technical Session XII, Friday 11:30

#### GEOMETRIC MORPHOMETRICS AND FUNCTIONAL MORPHOLOGY OF A SARDINIAN FOSSIL MACAQUE: WARPING AND FINITE ELEMENTS ANALYSIS OF CRANIOFACIAL FEATURES IN *MACACA MAJORI*

SMITH, Amanda, Department of Anthropology, University at Albany, Albany, NY, USA; KUPZIK, Cornelius, Max Planck Institute of Evolutionary Anthropology, Leipzig, Germany; FAGAN, Michael, Functional Morphology and Evolution Research Unit, Hull York Medical School, Hull, United Kingdom; ROOK, Lorenzo, Dipartimento di Scienze della Terra, Università di Firenze, Florence, Italy; O'HIGGINS, Paul, Functional Morphology and Evolution Research Unit, Hull York Medical School, Hull, United Kingdom

*Macaca majori*, a Sardinian fossil Old World monkey, possesses a highly derived craniofacial morphology. This is evident in a partial adult specimen (ty5199) which possesses a robust and laterally flaring zygomatic root, broadened posterior palate and

enlarged postcanine dentition. While these features appear to represent dietary adaptations it is not possible to build finite elements models (FEMs) from the fragmentary cranium in order to model the biomechanical consequences of these robust anatomical features. With such fragmentary material it is possible to produce FEMs using comparative anatomical knowledge and 3-D CAD-CAM and reconstruction software but the resulting morphology is dependent on subjective judgment and unlikely to be sufficiently anatomically detailed and accurate for finite elements analysis (FEA). An alternative approach is exploited here using geometric morphometric methods to spline the cranium, or parts of the cranium, of an intact living macaque into that of *Macaca majori* using landmarks taken from the fossil to warp the FEM of the living species into the form of the fossil. This results in anatomically pleasing reconstructions of the fossil that have sufficient detail to allow functional analysis. We apply this approach to compare load bearing during biting between extant *M. fascicularis* and *M. majori*. Results reveal that strains are generally more evenly distributed and reduced in the fossil face but not in the palate, which displayed elevated strains with most manipulated morphologies. When parts of the face are warped between the fossil and living macaque the lowest levels of strain are found in models with enlarged zygomatic and postorbital regions while those with only an anteriorly narrowed palate exhibit the highest levels. This suggests that increased robusticity of the zygomatic and postorbital regions was important in *M. majori* for reducing strains associated with masticatory loading. This warping approach has proved useful in the context of the present study but opens up many possibilities for future integration of geometric morphometric studies that statistically examine functional aspects of form with finite element studies to test the results.

Poster Session II (Thursday)

**THE CRANIAL ENDOCAST OF *EUTRETAURANOSUCHUS DELFSI* (CROCODYLIFORMES, GONIOPHOLIDIDAE) AND ITS RELATIONSHIP TO OTHER CEPHALIC SPACES**

SMITH, David, Northland Pioneer College, Show Low, AZ, USA; DUFEAU, David, Ohio University, Athens, OH, USA; SANDERS, R., University of Utah, Salt Lake City, UT, USA; RIDGELY, Ryan, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

Two subadult skulls of the crocodyliform *Eutretauranosuchus delfsi* from the Upper Jurassic Morrison Formation of Colorado were CT scanned. Better results were obtained for the Canyon City *Eutretauranosuchus* (CMNH 8028, holotype) than the Dry Mesa specimen (BYU 17628), but good separation was obtained for both, permitting digital extraction of the cranial endocast and other structures. The endocast, cranial nerves, and endocranial vasculature of *Eutretauranosuchus* are very similar to those of extant crocodylians, as well as those of the Cretaceous taxa *Pholidosaurus* and *Goniopholis*. As in extant crocodylians, the rostral portion of the endocast is a more faithful representation of the underlying brain structure, and indications of more caudal neural structures such as the optic lobes are subtle at best. The endosseous labyrinth of the inner ear strongly resembles that of extant crocodylians. *Eutretauranosuchus* also shares with extant crocodylians a highly expanded paratympanic sinus system characterized by two separate but confluent pneumatic invasions of the braincase: inflation of the medial pharyngeal recess and several secondary recesses (e.g., the intertympanic recess). The degree of pneumatization corresponds most closely with that seen in juvenile extant crocodylians rather than the relatively reduced pneumatization seen in adults. The organization of the nasal cavity and paranasal air sinuses is also remarkably modern, resembling, in particular, many *Crocodylus* species in having cecal pneumatic recesses. *Eutretauranosuchus* has been noteworthy because it has an extra palatal aperture rostral to the choanae. Both specimens show this trait. However, CT show that the airway itself is unremarkable and essentially modern, and thus the extra bony aperture represents little more than a fontanelle and was presumably bridged by soft tissues. These findings indicate that the fundamental neural and sensory organization observed in modern crocodylians evolved minimally in Neosuchia and was in place by the Late Jurassic, as were most elements of both cephalic pneumatic systems.

Poster Session I (Wednesday)

**TUSK GROWTH RECORD OF A FEMALE AMERICAN MASTODON (*MAMMUT AMERICANUM*) FROM SOUTHEASTERN NEW YORK STATE**

SMITH, Kathlyn, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA

Tusks are important sources of paleoecological data because they record changes in growth rate and isotopic composition throughout the life of an individual. American mastodon (*Mammuth americanum*) tusks grow by accretion, and increments marking growth at annual, bi-weekly, and daily scales are visible in tusk dentin. Increment thicknesses reflect the nutritional status of an individual. This study presents the tusk growth record of a female mastodon from Orange County, New York (NYSM V50). Previous studies of female mastodon life history have tentatively identified calving cycles in the tusk record. Calving cycles are critical to understanding the extinction of mastodons in North America because, by analogy with living elephants, the length of the cycle is a function of environmental conditions. Evaluating tusk records of additional female mastodons will allow for a more complete documentation of these cycles. Fragmentation of the tusk mid-section prevents analysis of the entire lifespan of NYSM V50, but thin sections of dentin taken at 10-cm intervals along the tusk length reflect nearly 13 years of growth. The pattern of bi-weekly increment growth is non-cyclical on an annual scale, suggesting the individual lived in an

area of low seasonality. Tusk-year 7 is conspicuous in the bi-weekly growth profile because the lowest growth rate occurs in late spring. Spring, a season of high nutrient availability and expected high tusk growth rate, is a likely season for mating, as evidenced by the onset of musth in male mastodons. Thus, the low growth rate may reflect the effect of courtship on normal feeding activity. Years 7-11 in the annual increment profile show two years of decreasing growth rate followed by a recovery in growth rate. This period is tentatively interpreted as a calving cycle. An additional approach to evaluating the reproductive record of this individual is to track changes in isotopic composition of tusk dentin. Identification of compositional signals previously proposed as indicative of lactation, combined with periodic variations in tusk growth rate, has the potential to clarify characterization of calving cycles in the tusk record.

Poster Session II (Thursday)

**A PRELIMINARY ANALYSIS OF PHYLOGENETIC RELATIONSHIPS WITHIN THE GENUS *COPEMYS* (RODENTIA: CRICETIDAE) WITH EMPHASIS ON BARSTOVIAN SPECIES**

SMITH, Kent, OSU-CHS, Tulsa, OK, USA; CZAPLEWSKI, Nicholas, OMNH, Norman, OK, USA

Most species of *Copemys* are represented by a single tooth or dentary with teeth from a single local fauna. The Eastgate local fauna, Nevada (early Barstovian) is an exception to the lack of both *Copemys* species and low number of specimens at a single local fauna. At Eastgate a large sample (>200 specimens) of *Copemys* provides an excellent opportunity for qualitative and quantitative studies of dental characters and phylogenetic analysis. Numerous qualitative characters of the maxillae, mandibles, and upper and lower cheekteeth taken from the Eastgate specimens and the literature were evaluated. Quantitative analyses of lower molars of *Copemys* includes coefficient of variation, principal components analysis, correspondence analysis, and cluster analysis. These univariate and multivariate methods support the identification of multiple species of *Copemys* from Eastgate. Preliminary phylogenetic analyses of most named species of the genus *Copemys* (*C. loxodon*, *C. longidens*, *C. dentalis*, *C. niobrariensis*, *C. esmeraldensis*, *C. russelli*, *C. pagei*, *C. pisinnus*, *C. tenuis*, *C. barstowensis*, species A, species B, and species C) were conducted. Three species of *Copemys* (species A, species B, and species C) are proposed as new for the genus. Phylogenetic analyses also indicate some structure within the genus.

Technical Session III, Wednesday 3:00

**A COMPLETE NECROSAUR (SQUAMATA: ANGUIMORPHA) FROM THE MIDDLE EOCENE LAGERSTÄTTE OF MESSEL, GERMANY**

SMITH, Krister, Senckenberg Museum, Frankfurt am Main, Germany; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, USA; HABERSETZER, Jörg, Senckenberg Museum, Frankfurt am Main, Germany

The Paleogene phosphorite deposits of Quercy, France, yielded the first, fragmentary specimens of *Necrosaurus* in the latter part of the 19th century, and since then fossils from the Cretaceous through Oligocene have been recognized as close relatives of necrosaurids ('Necrosauridae'). Historically, *Necrosaurus* has been synonymized with *Varanus* or placed variously in Varanidae, in Xenosauridae, on the stem of Varanidae, and on the stem of Varanoidea (=Varanidae + Helodermatidae). The relationships of *Necrosaurus* to other necrosaurids and to anguimorphs generally is not yet well-resolved. We use high-resolution X-ray computed tomography and stereo X-ray microradiography to study complete skeletons of *Necrosaurus* from the middle Eocene *lagerstätte* of Messel, Germany, providing the first detailed look at the osteology of the taxon. These techniques reveal a mosaic of primitive and derived characters consistent with a position of the taxon on the stem of Varanoidea. As in Varanoidea, the palatine articulation on the maxilla is posteriorly displaced. Additionally, the splenial is restricted anteriorly, and the angular is forked and bears the posterior mylohyoid foramen in its dorsal 'tine'. The apex of the coronoid is posteriorly displaced. Yet unlike in living Varanoidea, the external nares are unretracted. Plicidentine is not developed, nor are strong subolfactory processes of the frontal. Osteoderms are found on the entire body, including the limbs and the tail, where they are arrayed in transverse whorls, and different developmental stages show the keels of the scales to be filled out first. If Messel *Necrosaurus*, despite its late occurrence, is in fact on the stem of Varanoidea, it may have an important role to play in the elucidation of the position of enigmatic taxa like Mosasauridae within Anguimorpha, for the number of specimens and their individual completeness make it one of the best-preserved stem-varanoids known.

Preparators' Session, Thursday 9:15

**A RELATIONAL DATABASE DEVELOPED AT JOHN DAY FOSSIL BEDS NATIONAL MONUMENT FOR THE PURPOSE OF MANAGING AND STANDARDIZING PREPARATION DOCUMENTATION**

SMITH, Matthew, John Day Associates, Gainesville, FL, USA

Laboratory data collection at John Day fossil Beds National Monument has traditionally been concerned with who has done what to a particular fossil, with what chemicals and tools, and how long it took a person to accomplish that task. These documents were stored as Microsoft Word documents and were difficult to compare for the purpose of quantitatively answering questions regarding fossil conservation issues. A new Microsoft Access Database

has been created which helps to standardize data entry and facilitate research into the effects of long-term storage of fossil specimens in a variety of museum settings. Issues such as the interaction of fossil pH and adhesives, the effect of casting material on the longevity of molds, storage of fossil specimens with plastic casts, and the physical consequences of long term display versus collection storage on similar fossils from a single locality can now be addressed. However, the database will require the due diligence of preparators and curators over an extended period of time in order to address these questions universal to paleontology collections.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)  
**A NEW SPECIES OF AUK FROM THE MIOCENE OF CALIFORNIA REVEALS MORPHOLOGICAL TRENDS RELATED TO FLIGHTLESSNESS WITHIN ALCIDAE**  
SMITH, N., NCSU, Raleigh, NC, USA

Alcidae is a clade of pelagic wing-propelled diving birds, which are closely related to skuas (Stercorariidae) and other shorebirds (Charadriiformes). Although all extant alcids are volant, flightless alcids are known from Miocene through Pleistocene deposits along both the eastern and western shores of the Atlantic and Pacific oceans. Despite the thousands of fossils referred to the Pacific alcid taxon *Mancalla*, paucity of associated specimens has prevented the referral of all but a few specimens to the species level, and as a result the systematic relationships of *Mancalla* have not been resolved. Discovery of associated remains of a previously unknown species of *Mancalla* from the Late Miocene (Hemphillian) Capistrano Formation of Orange County, California has facilitated the evaluation of the systematic position of *Mancalla* within Alcidae. This new specimen (SDSNH 68312) consists of a complete skull and partial post-cranial skeleton and is the most complete exemplar of *Mancalla* presently known. Notable features of this new taxon include large size and mandibular morphology convergent with that of the Great Auk *Pinguinus impennis*. The phylogenetic placement of this new species with respect to other *Mancalla* species, and the relationship of the *Mancalla* clade to other alcids will be evaluated using a comprehensive (>300 characters) morphological dataset. The taxonomic validity of all seven previously described species of *Mancalla* will also be evaluated. Knowledge gained as a result of this study will allow for comparisons with other extant (e.g., Spheniscidae) and extinct (e.g., Plotopteridae) flightless wing-propelled divers, and holds potential to reveal patterns related to the acquisition of characters associated with the transition from aerial flight to sub-aqueous flight and flightlessness in Alcidae.

Poster Session IV (Saturday)  
**A MEGARAPTOR-LIKE THEROPOD (DINOSAURIA: TETANURAE) FROM AUSTRALIA; SUPPORT FOR FAUNAL EXCHANGE BETWEEN EASTERN AND WESTERN GONDWANA IN THE MID-CRETACEOUS**  
SMITH, Nathan, The Field Museum of Natural History, Chicago, IL, USA; MAKOVICKY, Peter, The Field Museum of Natural History, Chicago, IL, USA; AGNOLIN, Federico, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina; EZCURRA, Martín, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina; SALISBURY, Steven, The University of Queensland, Brisbane, Australia

The fossil record of Australian dinosaurs in general, and theropods in particular, is extremely sparse. We describe an isolated ulna from the Early Cretaceous (late Aptian–early Albian) Eumeralla Formation of Australia that shares unique autapomorphies with the South American theropod *Megaraptor*, including: an expanded, blade-like olecranon process that extends distally as a caudal olecranon crest, and a robust lateral tuberosity that extends as a distinct lateral crest. A phylogenetic analysis of basal Theropoda performed on a dataset consisting of 58 taxa scored for 353 characters recovers *Megaraptor* and the Eumeralla material as derived spinosauroids. Though statistical support for Spinosauroidea and less inclusive clades is low, several derived characters support this placement of *Megaraptor*, including: a hypertrophied manual ungual I-2; a hypertrophied ulnar lateral tuberosity; a manual phalanx I-1 with a pronounced ventral groove; a compressed olecranon process; and an expanded, triangular cranial process on the proximal radius. *Megaraptor* thus represents the youngest known member of Spinosauroidea, and increases the overlap between typical ‘middle’ and ‘Late’ Cretaceous Gondwanan theropod faunas. The Eumeralla ulna represents the first occurrence of Spinosauroidea in Australia, and the first Australian non-avian theropod with unquestionable affinities to taxa from other Gondwanan landmasses, suggesting faunal interchange between eastern and western Gondwana during the mid-Cretaceous. This evidence counters claims of Laurasian affinities for Early Cretaceous Australian dinosaur faunas, and of a geographic/climatic barrier isolating Australia from the other Gondwanan continents during this time. The temporal and geographic distributions of *Megaraptor* and the Eumeralla ulna are less consistent with traditional paleogeographic models for Gondwanan fragmentation, but compatible with models positing connections between South America and Antarctica in the mid-Cretaceous. Accordingly, the Eumeralla material adds a phylogenetically constrained data point from a poorly sampled geographical area, which may be valuable to future paleobiogeographic analyses.

Poster Session IV (Saturday)  
**CRANIUM AND ASSOCIATED POSTCRANIAL ELEMENTS OF THE PRIMITIVE TAPIROID CHOWLIA FROM THE EARLY EOCENE OF WUTU COAL MINE**

(SHANDONG PROVINCE, CHINA): PHYLOGENETIC AFFINITIES  
SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; WEI, Ming-Rui, Beijing Museum of Natural History, Beijing, China; MA, Qing-Wen, Beijing Museum of Natural History, Beijing, China; LI, Cheng-Sen, Institute of Botany, Chinese Academy of Sciences, Beijing, China

Wutu is a coal mine in Shandong Province, China, that is important for yielding abundant and well preserved early Eocene land mammals. Initiation of a bilateral program of cooperation between Belgium and China has enabled further sampling at Wutu, including recovery of a cranium and associated postcranial elements of the primitive tapiroid *Chowliia*. The specimen comes from the middle coal-bearing Member of the Wutu Formation at the level of the seventh coal layer about 250 meters deep. Teeth of the cranium are very similar to those of the holotype of *Chowliia laoshanensis* from the nearby Laowanggou coal mine. As already mentioned by Tong and Wang, the morphology of the teeth indicates that *Chowliia* is close to *Cardiophorus* and *Homogalax* and belongs to the family Isectolophidae. *Chowliia* is characterized by moderate lophodonty; double-rooted and laterally compressed P1 and P2; and presence of an extra cusp near the metaconule on P4. Upper molars are little expanded transversely, giving the teeth a relatively square shape in occlusal outline. Cladistic analysis based on dental, cranial, and postcranial characters helps to locate *Chowliia* in the phylogeny of primitive tapiroids.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny  
Wednesday 8:45

**FROM GOGO TO GORGONICHTHYS: VARIATION OF STRUCTURAL MECHANICS IN ARTHRODIRE JAWS**  
SNIVELY, Eric, University of Alberta, Edmonton, AB, Canada; ANDERSON, Philip, University of Bristol, Bristol, United Kingdom; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA; WILSON, Mark, University of Alberta, Edmonton, AB, Canada

Arthrodire placoderms display a wide diversity in their feeding apparatus, beyond the familiar shearing morphology of *Dunkleosteus terrelli*. Much of this diversity among smaller arthrodires is preserved in nodules of the Frasnian Gogo Formation (northwestern Australia), and among larger forms in the Ohio Shale Formation. To investigate feeding variation in these arthrodires, we compared structural mechanics of their inferognathals (lower jaws) using validated 2D finite element analysis (FEA). Absolute stresses and strains were compared with forces calculated through muscle parameters and linkage kinematics, and relative performance compared using models set to unit lengths and forces. Results indicate a trophically diverse assemblage of Gogo Reef arthrodires. *Eastmanosteus calliaspis* could impose *Dunkleosteus*- or *Heintzichthys*-like shearing to resistant prey tissues, and gracile inferognathals of contemporaneous *Camuropiscis* and *Fallacosteus* adapted them to softer-bodied prey. Cusps of *Mcnamaraspis kaprios* applied high local stress suitable for piercing relatively small prey. FEA indicates similar piercing capability for the anterior fang of the North American *Gorgonichthys clarki*, which attained the largest size among predatory arthrodires. Integrating Von Mises stress suggests lower bite forces in *Gorgonichthys* versus adult *Dunkleosteus*, and the capability of powerful bites in *Dunkleosteus* juveniles. *Gorgonichthys* appears to have been adept at seizing lightly- or non-armored prey, whereas during growth *Dunkleosteus* may have shifted from feeding upon eurypterids to shearing into armored vertebrates.

Poster Session III (Friday)  
**A SUPERTREE APPROACH TO PROLACERTIFORM PHYLOGENY**  
SOBRAL, Gabriela, USP, Ribeirao Preto, Brazil; LANGER, Max, USP, Ribeirao Preto, Brazil

Prolacertiformes (= Protosauria) corresponds to a possibly monophyletic assemblage of diapsid amniotes that may conceal, in an alternative paraphyletic arrangement, the origin of important reptilian groups such as Archosauria and Pterosauria. Indeed, the outcome of more recent analyses shows the placement of various taxa not usually referred to as prolacertiforms (i.e.: archosaurs, *Coelurosauravus*, lepidosaurs, *Longisquama*, pterosaurs, rhynchosaurs, *Sharovipteryx*, younginiforms, and *Trilophosaurus*) within the limits of minimal clades necessary to congregate all typical members of the group. Here, we present a supertree based on 28 published phylogenies dealing with the interrelationships of Prolacertiformes and the aforementioned taxa. Trees were redrawn using the software TreeView and coded with RadCon via MRP. The resulting data matrix was analyzed using TNT (TBR heuristic search; 10,000 replicates; hold = 20), and a total of 2,140 MPSTs were found. The strict consensus nests all prolacertiforms within Archosauriforma (exclusive of *Coelurosauravus*); *Prolacerta*, *Kadimakara*, and *Prolacertoides* in a clade with *Proterosuchus* and *Euparkeria*; and *Macrocnemus*, *Langobardisaurus*, *Cosesaurus*, *Tanytrachelos*, and *Tanytropheus longobardicus* into a monophyletic Tanytropheidae. In addition, the majority consensus tree shows a paraphyletic Prolacertiformes with two major clades: the “Avicéphala” clade includes, among others, drepanosaurids, *Longisquama*, *Sharovipteryx*, and Pterosauria; the other group has *Protosaurus* basal to another dichotomy including the *Prolacerta*-archosaur clade, and a group composed of tanytropheids plus forms such as *Boreopricea*, *Pamelaria*, and *Malerisaurus*. This is the first outcome of a project dealing with prolacertiform phylogeny from a meta-analytic viewpoint. Future steps include the building of a supermatrix to compare both methodological approaches and to assess still problematic relationships among the included taxa.

Technical Session XIII, Friday 2:30

**HERBIVORE DIETARY INTERPRETATION AND PALEOECOLOGY OF THE PIKERMIAN BIOME (LATE MIOCENE)**

SOLOUNIAS, Nikos, New York College of Osteopathic Medicine, Old Westbury, NY, USA; RIVALS, Florent, ICREA & Institut Català de Paleocologia Humana i Evolució Social, Tarragona, Spain; SEMPREBON, Gina, Bay Path College, Longmeadow, MA, USA

Tooth microwear of the Pikermi and Samos ungulates was examined with a light stereomicroscope (561 extinct; 809 extant specimens). These two localities represent the Pikermian biome, which extended from Greece to China. Many of the brachyodont and mesodont bovids were mixed feeders but a few were mesodont browsers and grazers. The giraffids were browsers, mixed feeders and grazers. The majority of the three-toed horses (*Hippotherium*) were hypsodont grazers except for two mixed feeders. The colobine monkey *Mesopithecus pentelici* apparently ate both leaves and fruits. The older tooth microwear results at 500 magnification versus the new light microscope method at 35 magnification of the same species show great similarity in results. We find that diet can differ between species that have very similar dental morphologies. The Pikermian Biome was most likely woodlands which can provide for species trending towards grazing and open space as well as for species that need browse and plant cover. The grasses, which were apparently C<sub>3</sub>, would grow in shaded areas of the woodland; mostly in glades and riverine margins. Pikermi and Samos sampled: 8 hyaenids, 6 felids, 2 hyracoids, 6 hippotheria, 2 chalicotheres, 7 rhinos, 3 suids, 1 tragulid, 1 muntjak, 1 cervid, 8 giraffids and 26 bovids. The ungulate part of the fauna was more species rich and dietarily more diverse than the ungulates observed in modern African forests, woodlands or savannas. The fauna was dietarily most similar to the woodland elements of Africa and India. If the Pikermi and Samos ungulates inhabited dense forests, fruit browsers would have been detected by microwear; if they inhabited savanna, there would not be so many mixed feeders. The plants probably were: hemlock, umbrella pine, bald cypress, redwoods, oak, elm, alder, hickory, sycamore, willow, tupelo, cherry, walnut, silver birch, magnolia, many flowering bushes and C<sub>3</sub> grasses. It is proposed that major dietary and morphologic ungulate evolution has been taking place within woodlands both during the late Miocene of Pikermi and Samos and during the Pleistocene-Recent of Central Africa.

Poster Session IV (Saturday)

**FROM DINOTURBATION TO CRYOTURBATION: THE COMPLEX TAPHONOMY OF THE REX PIPELINE DINOSAUR QUARRY**

SOUTHWELL, Elizabeth, Uinta Paleontological Associates, Inc., Laramie, WY, USA; TRUJILLO, Kelli, Uinta Paleontological Associates, Inc., Laramie, WY, USA; DEMAR, David, Uinta Paleontological Associates, Inc., Laramie, WY, USA; BREITHAUPT, Brent, University of Wyoming Geological Museum, Laramie, WY, USA; BILBEY, Sue Ann, Uinta Paleontological Associates, Inc., Vernal, UT, USA

In September 2006 a multitaxic bonebed was discovered in the Upper Jurassic Morrison Fm. of southeastern Wyoming during construction of Kinder Morgan's Rockies Express-Entrega (REX) natural gas pipeline. Ongoing preparation of the fossils has revealed extensive pre- and post-burial bone alteration and has yielded unique taphonomic data suggesting multiple events. Elements in the mixed fossil assemblage range in size from tiny fish teeth to a 1.5 m long *Camarasaurus* scapula, and include isolated elements and partially articulated segments. Microvertebrate fossils include fish teeth, turtle shell fragments, vertebrae of small reptiles, and crocodile teeth and scutes. Dinosaurian fossils include numerous bones and teeth of *Apatosaurus*, *Camarasaurus* and *Allosaurus*. The dinosaur bones preserved in this bonebed were subjected to a series of taphonomic events over the last 152 million years. First, early post-mortem bone modification occurred, possibly the result of scavenging, trampling, and fluid transport. These interpretations are supported by numerous parallel tooth marks on ribs and caudal vertebrae, multiple shed allosaur teeth, non-horizontal orientation of many elements, and bone deformation. Several bones exhibit plastic deformation and others show brittle deformation, with delicate processes broken off and displaced. Bone modification continued after burial, with calcite crystallization fracturing many bones. The bones were next impacted by cryoturbation under periglacial conditions during the Late Pleistocene. Due to tectonic activity and weathering the Morrison Fm. was exposed at the surface at this time, and ice-wedge casts that cut as much as 2 m into this mudstone give evidence of permafrost in the area. Repeated freeze/thaw movement of the ground containing the fossils caused deep cracks, pressure deformation and step-wise displacement of many of the bones. These cracks were later filled with coarse sand, allowing surface water to seep down to the bones. As a result, many bones situated near sand wedges were extensively corroded. Mechanical disruption by the excavation of the pipeline trench adds a final episode to this complex taphonomic story.

Technical Session V, Wednesday 2:00

**A NEW MAMMALIAN CARNIVORE FROM THE GREEN RIVER FORMATION, POSSIBLY POSSESSING A PREHENSILE TAIL**

SPAULDING, Michelle, Columbia University/AMNH, New York, NY, USA; FLYNN, John, American Museum of Natural History, New York, NY, USA; GRANDE, Lance, Field Museum of Natural History, Chicago, IL, USA

The Fossil Butte Member of the Green River Formation of the western US has been the source of many spectacular articulated skeletons of various vertebrate clades, resulting in

an informative snap shot of mammalian morphological diversity in the Eocene. Here we present a new complete, articulated skeleton of a carnivorous mammal, a member of Ferae, which we have preliminarily identified as a basal carnivoramorphan. However, we have not precluded the possibility that this specimen might be a creodont, as it is not fully adult and many potentially informative characters of the dentition are obscured through preservation. While a phylogenetic analysis places the fossil as a basal carnivoramorphan, the placement is not well supported. Features grouping this taxon with Carnivoramorpha include a well-developed deltopectoral crest and non-fissured claws. However, creodonts are known that lack fissured claws, and features of the specimen such as lower molars all sub equal in size and a large lacrimal facial presence are similar to both known creodonts and some basal carnivoramorphan. In any case, this exciting specimen is the first articulated carnivorous mammal from this deposit to be studied. We compare this specimen with previously known carnivoramorphan and creodonts, emphasizing comparisons to taxa represented by articulated specimens from the Messel Formation of Germany. Due to the compressed nature of the specimen, we are analyzing x-rays of the dentition and other features. These structures would remain unclear without extensive preparation of the specimen, which could destroy information gained from the articulated nature of the fossil. Perhaps the most intriguing aspect of this fossil is its extremely long tail, represented by over 50 caudal vertebrae, and the possibility of a prehensile function as suggested by the morphology of the caudal vertebrae. To further explore this possibility, we present a comparison of the caudal vertebrae morphology across living mammals that possess prehensile tails. Morphology of specific caudal vertebrae and size proportions, are compared between this specimen and living carnivorans, primates, and other taxa with a variety of tail functions.

Poster Session I (Wednesday)

**THE NATION'S FIRST BLM PALEONTOLOGICAL SITE STEWARDSHIP PROGRAM ESTABLISHED IN WASHINGTON COUNTY, UTAH**

SPEARS, Sarah, University of Kansas, Department of Geology, Lawrence, KS, USA; MILNER, Andrew, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; FERRIS-ROWLEY, Dawna, Bureau of Land Management, St. George Field Office, St. George, UT, USA; FOSS, Scott, Bureau of Land Management, Utah State Office, Salt Lake City, UT, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA

In 2006, the Bureau of Land Management's (BLM) St. George Field Office partnered with the St. George Dinosaur Discovery Site at Johnson Farm (SGDS) and the Southwest Chapter of Utah Friends of Paleontology (UFOP) to establish the first "site stewardship" program for paleontological localities in the nation. BLM expanded its Color Country Site Steward Program, a volunteer program for archeological site monitoring, to include at-risk paleontological localities on public lands managed by BLM in Washington County, Utah. Volunteers primarily monitor site conditions regularly, but may also assist qualified paleontologists to conduct field surveys and record paleontological sites. To become a BLM site steward, volunteers must complete a training course and agree to abide by a Code of Ethics and the terms of a federal Volunteer Agreement. The St. George Field Office receives assistance from SGDS in the identification of paleontological localities to be included in the monitoring program. Staff from SGDS evaluates individual localities for importance and/or sensitivity, using standards established by the Office of the State Paleontologist of the Utah Geological Survey. Scientifically important sites that are at risk of loss or damage are given priority for monitoring and assigned to site stewards. SGDS staff assists BLM by preparing information packets for each site. These include topographic locality maps, locality coordinates, site descriptions, and photos showing location and fossils from the site. The stewards visit their assigned areas at least four times annually, checking for evidence of destruction, vandalism, theft, and natural impacts. Any vandalism is immediately reported to BLM Law Enforcement Rangers for investigation. In 2007, site stewards donated nearly 1500 hours of site-monitoring time to the St. George Field Office. Many federal land managing agencies already host volunteer archeological site stewardship programs, and the expansion of these existing programs to include at-risk paleontological localities would be an easy and cost-effective way to increase the level of protection that can be provided for these important and threatened resources.

Poster Session II (Thursday)

**THE TRIALS AND TRIBULATIONS OF EXCAVATION: TECHNIQUES FOR REMOVING LARGE, HEAVY FIELD JACKETS**

SROKA, Steven, Utah Field House of Natural History State Park Museum, Vernal, UT, USA; FINLAYSON, Heather, Utah Field House of Natural History State Park Museum, Vernal, UT, USA

Each paleontological excavation has its own unique challenges and it takes innovation, creativity and patience, to come up with techniques that work well to overcome obstacles encountered while attempting to remove fossil bone. One such quarry is the Utah Field House's sauropod site located on a small patch of BLM land near Dinosaur National Monument. The fossils are coming out of the Jurassic aged Brushy Basin Member of the Morrison Formation. There are several factors that make this site challenging. The bone is highly fractured and incomplete, many of the bones overlap, and new bone is often exposed while trenching around a block. In addition, extremely hard channel sandstones lie above and within the bone bed, making it very tiring and time consuming to work in. Furthermore, the bone is coming out of the side of a steep hill, and is trending back into the hill, which

calls for frequent removal of overburden. The problem of an oversized field jacket arose when trying to deal with three smaller jackets that lay adjacent to each other. As we trenched around these jackets, we encountered bone that appeared to be overlapping with the adjacent block. The three jackets consisted of parts of cervical vertebrae that were partially articulated. Rather than continuing to trench between the jackets and risk destroying bone in the areas of overlap, we incorporated all of them into one large block. We used electric hammer drills and chisels operated by a small generator to remove the hard sandstone around the block. Longer drill bits were used to drill tunnels through the pedestal and plaster bandages were threaded through the tunnels to prevent rock from falling out of the bottom of the jacket. Two-by-fours were used to reinforce the jacket and holes were drilled around the base of the pedestal, creating a fracture plane that helped the jacket break free when we rolled it. A backhoe was used to build an earthen ramp for easier access up the hill to the quarry. Once the jacket was rolled, the backhoe lifted the jacket up, transported it down the ramp and loaded it onto a trailer.

Poster Session I (Wednesday)

**NEW RECORDS OF *GONIACODON LEVISANUS* (MAMMALIA, TRISODONTINAE) FROM THE LATE PALEOCENE OF THE CRAZY MOUNTAINS BASIN, MONTANA**

ST CLAIR, Elizabeth, Stony Brook University, Stony Brook, NY, USA; BOYER, Doug, Stony Brook University, Stony Brook, NY, USA; BLOCH, Jonathan, University of Florida, Florida Museum of Natural History, Gainesville, FL, USA; KRAUSE, David, Stony Brook University, Stony Brook, NY, USA

The transition in North American mammalian faunas between the early and late Paleocene, equivalent to the boundary between the Torrejonian and Tiffanian North American Land Mammal Ages, has historically been difficult to document due to the paucity of fossiliferous localities in this interval in otherwise well sampled regions such as the Crazy Mountains Basin (CMB), Montana. New richly fossiliferous localities in this previously unsampled part of the section are beginning to provide insights into faunal changes during the transition in the CMB, including novel occurrences and combinations of taxa. We report here the first record of the presence of a trisodontine mammal from the late Paleocene of the CMB. The new samples include two teeth of *Goniacodon levisanus*; a left m2 from a new locality in the western CMB, and a left m3 from Bingo Quarry in the eastern CMB. Other mammalian taxa known from these localities include the phenacodontid *Ectocion* and the pantolestid *Aphronorus orieli*, both indicative of an earliest Tiffanian (late Paleocene) age. The new specimens document a geographic and temporal range extension as they are the most northerly occurrences of *Goniacodon* and the first known occurrences from the Tiffanian, adding to the diversity of species known from this interval in the CMB. Previously, the most northerly and latest record of *Goniacodon* was from the late Torrejonian Rock Bench Quarry, Wyoming. *G. levisanus* is best known from the San Juan Basin, New Mexico, and could be described as a typically southern, early Paleocene form. No specimens of *G. levisanus* are yet known from Torrejonian localities in the CMB. Presence of *Goniacodon* in two earliest Tiffanian, geographically separated CMB localities suggests a range extension of this genus into the CMB near the Torrejonian-Tiffanian transition. This temporal and geographic distribution is similar to that of *Acmeodon* which is also known from the early Paleocene of the San Juan Basin, but appears in the CMB following the Torrejonian-Tiffanian transition. Such records have important implications for reconstructing biogeographic regions, and connections among these regions, during the Paleocene.

Technical Session XX, Saturday 3:30

**EARLY MIOCENE TOOTHED CETACEANS FROM THE VAQUEROS FORMATION, ORANGE COUNTY, CALIFORNIA**

STALEY, Meredith, LSA Associates, Inc., Irvine, CA, USA; BARNES, Lawrence, Natural History Museum of Los Angeles County, Los Angeles, CA, USA

Paleontological mitigation of roadwork in the San Joaquin Hills of Orange County, California recovered a diverse and significant collection of marine mammals from the early Miocene Vaqueros Formation. At least thirty-two individual skulls, some with associated post-cranial material, have been identified thus far, representing a minimum of eight genera. Toothed whales (Cetacea: Odontoceti) dominate the fauna. Especially common in the assemblage are platanistoids from the family Allodelphinidae. A minimum of two species of Allodelphinidae are recognized in the large collection of skulls from this family. At least one new genus and species of the family Platanistidae is also present in large numbers. Also, two species of Eurhinodelphinidae are present, one being represented by a rostrum and the other by a partial vertebral section. A well-preserved Squalodontid skull with intact dentition and associated vertebrae was also recovered. Baleen whales (Cetacea: Mysticeti) are also present, but interestingly only the primitive toothed forms are represented in this collection. Prior to the discovery of this assemblage, toothed mysticetes were not known to have survived beyond the end of the Oligocene. At this site, there are individuals from three different groups of toothed mysticetes, indicating that they were much more widespread temporally and geographically than previously known. Included are two different varieties of the family Aetiocetidae (Subfamilies Aetiocetinae and Morawanocetinae), and the skull and postcranial material of a new genus of the family Llanocetidae. These cetaceans make up an extraordinary assemblage, differing greatly from other localities that occur nearby within the same formation. Nearly all specimens represent undescribed species which will certainly illuminate new aspects of cetacean evolution in the North Pacific during the early Miocene.

Poster Session II (Thursday)

**CHALLENGES OF A NATIONAL PARK PALEONTOLOGICAL QUARRY: THE BIG PIG DIG**

STARCK, Ellen, South Dakota School of Mines & Technology, Rapid City, SD, USA; WEILER, Matthew, University of North Dakota, Grand Forks, ND, USA; HOFFNAGLE, Eric, South Dakota School of Mines & Technology, Rapid City, SD, USA; OLINGER, Danielle, South Dakota School of Mines & Technology, Rapid City, SD, USA; DOPHEIDE, Amanda, South Dakota School of Mines & Technology, Rapid City, SD, USA

The Big Pig Dig, located in Badlands National Park, South Dakota, is a unique site, both scientifically and in public allure. The Pig Dig is distinguished by its proliferation and concentration of Orellan fossils, yet the site also allows unprecedented ease of public access to the daily workings of a scientific excavation. Since the Pig Dig is a seasonal operation, multifaceted challenges result from an array of factors. A rotating crew offers an exceptional opportunity for students to gain experience in all aspects of quarry mapping and excavation. Nevertheless, the lack of consistency in education among staff as well as an absence of cumulative experience from year to year can be a hindrance. In response, every season must begin with intensive training to keep information current regarding paleofaunal lists, data accuracy, and methods of collection and documentation. Internal operations of the excavation have been held consistent and critical errors have been minimized by initiating a standard operating protocol in 1998. Visitors impart a different set of challenges in that they expect to be informed and engaged while interacting with the excavators. Ensuing enthusiasm often results in visitors overstepping established park guidelines via unauthorized fossil collection, degradation to quarry walls, damaging exposed fossils, and possible personal injury. Visitors are updated by means of wayside exhibits, onsite interpretive rangers, and park bulletins alerting them to all aspects of resource management and visitor safety. Severe weather affects Total Station performance, and extreme conditions pose great risks to unconditioned visitors. As a result, a network of shelters has been erected, and first aid provisions and emergency communications are readily accessible. The remoteness of the Pig Dig presents a security threat, and easy road access to the site offers substantial temptation for after-hours violation. To deter site breaches, increased vigilance has been implemented through the support of park law enforcement. Furthermore, the site is secured daily during excavation, and the quarry is refilled and closed at the end of each season.

Technical Session VII, Thursday 2:30

**AN EMERGING LATE OLIGOCENE RODENT FAUNA FROM THE NSUNGWE FORMATION, RUKWA RIFT BASIN, TANZANIA**

STEVENS, Nancy, Ohio University, Athens, OH, USA

Rodent fossils from the late Oligocene interval on continental Africa are critical for linking the richly diverse early Paleogene faunas of Saharan Africa and Oman with the well-sampled Miocene faunas throughout Afro-Arabia and beyond. Three new rodent taxa from the upper Oligocene Songwe Member of the Nsungwe Formation (Red Sandstone Group) in the Rukwa Rift Basin of southwestern Tanzania exhibit an interesting mosaic of morphologies, exhibiting features transitional between phiomorph taxa from the early Paleogene and early Miocene. In size and relative tooth proportions, two of these forms are generally similar to smaller Paleogene rodents described from northern Africa and the Arabian Peninsula. They differ from these taxa in having better developed crests, relative to even the most crestiform early Oligocene forms such as *Metaphiomys* and *Gaudeamus*. One new taxon exhibits a strong postmetacristid with crests that rim and more fully enclose the molar basins, resembling early Miocene *Epiphomys*, although much smaller in size. The second new species is distinctive in having a strongly pronounced posterior arm of the protoconid on lower molars in combination with smooth margins on the buccal cusps. The third new species is larger, with mesiodistally elongate and still more crestiform molars, more closely resembling *Diamantomys*, a common taxon in early Neogene faunas of Kenya and Namibia. The recovery of late Oligocene micromammals from the Rukwa Rift Basin of Tanzania reveals the first Paleogene rodent fauna known exclusively from East Africa. The emerging distinctiveness of the Rukwa fauna from earlier Paleogene assemblages, along with similarities between small-bodied rodents from this locale with sites of early Miocene age in Kenya, suggest the possibility of faunal continuity with younger faunas in East Africa.

Technical Session IX, Thursday 2:45

**EXTINCTION OF BIRDS AT THE END OF THE CRETACEOUS: CHRONOSTRATIGRAPHIC DATA**

STIDHAM, Thomas, Texas A&M University, College Station, TX, USA

The majority of published individual bird fossils from the Late Cretaceous lack detailed chronostratigraphic placement. As a result, the discussion about avian extinction at the end of the Cretaceous has treated all bird clades from the Maastrichtian as present at the very end of that time period and during the extinction. However, the Maastrichtian is over 5 million years long and a period with significant climatic and environmental change coincident with turnover in other clades. The assumption that birds were unaffected by these perturbations is most likely incorrect, and not all Maastrichtian bird taxa would have been present in the final moments of the Cretaceous. Additionally, the assessment of the pattern of avian extinction must contend with sampling problems and the Signor-Lipps effect. Therefore, the only way to examine the pattern of change in avian diversity is through documentation of the chronostratigraphic position

of identified individual specimens relative to the K-P Boundary. Examination of the majority of avian remains from the Lance and Hell Creek Formations in Wyoming and Montana indicate that those fossils were deposited during magnetochron 29R and are from the last ~333 ka of the Cretaceous. Additionally, some of the specimens have been found within meters (or less) of the K-P Boundary. These North American specimens appear to be the youngest Mesozoic avian remains in the world. In addition, the Hell Creek and Ft. Union (Tullock Member) Formations contain the only records of fossil bird bones from the earliest Paleocene. The fossil specimen data indicate that the well-known clades of Enantiornithes, Hesperornithiformes, and Neornithes are all present in the latest part of the Maastrichtian. Only remains of Neornithes have been found in definitive earliest Paleocene sediments (including at least one species that was present in the Cretaceous). Non-neornithine taxa are present in mixed age assemblages near the K-P Boundary suggesting the possibility (but not certainty) that other avian clades survived the mass extinction. The diversity of non-neornithine birds prior to the extinction is low, possibly as few as 3 species.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**A FUNCTIONAL ANALYSIS OF THE FORELIMB IN THE MACROPODIDAE**  
STIEGLER, Josef, Montana State University, Bozeman, MT, USA

Functional morphological differences on the spectrum from terrestrial to arboreal are poorly understood as climbing has received relatively little attention compared to the biomechanics of other locomotor modes. Therefore, it is difficult to assess with certainty the locomotor habits of fossil taxa that are hypothesized climbers. Of particular interest are dromaeosaurs, which some have attributed arboreal capabilities while others maintain that they were strictly terrestrial. Without quantitative data on known bipedal climbers, neither hypothesis can be rejected. The crown group Macro podidae exhibit a diversity of locomotor niches and forelimb morphologies despite sharing a common ancestor that was likely a terrestrial saltator with reduced forelimbs. The macro podid forelimbs have been completely freed from an obligate locomotor role, but are commonly employed in scansorial, arboreal, and "pentapedal" locomotion. In this respect macro pods are the best extant example for examining a transition from obligate terrestrial bipedality to fully arboreal locomotion. I present preliminary results from an osteological study of the forelimb in crown group macro pods designed to: (1) quantify variation in element length, robusticity, and range of motion; (2) test for correlation of the variation with locomotor strategy; and, (3) assess the functional and phylogenetic importance of the observed metrics.

Technical Session XVI, Saturday 9:45

**A REINTERPRETATION OF PHYTOSAURIAN DIVERSITY IN THE SONSELA MEMBER (CHINLE FORMATION) OF PETRIFIED FOREST NATIONAL PARK AND ITS INFLUENCES ON THE EVOLUTION OF AND PHYLOGENETIC RELATIONSHIPS WITHIN PHYTOSAURIA**

STOCKER, Michelle, University of Iowa, Iowa City, IA, USA

Though phytosaurs have long been recognized as monophyletic, phytosaur ingroup relationships and taxonomy have been poorly understood. Recent taxonomic and phylogenetic work within Phytosauria has been limited to Pseudopalatinae. The relationships of all other phytosaurs, including *Leptosuchus*, are therefore still in need of revision. *Leptosuchus* is a common, if poorly understood, phytosaur taxon from the Late Triassic of the American Southwest. Currently there are two recognized taxa of *Leptosuchus*, though as many as seven taxa have been named. The lack of phylogenetic analyses, descriptions without comparisons, and an overlap in the morphology of many specimens have confounded the taxonomy of the clade. Here, I present three new specimens from the Devils Playground area of Petrified Forest National Park, Arizona. These three specimens represent the same species-level taxon and were previously referred to *Leptosuchus* outside a phylogenetic framework. Here, I test the taxonomic affinities of the new specimens in a rigorous cladistic analysis. Though they share several characters with *Leptosuchus*, the Devils Playground specimens are recovered as the sister taxon to Pseudopalatinae. In addition, the phylogenetic relationships of *Leptosuchus* are tested for the first time in twenty years, and *Leptosuchus* is found as a non-monophyletic taxon. These new phylogenetic data on the relationships of all phytosaurs have several implications. The documentation of the morphological diversity present within Phytosauria, and specifically within "*Leptosuchus*", illuminates the origins of character states already examined in Pseudopalatinae by placing them into a phylogenetic context. Further, specific identification of specimens can no longer be made by isolated elements, such as the squamosal, because many characters are homoplastic. The identification of paraphyly in both "*Paleorhinus*" and "*Leptosuchus*" recognizes the lack of analyses used for past taxonomic assignment, and emphasizes the need for continued clarification of the taxonomy and phylogenetic relationships within Phytosauria.

Poster Session I (Wednesday)

**NEW INSIGHTS INTO THE ANATOMY AND FUNCTION OF DUNKLEOSTEUS TERRELLI (NEWBERRY), A GIANT ARTHRODIRE FROM THE FAMENNIAN CLEVELAND SHALE OF OHIO**

STORRS, Glenn, Cincinnati Museum Center, Cincinnati, OH, USA; KAMPOURIS, George, Cincinnati Museum Center, Cincinnati, OH, USA; CARR, Robert, Ohio University, Athens, OH, USA

*Dunkleosteus (Dinichthys) terrelli* is the iconic arthrodire of the Upper Devonian (Famennian) Cleveland Shale fauna. Multiple specimens have been collected since the first discoveries in the 19th century, and numerous casts are exhibited in museums worldwide due to the 3-

dimensional reconstructions of Peter Bungart. Much of our anatomical knowledge of this taxon results from detailed study by Anatol Heinz in the early 20th century. Traditional preparation techniques available to early workers, however, were not able to recover the full range of anatomical detail preserved by the *Konservat-Lagerstätte* conditions of the anoxic Cleveland Shale. New specimens of *Dunkleosteus* have been subjected to a range of recently developed advanced preparation techniques, revealing the presence, along with the resilient dermal bone plates, of soft tissues and perichondral ossifications. Organic films reveal the limits of pectoral fin shape, permitting an estimate of the fin's, previously unknown, aspect ratio. The new data allow interpretation suggesting that the fin outline was comparable to that of Cleveland Shale chondrichthyans. Significantly, both basal and radial elements are seen. In the oral region, the oropharyngeal mucosa is also seemingly present. Of interest is the lack of a denticulate mucosa. The position of the basibranchials/interlaterals is confirmed and relevant to any discussion of feeding function. The posterior wall of the gill chamber is denticulate. Naturally articulated interferognathals and mentomandibular indicate an elastic mandibular symphyseal joint. Our understanding of the neurocranium, previously limited to the olfactory capsules and isolated ethmoid ossifications, is also enhanced by the new material. The braincase is expanded posteriorly to cover the gills and is situated farther posterior relative to sharks. The otic capsule is preserved with indications that other neurocranial (e.g., ethmoidal), viscerol arch and postcranial structures are present, potentially adding greatly to our knowledge of arthrodire comparative neuroanatomy and axial structures.

Poster Session IV (Saturday)

**FOSSILS FROM THE EAGLE POINT QUARRY PROVIDE INSIGHT INTO A PLIOCENE MARINE FISHES FAUNA FROM SOUTH CAROLINA**

STRINGER, Gary, University of Louisiana at Monroe, Monroe, LA, USA; CICIMURRI, David, Bob Campbell Geology Museum, Clemson University, Clemson, SC, USA; KNIGHT, James, South Carolina State Museum, Columbia, SC, USA; CAMPBELL, Lyle, University of South Carolina Upstate, Spartanburg, SC, USA; KING, Lorin, Consultant geologist/paleontologist, Lafayette, LA, USA

Prior to this study, information on Pliocene marine fishes from South Carolina was quite limited and incomplete. This is partly related to the sporadic exposure of Pliocene marine sediments in the state, as well as to factors such as leaching and erosion. Chondrichthyan and actinopterygian remains from the Eagle Point Quarry, located in Darlington County, South Carolina, have provided important insight into a Pliocene marine vertebrate assemblage. Vertebrate remains appear to be from the Raysor Marl (3.2 to 3.8 Ma). Isotope studies have indicated two minor transgressions during this period, and the marine sediments at the site may correspond to this interval. Vertebrate material obtained through screen washing bulk matrix from the site includes six elasmobranchs and as many as 24 bony fishes. Shark teeth represent *Mustelus* sp. (smoothhound shark), *Rhizoprionodon* sp. (sharpnose shark), *Carcharhinus* cf. *C. obscurus* (dusky shark), *Carcharias* sp. (sand tiger shark), *Notorhynchus* cf. *N. cepedianus* (broadnose sevengill shark), and *Parotodus benedeni* (extinct lamnid). Skeletal remains of bony fish indicated only a few taxa, but over 175 fish otoliths allowed for identification of at least 21 taxa of actinopterygians. The Eagle Point otoliths revealed a fish assemblage that is dominated numerically and taxonomically by ophiidiids (cusk-eels). Otoliths also indicate the presence of conger eels, anchovies, phycid hakes, midshipman, sea basses, cardinalfishes, drums, jawfishes, butterfishes, sand flounders, and tonguefishes. The cartilaginous and bony fishes, especially fish otoliths, point toward a middle shelf-depth paleoenvironment (20-100 m) of normal salinity and a soft substrate. Vertebrate remains from the Eagle Point Quarry are considered highly significant considering our restricted knowledge of Pliocene marine fishes from South Carolina. Furthermore, the assemblage allows for comparison to other Pliocene marine ichthyological faunas, especially those from North Carolina and Florida, and also assists in determining changes in fish faunas of South Carolina since the Pliocene.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 9:45

**THE LAETOLI PALEOENVIRONMENT: RECONSIDERATIONS AND IMPLICATIONS FOR HOMININ EVOLUTION**

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The Pliocene hominin-bearing site of Laetoli in northern Tanzania has yielded a large and diverse fauna associated with a unique depositional environment. The paleoenvironment of the Upper Laetoli Beds (~3.5-3.8 Ma) has previously been reconstructed as an arid to semi-arid grassland with scattered bush and tree cover, and possibly patches of acacia woodland. The site is unusual in that there is no evidence of permanent or large seasonal bodies of water. This contrasts with most contemporary East African hominin sites, which are generally inferred to be more heavily wooded and associated with riverine or lake-margin settings. New evidence from the fauna and flora from the Upper Laetoli Beds allows a reinterpretation of the paleoenvironment, and it indicates a mosaic of different vegetation types, with greater representations of bushland and woodland. However, some elements of the fauna do indicate the presence of dry grasslands. The totality of the data supports the inference that while grassland habitats (including bushed- and wooded-grassland) were an important and significant part of the habitat mosaic at Laetoli, there was greater representation of bushland and woodland habitats than previously reconstructed. This implies that the early hominin *Australopithecus afarensis* had access to a wide variety of potential habitats. While no hominins have been recovered from the Lower Laetoli Beds (~3.8-4.3 Ma), its paleoenvironment may have been similar to that of the Upper Laetoli Beds, although there is evidence of permanent sources of water.

Poster Session III (Friday)

**STABLE CARBON ISOTOPE CHEMOSTRATIGRAPHY OF THE FOSSIL BIRD-BEARING EARLY CRETACEOUS XIAGOU FORMATION IN CHANGMA BASIN, GANSU PROVINCE, CHINA**

SUAREZ, Marina, University of Kansas, Lawrence, KS, USA; GONZALEZ, Luis, University of Kansas, Lawrence, KS, USA; LUDVIGSON, Gregory, Kansas Geological Survey, Lawrence, KS, USA; YOU, Hailu, Chinese Academy of Geological Sciences, Beijing, China

Early Cretaceous fossiliferous beds of China have yielded numerous early bird specimens that are important to understanding bird evolution. The Xiagou Formation in Changma Basin of Gansu Province, northwestern China, has produced two important bird taxa, *Gansus yumenensis*, a member of the Ornithurae, and an unnamed specimen assigned to the Enantiornithes. While bird-bearing deposits in northeastern China (i.e. Jehol Group) have well constrained ages (biostratigraphic and radiometric), a precise age of the Xiagou Formation is lacking due to an absence of datable deposits (e.g. ash layers). To constrain the age of these important fossiliferous deposits, we utilize sedimentary organic carbon to generate a stable carbon isotope chemostratigraphy for the Xiagou Formation to correlate with the well documented global carbon isotope chemostratigraphy. Two sections, one through the active quarry that produced the numerous specimens of *Gansus*, and one through the inactive quarry that produced the unnamed specimen, were collected systematically at 1 meter intervals. Samples were prepared by powdering and decarbonating, and were analyzed with a Costech elemental analyzer connected to a MAT 253 isotope ratio mass spectrometer.  $\delta^{13}\text{C}$  values range from  $-31.83\text{‰}$  VPDB to  $-20.92\text{‰}$  VPDB, with an overall increasing trend from the base of the section to the top of the active quarry. Values for the section through the unnamed specimen quarry range from  $-33.18\text{‰}$  to  $-20.66\text{‰}$ , and have a similar increasing trend. The  $\delta^{13}\text{C}_{\text{org}}$  profiles can be correlated between each other and indicates an overlap of the two sections. Based on our preliminary analysis, the unnamed specimen quarry is placed approximately 10 to 20 meters below the active quarry. The overall trend,  $\delta^{13}\text{C}$  values, and magnitude of variations in the curves suggest the sections might encompass the early Aptian "Selli Event," which falls between the *Globigerinelloides blowii* planktonic foraminiferal zone and the *Leupoldina cabri* planktonic foraminiferal zone. This supports previous estimates of an Aptian-Albian age for the Xiagou Formation and possibly indicates that *Gansus yumenensis* is slightly older (early Aptian) than previously indicated (late Aptian).

Technical Session XI, Friday 11:15

**TRAVERSODONT CYNODONTS FROM THE UPPER TRIASSIC OF EASTERN NORTH AMERICA**

SUES, Hans-Dieter, National Museum of Natural History, Washington, DC, USA; HOPSON, James, University of Chicago, Chicago, IL, USA

Gomphodont cynodonts form a major element of Middle and early Late Triassic continental tetrapod assemblages, especially in Gondwana. They are distinguished by the presence of buccolingually wide, molariform postcanine teeth that met in complex crown-to-crown occlusion. Traditionally, most derived gomphodonts have been grouped together in a family Traversodontidae. We have argued that the Tritylodontidae are descended from this group, rendering Traversodontidae paraphyletic. Long considered exclusively Gondwanan in distribution, traversodonts are now known from several formations in the Newark Supergroup of eastern North America. One taxon, *Boreogomphodon jeffersoni*, is represented by abundant craniodental remains and some referred postcranial bones from the Carnian-age Vinita Formation of the Richmond basin in Virginia. Superbly preserved dental material permits detailed inferences regarding tooth replacement and dental function during ontogeny. *Boreogomphodon* is primarily distinguished from other known traversodont taxa by the possession of lower molariform postcanine teeth with three rather than two anterior cusps in larger specimens, laterally bowed zygomatic arches, and pronounced, irregular sculpturing on the dorsal surface of the snout. Plesiomorphic features of *Boreogomphodon* include the position of the paracanine fossa anterolingual to the upper canine as well as the presence of a distinct central cusp in the transverse row of principal cusps and of a posterior cingulum on the upper molariform postcanines. Phylogenetic analysis indicates that *Boreogomphodon*, *Arctotraversodon* from the Carnian-age Wolfville Formation of Nova Scotia, and *Nanogomphodon* from the Ladinian-age Erfurt Formation of Germany compose a Northern Hemisphere clade that forms the sister-group to all but the most basal traversodonts from Gondwana.

Poster Session IV (Saturday)

**SOME FUNCTIONALLY SIGNIFICANT ASPECTS OF ANKLE STRUCTURE IN THEROPOD DINOSAURS**

SULLIVAN, Corwin, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; ZHANG, Fucheng, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

In crocodylians, other crurotarsan archosaurs, and archosaurs basal to the phylogenetic division between the crurotarsan and ornithomimid lineages, the calcaneal bone of the tarsus bears a prominent process that acts as an analogue of the mammalian heel. The functional role of this process is to increase the moment arms of muscles that act to plantarflex the ankle, contributing to the generation of propulsive force during locomotion. A curious aspect

of dinosaur evolution is that the calcaneal process is lost or much reduced in all dinosaurs, apparently indicating that dinosaurs had only a limited ability to generate propulsion at the ankle. However, a survey of specimens from various theropod dinosaur clades, as well as published descriptions, indicates that some theropods did possess modifications of the distal tarsus and/or metatarsus that could have served as heel analogues. In the basal tyrannosaur *Guanlong*, for example, the fourth distal tarsal projects slightly posteriorly beyond the proximal surface of the fourth metatarsal, and the proximal end of the second metatarsal is somewhat expanded both posteriorly and anteriorly. In at least some ornithomimid taxa, the proximal end of metatarsal II bears a distinct posterior flange, closely analogous to the hypotarsal flanges of extant birds. These structures would have acted to increase the moment arm of the plantarflexor musculature at least slightly. The implication for locomotor function is that some non-avian theropods were probably more capable of generating propulsive force with the ankle than has been previously recognized. However, the moment arms of the plantarflexor muscles were almost certainly still proportionally smaller than was the case in suchian archosaurs, indicating that the ankle was a comparatively "high gear" (low mechanical advantage) structure better suited to rapid rotation through a large angle than to extensive force production.

Poster Session IV (Saturday)

**A NEW MARINE ICHTHYOFAUNA FROM THE LATE ANISIAN (MIDDLE TRIASSIC) OF LUOPING, YUNNAN PROVINCE, SOUTH CHINA**

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Middle Triassic marine ichthyofaunas in Guizhou and Yunnan Provinces have previously been known from the Middle Anisian (Panxian Fauna), the latest Ladinian (Xingyi Fauna) and the Early Carnian (Guanling Fauna). We herein report a newly discovered Late Anisian one exposed around Dawazi village, Guishan area of southeastern Luoping, Yunnan Province. The fossil-bearing level is in the Upper Member of the Guanling Formation, 10 m below the overlying Yangliujing Formation: it comprises two horizons, namely lower and upper vertebrate horizons (LVH and UVH, respectively). LVH is 1.8 m thick, consisting of black medium-bedded limestone, whereas UVH is represented by light grey laminated marly shales 10.5 m thick. Between LVH and UVH exists a 1.8 m thick interval of grey marly limestones with chert concretions, where few fossils have been found. Along with marine reptiles (e.g. protorosaurs, ichthyosaurs, pachypleurosaurs etc.), crustaceans and terrestrial plants, thousands of well-preserved fossil fishes were produced. The latter represent a new southern China fish assemblage comprising new *Saurichthys* species as well as new subholosteans, close to *W. Tethys* genera (*Habroichthys*, *Perleidus*, *Ctenognathichthys*), and several neopterygians with *Placopleurus* being very common, again as in *W. Tethys*. More than two thirds of the specimens are neopterygians (semionotids, *Archaosemionotus*, etc.) mainly preserved in a 10 cm thick layer (herein called the fish layer) of the basal LVH, yielding also a mass fish mortality surface with an average of 40 specimens for square meter. Coelacanth is also present. Crustaceans (decapods and isopods), and terrestrial plants are restricted to UVH, indicating probably freshwater influx. The importance of this new find, besides the very nice fossil preservation, is that it makes the marine vertebrate succession more complete than previously known from the Middle Triassic of South China and allows a better trans-Tethys comparison with the fossiliferous sequence of Besano/Monte San Giorgio area at Italy/Switzerland border, the core of the marine vertebrate paleontology for the Western Tethys Middle Triassic.

Poster Session II (Thursday)

**EVOLUTIONARY PATTERNS IN PLEISTOCENE TO RECENT CALIFORNIA CONDORS**

SYVERSON, Valerie, California Institute of Technology, Pasadena, CA, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA

Pleistocene fossils related to the living California condor (*Gymnogyps californianus*) have been found in several locations in western North America. Different authors have either assigned these to the species *G. amplus* or considered them a chronological subspecies of *G. californianus*. We examined the morphology of the genus *Gymnogyps* from the late Pleistocene to the present, using hundreds of specimens from the asphalt deposits of Rancho La Brea (RLB) and 80 modern skeletons. The limb bones (using seven variables on each element) and skulls (using 13 variables) were quantitatively compared using bivariate and multivariate techniques. No significant size or shape change through time was apparent in RLB samples ranging from the late Pleistocene (35,000 radiocarbon years b.p.) to the early Holocene (9000 radiocarbon years b.p.), suggesting evolutionary stasis in the face of the climatic changes of the last glacial-interglacial cycle. However, proximal limb elements and skulls showed patterns of variation consistent with a species distinction between the RLB specimens and modern *G. californianus*. This confirms the idea that the RLB species is *G. amplus*, and not referable to the modern species. A set of specimens from a 9000 year old Indian midden in Oregon as well as the presence of *Gymnogyps* in early Holocene Pit 10 at RLB suggest that the modern and ancient *Gymnogyps* may have coexisted with each other as well as with humans, and not died out with the other Pleistocene megafauna, as suggested by some authors.

Poster Session I (Wednesday)

**VERTEBRATES FROM THE UPPER KELLWASSER LIMESTONE, FRASNIAN-FAMENNIAN BOUNDARY BEDS (UPPER DEVONIAN) OF THE HOLY CROSS MOUNTAINS (POLAND)**

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The only place in Poland where Kellwasser-type limestone layer occurs is located at Plucki village near Lagów in the Holy Cross Mountains (190 km S of Warsaw). The Upper Kellwasser limestone is a fossiliferous layer known from many places in Europe that originated during the world-wide Frasnian-Famennian anoxic event. In the Lagów area, this layer of black bituminous limestones is exposed in a small outcrop, forming a part of a long Lower to Upper Devonian section, easily accessible for investigation. The Upper Kellwasser bed at Plucki is characterized by the relatively small thickness (to 0.5 m) and the occurrence of abundant, well preserved fossils of cephalopods, bivalves, ostracods, brachiopods, conodonts, and fishes. Within the horizon, the position of the Frasnian-Famennian boundary was determined. During the field works since 1998, the author has collected a large collection of about 400 vertebrate remains; placoderm plates dominate there. The preservation of a large number of specimens is unique for the Devonian of Poland. Hitherto, the following fish taxa were identified: *Dunkleosteus denisoni*, *Dunkleosteus* sp., *Pachyosteus* cf. *bulli*, *Eastmanosteus pustulosus*, *Brachyosteus dietrichi*, *Heinzichthys* cf. *gouldii*, *Aspidichthys* cf. *ingens*, one yet unnamed new species of small *Eastmanosteus*, probable antiarch and ptyctodont remains, onychodonts, and dipnoans. Recently, a shoulder girdle elements of medium- and large-sized tetrapodomorph animals were discovered. The list of taxa shows certain similarity to the Kellwasserkalk fauna of Bad Wildungen (Germany). No noticeable reaction on the Kellwasser event was recognized within the vertebrate fauna of Plucki. Only the lack of *Aspidichthys* and the appearance of large dinichthyids in Famennian part of the Kellwasser layer can be explained as a rebuilding of the ecosystem just after the Frasnian-Famennian boundary. Assumed by previous authors anoxic conditions during the formation of this layer was revisited, because of the repeated finds of benthic fauna, such as brachiopods and bivalves, as well as ptyctodont and antiarch placoderms, usually considered as connected to the bottom of the sea.

Poster Session II (Thursday)

**LAGOMORPHS FROM THE LATE DUCHESNEAN (LATE MIDDLE EOCENE)**

**DIAMOND O RANCH LOCAL FAUNA OF SOUTHWESTERN MONTANA**

TABRUM, Alan, Carnegie Museum of Natural History, Pittsburgh, PA, USA; FOSTOWICZ-FRELIK, Lucja, Carnegie Museum of Natural History, Pittsburgh, PA, USA

The Diamond O Ranch local fauna is derived from a series of small exposures of the Climbing Arrow Member of the Renova Formation located about two miles west of Beaverhead Rock in northern Beaverhead County, Montana. A lagomorph previously identified as *Megalagus*? new species from this fauna is probably better regarded as representing a new species of *Mytonolagus* based on size and morphology. This lagomorph is one of the most abundantly represented mammals at Diamond O Ranch with more than 125 specimens currently available, including maxillae and mandibles as well as numerous isolated teeth. The teeth are more hypsodont than those of *Mytonolagus petersoni* or the Badwater Creek sample referred to *Mytonolagus* near *M. petersoni*. Tooth morphology is generally similar to that of *Mytonolagus wyomingensis* but differs in the variable configuration of the buccal roots of P3 and P4 and the enamel pattern of p3. Nine of thirteen isolated P3 and four of ten isolated P4 have a single buccal root, two P3 and three P4 have two buccal roots that share a common base, and two P3 and three P4 have two separate buccal roots. As in *M. wyomingensis* the talonid of p3 is wider than the trigonid, but the lingual reentrant of p3 of the Diamond O Ranch species, though relatively persistent, is shallow, and it does not appear that a lingual enamel lake would be isolated in any wear stage. A few isolated teeth from a separate exposure at Diamond O Ranch appear to represent a species of *Palaolagus*. Further study is necessary to clarify the relationship of this locality to those that have produced specimens referred to *Mytonolagus*. The presence of *Mytonolagus* at Diamond O Ranch tends to strengthen the late Duchesnean age assignment made for this local fauna.

Poster Session IV (Saturday)

**RECONSTRUCTING THE CRANIAL PNEUMATICITY OF ORNITHOMIMUS (DINOSAURIA: THEROPODA)**

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Archosaur reptiles share a high degree of cranial pneumaticity. This pneumatic system is composed of nasal and tympanic diverticula that often invade the surrounding bones. We treat this system as a complex character to study archosaur cranial evolution. Nasal pneumaticity is mainly constituted of an antorbital sinus and some outgrowths from itself, which have been examined in archosaurs. While the anatomy of tympanic pneumaticity is well known in modern birds and crocodiles, it is considerably less well known in their fossil ancestry and theropods because an observation has been limited to the external skull. Here, we present the first description of cranial pneumaticity of *Ornithomimus edmontonicus*, using CT scan data and computer aided reconstruction. The analysis reveals the location and extension of cranial sinuses and is compared in an evolutionary context

with extant archosaurs (crocodiles and birds). Pneumatized maxilla and lacrimal bones indicate moderate expansion of the nasal sinus into the antorbital bones. The middle ear region indicates three tympanic pneumatic recesses are present—the anterior, caudal and dorsal tympanic recesses (ATR, CTR, and DTR, respectively). The ATR lies on the lateral side of the prootic and basisphenoid. The participation of the prootic to the ATR is shared with birds. The CT scan also clearly shows the contralateral communication of the ATR through the parasphenoid which is another shared feature with birds. The CTR is located posterolateral to the otic cavity and invades to the paroccipital process and basioccipital as in birds. The DTR is represented mainly by a depression on the dorsolateral surface of the prootic as in birds. Siphonium sinuses are present in the quadrate and extending into the articular in this specimen as in crocodiles and birds. The first complete reconstructed sinuses of *Ornithomimus edmontonicus* clearly show, not surprisingly, the similarities to the cranial pneumaticity of birds. The details of these pneumatic sinuses are mapped phylogenetically to discuss the evolution of the origin of cranial pneumatic anatomy in birds.

Poster Session III (Friday)

**STATISTICAL APPROACHES TO CLASSIFY DINOSAUR EGGS FROM THE HEYUAN BASIN, NORTHEASTERN GUANGDONG PROVINCE, CHINA**

TANAKA, Kohei, Hokkaido University, Sapporo, Japan; LÜ, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan; ZELENITSKY, Darla, University of Calgary, Calgary, AB, Canada

The Zhutian and Dafeng formations (Upper Cretaceous) of the Heyuan Basin in northeastern Guangdong Province, China, have produced thousands of largely unstudied dinosaur eggs. Macromorphological features (egg diameters, egg shape, outer surface texture, shell thickness) of 461 isolated eggs from the Heyuan Basin were analyzed using non-destructive techniques and subject to statistical analyses in order to assess diversity and taxonomic affinities of these eggs. Three types (I, II, III) of eggs were discerned based on egg shape and outer surface morphology. The eggs of Type I (n=443) are spherical to ellipsoidal in shape and have a rough shell surface. Three subtypes of Type I (I-A-1, I-A-2, and I-B) are recognizable based on scatter plots and cluster analyses of egg length, width, and shell thickness: Type I-A-1 are small eggs (70-95 mm x 55-85 mm) with thin shell (mean 1.10 mm); Type I-A-2 are medium eggs (95-115 mm x 85-105 mm) with thick shell (mean 1.85 mm); and Type I-B are large eggs (120-175 mm x 115-155 mm) with thin shell (mean 1.12 mm). Type II (n=15) eggs are elongate (160 mm x 60 mm, mean shell thickness of 0.95 mm) with linear ridges and nodes on their outer surface, and are comparable to elongatoolithid eggs. Type III (n=3) eggs are elongate (> 95 mm x 50 mm, mean shell thickness of 0.52 mm) and have a smooth surface, and are comparable to prismatoolithid eggs. Observed macrofeatures indicate that Type I eggs could have been laid by ornithischian, sauropod or therizinosaur dinosaurs, Type II by oviraptorids, and Type III by troodontids. This study represents the first comprehensive statistical analyses of macrofeatures of dinosaur eggs, and reveals taxonomic diversity in the dinosaurs laying eggs in the Heyuan area during the Late Cretaceous heretofore unrecognized by skeletal remains.

Poster Session III (Friday)

**COMPARISONS OF SCAPULAE AND HUMERI OF THE ODOBENIDS (CARNIVORA: PINNIPEDIA) AMONG THE PINNIPEDS**

TANAKA, Yoshihiro, Hokkaido University, Sapporo, Japan; KOHNO, Naoki, National Museum of Nature and Science, Tokyo, Japan

Modern pinnipeds include three families; i.e., Otariidae, Phocidae and Odobenidae. The relationships among these groups, however, remain controversial because of a conflict between cranial and postcranial as well as morphological and molecular evidence. Anatomical features of postcranial bones that are thought to be associated with swimming locomotion are sometimes incorporated to reconstruct pinniped phylogeny. But, the transformation series of such characters within each taxon such as a family have been insufficiently studied. Thus, comparisons of characters in relation to locomotion such as those of shoulder girdle within a family are important to understand the evolution of each taxon within the pinnipeds. Here, we compared features on the scapula (8 characters) and humerus (6 characters) among living pinnipeds (18 specimens of 11 species), and two fossil taxa of odobenids from Japan are also observed to estimate importance of such characters to reconstruct their phylogeny. Nine characters in the odobenids show affinities with those in the otariids; i.e., acromion lower than scapular notch, acromion process well developed, caudal angle for process of teres major squared, supraspinous fossa larger than infraspinous fossa, greater tubercle higher than lesser tubercle, head of humerus higher than lesser tubercle, reduced lower part of epicondyle, epicondylar foramen absent and crest of greater tubercle enlarged. However, two characters show phocid affinities; i.e., developed scapular tuberosity and expanded greater and lesser tubercles. Although these characters are stable in each family, two additional characters in two fossil odobenids show otariid-like conditions; i.e., widely expanded of scapula and scapular notch strongly excavated, although the living odobenids show phocid-like conditions. It suggests that these characters are changed from otariid-like condition in the fossil odobenids to phocid-like condition in the living odobenids. Thus, these character changes within Odobenidae are results of adaptation for the phocid-like locomotion toward the living odobenids as convergence, which is an example of masking the phylogenetic signals.



Poster Session III (Friday)

**COMPARATIVE MORPHOLOGY OF BASAL CERATOPSID DENTITION**

TANOUE, Kyo, University of Pennsylvania, Philadelphia, PA, USA; YOU, Hailu, Chinese Academy of Geological Sciences, Beijing, China; DODSON, Peter, University of Pennsylvania, Philadelphia, PA, USA

Derived ceratopsians (ceratopsids) are known to have jaws with large numbers of teeth, which are compressed for close packing in dental batteries. In contrast, basal ceratopsians lack dental batteries, with teeth merely erupting in a line. It is important to examine the tooth morphology of basal ceratopsians to elucidate the evolutionary transformation of dentitions within the Ceratopsia. Recent discoveries of skulls of basal Ceratopsia often in superb preservation make it possible to study the evolution of ceratopsian dentition. In this study, the dentition in basal ceratopsians has been examined. Basalmost ceratopsians *Yinlong* and *Chaoyangsaurus*, and most basal neoceratopsians have premaxillary teeth, which are absent in psittacosaurids and ceratopsids. Well-preserved premaxillary teeth of some basal ceratopsian genera show denticles along the carinae. Denticles on the distal carinae extend a greater distance than on the mesial carinae. This distribution of denticles suggests the premaxillary teeth were used to bite an object with their axes sloping caudally. Maxillary and dentary teeth of basal ceratopsians clearly differ from those of ceratopsids in that the mesiodistal diameters of the crowns are longer than the labiolingual diameters, whereas these proportions are the opposite in ceratopsids. Maxillary teeth and dentary teeth of basal ceratopsians generally occlude individually with each other and hence it is more efficient to have a mesiodistally broad crown for mastication. Maxillary and dentary tooth rows of some basal ceratopsian genera are labially concave as opposed to straight tooth rows of ceratopsids. Since the primary dental ridges of basal ceratopsians are less developed than those of ceratopsids, the apices of maxillary and dentary teeth of basal ceratopsians were more prone to abrasion than those of ceratopsids. Dental morphology of basal ceratopsians shows the range of diversity within the basal Ceratopsia as well as the transition toward the ceratopsid dentition.

Technical Session VI, Thursday 2:45

**LOW MAGNIFICATION DENTAL MICROWEAR: THE PROBLEM OF POSTMORTEM ARTEFACTS**

TEAFORD, Mark, Johns Hopkins University, Baltimore, MD, USA; GRINE, Frederick, Stony Brook University, Stony Brook, NY, USA; KAY, Richard, Duke University, Durham, NC, USA; SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, USA; UNGAR, Peter, University of Arkansas, Fayetteville, AR, USA

Recently, a low magnification microwear technique was developed as a way to circumvent the time and labor involved in traditional image-based analysis. Regrettably, many researchers have begun to use this light microscope technique on fossil teeth without reporting protocols for eliminating specimens that were subject to various postmortem effects. When combined with the inexperience of many researchers (in working on modern teeth), this is a pervasive and unappreciated problem. Previous publications using scanning electron microscopy demonstrate that postmortem effects can include the consequences of cleaning and preparing fossils, in addition to postmortem damage in deposition or by exposure of teeth to groundwater or surface processes – all of which can obliterate wear patterns produced in life, or create new ones. These effects often cannot be identified without inspection of surface wear under high magnification. In a series of published papers and presentations at SVP meetings, some researchers seem unaware of these effects, as there has been virtually no mention of the potentially-disruptive/misleading effects of postmortem wear on low magnification analyses of microwear on fossil teeth. We here present examples of such problems. As we have shown in numerous publications, postmortem wear can dramatically reduce the sample sizes available at some sites (sometimes by as much as 80%). However, we feel that the analysis of smaller samples is far preferable to the analysis of postmortem wear irrelevant to the diets and tooth use of the animals in life.

Preparators' Session, Thursday 8:00

**A SMALL SCALE, LOW-BUDGET, HYDRO-EFFICIENT SCREEN WASHING METHOD: THE "MINI-SCREENER"**

TEMME IV, Thomas, Intermountain Paleo-Consulting, Vernal, UT, USA; MASTERS, Simon, Intermountain Paleo-Consulting, Vernal, UT, USA; SANDAU, Stephen, Intermountain Paleo-Consulting, Vernal, UT, USA

Screen washing is an invaluable technique for revealing scientifically significant microfossils that are otherwise undetectable and inaccessible, yet in most instances it is a large scale, outdoor endeavor restricted to water access and favorable weather. The Mini-Screener is a compact and economic alternative that can be utilized indoors throughout the year. The Mini-Screener is a simple apparatus that mimics the fundamental processes of conventional bulky screen washing, utilizing inexpensive and readily available supplies that can be operated in small spaces and simultaneously conserve water. The device is comprised of a fine-gauge mesh strainer, a standard wash basin, a stainless steel mesh strainer basket (which is suspended in the wash basin), a 20 gallon aquarium air pump (or larger), and associated plastic tubing. The tubing is attached to underside of mesh strainer basket to aerate the water bath which prevents sludge buildup in the suspended strainer basket. Microfossil bearing rock or sediment which readily breaks down in water is placed in the mesh basket and immersed in the wash basin and soaked. The percolating water speeds up the break-down time and reduces the matrix sufficiently to allow for the finer particles and microfossil elements to collect at the bottom of the wash basin. The collected material is then poured and strained through the fine-gauge, mesh, kitchen strainer and the

concentrate is collected and dried for analysis. This method allows for low budget, hydro-efficient screen washing when traditional large scale methods are unable to be performed. The Mini-Screener is also an easily modifiable system which can utilize different solutions for soaking, varying screen gauges, and diverse methods of agitating the material.

Technical Session II, Wednesday 11:00

**QUANTIFYING THE SCALE AND DYNAMICS OF TIME-AVERAGING IN GREAT BASIN HOLOCENE CAVE DEPOSITS THROUGH AMS <sup>14</sup>C DATING OF KANGAROO RAT (*DIPDOMYS*) BONES**

TERRY, Rebecca, University of Chicago & Stanford University, Chicago, IL, USA

The shape of the age-frequency distribution of skeletal remains within a death-assemblage is of fundamental importance to paleobiological analysis. The most direct method for obtaining age-frequency distributions is via radiometric dating. The use of radiometric dating to quantify such distributions is growing in marine systems, however this direct approach to examining the scale and dynamics of time-averaging is seldom applied in terrestrial vertebrate systems. Here I use 70 new AMS <sup>14</sup>C dates from kangaroo rat femora to quantify age-frequency distributions from four strata of the Holocene Homestead Cave record to address: (1) the consistency of age-frequency distributions across strata, (2) how a stratum's effective temporal resolution relates to the maximum extent of time-averaging it represents, and (3) the extent to which a bone's overall taphonomic condition is predictive of its age. I also use simulations to explore multiple hypotheses regarding how varying distribution shapes may arise in this system. Results indicate that, while the age-frequency distribution of the modern surface assemblage is near exponential, deeper strata exhibit modes at intermediate ages. While a stratum's maximum extent of time-averaging can range from 300 to 8000 years, its effective temporal resolution is often constrained by an order of magnitude. In contrast to expectations, no predictive relationship emerges between a bone's age and its taphonomic condition. Simulations indicate that exponential decay curves cannot account for the observed age-frequency distributions. Instead, they suggest a more complex interplay between decreasing rates of input over time, and loss rates that increase as a function of a bone's age. Results from this study fill in the gap in our understanding of the scale and dynamics of time-averaging in small-bodied terrestrial vertebrate systems, and indicate that such deposits, even when significantly time-averaged, can represent valuable sources of ecological information over 10<sup>2</sup> – 10<sup>3</sup> time-scales. This is good news for paleontologists and neontologists interested in reconstructing Holocene community dynamics.

Technical Session VIII, Thursday 3:00

**FEEDING BEHAVIOR AND BITE FORCE OF THE GIANT CROCODYLIAN *DEINOSUCHUS***

THERRIEN, Francois, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; ZELENIISKY, Darla, University of Calgary, Department of Geoscience, Calgary, AB, Canada; LANGSTON, JR., Wann, The University of Texas, Austin, Vertebrate Paleontology Laboratory, Austin, TX, USA

*Deinosuchus*, known from the Late Cretaceous of North America, is among the largest of crocodylians. The extreme body size of *Deinosuchus* has led to speculations that this crocodylian fed upon dinosaurs, although direct fossil evidence of such diet is scant. To shed light on the feeding ecology of this extinct predator, the principles of beam theory were used to model the mandible of *Deinosuchus* in order to gain insight into its feeding behavior and bite force. Dorsional bending force of the dentary and of the symphysis, obtained from the external dimensions of the mandibular corpus, were determined for four *Deinosuchus* individuals from the Upper Cretaceous Aguja Formation of Texas. Comparison of *Deinosuchus* mandibular properties to those of large extant crocodylians of known feeding behaviors (piscivores, generalists, large prey hunters, and small prey hunters) reveals that *Deinosuchus* is most similar to extant predatory crocodylians that capture large terrestrial prey. Bite force estimates for *Deinosuchus*, obtained by comparing bending force at mid-dentary to that of the American alligator (*Alligator mississippiensis*), reveal that the extinct crocodylian delivered bites up to 12 times more powerful than *A. mississippiensis*. Compared to non-avian theropods, *Deinosuchus* had a bite force that exceeded that of *Giganotosaurus* and approached that of the largest known *T. rex*. Mandibular properties and high bite force indicate that *Deinosuchus* was an active predator capable of subduing large dinosaurian prey. This feeding ecology would have made *Deinosuchus* an important member of terrestrial ecosystems, particularly in coastal-estuarine settings where it may have occupied the role of top predator.

Technical Session IV, Wednesday 3:00

**RAMAN SPECTROSCOPY OF FOSSIL AND SYNTHETIC APATITES TRACKS DIAGENETIC ALTERATION IN FOSSIL BONE USED FOR ISOTOPE STUDIES**

THOMAS, Daniel, University of Otago, Dunedin, New Zealand; GORDON, Keith, University of Otago, Dunedin, New Zealand; FORDYCE, R. Ewan, University of Otago, Dunedin, New Zealand; FREW, Russell, University of Otago, Dunedin, New Zealand; GORDON, Keith, University of Otago, Dunedin, New Zealand

Stable isotopes from fossil vertebrate hard tissues are routinely used to reconstruct ancient physiologies and habitats. These inherently weak signals may be altered or lost during diagenesis; an understanding of original signal versus diagenetic noise is thus a key issue in fossil isotopic studies. We have utilised Raman spectroscopy as a rapid, nondestructive method to assess diagenesis in fossil bone. Raman spectroscopy analyses inelastically

scattered light from a sample irradiated with a low power laser. For bone, the Raman spectrum elucidates the ionic environment of the apatite mineral lattice. Modern bone samples (teleost, anuran, chelonian, avian, mammal) have been combined to form an unaltered bone standard, calibrating two fundamental Raman spectral parameters: the peak position ( $961.5\text{ cm}^{-1}$ ) and full width at half maximum height ( $14\text{--}18\text{ cm}^{-1}$ ) of the phosphate symmetric stretch ( $\nu_1\text{-PO}_4^{3-}$ ) Raman band. Deviations from these parameters reflect ionic substitutions. We have tracked such substitutions using synthetic apatites “doped” with known cations, allowing the nature and degree of ionic substitution to be identified. Raman spectra are capable of indicating the difference between modern (unaltered) bone and variably altered fossils in terms of nature and scale of ionic addition, substitution and loss. We have used this technique to track diagenetic alteration in oxygen isotopic values of enamel and dentin phosphates from Oligocene shark and mammal teeth. Raman spectroscopy is potentially a key diagnostic tool in geochemical studies of fossil bone from both marine and nonmarine settings.

Poster Session I (Wednesday)

**BIRDS, REPTILES, AND AMPHIBIANS: ADDITIONS TO THE RICHMOND HILLS LOCAL FAUNA (BLANCAN), BLACK HILLS, SOUTH DAKOTA**  
THOMPSON, Wayne, South Dakota School of Mines and Technology, Rapid City, SD, USA; MOSES, Randolph, South Dakota School of Mines and Technology, Rapid City, SD, USA

Gold mining operations during the 1990's at the Richmond Hill Mine in the Black Hills of South Dakota discovered richly-fossiliferous, fissure-fill deposits within the Pahasapa Limestone (Mississippian). These fossiliferous deposits have produced an extensive paleofauna, including mammals, birds, lizards, snakes, and amphibians, of which, only the mammalian component has been described. Mammalian paleofaunal occurrences indicate a late Pliocene age (Blancan) for the Richmond Hill Local Fauna. The principle correlative local fauna to Richmond Hills is the Hagerman Local Fauna (Bl-3, 4.1 – 3.0 mya) of Idaho. Reference local faunas include the Deer Park Local Fauna (Bl-3, Kansas), Sand Draw Local Fauna (Bl-3, Nebraska), Clarkdale Local Fauna (Bl 3-5, Arizona), and Rex Road Local Fauna (Bl-2, Kansas). Three genera of amphibians, *Ambystoma*, *Rana* and *Bufo* have been identified. A number of lizard specimens have also been recovered, with some material loosely attributed to Scincidae. In addition, two colubrid snake genera, *Lampopeltis* and cf. *Salvadora*, have been identified. The occurrence of cf. *Salvadora* in this assemblage is both a biogeographic and temporal range extension for the genus. Three extant avian families of three orders have been identified from Richmond Hills. Tentatively identified genera include: the passeriforms, cf. *Hirundo* and cf. *Progne*, a woodpecker, cf. *Melanerpes*, and a grouse, cf. *Centrocercus*. The Richmond Hills Local Fauna represents one of the northwestern-most Great Plains assemblages of Blancan age. In addition, this amphibian, reptilian and avian assemblage is the first reported from South Dakota of Blancan age. Furthermore, the Richmond Hills Local Fauna may represent the only Blancan high altitude (~ 1750 m above sea level) avian, reptilian, and amphibian assemblage known from the Northern Great Plains. Finally, the passerine assemblage is one of only five other Pliocene passerine assemblages known in North America and is the northern-most assemblage identified. Continued identifications may lend themselves to establishing a paleoecological context for the late Pliocene Black Hills.

Poster Session II (Thursday)

**CAN MORPHOLOGICAL DIFFERENCES AMONG EXTINCT SPECIES BE EXPLAINED BY MEANS OF GENETICS? AN EXAMPLE FROM FOSSIL RABBITS**

TOMIDA, Yukimitsu, National Museum of Nature and Science, Tokyo, Japan; JIN, Changzhu, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Statistical analysis is used to evaluate morphological structures of abundant fossil material of *Pliopentalagus* from three localities within a single limestone hill in Anhui Province, China. Three species are recognized, dating from the late Late Miocene through Late Pliocene: *P. huainanensis*, *P. dajushanensis*, and *P. anhuiensis*, of decreasing age. Although a number of characters overlap among those species, when the specimens from each locality are treated statistically as populations, three species can be distinguished. Further, when these 3 species and recent *Pentalagus furnessi* are arranged by geologic age, they clearly show that (1) average size increases, (2) the frequency of presence of the enamel lake (EL) in p3 decreases from 100 % to about 18 %, and (3) the ratio of a developed anteroexternal reentrant (AER) in p4 – m2 decreases from about 70 % to 0 %, in addition to other characters. Thus, these three species of *Pliopentalagus* can be interpreted to represent a gradually evolving sympatric lineage, from the late Late Miocene through Late Pliocene. “*Aztlanolagus*” *agilis* known from the Late Pliocene to Late Pleistocene in North America should be synonymized with *Pliopentalagus* based on its highly similar morphology but is separated from other species by its smaller size. “*A.*” *agilis* shows a constant occurrence of EL in p3 at 100 % through time, while frequency of AER in p4 – m2 is about 14 % in the Late Pleistocene. *P. dietrichi* from the late Pliocene of Europe shows both characters at 0 %. These facts strongly suggest that (a) no matter where the genus originated, the populations of *P. huainanensis* and “*A.*” *agilis* share the genetic control for universal presence of EL in p3, and (b) this mechanism did not change throughout the lineage in North America, while the frequency of this polymorphism changed gradually in the lineage in Asia, and (c) the ancestor of *P. dietrichi* dispersed to Europe from a population like that of *P. dajushanensis* and/or *P. anhuiensis*, and the genetics of the immigrant population had fixed the absence of EL in p3 and of AER in p4 – m2.

Romer Prize Session, Thursday 9:00

**A NEW METHOD TO INFER FEEDING STRATEGIES OF EXTINCT LAMNIFORM SHARKS BASED ON TOOTH ROOT MORPHOLOGY**

TOMITA, TAKETERU, The University of Tokyo, TOKYO, Japan

Sharks are carnivorous fishes that occupy a variety of positions within a high trophic-level regime in modern marine ecosystems. Based on extant forms, feeding strategies of sharks can be divided into two broad categories, ‘cutting type’ and ‘swallowing type.’ Cutting-type sharks (e.g., *Carcharodon carcharias*, *Isurus oxyrinchus*, and carcharhinidae) can cut their prey into small pieces in order to swallow, whereas swallowing-type sharks (e.g., *Carcharias taurus*, *Mitsukurina owstoni*) cannot cut their prey. Thus, cutting-type sharks can eat larger animals than swallowing-type sharks. Where most extinct sharks are represented only by their teeth, a new quantitative method is described here to objectively assign extinct sharks, such as the Late Cretaceous lamniform *Cretoxyrhina mantelli*, into the two types of feeding strategies based on the tooth root morphology of modern sharks. This method consists of two steps: (1) a surface-area approximation of the lingual side of tooth root expressed by simple V-shaped cartilage, and (2) a calculation of force required for separating a tooth from its supporting jaw cartilage under various directions of force applied to the tooth crown. The results show that (1) resistance direction is mainly related to the angle between root lobes, and that (2) teeth of cutting-type sharks are resistant to the mesiodistal force (e.g., applied when shaking their head to cut their prey), that (3) teeth of swallowing-type sharks are resistance to the labiolingual force. If the method is applied to the dentition of *C. mantelli*, the result indicates that it was a cutting-type shark. Using this method, the major changes in feeding strategies of lamniform sharks though Cretaceous can be reconstructed. The results indicate that the cutting-type lamniform sharks had diversified during the mid-Cretaceous and the range of prey sizes remarkably increased. Generally, prey volumes are correlated to the predator trophic levels in extant marine ecosystems. Therefore, this increased prey size indicates that trophic level in lamniform sharks shifted during the mid-Cretaceous.

Technical Session V, Wednesday 1:45

**SUCCESSION OF MIDDLE EOCENE CARNIVOROUS MAMMALS IN SOUTHERN CALIFORNIA**

TOMIYA, Susumu, Museum of Paleontology and Department of Integrative Biology, University of California, Berkeley, Berkeley, CA, USA

The middle Eocene terrestrial vertebrate localities in San Diego and Ventura Counties, California, provide an important record of the faunal succession that occurred in coastal southwestern North America from the Bridgerian to the Duchesnean land mammal ages. The record of carnivorous mammals is of particular interest because of the interplay of their unique ecological roles, geography of the region (located on the southwestern edge of the continent), and the major climate changes (global cooling and local aridification) that took place during this period. Based on published and newly discovered records, I have compiled data on taxonomic ranges and occurrences of carnivorous mammals through the middle Eocene for this region. The temporal pattern of change in the representation of carnivorous mammals in southern California generally conforms to that observed elsewhere on the continent: mesonychids such as *Harpagolestes* and early creodonts (e.g. *Limnocyon*) seem to have disappeared by the end of the Uintan and were replaced by hyaenodontines of the White River chronofauna (e.g. *Hyaenodon*) in the Duchesnean. Consideration of body mass and dental traits indicates decline in the ecomorphological diversity of the mammalian carnivores toward the later middle Eocene, a pattern that may be explained in terms of changes in vegetation and potential prey. At the same time, at least one lineage of derived ‘miacids’ appears to have persisted across the Uintan-Duchesnean boundary. Possible synapomorphies suggest that this lineage, which includes the genus *Procyonictis* and two new species of carnivoramorphans from Duchesnean localities of Carlsbad, California, may be very close to the root of the family Canidae. The study of middle Eocene carnivorous mammals from this region has the potential to shed new light on the origin of the crown-clade Carnivora.

Poster Session I (Wednesday)

**IRVINGTONIAN OCCURRENCES OF HOMOTHERIUM FROM IRVINGTON AND FAIRMEAD LANDFILL IN CALIFORNIA**

TOVAR, Danny, Department of Earth & Environmental Sciences, California State University, Fresno, CA, USA; DUNDAS, Robert, Department of Earth & Environmental Sciences, California State University, Fresno, CA, USA

Irvingtonian records of *Homotherium* are sparse in North America, the genus having been reported from a half dozen localities. Most specimens are postcrania, thus lacking diagnostic characters for species identification. Two species of *Homotherium* are recognized in the Pleistocene of North America; early-middle Pleistocene *Homotherium crenatidens* and late Pleistocene *Homotherium serum*. This study evaluates *Homotherium* from the middle Irvingtonian age Irvington locality at Fremont, California and the late Irvingtonian Fairmead Landfill site in Madera County, California. UCMP 39228 is a partial cranium from Irvington. The left anterior portion of the skull is present but the right side is missing. The right zygomatic arch, and most of the left, is gone. The frontals are crushed, with only the central area preserved. From the anterior border of the parietals back, the cranium is mostly complete. The premaxillae and incisors are missing, as is the remaining right side dentition. The left canine is broken at the alveolar border and the P3 and M1 are missing, although the

alveoli are preserved. The left P4 has a broken parastyle and an internal root (protoradix) is present. UCMP 140390 is a partial cranium from Fairmead Landfill. The left side is crushed and missing the zygomatic arch. The premaxillae and right maxilla are gone, along with their accompanying teeth. Much of the posterior of the skull is preserved. The left canine is broken at the alveolar border, and the alveoli for the P3-M1 are preserved, with a protoradix in the P4 alveolus. UCMP 140391, from Fairmead Landfill, is a right upper canine measuring 105.4 mm in total length, with a crown length of 62.3 mm. The canine exhibits serrations (1.7 serrations/mm) on the anterior and posterior crown margins. A protoradix on the P4 of the Irvington and Fairmead Landfill crania precludes their assignment to *Homotherium serum*. Further analysis is necessary to determine whether the Irvington and Fairmead Landfill crania are referable to a new species or to *Homotherium crenatidens*, which possesses a P4 protoradix.

Technical Session V, Wednesday 2:30

**BONE-CRACKING CAPABILITY IN THE SKULL OF *DINOCROCUTA GIGANTEA* (CARNIVORA, MAMMALIA) REVEALS BIOMECHANICAL CONVERGENCE BETWEEN HYAENIDS AND PERCROCUTIDS**

TSENG, Zhijie Jack, Univ. of Southern California, Los Angeles, CA, USA

Iterative evolution of ecological morphologies presents prime examples of morphological convergence in the mammalian fossil record. Cranial similarities between some eutherian and marsupial predators, nimravid and felid carnivorans, and hyaenid and canid carnivorans are highly suggestive of common ecological roles. However, the extent of functional similarity in the context of cranial biomechanics is often poorly characterized. The large feliform carnivoran *Dinocrocuta gigantea*, a late Miocene member of carnivoran guilds throughout Eurasia, has a suite of craniodental characters that ally this species and its related forms to the Hyaenidae (robust premolars, reduction of molars and their cusps, and a highly vaulted fronto-parietal region). However, evidence from deciduous dental morphology, superficial basicranial anatomy, and a lack of clear morphological connection to basal hyaenids have prompted the assignment of *Dinocrocuta* and its sister taxa to the family Percrocutidae. To test the extent that the skull of *Dinocrocuta* is “hyaena-like” in its capability to distribute and dissipate cranial stress during a bone-cracking bite using the third premolar, finite element models of the skulls of *Dinocrocuta gigantea* and the spotted hyena *Crocuta crocuta* were constructed and compared to the hypercarnivorous *Canis lupus* in a biomechanical analysis. Findings indicate that the crania of *D. gigantea* and *C. crocuta* perform better in stress distribution and dissipation than that of *C. lupus*, regardless of P3 or P4 biting. More specifically, the vaulted fronto-parietal region of *D. gigantea* and *C. crocuta* received lower, as well as more evenly distributed stress than *C. lupus*. Thus, the craniodental structures of the two feliform carnivorans are linked by functional advantage over that of *C. lupus* for bone-cracking, and this capability evolved separately from less durophagous forms in the two families. Further examination of lineages such as borophagine canids could elucidate the extent of functional convergence of the bone-cracking ecomorphology across the carnivoran order.

Poster Session III (Friday)

**PHYLOGENETIC POSITION OF DERIVED ORNITHOPODS OF EARLY LATE CRETACEOUS (BAYNSHIRE AND DJADOKHTA AGE) IN MONGOLIA**

TSOGTBAAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia; WATABE, Mahito, Hayashibara Center for Paleobiological Researches, Okayama, Japan

Derived hadrosaurid genera *Saurolophus* and *Barsboldia* have been discovered from the Nemegt Beds (Maastrichtian) in western Gobi Desert. On the other hand, the early Late Cretaceous (Baynshire and Djadokhta ages: Turonian – Santonian and Campanian respectively) ornithopods have been poorly studied. Mongolian Paleontological Center and Hayashibara Museum of Natural Sciences Joint Paleontological Expedition party collected well-preserved specimens of ornithopods including a nearly complete skeleton from Bayshin Tsav, Khorai Tsav, Khongil Tsav, and Bayn Shire (Baynshire age) in southeastern and eastern Gobi desert, and from Alag Teg (Djadokhta age) in central area of the desert. A result of cladistic analysis on those early Late Cretaceous ornithopods including Asian and North American ornithopods (iguanodonts, hadrosauroids, and hadrosaurids) suggests that (1) early Late Cretaceous ornithopods of Mongolia are placed as derived hadrosauroids in the cladogram (positioned between *Eolambia* and *Telmatosaurus*); (2) a Djadokhta (Campanian) hadrosauroid from Alag Teg is more closely related to the Bayn Shire (Turonian – Santonian) form than to the Nemegtian hadrosaurids. The result that there is no phylogenetic relationship between the Djadokhta hadrosauroid and the Nemegt hadrosaurids suggests that the Mongolian hadrosaurids of Nemegt age immigrated from North America to Mongolia in the early Maastrichtian age, and the early Late Cretaceous (Baynshire) and Djadokhta hadrosauroids became extinct by the beginning of the Nemegt age. There is no co-existing of specimens of derived hadrosauroids and Hadrosauridae in the dinosaur fossil-bearing Upper Cretaceous beds in Mongolian. The “Hadrosaurid Datum” defines the Djadokhta (Campanian) and Nemegt (Maastrichtian) ages in the biostratigraphy of the Upper Cretaceous in Mongolia.

Poster Session IV (Saturday)

**ANTHRACOTHERIID ARTIODACTYLS FROM THE UPPER EOCENE ERGILIN DZO FORMATION OF MONGOLIA**

TSUBAMOTO, Takehisa, Center for Paleobiological Research, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia

We report new fossil specimens of two anthracotheriid artiodactyls (Mammalia) discovered from the upper Eocene Ergilin Dzo Formation of southeastern Mongolia. The specimens reported here are: an upper molar, an astragalus, and a calcaneus of a bunodont anthracotheriid; and upper and lower postcanine dentitions, an astragalus, and a distal tibia of a selenodont anthracotheriid. The bunodont anthracotheriid is similar in size and general morphology of the upper molar to small and bunodont anthracotheriids such as *Siamotherium*, *Anthrakoceryx*, and *Microbunodon*. The upper molar differs from that of *Siamotherium* in having much larger parastyle and mesostyle and in lacking the oblique buccal wall and flattening of the buccal wall of the metacone. It also differs from that of *Anthrakoceryx* and *Microbunodon* in having a better-developed and more mesially protruded parastyle and a more distally shifted mesostyle. The astragalus and calcaneus are similar in morphology to those of *Siamotherium*. The upper molar specimen indicates an existence of a bunodont anthracotheriid in the northern part of East Asia during the late Eocene. The selenodont anthracotheriid is morphologically referable either to *Bothriodon* or to *Aepinacodon* in having an upper molar wider than long, a mesiodistally compressed paracone and metacone, a large and buccally protruding mesostyle forming a loop around the buccal end of the transverse valley, a relatively well-developed molar paraconule, and mesiodistally compressed molar trigonid and talonid. Further generic identification is impossible because the present specimens do not include any anatomical part that is critical to distinguish the two genera. Although anthracotheriids have been listed in the faunal list of the Ergilin Dzo Formation, no information on the specimens has been reported yet. The present new specimens provide precise morphologies of the poorly-understood anthracotheriids of the formation, confirming the existence of two anthracotheriid genera in the formation.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 9:00

**NEW INFORMATION ON THE CRANIAL ANATOMY OF *AVIMIMUS PORTENTOSUS* (DINOSAURIA: THEROPODA) INCLUDING VIRTUAL ENDOCASTS OF THE BRAIN AND INNER EAR**

TSUIHIIJI, Takanobu, National Museum of Nature and Science, Tokyo, Japan; WITMER, Lawrence, Ohio University, Athens, OH, USA; WATABE, Mahito, Hayashibara Center for Paleobiological Research, Okayama, Japan; BARSBOLD, Rinchen, Mongolian Paleontological Center, Ulaanbaatar, Mongolia; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

In the past decade, the Hayashibara Museum of Natural Sciences - Mongolian Paleontological Center expeditions have collected several new specimens of the oviraptorosaur *Avimimus portentosus*, known for its avian-like skeletal features, from Upper Cretaceous localities in Mongolia. All skull material was micro-CT scanned. Discovery of two braincases and such previously unknown elements as the nasals and maxilla provide new information on the skull and, for the first time, the facial skeleton of this enigmatic theropod. The nasals are fused to each other, as in oviraptorids, comprising a wing-like, postnasal plate and a median, internarial process that bifurcates anteriorly to clasp the nasal processes of the premaxilla. Unlike in most oviraptorids, the dorsal surface of the postnasal plate is rather smooth and bears no pneumatic fossa. Instead, a pair of large, presumably pneumatic openings lies posterior to this plate, bounded posteriorly by anterior concavities on the frontals. The putative maxillary fragment is thin and edentulous. Cranial endocasts were digitally reconstructed for both braincases, and their overall morphology is similar to those previously described in other oviraptorosaurs. Derived features are shared with avialans and other derived maniraptorans, such as a large flocculus, laterally positioned optic lobes, and two rami of the trigeminal nerves separately exiting the braincase. One of the prominent cranial characteristics of the *Avimimus* skull is its dome-like, inflated roof of the frontals, and it is here confirmed that this reflects the strong development of the cerebral hemispheres. The endosseous labyrinth of the inner ear also shows derived ornithurine-like characteristics, such as the caudal semicircular canal extending well below the plane of the horizontal canal. The new findings on *Avimimus* potentially clarify its position within Oviraptorosauria. More broadly, the position of oviraptorosaurs has been controversial, particularly relative to Avialae. These new data are relevant to that controversy, but caution is prudent pending the analysis of similar endocranial data from relevant avian and nonavian maniraptorans.

Technical Session XI, Friday 8:45

**A ENIGMATIC NEW PARAREPTILE (AMNIOTA: REPTILIA) FROM THE EARLY PERMIAN FORT SILL FISSURE FILL DEPOSITS IN OKLAHOMA**

TSUJI, Linda, Museum für Naturkunde, Humboldt-Universität zu Berlin, Berlin, Germany; MÜLLER, Johannes, Museum für Naturkunde, Humboldt-Universität zu Berlin, Berlin, Germany; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada

The monophyly of the Parareptilia has been confidently established only relatively recently, but debates over turtle origins and studies detailing the remarkable morphological innovations of some of its members have brought increased attention to the group. Whereas the vast majority of parareptilian taxa have been found in Middle and Upper Permian sediments of Russia and South Africa, earlier members of this group are rare and yet also key to understanding the evolutionary relationships and patterns within the clade. The Lower Permian fissure fill deposits near Fort Sill, Oklahoma, have produced a remarkably rich, diverse, and well-preserved assemblage of fully terrestrial tetrapods, including the parareptiles *Bolosaurus grandis*, *Colobomycter pholeter*, and *Delorhynchus priscus*. This study describes a superbly preserved new parareptile recently recovered from the site. The fossil consists of a small, gracile, mostly articulated isolated skull with an attached lower jaw. Distinct sculpturing is present consisting of small pinprick-size pits interspersed among larger round pits, with shallow grooves radiating to the edges of some of the bones, a pattern somewhat similar to both the Oklahoman parareptile *Acleistorhinus* and the millerettids from South Africa. In addition to possessing a very broad palatine, there is an indication that the lacrimal reached the naris, a feature shared with more basal parareptiles. The postorbital is relatively broad for an animal of this size and extends far back towards the occipital region. A phylogenetic analysis of Paleozoic parareptiles indicates that this taxon falls fairly basally, between the millerettids and the group including *Acleistorhinus* and *lanthanosuchids*, providing much needed insight into the early history of the clade. As such this taxon fills a significant gap in our knowledge of Lower Permian parareptiles, with interesting implications for biogeography. Whereas previous evidence argued for an initial Gondwanan diversification of parareptiles, the early age and basal phylogenetic position of this taxon and other parareptiles from Laurasia appear to contradict this hypothesis.

Poster Session I (Wednesday)

**ECOLOGICAL STABILITY AMONG EARLY EOCENE MAMMALIAN FAUNAS FROM THE BIGHORN BASIN, WY**

TSUKUI, Kaori, University of New Hampshire, Durham, NH, USA; CLYDE, William, University of New Hampshire, Durham, NH, USA

The extent of ecological stability and niche utilization among fossil mammal groups offers insights into the cohesiveness of communities over geological time scales. Over 300 mammalian species from a single taphonomic mode (surface-collected overbank deposits) in the northern Bighorn Basin, WY were analyzed to assess changes in ecological diversity during the 5 million years following the Paleocene/Eocene (P/E) boundary. The Bighorn Basin faunal records from the early Paleogene are one of the most complete and best studied in North America and capture the major taxonomic turnover that is linked to a global warming event that marks the P/E boundary. In this study, ecospace was described by diet, locomotion, and body size, each of which was further subdivided into 5 or 6 character states. When taken together, these 3 variables describe a species' life habit. By applying this method to all species in a fossil assemblage, this approach allows us to visualize the extent of ecospace occupation through time. We employed this 3-D ecospace framework to the faunas from 243 localities that were grouped into 6 different faunal zones (Wa-1 to Wa-6). Our results demonstrate that these isotaphonomic Wasatchian faunas utilized only ~20 % of the potential theoretical ecospace between Wa-1 and Wa-6. Furthermore, our study reveals that the proportion of ecospace filled, and the types of the life habits utilized, remained relatively uniform during the entire study interval, indicating that the Wasatchian faunas from the Bighorn Basin were characterized by ecological stasis despite recurring taxonomic turnover and environmental changes. We argue that abiotic and biotic disturbances during Wa-1 and Wa-6 did not exceed the capacity of the system, thus keeping it in a stable state. This is in distinct contrast to the P/E boundary when a climatic and immigration threshold was clearly crossed inducing a major ecological reorganization. Integration of further analyses on turnover rates, diversity, and morphological changes at the species level during the same interval will provide a more complete view of the strength and extent of evolutionary stasis among these mammalian communities.

Poster Session III (Friday)

**LONG BONE SURFACE TEXTURES AS ONTOGENETIC MARKERS IN CENTROSAURINE CERATOPSIDS**

TUMARKIN-DERATZIAN, Allison, Temple University, Philadelphia, PA, USA

Among archosaurs, characteristic changes in bone surface textures on postcranial elements occur in pterosaurs and birds (modern and sub-fossil), but are absent in modern crocodylians. Where a consistent transition occurs, observed texture changes follow a decrease in overall surface porosity with increasing skeletal maturity and/or size, although specific textures and patterns of change are not universal across taxonomic groups. To date, few detailed studies of postcranial bone texture changes have been attempted on non-avian dinosaurs. Centrosaurine ceratopsids, with several taxa known from monodominant bonebed assemblages comprising remains of multiple individuals from a range of sizes

(and presumably ages), are excellent candidates for analyses of textural trends. Although several authors have examined ontogenetic textural changes in the centrosaurine skull, comparatively little attention has been paid to the postcrania. Surface textural changes in long bones, although often not as striking as those on the skull, may be highly valuable for aging centrosaurine remains, particularly if they may be ultimately combined with osteohistological data and life history analyses. The current study examines surface textures on long bones from several centrosaurine taxa, to assess whether any consistent pattern of textural change may be linked with increasing size and/or age classes, and whether observed changes are consistent across taxa. Preliminary results suggest a regular pattern of decreasing surface porosity in the midshaft regions of all major long bones, broadly similar to the patterns observed in birds and pterosaurs. Since long bones are also widely used for histology-based growth studies, future combined analyses of surface textures and osteohistology could potentially link textural transitions to significant growth changes at specific points in an individual's life history, such as growth deceleration associated with sexual maturity. If such links could be established, it is possible that surface textural features could ultimately be used to approximate reproductive status and/or chronological age without the need for destructive sampling.

Romer Prize Session, Thursday 10:45

**PHYLOGENETIC HISTORY AND BODY SIZE EVOLUTION IN COELUROSAUR THEROPODS**

TURNER, Alan, American Museum of Natural History, New York, NY, USA

Body size change in coelurosaurs is important because of proposed links to physiological changes and flight evolution in the clade. Furthermore an orthodox view has developed that a directional trend of size decrease leads towards bird origins. Here, an empirically derived phylogeny of Coelurosauria was generated by examining 101 fossil and extant species-level taxa and 472 morphological characters. Ancestral body mass estimates for all coelurosaur clades including basal ornithurine birds were made, and model tests performed looking for the presence of any trends within these body size data. A statistical approach was taken using maximum likelihood and a GLS framework to test models of body size evolution across this coelurosaur tree. The GLS approach allows the estimation of parameters relating to the fit of a model to the data. These parameters are directly interpretable as variations in tempo and mode of evolution. The results reject a two-parameter directional model of trait evolution, favoring an unbiased random walk model. No evidence is present for a directional bias in coelurosaur size change. Indeed, coelurosaurs like other dinosaurs are characterized by an expansion in body size range throughout the clade, but these data do not support an active trend of coelurosaur body size decrease or increase. Both GLS and linear parsimony estimates of ancestral coelurosaur body sizes support two conclusions: 1) birds' small body size is the result of a complex, non-linear path of body size change and 2) coelurosaur origins are marked by a decrease in body size. Maximum likelihood estimates of model parameters indicate that the rate of body size change accelerated during the latter part of Mesozoic coelurosaur evolution and finds evidence for trait evolution like that seen during an adaptive radiation. It is also at the base of Coelurosauria that feather elaboration occurs. These results mark some of the first support coaxed in the comparative method for an adaptive link between feather evolution and the body size reduction seen in the early evolutionary history of Coelurosauria.

Technical Session XX, Saturday 2:30

**THE OLDEST CETACEANS FROM THE SOUTHERN HEMISPHERE: NEW ARCHAEOCETES FROM THE PISCO BASIN OF SOUTHERN PERU**

UHEN, Mark, Alabama Museum of Natural History, Tuscaloosa, AL, USA; PYENSON, Nicholas, Museum of Paleontology, University of California, Berkeley, Berkeley, CA, USA; THOMAS, DeVries, University of Washington Burke Museum, Seattle, WA, USA; MARIO, Urbina Schmitt, Museo de Historia Natural de San Marcos, Lima, Perú

The early evolution of cetaceans has been documented almost entirely by fossils from the tropical and subtropical marine deposits of the Northern Hemisphere. We report on recent fieldwork in the Pisco Basin, Peru, which documents the presence of archaeocetes based on multiple specimens from the Paracas and Otuma Formations. The middle Eocene Paracas Formation has produced a marine tetrapod fauna including marine turtles, one species of early penguin, and at least two species of archaeocete whales. The Otuma Formation is late Eocene in age, and produces turtles, one species of penguin, and at least two additional species of archaeocete whales, many of which are represented by complete skeletons. The age of these formations is based on microfossil correlations and is confirmed by several independent Ar/Ar dates from an ash bed at the base of the Otuma Formation at 36.1 Ma. The Paracas Formation archaeocetes represent forms that display a mixture of characteristics found in protocetids and basilosaurids. The specimen of the smaller species includes a manubrium of the sternum that is T-shaped, with the body long and rod-like. This feature is very similar to the sternum of other protocetids like *Rodhocetus*, and unlike those of basilosaurids. This specimen also includes an upper molar tooth, which clearly displays accessory denticles characteristic of basilosaurids. The specimen of the larger species has vertebrae that are similar in form to those of *Eocetus*, but are considerably smaller. This specimen includes molar teeth that have accessory denticles characteristic of basilosaurids. The Otuma Formation archaeocetes are more abundant than those of the Paracas Formation. The smaller species is similar in size to *Dorudon* or *Zygorhiza*, but detailed comparisons with these taxa have yet to be made. Overall, the presence of several species of fully aquatic

archaeocetes from Peru is significant because these are the first archaeocetes to be found in demonstrably cold-water deposits. All others are known from sub-tropical to tropical seas, whereas microfossils clearly indicate that the coast of Peru was a cold-water upwelling zone, as it still is today.

Technical Session VI, Thursday 3:30

**DIETARY PREFERENCES OF DESMOSTYLIANS BASED ON ISOTOPE, MICROWEAR AND CRANIAL MORPHOLOGY**

UNO, Hikaru, University of Tokyo, Kashiwa, Japan; YONEDA, Minoru, University of Tokyo, Kashiwa, Japan; TARU, Hajime, Kanagawa Prefectural Museum of Natural History, Odawara, Japan; KOHNO, Naoki, National Museum of Nature and Science, Tokyo, Japan

Two genera of desmostylians, *Desmostylus* and *Paleoparadoxia*, have been known from the Early to Middle Miocene of the North Pacific realm. Each has distinct morphology that is apparently a result of different feeding adaptation. However, their nutrient sources and microhabitats have remained controversial. Thereby, we attempt to interpret the ecological setting for *Desmostylus* and *Paleoparadoxia* on the basis of the combined-knowledge obtained from isotope geochemistry, dental microwear and cranial morphology. Both *Desmostylus* and *Paleoparadoxia* have high  $\delta^{13}\text{C}$  values, but the values significantly differed from each other. The  $\delta^{18}\text{O}$  values are indistinguishable from each other, and both show that of freshwater mammals. These data might mean both animals shared an identical habitat under the effect of freshwater and that they might also forage at the place where estuarine nutrition resources were available. As for dental microwear, scratch-to-pit ratios are distinct between *Desmostylus* and *Paleoparadoxia*. *Desmostylus* has the sigmoidal dorsal margin of the mandible that fits the maxillary margin, and the gum lines of upper and lower tightly match at the labial margin. When *Desmostylus* close the mouth, the labial gum line with no upper incisor and lateral margins of the long diastema may be effective for restricting the aperture of the oral cavity. In addition, the oral cavity of *Desmostylus* is composed of a strongly vaulted palate and deep mandible. These features suggest that the masticatory apparatus of *Desmostylus* is characterized by enlargement of the volume and limited opening of oral cavity and would be suited for suction feeding like odobenine walrus that catch mollusks by negative pressure in the oral cavity. On the other hand, the corresponding portions of *Paleoparadoxia* are characterized by a flat maxillary palate surface, wide-open oral cavity and presence of upper and lower incisors. These features suggest that *Paleoparadoxia* would prove and process to get food items like generalized aquatic herbivorous mammals such as sirenians and semiaquatic proboscideans.

Poster Session III (Friday)

**STABLE CARBON AND OXYGEN ISOTOPE RATIOS OF FOSSIL TOOTH ENAMEL FROM THE NAKALI AND NAMURUNGULE FORMATIONS, KENYA: CAPTURING THE C<sub>3</sub>-C<sub>4</sub> TRANSITION IN EAST AFRICAN EQUID DIET AT ~9.6 MA**

UNO, Kevin, University of Utah, Salt Lake City, UT, USA; CERLING, Thure, University of Utah, Salt Lake City, UT, USA; NAKAYA, Hideo, Kagoshima University, Kagoshima, Japan; NAKATSUKASA, Masato, Kyoto University, Kyoto, Japan; KUNIMATSU, Yutaka, Primate Research Institute, Kyoto University, Inuyama, Japan

Stable carbon isotope ( $\delta^{13}\text{C}$ ) values of fossil tooth enamel from the Nakali and Namurungule Formations in Kenya appear to bracket the dietary transition from C<sub>3</sub> to C<sub>4</sub> resources in equids. These two hominoid-bearing sites lie within 60 km of each other and collectively span a time period that is poorly represented in the East African fossil record (10.1-9.3 Ma). The average  $\delta^{13}\text{C}$  value of equid teeth from the Nakali Formation (10.1 to ~9.6 Ma) is  $-10.6 \pm 1.2\text{‰}$  (n=3), which indicates a C<sub>3</sub> diet. Conversely, the average  $\delta^{13}\text{C}$  value of equid teeth from the Namurungule Formation (9.6 to ~9.3 Ma) is  $-2.3 \pm 1.7\text{‰}$  (n=26). Equid  $\delta^{13}\text{C}$  values from the Namurungule Formation are the earliest robust isotopic evidence of C<sub>4</sub> resources in East Africa from fossil tooth enamel.  $\delta^{13}\text{C}$  values of suid, rhinocerotid, hippopotamid and proboscidean teeth (n=28) from this formation support the presence of C<sub>4</sub> resources at the site. In particular,  $\delta^{13}\text{C}$  values of rhinocerotid teeth from the Namurungule Formation range from  $-9.6$  to  $-1.0\text{‰}$ . This represents nearly the entire spectrum of C<sub>3</sub>- to C<sub>4</sub>-dominated diet within a single taxon. Preliminary data of teeth (n=6) from the Nakali Formation indicate C<sub>3</sub> diets for rhinocerotids, hippopotamids, and proboscideans. Alternatively, if these data do not capture the C<sub>3</sub> to C<sub>4</sub> transition in equid diet, then the two sites are an exceptional example of temporally and spatially proximal sites that had very different environments.  $\delta^{18}\text{O}$  values of teeth from evaporation-sensitive (i.e., giraffids) and evaporation-insensitive (i.e., hippopotamids) taxa may be used to evaluate relative differences in aridity between the two sites.

Technical Session X, Friday 9:45

**NEW FOSSIL EVIDENCE FOR A BROAD FOREWING IN PTEROSAURS**

UNWIN, David, University of Leicester, Leicester, United Kingdom; WILKINSON, Matthew, University of Cambridge, Cambridge, United Kingdom; LÜ, Jungchang, Chinese Academy of Geological Sciences, Beijing, China

The basic configuration of the pterosaur flight apparatus is now widely agreed upon, but debate continues regarding the shape of the forewing. Most workers favour a narrow construction consisting of a membrane (propatagium) extending from the shoulder to the

wrist and supported along the distal part of its leading edge by the pteroid, a medially directed spar-like bone that articulated with the medial carpal. Some researchers have argued for a broad forewing wherein the membrane extended from the shoulder to the base of the digits and was controlled by an anteriorly directed pteroid. Here we present new evidence in support of this controversial idea. 1. Well preserved wrists of ornithocheirids and azhdarchoids from the Santana Formation of Brazil show that the articular condyle of the pteroid has a complex shape that is complementary to the anterior cotyle of the medial carpal, within which it articulated, and that permitted both anterior and medial orientations of the pteroid. We found no evidence in these, or other fossils, for articulation of the pteroid with the medial aspect of the medial carpal. 2. Remarkably complete well preserved remains of the propatagium in two examples of *Jeholopterus*, an antrognathid from the Upper Jurassic of China, in which the pteroids are directed forward, demonstrate that the propatagium was broad and extended to the base of the digits. 3. Morphometric analysis of 38 species of pterosaur, representing 16 (from ~18 known) families and a range of wingspans from 0.4-7.0 metres, shows a good correlation ( $r^2 = 0.91$ ) between the length of the pteroid and the wing-metacarpal, consistent with the particular shape constraints imposed by a broad forewing model. A broad forewing and anteriorly directed pteroid was likely true for all pterosaurs and offers distinct mechanical advantages compared to the traditional reconstruction. This construction also explains the function of the medial carpal which, through abduction-adduction, compensated for limb movements distal to the proximal syncarpal during flight, and has been shown by experimentation to produce useful aerodynamic forces far superior to those generated by the narrow forewing.

Technical Session X, Friday 10:45

**RECONSTRUCTING THE BIOGEOGRAPHIC HISTORY OF MIDDLE AND LATE JURASSIC DINOSAURS USING EVENT-BASED PARSIMONY TREEFITTING**

UPCHURCH, Paul, University College London, London, United Kingdom; MAIDMENT, Susannah, n/a, Ho Chi Minh City, Viet Nam; BUTLER, Richard, The Natural History Museum, London, United Kingdom; BENSON, Roger, University of Cambridge, Cambridge, United Kingdom

Event-based parsimony treefitting is a cladistic biogeographic technique, which assigns costs to the principal types of biogeographic event (vicariance, dispersal, extinction and sympatry) and calculates the total cost implied by the phylogenetic relationships and spatial distributions of a given clade. The reconstructions with the lowest cost are then compared with randomized versions of the original data set in order to evaluate whether congruent spatial patterns can be recognized against background distributional noise. A dataset comprising the phylogenetic relationships and geographic/stratigraphic ranges of approximately 80 Middle and Late Jurassic dinosaurian genera and species was subjected to event-based treefitting using the package TREEFITTER 1.03B. The single statistically significant area cladograms are (South America, (Africa, (Europe, Asia))) for the Middle Jurassic, and ((South America, Africa), (Asia (Europe, North America))) for the Late Jurassic. These results suggest that barrier formation in the Middle and Late Jurassic shaped dinosaurian distributions and restricted dispersal opportunities. Area cladogram topologies are not strongly affected by sampling biases and phylogenetic uncertainty, with the possible exception of Africa in the Middle Jurassic, which is represented by only 3% of the data. Palaeogeographic and palaeoclimatic data provide potential explanations for the observed patterns. During the Middle Jurassic, an arid latitudinal zone could have separated southern South American taxa from those in north Africa. The clustering of Europe and Asia (Middle Jurassic) and all three Laurasian areas versus South America+Africa (Late Jurassic) is consistent with the break-up of Pangaea into Laurasia and Gondwana by the Callovian or earlier. Finally, the separation of Asia from Europe and North America may have been caused by the formation of the Turgai epicontinental sea during the Middle Jurassic. These results demonstrate an important role for vicariance during the Middle and Late Jurassic, with barrier formation and destruction reflecting a complex history of tectonic fragmentation, sea-level change and climatic shifts.

Poster Session II (Thursday)

**UNUSUAL BONE PRESERVATION AND TAPHONOMY IN METAXYTHERIUM CRATAEGENSE (SIRENIA: DUGONGIDAE) FROM CALVERT CLIFFS, MARYLAND, U.S.A. (MIOCENE, CHESAPEAKE GROUP)**

VAN ORDEN, Tess, Calvert Marine Museum, Solomons, MD, USA; GODFREY, Stephen, Calvert Marine Museum, Solomons, MD, USA

During the Miocene epoch, the Atlantic Ocean periodically covered southern Maryland. This shallow marine environment was host to a diverse mammal community that included the extinct dugongid sea cow, *Metaxytherium crataegense*. Fossilized remains of dugongids are known from the sea cliffs along the western shore of the Chesapeake Bay in Calvert County, Maryland. The pachyostotic and osteosclerotic bones of sea cows serve as ballast, adaptations to counter the buoyancy of their large and elongate lungs. The fossilized bones of sea cows are, in their vast majority, well preserved. However, in at least two associated partial skeletons from Calvert Cliffs (Calvert Marine Museum and United States National Museum of Natural History) many of the bones are significantly altered from their living state morphology. These osteological changes are presumed not to be the result of pathology but rather, postmortem winnowing. In some elements (ribs, humeri, and skull bones), at least 50% of the original bone mass was lost from the outside in. The degree to which the bones are "dissolved" is not uniform in either specimen: 1) some elements appear to be

unaltered; 2) other bones are nearly uniformly winnowed; and 3) other single bones range from normal in appearance at one end to greatly reduced in size and appearance at the other end. That the bones (including some delicate cranial elements) of these individuals remained in association supports the conclusion that they were not modified as a result of abiotic mechanical abrasion or postmortem transport. This would then suggest that either the bones were winnowed mechanically through the activity of organisms (akin to bone-eating worm action on whale bones in whale-fall communities) or they were dissolved chemically. If the latter occurred, it is not yet known if it was biologically mediated or happened in the absence of a biological agent (i.e. abiotic chemical winnowing) either before or after the skeletons were entombed in sediment.

Poster Session I (Wednesday)

**BIOSTRATIGRAPHY OF THE FREIGHTER GAP AND PINNACLES AREAS, GREAT DIVIDE BASIN, SOUTHWESTERN WYOMING**

VAN REGENMORTER, John, Western Michigan University, Kalamazoo, MI, USA;  
ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA

Ongoing interdisciplinary investigations of the paleontology and geology of the Great Divide Basin in southwestern Wyoming have allowed the biostratigraphic correlation of fossil localities between Freighter Gap and the Pinnacles regions in the northern part of the basin. Laterally extensive marker beds were used to correlate mammal bearing fossil localities between the two areas, and faunal compositions were used to determine the NALMA and subage of individual localities. The Freighter Gap region includes 44 localities that have produced 1829 identifiable mammal fossils from the Main Body of the Wasatch Formation in the Wa-6 (Lysitean) and Wa-7 (Lostcabinian) subages of the Wasatchian NALMA. The Pinnacles region is also within the Main Body of the Wasatch Formation, and has produced 15 localities with 248 identifiable mammal fossils from the Wa-7 (Lostcabinian) subage of the Wasatchian NALMA. In addition, Geographic Information Systems (GIS) were employed for map digitization, improving mapping accuracy, and to create an interactive, searchable, and spatially referenced database containing localities and associated fossils. In this paper we report the results of the geological mapping of identified marker beds within these areas, as well as the biostratigraphic correlations between the Freighter Gap and Pinnacles regions. These findings are integrated with geological investigations of the area in a composite stratigraphic section that displays the relative positions of all the localities within these two areas aligned with the generalized geology, marker beds, and NALMA age correlations. This paper also demonstrates the utility and functionality of the interactive spatial GIS database, which is adaptable to any fossil collection. Finally, we demonstrate the ease with which such a system can be used in conjunction with Google Earth to share paleontological and geological data with colleagues around the world.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**DENTAL MICROWEAR AND JAW MECHANICS IN BASAL NEOCERATOPSIDS**  
VARRIALE, Frank, Johns Hopkins University School of Medicine, Baltimore, MD, USA

The accepted model of ceratopsian chewing posits that the mandible adducted in an orthal direction, with no transverse or propalinal components. However, dental microwear in the basal neoceratopsians, *Leptoceratops* and *Archaeoceratops*, displays a pattern that is not congruent with a strictly orthal power stroke. Many of the microwear striations in these taxa are curvilinear, and the pattern differs for upper and lower teeth. Upper teeth show striations that begin near the apex with an apicobasal axis that curves distally into a mesiodistal orientation. Striations on lower teeth also start with an apicobasal axis but curve mesially, ending in a mesiodistal orientation near the base of the tooth. These striations accord with a model of mastication where occlusion began in an orthal direction but transitioned into a palinal (retraction) power stroke. This pattern differs from that seen in Psittacosauridae and the more derived Ceratopsidae. Psittacosaurids show rectilinear unimodal striations, whereas ceratopsids possess rectilinear bimodal and polymodal striations typically oriented in both apicobasal and mesiodistal directions. Clearly the transition from orthal to palinal directions in basal neoceratopsians was accomplished in a single fluid motion, whereas the same action was produced by separate events in ceratopsids. Additionally, the buccal shelf on the lower teeth of *Leptoceratops* is the product of differential wear. In *Leptoceratops* curvilinear striations on the vertical occlusal surface are in the same orientation as the edge of the shelf adjoining the occlusal surface. The shelf also exhibits microwear with striations that are more randomly oriented and pitted compared to the vertical occlusal surface. Moreover, the shelf has no counterpart on the upper dentition to occlude with. Therefore, microwear on this portion of the tooth is probably the result of food-on-tooth rather than tooth-on-tooth wear. The microwear pattern observed in basal neoceratopsians may indicate a transitional stage from the unidirectional chewing of psittacosaurids to the more complex mastication of ceratopsid ceratopsians.

Poster Session III (Friday)

**LARGE SCALE PATTERNS OF DINOSAUR DISTRIBUTION DURING THE CRETACEOUS**

VAVREK, Matthew, Redpath Museum, Montreal, QB, Canada; LARSSON, Hans, Redpath Museum, Montreal, QB, Canada

Non-metric Multidimensional Scaling (NMDS) has become a common tool used by ecologists in examining the interrelationships between different species assemblages. The process involves using a pair-wise distance measure to calculate the differences/similarities

between the different assemblages, and then attempts to arrange these in a low dimensional space while preserving the original distances as best as possible. Using NMDS along with a clustering type called Minimum Spanning Trees (MST) we were able to search for patterns of dinosaur distributions during the Cretaceous. The results show a definite split in the faunas of the Early and Late Cretaceous, as well as some separation between different continents. An MST was also combined with both a modern and a paleoreconstruction of the continental plates at the time, and a similar pattern emerged. Also, the average geographic distance between similar point faunas decreased when a paleoreconstruction was used, showing the importance of using proper continental positions when conducting large scale paleoecological studies. While the results from this study do not show unexpected results and largely conform to the models previously found using qualitative or other quantitative methods, this new method provides a semi-independent verification of those findings.

Poster Session IV (Saturday)

**MULTIPLE PATHOLOGICAL ELEMENTS IN A PHYTOSAUR (DIAPSIDA: ARCHOSAURIA) SKELETON FROM THE UPPER TRIASSIC OF ARIZONA, USA: EVIDENCE OF EXTREME OSTEOMYELITIS**

VINER, DVM DACVP, Tabitha, Smithsonian Institution, National Zoological Park, Washington, DC, USA; HECKER, PHD, Andrew, Appalachian State University, Boone, NC, USA; CARRANO, PHD, Matthew, Smithsonian Institution, National Museum of Natural History, Washington, DC, USA

Phytosaurs are an extinct clade of crurotarsan archosaurs known from Upper Triassic strata across much of Pangaea. A specimen from the lower Chinle Group of eastern Arizona in the National Museum of Natural History (USNM 18313) is remarkable in preserving a nearly complete skull and lower jaws along with most of the postcranial skeleton. Although the tarsus of this specimen has been frequently studied, no previous author has commented on the many exophytic lesions that characterize much of the appendicular skeleton. Specifically, the left humerus, both femora, the left fibula, and a metapodial all preserve extensive exostoses along the shaft of the bones; other limb elements show similar, but lesser, modifications. These irregular, proliferative lesions are so extensive that they have completely engulfed the deltopectoral crest on the humerus and thoroughly altered the architecture of both femora. The exostoses spare the articular surfaces and are often centered on diaphyseal cavitations reminiscent of draining tracts. The character and location of these lesions is consistent with osteomyelitis. This condition is not well explored in extant reptiles, but may be associated with local soft-tissue inflammation (e.g. stomatitis) or with disseminated bacterial or fungal infection (e.g. mycobacteriosis). Because the articular surfaces were unaltered, the range of limb motion in this phytosaur was likely unaffected, but movement may have been mitigated by pain associated with periosteal inflammation and alteration. The assumed low metabolic rate of this extinct reptile would have allowed several months of lesion progression before death from nutritional deficiency or systemic infection. The National Zoo pathology database records an osteomyelitis incidence of 0.54% (12/2230) in necropsied reptiles and 2.86% (1/35) in crocodylians alone, whereas birds and mammals each have a 1.0% incidence (63/6307 and 80/7703, respectively). Chi-square tests indicate that the occurrence of osteomyelitis in reptiles may be significantly lower than in endothermic groups, and leads us to suggest that this disease may be over-diagnosed in the paleopathological literature.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 9:15

**AN EARLY AUSTRALOPITHECINE FEMUR FROM GALILI, ETHIOPIA**  
VIOLA, Bence, Department of Anthropology, Faculty of Life Sciences, University Vienna, Wien, Austria; KULLMER, Ottmar, Paleoanthropology Section, Research Institute Senckenberg, Frankfurt, Germany; SANDROCK, Oliver, Paleontology Department, Hessian State Museum, Darmstadt, Germany; HUJER, Wolfgang, Department of Sedimentology and Geodynamics, Faculty of Earth Sciences, University Vienna, Vienna, Austria; SEIDLER, Horst, Department of Anthropology, Faculty of Life Sciences, University Vienna, Vienna, Austria

At Galili in the Somali region of Ethiopia, extensive N-S running normal faults expose an about 180 m thick fluvial to lacustrine sedimentary and volcanic succession. These deposits are assigned to the Mount Galili Formation, subdivided into six members separated by volcanic marker beds. Investigations by the PAR team since 2000 resulted in the recovery of a diverse fauna, six hominid teeth and a proximal femur fragment. The GLL 888 femur is the most complete hominid femur between 6 and 3.4 Ma, and gives us a unique insight into the evolution of the Australopithecine femur. Preliminary Ar/Ar dating of feldspars from the ignimbrite on top of the Dhidinley Member indicate a minimum age of 4.1 Ma for GLL 888, recovered almost 25 m below. Suids from the Dhidinley member include *Nyanzachoerus patersoni*, *Notochoerus jaegeri* and *Kolpochoerus deheinzellini*, indicating an age older than 3.75 MYA. The strong similarity of these specimens to the Kanapoi suids leads us to correlate the Dhidinley Member temporally with Kanapoi. This age determination is also supported by the presence of *Anancus kenyensis*, *Loxodonta cf. adaurora* and *L. cf. exoptata* in this Member. GLL 888 is the proximal half of a left femur, recovered in 26 fragments. Its proximal extremity is mostly complete, with exception of a small fragment missing at the top of the neck, and strong erosion on the top of the greater trochanter. Its morphology is in many ways more primitive than the femurs of *Australopithecus afarensis*, such as in the absence of an obturator externus groove, an intertrochanteric line and a linea aspera. Each of these traits is also present in one or more *A. afarensis* femora, but the combined presence

of these primitive features is unique. Of special interest is the large size of the femoral head relative to both neck and subtrochanteric shaft diameter, unlike *Australopithecus*, but very similar to *Orrorin tugenensis*. GLL 747, an upper M2 from the same sand layer as the femur is most similar to *Australopithecus anamensis*, with strongly bulging buccal and lingual walls. This research was supported by the BMBWK, GZ 200.093/I-VI/2004.

Poster Session I (Wednesday)

**USING MORPHOMETRICS FOR THE DESIGNATION OF ENIGMATIC HOLOYPES: AN ISOLATED TOOTH AS A TEST CASE**

WALLACE, Steven, Don Sundquist Center of Excellence in Paleontology, East Tennessee State University, Johnson City, TN, USA; BREDEHOEFT, Keila, Department of Biology, East Tennessee State University, Johnson City, TN, USA

Though rare, instances where a holotype has not been assigned to a specific tooth location do exist. In such situations, the usefulness of the type is greatly limited. A case in point is the dwarf tapir, "*Tapiravus polkensis*", where a single tooth from Florida was designated the type, yet it could not be confidently identified as either a P3 or a P4. As a result, though its placement within the genus was questionable, evaluation was hampered by the ambiguous nature of the type. Moreover, no skulls of this rare taxon were available, leading various authors to struggle with the assignment. The Gray Fossil Site of eastern Tennessee however, offers for the first time many complete skulls (most with associated post-crania) for direct comparison. Consequently, standard linear measurements and landmarks were used in two separate analyses to define the morphospace of individual "known" teeth, against which the holotype was then assessed. Morphological changes resulting from wear were taken into consideration during landmark selection. Both methods yielded an assignment of P3, therefore we formally propose this designation for the type. We hope that our methods, as well as the landmarks we chose, will assist others with similar unusual, but significant problems.

New Directions in the Study of Fossil Endocasts: a Symposium in Honor of Harry J. Jerison, Thursday 10:45

**CAN HEARING AND VOCALIZATION CAPACITIES BE ESTIMATED FROM COCHLEAR DUCT ENDOCASTS?**

WALSH, Stig, The Natural History Museum, London, United Kingdom; MILNER, Angela, The Natural History Museum, London, United Kingdom; BARRETT, Paul, The Natural History Museum, London, United Kingdom; MANLEY, Geoffery, Technischen Universitaet Muenchen, Muenchen, Germany; WITMER, Larry, Ohio University, Athens, OH, USA

Braincase structures that housed the auditory and vestibular apparatus are frequently preserved in fossil material, but rarely described. Some authors have attempted to infer hearing and vocalization capabilities by comparing cochlear duct dimensions in extinct taxa (e.g., hadrosaurid dinosaurs) with those of living species. However, in living reptiles the internal space of the endosseal cochlear duct (ECD) is occupied by soft tissues (e.g., perilymph) other than the hearing organ, the basilar papilla. The dimensions of the ECD thus may not reflect accurately the dimensions of the basilar papilla itself, bringing into question some inferences about hearing and vocalization drawn from the structure. The relationship between the bony anatomy of the inner ear and hearing (e.g., range of best hearing) has never been rigorously tested in either extant or fossil taxa. Here, we use high resolution micro-XRCT analysis to investigate whether simple ECD measurements can be fit to models of vocalization, sociality and environmental preference in living reptiles and birds. Fifty-seven extant taxa representing Chelonia, Crocodyliformes, Sphenodontia, Squamata, and eight avian orders were selected on the basis of whether they vocalize and on vocalization complexity. After scanning, virtual endocasts of the ECD were digitally segmented, and measurements of length, rostrocaudal and mediolateral width, and volume were taken and scaled to basicranial length. These data were subjected to multiple regression analysis along with measures of vocal complexity and pitch, hearing mean sensitivity and range, sociality and habitat. Hearing range and mean sensitivity were found to strongly positively correlate with ECD length. ECD length also positively correlated with vocal complexity, higher pitch vocalizations, pair bonding and large aggregations (>20 individuals). Volume was strongly correlated with low pitch vocalizations and aquatic habitats. Our results suggest that ECD length can be used to predict mean hearing frequency/range in fossil taxa, and that this measure may also predict vocal complexity and large group socialization given sufficient data to form a comprehensive model.

Technical Session XVII, Saturday 11:45

**A NEW CROWN-ANTLERED DEER, *STEPHANOCEMAS*, FROM NORTHERN TIBETAN PLATEAU, CHINA, AND THE RELATIONSHIP OF EURASIAN FORMS**

WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA, USA; XIE, Guangpu, Gansu Provincial Museum, Lanzhou, China; DONG, Wei, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

*Stephanocemas* is one of the early groups of deer (Cervidae) that shows indications of shedding their antlers, and as such, occupies a special position in the transition from non-deciduous to deciduous antlers in the evolution of cervids. Despite this basal position in cervid phylogeny, however, it has a highly peculiar, palmate antler morphology that is easily recognized in the fossil records of early to middle Miocene of Eurasia. A new species

of *Stephanocemas* is described based on three partial antlers ranging from juvenile to full adult individuals, recently collected from the late middle Miocene Lower Youshushan Formation in the Qaidam Basin of northern Tibetan Plateau. Another indeterminate species (*Stephanocemas* sp.) of much smaller size and primitive characteristics is described from more fragmentary materials in strata lower than the level of the new species but is still middle Miocene in age. A species-level phylogeny suggests that the new Tibetan Plateau species is the most derived among known taxa, with its large size, great expansion of palm part of the antler, and horizontally radiating tines being the most diagnostic characters. We recognize a *Paradicrocemas* clade that includes *P. feroxi*, *P. elegantulus*, and *P. brevistephanos*; the latter two were traditionally regarded as belonging to *Stephanocemas*. As a result, the *Paradicrocemas* clade is largely European and western Asian, whereas the restricted *Stephanocemas* is now Asiatic in geographic distribution.

Technical Session XVII, Saturday 9:30

**EARLY EOCENE PERISSODACTYLS FROM THE UPPER NOMOGEN FORMATION OF THE ERLIAN BASIN, INNER MONGOLIA, CHINA**

WANG, Yuan-qing, Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), Beijing, China; MENG, Jin, American Museum of Natural History, New York, NY, USA; BEARD, K., Carnegie Museum of Natural History, Pittsburgh, PA, USA; BAI, Bin, IVPP, Beijing, China; NI, Xi-jun, IVPP, Beijing, China

The origin and early radiation of major perissodactyl clades near the Paleocene-Eocene (P-E) boundary comprise significant part of the terrestrial mammalian turnover associated with the PETM. However, the poorly known material of this group at the period hampered our understanding of this issue. During the fieldwork in the past several years, a number of mammal specimens were collected from the upper Nomogen Formation of the Erlian Basin, Inner Mongolia, China. Two different kinds of perissodactyls have been recognized from the collection. One is represented by the primitive hyracodont *Pataecops*, while the other represents a new form of Lophialetidae. The specimens referred to *Pataecops* are morphologically similar to the type species of the genus, *P. parvus*, in general, but differ in being smaller in size and in having a proportionally larger M3, narrower angle between metaloph and ectoloph, more lophodonty and higher-crowned molars, etc. The specimens identified as a new lophialetid share some features with *Schlosseria* and *Lophialetes*, including anteroposteriorly compressed paracone, flat outer surface of metacone, no paraconule and metaconule on molars, etc. However, it is clearly distinguished from the latter two genera by its apparently smaller size, lower crowned cheek teeth, and larger width/length ratio. The new specimens are also easily distinguishable from the other known genera of Lophialetidae. Biostratigraphic correlation of the deposits bearing the new perissodactyls indicates that this local fauna is contemporary with the Early Eocene Bumban fauna of Mongolia, which is further constrained with paleomagnetic data. The new perissodactyl taxa, together with those reported from other Asian Bumban localities, show an early radiation of Perissodactyla that is more complicated than previously thought and is characterized by early divergences of major lineages, including hippomorphs, chalicotheres, tapiroids, and rhinocerotoids. In particular, the earliest record of hyracodontine rhinocerotoid has been extended to at least the earliest Eocene. These new data call for a reexamination of the perissodactyl evolution across the P-E transition.

Early hominid evolutionary tempo and mode between 3 Ma and 4.5 Ma, Friday 9:00

**NEW FOSSILS OF *AUSTRALOPITHECUS ANAMENSIS* FROM KANAPOI, KENYA, AND EVOLUTION WITHIN THE *A. ANAMENSIS*-*AFARENSIS* LINEAGE**

WARD, Carol, University of Missouri, Columbia, MO, USA; MANTHI, Fredrick, National Museums of Kenya, Turkana Basin Institute of the Stony Brook University, Nairobi, Kenya

The species *Australopithecus anamensis* and *A. afarensis* are known from several different sites spanning over a million years in time in eastern Africa. Analysis of materials known as of 2001 suggested that the four site samples of these species known at the time (Kanapoi, Allia Bay, Laetoli and Hadar) represent a single anagenetic lineage, and more recently announced fossils appear consistent with this interpretation. The likelihood that these species are part of a single lineage provides the opportunity to examine how their morphology evolves. Several of the twenty characters evaluated previously may be functionally, spatially and/or developmentally linked, and appear related to reduction in size of aspects of the anterior dentition, as well as changes in the anterior portion of the mandible, and nasal aperture. In addition, over this time period, molar crowns became taller with less strongly sloping sides. Patterns of variation and covariation within and among characters over time provide a basis from which to interpret adaptive changes which could explain observed evolutionary trajectories. Since 2003, renewed fieldwork at the earliest known *Australopithecus anamensis* site of Kanapoi by a team led by one of us (FKM) has yielded eight new specimens, as well as additional information about associated fauna and paleoecology at this site. These include a partial edentulous mandible, an associated mandibular dentition from the canine through third molar, as well as several isolated teeth including a maxillary canine associated with a molar. In this presentation, we describe these new fossils within the context of previously documented variation seen in *A. anamensis* from Kanapoi, as well as within other published material from later time periods at other localities. These new fossils confirm the pattern of morphologies observed in the earliest *Australopithecus*, and provide additional evidence for the primitive nature and distinct morphology of the Kanapoi sample. In particular, they provide important additional evidence of changes in size and shape of the canine-premolar complex and molar morphology within the *A. anamensis*-*A. afarensis* lineage.

Poster Session III (Friday)

**A NEW PACHYCEPHALOSAUR (MARGINOCEPHALIA, DINOSAURIA)  
FROM THE LOWER UPPER CRETACEOUS IN MONGOLIA- THE EARLIEST  
PACHYCEPHALID FORM**

WATABE, Mahito, Hayashibara Center for Paleobiological Researches, Okayama, Japan;  
TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

Pachycephalosauria taxa were mainly distributed in Asia and North America. They are relatively less known from the upper Cretaceous beds in Mongolia compared with in North America. The Mongolian taxa (*Goyocephale*, *Homalocephale* – flat-headed forms, *Prenocephale* and *Tylocephale* – domed-headed forms) of this group are chronologically confined to Campanian and Maastrichtian ages. A new specimen of pachycephalosaur was found in a locality Amtgai, a Baynshirenian-aged (Turonian - Santonian) locality in the southern Gobi desert where several segnosaurian specimens had been found from the beds with alternation of sandstone and mudstone layers. The newly discovered specimen is a small-sized fused frontoparietal part. The specimen is clearly characterized by thick front-parietal bones and no development of the supratemporal fenestra. Its small size is due to its early ontogenetic stage. A result of cladistic analysis on the specimen shows that it belongs to a clade of domed-skulled forms (Pachycephalosauridae), not that of Homalocephalidae. This discovery is the first recognition of the pachycephalosaurid form in early Late Cretaceous period (Turonian - Santonian) in Asia and North America. The chronologically earliest pachycephalosaurian specimen from Mongolia already had derived cranial morphology. An Asian origin of Family Pachycephalosauridae is suggested by this discovery.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**STEGOSAURUS: HANDS, FEET, AND FOOTPRINTS**

WATANABE, Akinobu, University of Chicago, Chicago, IL, USA

New and undescribed specimens of the manus (AMNH 650) and pes (CMNH 41132) of *Stegosaurus* were studied, providing new information on their composition and posture and how these might affect footprint shape. The specimens are from two separate individuals, and both the manus and pes have been preserved in partial articulation. The manus has five digits with a phalangeal formula of 2-2-1-1-0, where digit V has a small acorn-shaped pisiform. Digits I and II bear flattened unguals, unlike the reduced crescentic proximal phalanges of digits IV and V. The middle digit also has a flattened ungule, but to a lesser extent. Positioning the manus and carpus in articulation suggests that the angles between the metacarpals and ground surface lie between 60° and 70°. These angles imply that footprints of the manus were broader than long, with two squared claw impressions of digits I and II directed anteromedially. Much of the anterior body weight will be exerted onto these two digits, and this downward force would allow an impression of digit III to be preserved in footprints. The pes has a phalangeal formula of X-2-2-2-0, with the vestigial fifth metatarsal preserved in articulation for the first time. As previously described, *Stegosaurus* has three functional digits (II-IV). The new specimen indicates that the metacarpals point toward the substrate at an angle of approximately 45°. In the pes, flattened regions on the ventral side of the phalanges extend from the unguals to the distal end of metacarpals, increasing the area in contact with the ground surface relative to the manus. This characteristic is most likely an adaptation for effectively distributing the body weight, the majority of which is supported by the hind limbs. The new information on the manus and pes match closely with footprints found in the earliest Jurassic (Hettangian) of Cognac-sur-l'Isle, which suggests that by the Jurassic both fore and hind feet in stegosaurs were supported by fleshy footpads under the metapodials.

Poster Session IV (Saturday)

**REEVALUATION OF SMALL VERTEBRATE FOSSILS FROM THE UPPER  
TRIASSIC CHINLE GROUP, SOUTHEASTERN UTAH**

WATTS, Ashley, Appalachian State University, Boone, NC, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA

Here we reevaluate and expand upon previous interpretations of small vertebrate fossils discovered at different stratigraphic horizons within the Upper Triassic Chinle Group in southeastern Utah. These localities are the Blue Lizard Mine in the Monitor Butte Formation and the Four Aces Mine in the Painted Desert Member of the Petrified Forest Formation. Previous workers reported a fauna of indeterminate metoposaurs, phytosaurs, archosauriforms and a crocodylomorph from the Blue Lizard Mine. Our reanalysis of the fauna shows that several of the amphibian vertebrae strongly resemble the metoposaur *Apachesaurus*. These vertebrae are characterized by their small size, simple morphology, and high length:height ratio. The crocodylomorph *Hesperosuchus* is represented by isolated osteoderms characterized by a series of fine ridges with a sunburst of radiating pits, and by randomly oriented sub-ovate pits around the sculpturing of the ridge. The crocodylomorph *Parrishia* is represented by elongate caudal vertebrae with a longitudinal furrow and closely associated chevron facets. Osteoderms shaped similarly to those of *Hesperosuchus* are associated with one of the caudal vertebra of *Parrishia* from this locality, and similar osteoderms have been found disassociated. These *Hesperosuchus*-like osteoderms are similarly shaped but do not have deeply incised ovate pits that do not cover the ridges and are randomly arranged, and may represent the first osteoderms reported for *Parrishia*. We also identified *Vancleavea*-like limb bone fragments from the archosauriform material.

The Four Aces Mine locality yields a fragmentary but distinct fauna. The condition of the fossils does not allow for any new interpretations with the exception of several teeth from the osteichthyan *Arganodus* (= *Asiatoceratodus*?). These lungfish teeth possess 5-7 radiating, sharp crests that are typical of lungfish toothplates for the Upper Triassic of the American Southwest and with angle measures consistent with *Arganodus dorotheae*. Other fossils include ungual claws and caudal vertebra from a theropod dinosaur, and the fragmentary right mandible of a possible ornithischian dinosaur.

Poster Session III (Friday)

**A NEW RECORD OF PROCYNOSUCHUS DELAHARPEAE (THERAPSIDA:  
CYNODONTIA) FROM THE UPPER PERMIAN USILI FORMATION (RUHUHU  
BASIN), TANZANIA**

WEIDE, D, University of Washington, Seattle, WA, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA; ANGIELCZYK, Kenneth, The Field Museum, Chicago, IL, USA; SMITH, Roger, South African Museum, Cape Town, South Africa

Cynodonts are the therapsid subclade most relevant to the origin of mammals. Mammalian hallmarks that first appear in cynodonts include multicuspated postcanine teeth, double occipital condyles, and a bony secondary palate formed primarily by the maxillae and palatines. Among early cynodonts, *Procynosuchus delaharpeae* is the best known and has the broadest geographic range. It is also common in the Upper Permian *Dicynodon* Assemblage Zone of South Africa, but also occurs in East Africa. Currently, there is only one documented occurrence from the Madumabisa Mudstone Formation of Zambia, and two specimens have been collected from the Usili (formerly Kawinga) Formation of Tanzania. The Tanzanian specimens include a poorly preserved, incomplete skull housed in Tübingen and a partial cranium originally attributed to *Parathrinaxodon proops*. The latter is now considered synonymous with *Procynosuchus delaharpeae*. Presented here is a new specimen collected near the base of Kingori Mountain in Tanzania in 2007. It preserves the postorbital region of the skull, including a nearly complete occiput, parietals, epipterygoids, the posterior segments of the pterygoids, basisphenoid, basioccipital, and most of the left squamosal. Also preserved are the posterior portions of the dentaries, each with several intact teeth. *Procynosuchus* postcanines consist of two types: simple A-type and relatively more complex P-type. A well-preserved, isolated P-type postcanine is present and exhibits the hallmarks of *Procynosuchus* dentition: it bears a slightly recurved dominant cusp with one anterior and one posterior cusp. The main cusp terminates in a well-developed lingual cingulum bordered by seven cusps. Our field work corroborates previous suggestions that the Usili Formation includes representatives of the *Cistecephalus*, *Dicynodon*, and *Tropidostoma* Assemblage Zones of South Africa. Moreover, the presence of several endemic Usili taxa (e.g., *Peltobatrachus*, *Katumbia*, *Kawingasaurus*), suggests that a straightforward correlation between the Karoo and Ruhuhu basins will be impossible.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**PALEONTOLOGY AND GEOLOGY OF THE FORT RANDALL FORMATION AT  
FEYEREISEN GAP, GREGORY COUNTY, SOUTH DAKOTA**

WEILER, Matthew, University of North Dakota, Grand Forks, ND, USA

The Feyereisen Gap Locality is located in south-central South Dakota. Two formations of the Ogallala Group are exposed at the site, the Fort Randall Formation and the Valentine Formation. The Fort Randall Formation is predominantly siltstone and claystone representing many distinct overbank deposits. The Valentine Formation is predominantly sandstone with a much higher degree of induration than the underlying Fort Randall Formation. The Valentine Formation represents bar deposits. Both of the formations were deposited in a meandering stream system. The locality contains an assemblage indicative of a medial portion of the Miocene epoch. Specifically, the locality is Barstovian in age, which ranges from 16.0 – 12.5 Ma, and includes both the early and late Barstovian as indicated by the assemblages present. Two distinct assemblages are present at the locality. The earlier assemblage is tentatively assigned to the early Barstovian (Ba1), while the later assemblage, as well as the specimens found in overlying units of the Fort Randall Formation, has been placed in the late Barstovian (Ba2). The two faunal assemblages at Feyereisen Gap were compared to the other Barstovian assemblages using similarity equations. The three equations that were utilized were the Dice, First Kulczynski Coefficients and the Coefficient of Community. The earlier assemblage is a temporal equivalent of the Lower Snake Creek Assemblage from the Olcott Formation in Nebraska. The later assemblage is a temporal equivalent of the Bijou Hills assemblage in South Dakota and the Norden Bridge assemblage in Nebraska.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

**PRELIMINARY PHYLOGENY OF TAENIODONTA, AN ENIGMATIC ORDER OF  
EUTHERIAN MAMMALS (PALEOGENE, NORTH AMERICA)**

WEINSTEIN, Deborah, The Ohio State University, Columbus, OH, USA

Taeniodonts are an enigmatic group of eutherian mammals from the Paleogene of North America that ranged from small insectivorous mammals to large, pig-like ones. Since Robert Schoch's monograph describing all then known taeniodonts and their relationships, researchers have made several important discoveries that either complement or contradict his ideas on taeniodont phylogeny and origins. Because there is now a debate about the



phylogeny and origins of this group, I here undertake a phylogenetic analysis including all of the taeniodonts. I also examine the relationships of taeniodonts to other early eutherian mammals. This study provides a phylogenetic analysis of the group using characters and descriptions from the literature. Using a Willi Hennig version of TNT, a phylogenetic analysis was performed using the characters from the literature as well as personal observations of taeniodont specimens at the American Museum of Natural History. The phylogenetic analysis shows that the Conoryctidae and Stylinodontidae family divisions of Schoch are supported. The plesiomorphic *Onychodectes*, however, falls outside of the Conoryctidae, in support of the removal of *Onychodectes* from this family. The monophyly of Taeniodonta was supported with the purported Stylinodontid *Schowalteria* falling out as the sister taxon to the rest of the Taeniodonta. More analyses with other outgroups and additional characters are still needed. Finding where the Taeniodonta are rooted in the phylogeny of early mammals will be able to help to evaluate the hypothesis of the Cimolesta, a higher level grouping of several extinct orders with the extant pangolins. This new phylogeny will also be used to test the claim of increased evolutionary rates in these animals, on the basis of their achieving large body size so early in the Cenozoic mammal record.

Poster Session IV (Saturday)

**NEW CHARACIFORMS (TELEOSTEI: OSTARIOPHYSI) FROM THE EOCENE-OLIGOCENE OF EASTERN BRAZIL, SOUTH AMERICA**

WEISS, Fernanda, PPGBAN-UFRGS, Porto Alegre, Brazil; MALABARBA, Maria, MCT-PUCRS, Porto Alegre, Brazil; MALABARBA, Luiz, UFRGS, Porto Alegre, Brazil

The Aiuruoca Basin is located in the southern Minas Gerais State, Brazil, near the borders of the states of São Paulo and Rio de Janeiro. Stratigraphically, the basin is composed of the Aiuruoca Group with two formations: Pinheirinho and Entre-Córregos. The Entre-Córregos Formation is made up of thin laminated shales, representing a lake paleoenvironment, with a well-preserved fossil content including plants, palynomorphs, insects, fishes (cichlids and characiforms) and amphibians. Based on palynomorphs, these shales were dated as Eocene-Oligocene. We recognize three new characid species in the Aiuruoca Basin. New Sp. A is distinguished from New Sp. B by the diameter of the teeth in the premaxillary inner row and by the shape of the premaxilla. The New Sp. C can be distinguished from the other two species by the structure of the caudal fin skeleton (e.g., modified anterior ventral procurrent caudal-fin rays and modified neural arches of the last caudal vertebrae). The morphological features presented by the three species indicate that they could be assigned to one of three possible subfamilies: the Tetragonopterinae, the Glandulocaudinae or the Stevardiinae. The lack of phylogenetic resolution of the Tetragonopterinae and the inexistence of synapomorphies based on fossilizable structures (e.g., bones) for the three subfamilies precludes the unequivocal allocation in any of the extant groups.

Poster Session I (Wednesday)

**HOW DOES SAMPLING METHOD INFLUENCE OUR INTERPRETATION OF BONE GROWTH?**

WERNING, Sarah, University of California Museum of Paleontology, Berkeley, CA, USA; SPECTOR, Phil, Department of Statistics, University of California, Berkeley, CA, USA; LEE, Andrew, College of Osteopathic Medicine, Ohio University, Athens, OH, USA

Full cross-sections are used to describe bone histology and growth in extinct vertebrates because they reduce ambiguity about the number, circumference, and ontogenetic trajectory of lines of arrested growth (LAGs). However, full cross-sections are difficult to produce from large, rare, or unstabilized specimens. In these cases, core sampling can be a viable alternative. Although data from partial sections and cores are biased, they do offer a partial record of growth and are useful in comparative growth studies. Here we present a quantitative method to assess the optimal location at which to core long bones in order to best measure growth. To obtain radial bone growth estimates, we calculated mean radial growth at each LAG using transects radiating from both ontogenetic and geometric centroids of long bones that were digitally photographed in full cross-section. We compared these results to those from partial data sets and digital "cores" through our full cross-sections, and to circumferential growth data to determine how sampling strategy affects growth rate estimation. Relative to the geometric centroid, zone thickness between inner LAGs is more variable around the bone because it reflects ontogenetic changes in centroid position, whereas zone thickness between outer LAGs varies less because it more closely reflects outer bone geometry. From a geometric centroid, all sampling methods yield fairly consistent estimates of radial bone growth in outer zones, but cores and partial sections more often over- or underestimate inner zone thickness. Long bones become more elliptical in cross-section with age, so measuring radial growth from ontogenetic centroids shows the opposite pattern (outer zone thickness is more variable compared to inner zones). This can be problematic for cores because ontogenetic centroids can only be determined from complete or nearly complete cross-sections, but geometric centroids can be estimated from outer bone measurements. Because sampling position directly affects growth estimates, statistical methods should be used to determine quantitatively the best position at which to take cores, though results are taxon and element specific.

Technical Session IV, Wednesday 4:00

**THE LIVING AND THE DEAD: HOW BONES RECORD 40 YEARS OF ECOLOGICAL CHANGE IN THE AMBOSELI ECOSYSTEM OF SOUTHERN KENYA**

WESTERN, David, African Conservation Centre, Nairobi, Kenya; BEHRENSMEYER, Anna, Smithsonian Institution, National Museum of Natural History, Washington, DC, USA

How well do time-averaged vertebrate fossil assemblages record the structure and dynamics of ancient communities? This question is critical for understanding ecological signals in the fossil record and can be addressed via parallel documentation of living mammal populations and their associated bone assemblages. A longitudinal study in Amboseli National Park, Kenya, spanning 4 decades (1964-2004), compares live census data (Western) and bone census data (Behrensmeier) for 16 wild ungulate species. A total of 198,326 live individuals (air and ground counts) and 1784 dead (ground transects) were recorded in 7 vegetation habitats over an area of ~600 km<sup>2</sup>. Bone weathering stages previously calibrated to years since death were used to divide the bone census data into four temporal bins, resulting in comparative live-dead samples for 1964-69, 1970-76, 1993-98, and 1999-2004. Fidelity of the two samples for all years combined using relative abundance of the 16 species is significant for both a simple 1:1 live vs. dead and for expected dead (calculated from population size and turnover rate based on body size) vs. actual dead (Spearman's rho, all p<.05). Comparisons of the four time blocks show similar high fidelity (Spearman's rho, all p<.05) for the later samples (1970-76 and 1999-2004) but slightly lower fidelity for the earlier samples (1964-69, 1993-2004), indicating a taphonomic bias against survival of bones of smaller species in weathering stages 3-5. Despite additional taphonomic changes reflecting predator impact, bone assemblages closely track the large mammal community as it responded to shifts in vegetation over the 4 decade interval. This fidelity is apparent in the proportion of browsers, mixed feeders, and grazers as well as in the relative abundances and habitat associations of the different species. The Amboseli research thus provides a basis for understanding how vertebrate community structure is recorded in attritional bone assemblages and can be used to model the effects of different periods of time-averaging in the vertebrate fossil record.

Poster Session I (Wednesday)

**SNAPSHOT FROM THE PAST: A UINTAN VERTEBRATE ASSEMBLAGE PRESERVING COMMUNITY STRUCTURE**

WESTGATE, James, Lamar University, Beaumont, TX, USA; TOWNSEND, Beth, Midwestern University, Glendale, AZ, USA; COPE, Dana, College of Charleston, Charleston, SC, USA; FRISCHIA, Anthony, UCLA, Los Angeles, CA, USA

In order to understand the community structure of early Tertiary fossil vertebrates, the members of a vertebrate community are generally pieced together from multiple localities at similar, but different stratigraphic levels. It is rare that a single early Tertiary locality will have multiple vertebrate taxa such as we have recently recovered at the Uinta C "Pond site," in the Uinta Formation, Uinta Basin, Utah. The Pond site fauna is the first late Uintan fauna in the Uinta Formation having a large micro-mammal community and offers an unprecedented opportunity to document a micro-habitat from a Rocky Mountain Tertiary intermontane basin. A test sample of 900 kg of friable grayish-red mudstone from the Pond site was screen-washed using 500 micron-mesh screens and reduced to 36 kg. Approximately 18 kg of this sample, having a grain size of >1 mm, was picked for microfossils using binocular microscopes. *Amia* sp. vertebrae and teeth dominate the assemblage in association with *Lepisisosteus* sp., *Trionyx* and emydid turtles, a small crocodylian, and a diverse suite of mammals. Recently collected mammalian taxa are based on more than 50 micro-mammal teeth from insectivores, the omomyine primates *Mytonius* and cf. *Omomyis*, the rabbit *Mytonolagus petersoni*, and the rodents *Microparamys*, *Pareumys*, *Janimus* and sciuravid rodents. Medium to larger mammals represented include pantolestids, the tapiroid *Colodon*, carnivorans, brontotheres, small cetartiodactyls as well as ischyromiid rodents round out the diverse community at this single locality. The association of fishes, water turtles, crocodylians and aquatic mammals, with a terrestrial mammal community buried in fine-grained sediments, suggests that deposition occurred in a semi-permanent, low-energy aquatic environment, such as an ox-bow lake.

Technical Session VIII, Thursday 3:45

**PALEOECOLOGY OF SIWALIK GROUP GAVIALIS (CROCODYLIA) AND CARBON FLUX IN AN ANCIENT RIVER SYSTEM**

WHEATLEY, Patrick, University of California, Santa Cruz, Santa Cruz, CA, USA; HEAD, Jason, University of Toronto Mississauga, Mississauga, ON, Canada; KOCH, Paul, University of California, Santa Cruz, Santa Cruz, CA, USA

The Siwalik Group of the Potwar Plateau in northcentral Pakistan has the most complete and continuous record of terrestrial vertebrate community evolution in the middle-late Miocene. This record spans the C4 grassland expansion in Southern Asia at approximately 7-8 Mya. The expansion has been recorded and studied extensively in the carbon isotope composition of soil carbonates and tooth enamel of the Siwalik mammalian fauna, but the influence of the event on the carbon cycle in fluvial systems and herpetofauna is unknown. Here we analyze the carbon isotope composition of *Gavialis* cf. *lewisei* (Crocodylia) tooth enamel from seven localities from 11.95-6.2 Mya. Pilot data show a carbon isotope shift to C4 values in the enamel of *Gavialis*. Because freshwater aquatic vegetation almost exclusively has a carbon

isotope composition similar to that of terrestrial C3 plants, it is apparent that terrestrial C4 carbon is making its way into the river systems from the surrounding banks. This connection between *Gavialis* and the terrestrial vegetation could occur either by *Gavialis* feeding on terrestrial animals or from terrestrial carbon deposition into the fluvial system. To test these alternative hypotheses, we compare the *Gavialis* carbon isotope shift to the shifts in the mammalian and aquatic invertebrate faunas. The *Gavialis* shift does not appear to be as large as the shift identified in the mammals, thus the *Gavialis* are incorporating at least some allochthonous river carbon in their diet. This discrepancy in isotopic shifts offers us a way to interpret the level of connectivity between the river system and the terrestrial system and provides us the opportunity to better understand the paleoecology of *Gavialis* and the flux of carbon through riverine systems.

Technical Session V, Wednesday 2:45

#### **MACHAIRODONT FUNCTIONAL MORPHOLOGIC GROUPS: THE VARIED ROLE OF SABER SHAPE AND INCISORS IN KILLING BITE MODELS**

WHEELER, H. Todd, George C. Page Museum of La Brea Discoveries, Los Angeles, CA, USA

The terms scimitar versus dirk-tooth are widely understood for sabertooth canine shape. Bite research distinguishes between the first order bite in which the canines cut on the down stroke, and require mouth opening to release; and the more sophisticated second order bite, in which the canines cut their way out of the prey in one continuous arc without the cat ever having to open its mouth. Features and proportions quantitatively distinguish four unique combinations of saber shape, cemento-enamel junction (CEJ), and incisor morphology. *Machairodus* is an example of a first order, ancestral scimitar-tooth, in which the cat may have pulled back as it opened its mouth on release; thereby also cutting on the upstroke, leaving a wound about 1.5 times the anterior-posterior diameter APD of the tooth. In lateral profile, APD to labial-lingual diameter (CEJ), canine width to thickness ratio (APD/LLD), and flat centered CEJ bending apically at the anterior, the canines of *Machairodus* are similar to the more derived Homotherini. Scimitar-tooth incisors are larger and more prognathous than those of other saber toothed cats. In the more derived Homotherini the CEJ is of similar shape but proportionally more apical at the anterior, and the incisors are larger, even more prognathous, and may be able to cut their way out of some prey; something bite experiments suggest the other incisor arcades cannot do. Dirk-toothed sabertooths have similar lateral saber profiles, bell curve shaped CEJs, comparable in height to the APD of the tooth and, presumably second order bites. The (APD/LLD) for the Smilodontini and some nimravids, is around 2:1. These cats have mildly prognathous incisor arcades, and gapes of about 90°. Typically the deciduous canines are of scimitar shape. More derived Barbourfelids and *Eusmilus* display hystricomorphy permitting gapes approaching 120° and have much thinner canines approaching a 4:1 (APD/LLD), extremely prognathous and procumbent incisors, and deciduous canines similar to the adult teeth. Bite models for these cats and the extent of second order bite capability in scimitar-tooths are speculative pending more bite experiments.

Technical Session XVI, Saturday 10:45

#### **EVIDENCE FOR ONTOGENETIC SHAPE CHANGE IN A JUVENILE SKULL OF *DIPLODOCUS***

WHITLOCK, John, University of Michigan, Ann Arbor, MI, USA; WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, USA; LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Diplodocoid sauropods have been defined in large part by their blunt, shovel-snouted skulls and their narrow-crowned, anteriorly sequestered dentition. This arrangement of the snout and teeth has also been the focus of some controversy, and hypotheses abound to explain the function of this anatomy for feeding. Here we describe a nearly complete juvenile skull of *Diplodocus* (CM 11255) that does not conform to the morphology expected based upon larger specimens. Although somewhat laterally crushed, the skull is still largely intact, and CT imaging has revealed a nearly complete palate, allowing an accurate reconstruction of the lateral dimensions of the skull. In dorsal view, the reconstructed CM 11255 is narrow and rounded anteriorly, in contrast to the characteristic broad, squared-off snout of adult *Diplodocus*. The dentition in CM 11255 is also not restricted to the extreme anterior portion of the skull, extending posteriorly to near the preantorbital fenestra. A rounded snout in dorsal view is typical of basal sauropods, and ontogenetic change towards a square snout is potentially related to feeding behavior and specialization in adults. Comparisons of snout shapes and dental microwear features between different diplodocoid sauropod genera (including *Diplodocus*) suggests that snout shape is closely linked to feeding strategy. Although no microwear features have been recovered from CM 11255, the shape change suggests ontogenetic niche partitioning between adults and juveniles—smaller juveniles accessed nutrients through highly selective browsing behaviors, and large adults obtained nutrition through less selective, bulk browsing behaviors.

Poster Session III (Friday)

#### **TESTING THE HOMOGENEITY OF THE MORRISON FORMATION FAUNA**

WILBORN, Brooke, Lynchburg College, Lynchburg, VA, USA

The description of the fauna from a locality in the Morrison Formation, the Two Sisters Quarry, has resulted in some questions regarding the apparent homogeneity of dinosaurs and mammals in the formation. The small sauropod remains from the quarry have been attributed

to a juvenile individual of a known taxon, although sizes of the elements are presently the only evidence to support that conclusion. Shoe-horning of new specimens into existing genera appears to be a problem, particularly pronounced for specimens from the Morrison Formation, as compared to the overlying formations, and has resulted in questionable conclusions as to the diversity of mammals and dinosaurs. Comparison of mammalian and dinosaurian diversity between the Morrison Formation and the Lower Cretaceous faunas of the Western Interior reveals a disparity. The more extensive collecting that has occurred in the Morrison Formation has yielded diverse mammalian and dinosaurian faunas. The Lower Cretaceous formations show a similar diversity of dinosaurs. However, when the data are standardized to the number of collection localities, the Morrison Formation only has 10% more generic diversity for 100% more collection sites. There are several reasons why this might occur, including taphonomy, phylogenetics, collection bias, and true measures of beta diversity. Only six new dinosaurian genera have been described from the Morrison Formation in the last 20 years compared to the 14 new genera from the Lower Cretaceous. It is possible that the Morrison Formation has been fully sampled, and truly has a low generic diversity. However, the large number of mammal genera from the Morrison Formation relative to the Lower Cretaceous, which reportedly inhabited the same alluvial plain environment as the dinosaurs, suggests this is not the case. A recent interest in the dinosaurs and mammals from the Lower Cretaceous may be causing a sampling bias which seems to increase the dinosaurian diversity. In addition, there is a larger specific diversity in the Morrison Formation dinosaurian fauna than in the Lower Cretaceous, which may be masking the true generic diversity of the Morrison Formation.

Technical Session XII, Friday 11:00

#### **NEW INDIAN EOSIMIIDS: THE OLDEST ASIAN RECORD OF ANTHROPOIDS**

WILLIAMS, Blythe, Duke University, Durham, NC, USA; KAY, Richard, Duke University, Durham, NC, USA; BAJPAI, Sunil, Indian Institute of Technology, Roorkee, India; KAPUR, Vivesh, Sector 40-C, Chandigarh, India; DAS, Debasis, Indian Institute of Technology, Roorkee, India

New eosimiid anthropoid specimens representing a new taxon have been recovered from the early Eocene (~53 Ma) of India. The new taxon extends the Asian record of anthropoids by 8 to 9 million years. It occurs at the same stratigraphic level as basal representatives of the Eocene primate groups Omomyoidea and Adapoidea, making it evident that India and the rest of the para-Tethyan region, both African and Laurasian, was an important center for the evolution of euprimates in the early Eocene. The timing and geographic origins of Anthropoidea and the more inclusive crown clade Haplorhini (tarsiers and anthropoids) are poorly understood. Some hypothesize that crown haplorhines arose from a single common ancestor within a paraphyletic Eocene Omomyoidea in which case the haplorhine crown clade could be as young as late early Eocene. Others suggest that tarsiers arose from a group of Eocene omomyoids but anthropoids stem from a separate group, the Eosimiidae, that is sister to omomyoids. A third alternative is that crown haplorhines are sister to Omomyoidea as a whole. If the first hypothesis is correct, then the anthropoid stem could be as young as middle Eocene. However, if the second or third hypothesis is correct, haplorhine (and anthropoid) origins must be sought in the Paleocene or earlier. Our new phylogenetic analysis based on 75 taxa and 343 characters of the cranium, postcranium, and dentition of living and fossil primates supports the hypothesis that the Eosimiidae are stem anthropoids and reaffirms that crown haplorhines are sister to a monophyletic Eocene Omomyoidea, rather than being nested within omomyoids. We reconstruct the new taxon as mouse-lemur sized with a mixed diet of fruit and insects. The small body size of basal members of anthropoids, omomyoids, and strepsirrhines indicates that insects rather than plants were the primary source of dietary protein in the last common ancestor of crown primates. Earliest eosimiid anthropoids were similar in size and diet to the earliest known omomyoids, and slightly smaller than the earliest known strepsirrhines. Eosimiids bear little adaptive resemblance to late Eocene-early Oligocene African Anthropoidea.

Technical Session IX, Thursday 2:30

#### **BONE HISTOLOGY OF HESPERORNITHIFORMS (AVES) FROM LATE CRETACEOUS GREENHOUSE HIGH-LATITUDE ENVIRONMENTS**

WILSON, Laura, University of Colorado, Boulder, Boulder, CO, USA; CHIN, Karen, University of Colorado, Boulder, Boulder, CO, USA

Late Cretaceous hesperornithiform birds are found in sediments from the Western Interior of North America ranging from Kansas to Elsmere Island in the Canadian High Arctic. This wide geographic distribution presents a unique opportunity to study the growth dynamics of these birds along a latitudinal gradient using histological analysis, a well-established means of studying the growth of organisms. Previous histological studies of hesperornithiforms used small sample sizes of mid-latitude specimens to infer phylogenetic relationships, analyze the effects of functional morphology, and compare growth rates to other birds, but to date, high-latitude hesperornithiforms have not been histologically analyzed. This study compares only hesperornithiform specimens to minimize phylogenetic influence and highlight environmental (e.g., climate, photoperiod) effects on growth. Tibiotarsal and femur fragments from high-latitude localities within the paleo-arctic circle of the Late Cretaceous including Bylot Island, Devon Island, Eglinton Island, and the Northwest Territories in the Canadian High Arctic, and from the Late Cretaceous of Kansas are being analyzed by thin section analysis. Preliminary analysis of high-latitude specimens reveals no lines of arrested growth (LAGs) in dense primary bone. The bones also show varying degrees of secondary

remodeling and erosion cavities (some completely lacking Haversian systems) indicating different ontogenetic stages. Overall, the bone pattern is similar to mid-latitude specimens and has important implications for hesperornithiform migration and paleobiology. Similarities in internal structure of hesperornithiform bones refute the hypothesis that mid- and high-latitude hesperornithiforms have distinctly different growth regimes reflected in histologic patterns. This may provide supporting evidence for long distance migration, possibly for nesting in high-latitude environments, as has been suggested by previous studies. Additional comparisons of vascularity, primary osteon density, and osteocyte density between high- and mid-latitude specimens provide insight into variations in growth regimes.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny, Wednesday 9:45

**MORPHOLOGY AND SQUAMATION OF FORK-TAILED THELODONTS (THELODONTI: FURCAUDIFORMES): NEW OBSERVATIONS AND INSIGHTS**

WILSON, Mark, University of Alberta, Edmonton, AB, Canada; MÄRSS, Tiit, Tallinn University of Technology, Tallinn, Estonia

Since their discovery 15 years ago, the unusual morphological features of the Silurian-Devonian fork-tailed thelodonts have caused researchers to suggest a variety of systematic positions, including a close relationship to gnathostomes, an artificial, paraphyletic assemblage, or as a derived clade within a monophyletic Thelodonti. One of their most striking features is the fan-shaped, superficially symmetrical caudal fin, while the structure of the mouth in thelodonts remains imperfectly known. Recently discovered specimens from the Lochkovian (Early Devonian) MOTH locality in northwestern Canada reveal new details of the underlying structure of the caudal fin in one species and excellent preservation of the oral region in two other species. The tail is remarkably similar to that in several heterostracans, as best seen in specimens from the same locality. The oral region of the best-preserved specimens gives evidence of internal supporting structures. The branchial region is also well preserved on the same specimens, confirming its similarity in form throughout the group. New research on scale morphology of all species suggests that furcaudoids have the same categories of body scale types as certain other thelodont genera, yet fewer variations than some other genera. Taken together these observations indicate that advanced furcaudiforms were capable of complex swimming and feeding behaviors, while sharing a modified version of a body plan inherited just once from primitive thelodont ancestors.

Poster Session IV (Saturday)

**GIS ANALYSIS OF THE JONES RANCH SAUROPOD QUARRY (EARLY CRETACEOUS, TEXAS)**

WINKLER, Dale, Southern Methodist University, Dallas, TX, USA; POLCYN, Michael, Southern Methodist University, Dallas, TX, USA

Jones Ranch quarry in the Early Cretaceous Trinity Group (Texas) preserves an accumulation of multiple individuals of the sauropod *Paluxysaurus jonesi*, along with numerous logs and other plant macrofossils. Many bones and logs are large, stacked in multiple layers, and commonly encased in massive concretions. Fossils are commonly invisible within concretions in the field. The skeletons are only partially articulated, with isolated elements and skeletal segments of different individuals juxtaposed. An X-Y-Z coordinate system was used to map more than 150 field blocks (and bones if visible) relative to a fixed datum over more than 15 years of excavations. Emplacement of bones and plants by episodes of flooding in a sandy ephemeral stream channel has been demonstrated. Jones Ranch quarry data are amenable to analysis using a Geographic Information System database, which can greatly enhance understanding the taphonomic origin of the accumulation and the paleoecology of the biota. For the minimum of four sauropods that are present in the quarry, GIS analysis also offers the best means to substantiate the allocation of bones to different individuals. As blocks are prepared, laboratory data including the dimensions, orientation, sketches and photographs of additional elements not visible in the field can be added to the database. GIS software facilitates visualization of the vertical sequence of fossils in the multistory sandstone, thereby more easily demonstrating the timing of their emplacement. Spatial patterning of different fossil types provides insight into the interaction of fossil clasts during emplacement. Separate analysis of the pattern and detailed distribution of articulated skeletal segments, each individual body part, and the relationship of fossils to depositional units helps to reconstruct the breakup and burial of individual skeletons. GIS analysis amplifies insight into the origin of the deposit that is not possible with traditional quarry maps alone.

Technical Session XVI, Saturday 10:30

**AIR SPACES WITHIN THE HEADS OF DINOSAURS AND THEIR CONTRIBUTION TO CEPHALIC STRUCTURE**

WITMER, Lawrence, Ohio University, Athens, OH, USA; RIDGELY, Ryan, Ohio University, Athens, OH, USA

When compared to such cephalic anatomical components as the brain, jaw muscles, eyes, or vascular system, air is all but forgotten. Nevertheless, air-filled spaces perform essential roles, and any integrated assessment of head structure and function must incorporate these spaces. The nasal cavity, paranasal sinuses, middle ear, and paratympanic sinuses were studied along with other cephalic spaces (brain cavity) in certain dinosaurs via CT scanning

and 3D visualization to document the anatomy and to examine the contribution of the air spaces to the organization of the head as a whole. Two representatives each of two dinosaur clades are compared as examples: the theropods *Majungasaurus* and *Tyrannosaurus* and the ankylosaurians *Panoplosaurus* and *Euoplocephalus*. Their extant archosaurian outgroups, birds and crocodylians, display a diversity of paranasal sinuses, yet they share only a single homologous antorbital sinus, which in birds has an important subsidiary diverticulum, the suborbital sinus. Both of the theropods had a large antorbital sinus that pneumatized many of the facial and palatal bones as well as a birdlike suborbital sinus. Given that the suborbital sinus interleaves with jaw muscles, the paranasal sinuses of at least some theropods (including birds) were actively ventilated rather than being dead-air spaces. Respiratory and olfactory regions of the nasal cavity can be discriminated, and all four taxa devoted considerable space to olfaction. Although many ankylosaurians have been thought to have had extensive paranasal sinuses, most of the snout is instead (and surprisingly) occupied by a highly convoluted airway, which may have played a role in vocalization and/or physiology. Digital segmentation, coupled with 3D visualization and analysis, allows the positions of the sinuses to be viewed in place within the skull and head and to be measured volumetrically. These quantitative data allow the first reliable estimates of dinosaur head mass and an assessment of the potential savings in mass afforded by the sinuses (6-8% and 16-19% mass savings in the head and skull, respectively, for the theropods).

Technical Session XV, Friday 2:30

**THE BONE HISTOLOGY OF OSTEODERMS IN TEMNOSPONDYLS**

WITZMANN, Florian, Museum fuer Naturkunde, Berlin, Germany; SOLER-GIJON, Rodrigo, Museum fuer Naturkunde, Berlin, Germany

The histology of the osteoderms is compared among armored temnospondyls. Taxa examined include plagiosaurids (*Gerrothorax*, *Plagiosuchus*), and dissorophids (*Aspidosaurus*, *Platyhystrix*). The chroniosuchian *Bystrowiella* serves as outgroup. The osteoderms of *Bystrowiella* possess thin cortices of parallel-fibered bone. Their fine cancellous central region consists of primary interwoven fibers with bone cell lacunae having stumpy canaliculi. This indicates that this tissue developed by metaplastic ossification. In the armor of *Gerrothorax*, the primary matrix is parallel-fibered bone in both the cortices and in the fine-to-coarse cancellous central region. Strong anchoring fibers penetrate the internal cortex. In *Plagiosuchus* osteoderms, the central region is compact and the bone matrix is composed mostly of interwoven primary fibers with extensively developed Sharpey's fibers. The osteoderms of the investigated dissorophids consist of a thin cortex of parallel-fibered tissue organized into a plywood structure that surrounds an extensively remodeled trabecular region with large vascular spaces. The differences in the histological structure of dissorophids and plagiosaurids suggest an iterative evolution of osteoderms. Furthermore, histology in *Plagiosuchus* indicates a metaplastic development of the osteoderms, whereas the osteoderms of *Gerrothorax* represent periosteal ossifications like in dissorophids. This accounts for a different origin of osteoderms also within the plagiosaurids. The osteoderm structure allows inferences concerning the mode of life. In the aquatic plagiosaurids and *Bystrowiella*, the osteoderms are rather compact and might have reduced buoyancy. Additionally, the extensive armor in *Gerrothorax* likely constituted a calcium reservoir, indicated by cyclical resorption events preserved in the external cortex and interpreted as a physiological response to periodic changes in salinity of the aquatic environment. In contrast, the unique osteoderm structure of dissorophids provides maximum stability and minimum bone mass, and is coherent with the interpretation that the osteoderms served to strengthen the vertebral column during terrestrial locomotion.

Technical Session VII, Thursday 3:00

**OSTEODERM HISTOLOGY OF THE CINGULATA (XENARTHRA, MAMMALIA): IMPLICATIONS FOR SYSTEMATICS**

WOLF, Dominik, Howard University, Washington, DC, USA

Recent research on xenarthan osteoderm histology yielded new evidence for the reconstruction of phylogenetic relationships among armadillos and glyptodonts. It can be inferred that pampatheres and true glyptodonts are derived monophyletic taxa, pampatheres uniquely featuring criss-crossing strands of marginal fibers within their osteoderms. Pampatheres furthermore appear to be more closely related to glyptodonts than to the cingulates commonly grouped as Dasypodidae. Dasypodid osteoderms are generalized regarding their histological structure and show no clear synapomorphy. This observation supports current hypotheses that the Dasypodidae are a paraphyletic assemblage of basal cingulates. Whereas pampatheres osteoderms are histologically organized in a very uniform way, subgroups within both the dasypodid and glyptodont cingulates could be distinguished. Among the dasypodids, the Dasypodinae form a distinctive subgroup. Within the dasypodid euphractines, a group comprising the genera *Prozaedyx* and *Zaedyx* can be distinguished from other taxa. A further and probably derived dasypodid taxon is represented by *Tolypeutes*. The Glyptodontidae can be separated into two subgroups. A basal subgroup is characterized by a well-developed, presumably plesiomorphic diploe-like structure. The other, more derived subgroup exhibits lightly built and strongly secondarily reconstructed osteoderms. The controversial systematic position of the eutateine cingulates remains unresolved. Peltephilid cingulates presumably form a sister taxon with all other cingulates, peltephilid osteoderms featuring, amongst other unique characteristics, an unusual type of primary cancellous cortical bone. There is furthermore evidence that *Cochlops*, a taxon of unclear systematic position, belongs to the Peltephilidae and is not a basal glyptodont as previously suggested.

Technical Session XVII, Saturday 9:00

#### NEW INSIGHTS INTO THE LOCOMOTORY CAPABILITIES OF THE EARLY EOCENE EQUID *HYRACOTHERIUM*

WOOD, Aaron, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; BEBEJ, Ryan, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; MANZ, Carly, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; GINGERICH, Philip, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA

A nearly complete skeleton of *Hyracotherium grangeri* (UM 115547) was found in 2007 at the University of Michigan early Wasatchian (Wa-1) locality SC-16 in the northwestern Bighorn Basin, Wyoming. The skeleton has a vertebral formula of 7 cervical, 17 thoracic (T), 7 lumbar (L), 6 sacral, and 2+ caudal vertebrae with well preserved processes and zygapophyses. The neutral posture of the five vertebrae (T15-17, L1, and L2) posterior to the anticlinal T14 forms an arc that is slightly convex dorsally based on the orientation of zygapophyses and the articular surfaces of the centra. The sagittally-oriented portion of the zygapophyses increases in height from T15-L2, constraining flexibility to the sagittal plane. Cranial orientation of the spinous processes and width and length of spinous process apices also increase from T15 to L1 such that the spinous process of L1 overhangs half the centrum length of T17. The transverse processes of L1 and L2 are much more ventrally oriented than those of the remaining lumbar. These features likely prevented hyperextension without precluding ventral flexion. Furthermore, epaxial musculature would have been advantageously positioned to provide stability during locomotion. In contrast, L3-7 exhibit a straight neutral posture, weakly revolute zygapophyses, posteriorly decreasing cranial orientation of the spinous processes, and horizontal transverse processes. Stability in this region was primarily facilitated by the zygapophyses with a reduced contribution from the musculature. Previous studies based on fragmentary vertebral elements interpreted the locomotion of *Hyracotherium* as energetically efficient with back motion minimized by a stable lumbar region and propulsion limited to the limbs. The highly flexed position of the hindlimb, robust femoral trochanters, and presence of a large gastrocnemius sesamoid in UM 115547 suggest that *Hyracotherium* was capable of powerful acceleration. The ability to ventrally flex a localized region of the vertebral column (T15-L2) may have assisted in accelerating without compromising the efficiency provided by a stable lumbar region.

Poster Session I (Wednesday)

#### AN UNEXPECTEDLY LARGE, MID-CRETACEOUS STEM EUTHERIAN MAMMAL FROM NORTHEASTERN CHINA (JILIN PROVINCE)

WOOD, C.B., Providence College, Providence, RI, USA; ROUGIER, Guillermo, University of Louisville, Louisville, KY, USA; CHEN, Jun, Jilin University, Cambridge, China; JIN, Liyong, Jilin University, Changchun, China; ZAN, Shuqin, Geological Museum of China, Beijing, China

In 2000 and 2002 Jilin University Geological Museum field parties excavated small dinosaur and mammal fossils from the Quantou Formation near Gongzhuling City. A new hypsilophodont ornithomimid and a new zalambdalestid eutherian have been published by the team. The age of the locality remains unresolved, but earlier studies of the formation have suggested a range from Aptian to Cenomanian, with early Cenomanian a most likely upper limit. During the 2002 field season one of us (J.C.) uncovered an almost complete (if somewhat compressed) skull and left dentary of a larger and different eutherian mammal, which is the subject of this report. It is only the eighth Mesozoic eutherian known by associated skull and mandible. As preserved the skull measures 44.8 mm from anterior margin of canine alveolus to post-glenoid crest. The same dimension on the stem eutherian *Maelestes gobiensis* is approximately 25 mm. The skull shares with *Maelestes* a mosaic of plesiomorphic and derived characters including a fusiform ectotympanic, medially directed epitympanic wing, and raised crista interfenestralis; evidence of five pre-molars; three molars with relatively narrow stylar shelf and lingual protocone (but lacking pre- and post-cingula); and trenchant ultimate lower premolar plus lower molars with compressed trigonids, transverse protocristid, and narrow, elongated talonids. The greater size, emphasized carnassiality in the dentition, and age for the Gongzhuling specimen possibly 20-30 million years older than *Maelestes*, raise some fascinating questions regarding diversity and evolution of Late Cretaceous eutherians.

Technical Session XIV, Friday 2:30

#### MODELING AN *ORYCTODROMEUS CUBICULARIS* (DINOSAURIA) BURROW

WOODRUFF, D., Montana State University, Bozeman, MT, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA

The hypsilophodont *Oryctodromeus cubicularis* from the Cretaceous Blackleaf Formation of Montana represents the first dinosaur recovered from within a burrow trace. The specimens occurred within an incompletely preserved chamber at the end of an S-shaped tunnel. Unlike many fossil vertebrates associated with burrows, the *Oryctodromeus* remains were disarticulated and elevated within the graded burrow fill. To test whether this skeletal arrangement reflected burial from within or transport into the chamber, we constructed a half-scale burrow model using PVC pipes and conducted a series of infilling experiments. The model followed the *Oryctodromeus* burrow proportions but was scaled to accommodate the available rabbit skeletons used. Experimental trials varied sediment input (low vs. high energy), sediment supply (en masses vs. incremental), chamber conditions (dry vs. water-

filled), bone placement (mixed with sediments, external to tunnel, within chamber), and bone condition (dry vs. water soaked). A number of trials produced similar conditions to the *Oryctodromeus* assemblage. Twelve of the 13 trials exhibited complete disarticulation, six trials elevated bones to the upper portion of the sediments, and six resulted in graded bedding. Two trials produced unusual but noteworthy results. Trial #8 using saturated bones uniquely preserved the skeleton on the chamber floor and largely articulated. Trial #13 tested the effects of the bones mixed with the sediment prior to deposition. Although the bone distribution was not unusual, this trial resulted in numerous broken bones. The upper sediment surface in several trials exhibited a soft-sediment deformation structures. Overall, the experiment failed to falsify the hypothesis that the *Oryctodromeus* bones were in the chamber prior to burial and results from several trials would favor this interpretation. This is supported by the nearly identical bone distributions and similar sedimentology in both the model and original *Oryctodromeus* burrow assemblage. Results from these experiments may clarify the taphonomy of other within-burrow vertebrate assemblages.

Poster Session IV (Saturday)

#### NEW FOSSILS AND MORPHO-ECOLOGIC DIVERSITY OF SAURICHTHIDAE (ACTINOPTERYGIAN) FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA

WU, Feixiang, Peking University, Beijing, China; SUN, Yuanlin, Peking University, Beijing, China; HAO, Weicheng, Peking University, Beijing, China; JIANG, Dayong, Peking University, Beijing, China; TINTORI, Andrea, Dip. Scienze della Terra, UNIMI, Milano, Italy

New fossils discoveries from the Middle Triassic marine deposits in localities near the border between Guizhou and Yunnan of China include various marine reptiles and fishes. Five to six morphotypes of saurichthid fish can be recognized from the fish assemblages, all belonging to the genus *Saurichthys*. Study of the material reveals that two of them from Panxian of Guizhou and Luoping of Yunnan, respectively, unquestionably are new forms diagnosed with a boot-shaped cleithrum and dorsal-positioned pectoral fins, while the rests are of ventral-positioned pectoral fins and an ordinary triadate-shaped cleithrum. The new form documented by materials from Panxian has pectoral fins about 15 cm long, more than 200 neural arches in the axial skeleton, and paired "clasper"-like gonopodium while the second new form represented by materials from Luoping has pectoral fins about 4-5 cm long and less than 150 neural arches in the axial skeleton. Both new forms bear six longitudinal rows of spine-decorated scales and have a large caudal fin. The peculiar cleithrum and pectoral fins indicate that the two new forms may achieve a different locomotion mode and ecological adaptation from the common species of the genus, possibly similar to the living needle fishes to active in surface water in school. The large caudal fin and spine-decorated scales may imply that these fishes are one of the fast swimmers in the marine realm of that time. The other important feature of these new forms is that their parasphenoid is perforated not only by the common carotids but also by the efferent pseudobranchials, which provides important information to concern the phylogenetic change of the course of the common carotids and development of the basiptyergoid process from endoskeletal to dermoskeletal in *Saurichthys*. Discovery of these new forms indicates *Saurichthys* not only has high morphological diversity but also has diversified ecological adaptations and locomotion modes during the Middle Triassic.

Technical Session III, Wednesday 2:15

#### AN UPPER CRETACEOUS LIZARD WITH A COMPLETE LOWER TEMPORAL BAR

WU, Xiao-chun, Canadian Museum of Nature, Ottawa, ON, Canada; LU, Jun-chang, Geological Institute, Chinese Academy of Geological Sciences, Beijing, China; JI, Shu-an, Geological Institute, Chinese Academy of Geological Sciences, Beijing, China; DONG, Zhi-ming, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Squamata (including lizards, snakes, and leg-less lizards) form a large group of Diapsida [also including dinosaurs (plus birds), crocodiles, and pterosaurs]. All fossil or extant squamates have an incomplete or totally missing lower temporal bar/arcade and a quadrate potentially movable (streptostylic) relative to the skull and mandible. It has been documented that the mandible protracts anteriorly at the beginning of the bite cycles and retracts posteriorly at the end of the cycles in many lizards because strong jaw ligaments connecting the jugal and quadrate or the surangular of the lower jaw prevent the mandible from retracting posteriorly when the jaws open and because the M. pterygoideus atypicus or the anterior portion of the M. pterygoideus is entirely lost, which would make the anterior protraction of the mandible impossible at the beginning of the bite cycles if the muscle were present. It has been recently well-demonstrated that the mandible does not have such a fore-aft motion during the bite cycles in many lizards; this is because the quadrate is stabilized by the jaw ligaments in those lizards. A new fossil lizard recently discovered from the Upper Cretaceous of Henan Province, central China possessed a complete lower temporal bar and an essentially unmovable quadrate. This is the first squamate with such a morphotype, which is superficially similar to that of *Sphenodon*, the only living taxon of Rhynchocephalia. The anatomical relationships indicate that the completeness of the lower temporal bar was secondarily obtained in the new lizard, which may have served as a brace to support the quadrate-jaw articulation and thus prevent it from twisting anteriorly rather than posteriorly during the bite cycles. This represents an entirely new pattern of jaw-muscle functions within Squamata.

Technical Session XVIII, Saturday 3:15

**TAXONOMIC REVISION AND BIOSTRATIGRAPHIC SIGNIFICANCE OF PLESIOFURO (ACTINOPTERYGII: PERLEIDIFORMES) BASED ON NEW FOSSILS FROM THE LOWER TRIASSIC OF NORTHERN GANSU PROVINCE, CHINA**

XU, Guang-Hui, Peking University, Beijing, China; GAO, Ke-Qin, Peking University, Beijing, China

Although Permo-Triassic actinopterygian fossils have been recorded from North China since early 1930s, most of the known taxa have remained problematic because of incomplete or inaccurate description of specimens. Among these, *Plesiofuro mingshuica*, from freshwater deposits exposed in Beishan Hills in northern Gansu Province, is especially problematic, as the taxon was regarded as the only known record of the Caturidae (Amiiformes) outside Europe, based on incorrect anatomical identification, and the age of the fossil beds was interpreted as Early Jurassic based on this incorrect taxonomic assignment. Extensive fieldwork in the last few years at the type locality of *Plesiofuro* has resulted the discovery of hundreds of nearly complete specimens of this taxon, along with other vertebrate fossils. Acquisition of this large sample allows a taxonomic revision of this problematic taxon. Comparative study of the new material with the holotype leads to reinterpretation of many cranial characters, including: presence of a posterior expansion of maxilla; suborbital single and small; preopercular vertical with a distinct anterodorsal expansion; and absence of interopercular. Based on these characters, this study concludes that *Plesiofuro* is not a member of the amiiform family Caturidae as previously classified, but a basal form of the family Perleididae in the order Perleidiformes. In addition, the age of the fossil beds exposed in the Beishan Hills is not Early Jurassic on the basis of misinterpreted relationships of this fish taxon, but Early Triassic supported by evidence from other vertebrate fossils from the same site. Therefore, this study concludes that no caturid fishes are recorded in the fish assemblage from the Beishan beds, and *Plesiofuro* turned out to be a definitive record of the Perleididae from the Triassic of North China.

Technical Session XVI, Saturday 11:15

**HOMOLOGIES IN THE HAND OF THEROPODS**

XU, Xing, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; CLARK, James, George Washington University, Washington DC, USA

Homologies are not self-evident. Topology and special quality of structures are the principal criteria used in the conjecture of primary homology, and intermediate forms can provide the basis for alternative primary homology conjectures. In case of inferring the homologies of theropod hand, most features such as manual phalangeal formula and innermost metacarpal morphologies of tetanurans (a theropod subgroup including birds) suggest that their three manual digits correspond to the digits I-III in basal theropods (the second criterion). However, often ignored is that some features such as the asymmetrical distal end of metacarpal II in some *Syntarsus* specimens and digit II being the most robust one in non-tetanuran theropods (resembling in this respect the innermost digit in most tetanurans) support the unconventional hypothesis that the manual digits of Tetanurae are II-III-IV, which is also supported by embryological studies on extant tetanurans. Given the contradictory information generated between the different criteria and even within the same criterion, new information from intermediate taxa can be critical. Ceratosaurs, an intermediate group positioned between coelophysoids and tetanurans, differ from other theropods in many manual features including a very slender digit I. Here we report a new basal ceratosaur with a strongly reduced digit I and a distally asymmetrical metacarpal II, which supports the intermediate status of the ceratosaurian hand and provides key information concerning the homology of the tridactyl tetanuran hand. A scenario proposed here to explain the evolution of the theropod hand suggests the reduction of digit I and enlargement of digit II in the ceratosaur-tetanuran common ancestor, and complete loss of digit I and an enlargement of digit IV early in tetanuran evolution. Although it requires an evolutionary increase in phalangeal counts and possibly the re-emergence of a small metacarpal V in basal tetanurans, it otherwise fits well with the distribution of manual morphological characters on the currently accepted theropod phylogeny, and is explicable from the perspectives of adaptive advantage and developmental plausibility.

Poster Session IV (Saturday)

**NEW INFORMATION FOR THE POSTCRANIAL OF TRIASSIC SAUROPTERYGIAN NOTHOSAURUS FROM THE GUIZHOU ANISIAN (MIDDLE TRIASSIC) MATERIAL**

YIN, Chao, Department of Geology and Geological Museum, Peking University, Beijing 100871, China, Beijing, China; JIANG, Da-yong, Department of Geology and Geological Museum, Peking University, Beijing 100871, China, Beijing, China; RIEPPEL, Olivier, Department of Geology, The Field Museum, 1400 S. Lake Shore Drive, Chicago, IL 60605-2496, USA, Chicago, IL, USA; HAO, Wei-cheng, Department of Geology and Geological Museum, Peking University, Beijing 100871, China, Beijing, China; SUN, Zuo-yu, Department of Geology and Geological Museum, Peking University, Beijing 100871, China, Beijing, China

Abundant skull material of Triassic sauropterygian *Nothosaurus* has been described from the western and eastern Tethys, but only very few articulated postcranial skeletons were reported. Here, we report an almost complete nothosaurian skeleton that was collected from the Pelsonian (middle Anisian) of the Middle Triassic in Panxian County, Guizhou Province,

China. The ratio of the longitudinal diameter of the upper temporal fenestra divided by the longitudinal diameter of the orbit is 2.40, the maxillary tooth row extends well beyond level of anterior margin (about one third) of upper temporal fenestra, and there are three sacral ribs. These and other characters enable us to assign the specimen to the genus *Nothosaurus*. Our specimen shows some differences from the diagnostic characters of *Nothosaurus*, e.g., the presence of four ossified carpals. These are the intermedium, the ulnare, and the third and fourth distal carpals, whereas never more than three ossifications in the carpus or tarsus of adult *Nothosaurus* have been described before. Also, the specimen exhibits hyperphalangy, whereas hyperphalangy in the manus has so far been regarded as a diagnostic feature of *Lariosaurus* that distinguished the genus from *Nothosaurus*. The phalangeal formula of the manus of our new specimen might be 2-5-5-5-4, and the pes 2-3-4-5-6. The specimen therefore establishes the presence of hyperphalangy in both manus and pes in *Nothosaurus*. Our study renders some characters thought to be diagnostic for *Lariosaurus* equivocal for the distinction of *Nothosaurus* from *Lariosaurus*, but more specimens are required to fully diagnose the two genera as different from one another.

Technical Session I, Wednesday 8:45

**PALEOGENE TAXA AND THE HIGHER-LEVEL INTERRELATIONSHIPS OF EUTHERIAN MAMMALS**

ZACK, Shawn, Marshall University, Huntington, WV, USA

The higher-level phylogeny of eutherian mammals is a source of controversy due to conflict between phylogenetic analyses emphasizing morphology and those emphasizing DNA sequences as character sources. Each source of data favors clades that receive little support from the other partition and, for some taxa, the two partitions (morphology and molecules) are in direct conflict. One potential explanation for this discrepancy is that, because existing morphologic data sets rely heavily on extant placental mammals, homoplasy in extant taxa may obscure relationships within a radiation that occurred several tens of millions of years ago. In order to address this issue, a new morphological data set focused on the dental and postcranial morphology of Paleocene and Eocene eutherians was constructed. Results of analysis of this matrix are most consistent with existing morphological analyses. Trees constrained to agree with a composite molecular topology present a significantly worse fit to the character data than do unconstrained trees. However, there are some noteworthy similarities to molecular topologies, including recovery of a clade containing Archonta and Glires, similar to molecular Euarchontoglires. While Afrotheria was not supported, a monophyletic assemblage of ungulate-like African mammals was recovered. This study also provides new data on the relationships of numerous extinct higher-level taxa, including: recovery of a paraphyletic Leptictimorpha that may form the xenarthran stem taxon; failure to unambiguously support alliance of most extinct lipotyphlans with living families; and, no support for the monophyly of Carnivoramorpha. Additionally, several supposedly distantly related taxa (amphilemurid erinaceomorphs; plagiomenid archontans; apelisoid condylarths) are united with macroscelideans. Results of this study are inconsistent with molecular hypotheses concerning the timing and biogeography of the placental radiation, but instead support the morphological view that this radiation occurred on northern continents in association with the K/T boundary.

Poster Session II (Thursday)

**FIRST EVIDENCE OF MIOCENE TERRESTRIAL VERTEBRATES FROM SUMATRA (INDONESIA)**

ZAIM, Yahdi, Institut Teknologi Bandung, Bandung, Indonesia; YAN, Rizal, Institut Teknologi Bandung, Bandung, Indonesia; GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA; STIDHAM, Thomas, Texas A & M University, College Station, TX, USA; CIOCHON, Russell, University of Iowa, Iowa City, IA, USA

The islands of oceanic southeast Asia (Indonesia, Malaysia, New Guinea) have played an influential role in the development of evolutionary thought, initially because of the historic studies by Alfred Russel Wallace and later by the discovery of Pleistocene *Homo erectus* on Java by Eugene Dubois. Unlike the majority of Sunda islands, much of the central core of Sumatra was emergent from the early Eocene through the early Miocene. Freshwater lacustrine sediments of the early Eocene Sangkarewang Formation have yielded an abundant diversity of fishes and a single bird skeleton but no other evidence of terrestrial vertebrates is known until the Pleistocene. In the summer of 2007 we initiated a reconnaissance survey of Cenozoic sediments in the Ombilin Basin located in the Barisan Mountains of central Sumatra. In addition to exploring the Sangkarewang Formation we examined sediments of the Sawahlunto and overlying Sawahtambang formations which span the early part of the Miocene. In the Sawahlunto Formation we discovered two series of avian tracks representing two different birds. These tracks were found at the base of a thinly laminated, coarsening upward sandstone overlain by a relatively thin layer (0.5 meter) of coaly shale, followed by a quartz-sand conglomerate at the top of the local section (12 meters total thickness). The sandstone contains carbonaceous debris and small to medium, parallel ripples are present. One set of tracks has an angle of about 90 degrees between digits one and three, is small and probably represents a gruiform (rail). The second set of tracks has approximately a 120 degree angle between digits one and three and was likely made by a charadriid (plover) or scolopacid (sandpiper) shorebird. In addition to the tracks, small, circular traces (*Skolithos* ichnofacies) are present representing tubes of suspension feeding invertebrates such as clams or worms. The presence of these traces and the sedimentology suggests that the bird tracks were formed on deltaic intertidal flats. The birds may well have been attracted to these areas by the presence of invertebrate food resources. Further exploration of Miocene sediments in Sumatra is warranted.

Technical Session VII, Thursday 3:45

**SEXUAL DIMORPHISM IN THE BONY PELVIS OF SEA COWS FROM THE EOCENE OF EGYPT (MAMMALIA, SIRENIA)**

ZALMOUT, IYAD, The University of Michigan, Ann Arbor, MI, USA; GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA

Pelvic bones of living sirenians are sexually dimorphic. Reproductive organs and muscle attachments differ in Recent dugongs (*Dugong dugon*), and ischia can be identified to sex. The ischia of mature dugong males are distinguished from those of mature females in having two processes on the ventral margin, having considerable dorsoventral expansion of their posterior (distal) end, having the posterior end of the ischium flaring away from the midline, and, most importantly, having a thicker distal end of the ischium (>0.5 cm; compared to ≤0.5 cm in females). Female ischia are mostly thin and narrow, with very little or no deflection. Well-preserved pelvises of a dozen or so Eocene sea cow specimens from Egypt (*Protosiren*, *Eotheroides*, and *Eosiren*) show interpretable variation in both form and size characteristic of males and females. Male ischia from the Eocene of Egypt have the following characteristics: posterior end expanded and developed into a thickened protuberance or tuberosity that extends dorsoventrally, with or without a rugose surface. In most cases the distal end of the ischium is flared and turned posterolaterally where small basins and scars for muscle attachments are present. Female ischia are narrow, thin, and smooth along their distal ends, showing no special thickening or rugosity. Ischia of both sexes from the Eocene of Egypt have smooth ventral margins lacking any prominences or processes. Distal thickening of the ischium is the sexing criterion in Eocene sirenian innominates, in all supposed males the ratio of the mediolateral thickness of the distal end to the mediolateral thickness of the ischiatic ramus is between 1.8 and 2.3, while in putative females the ratio is between 0.8 and 1.0.

Romer Prize Session, Thursday 12:00

**THE PHYLOGENY OF THERIZINOSAURIA (THEROPODA: MANIRAPTORA): IMPLICATIONS FOR THE EVOLUTION OF COELUROSAURUS**

ZANNO, Lindsay, Utah Museum of Natural History, Salt Lake City, UT, USA

The past decade has witnessed a surge in our knowledge of therizinosaurs. From their once poor fossil representation, these bizarre raptor dinosaurs are rapidly becoming one of the most diverse theropod clades, with at least 14 species arrayed across Asia and North America. Within the past eight years alone, more new therizinosaurs have been described than were known during the preceding half century of paleontological research. Once a topic of controversy, the broad phylogenetic relationships of therizinosaurs have recently been substantiated by the discovery of “transitional” Early Cretaceous forms (e.g. *Beipiaosaurus*, *Falcarius*) whose anatomy indicates a clear ancestry among maniraptoran dinosaurs. However, in-group relationships among therizinosaurs are poorly constrained and the purported monophyletic relationship between Therizinosauria and Oviraptorosauria, although a widespread hypothesis, has received little testing in a comprehensive phylogenetic framework. The recent discovery of the most primitive and most complete therizinosaur known—*Falcarius utahensis*, from the Barremian of Utah—offered the opportunity to reevaluate our current understanding of this intriguing group of theropods in light of novel anatomical information. A comprehensive phylogenetic analysis of 14 therizinosaurs, 62 outgroup taxa, and 345 characters was conducted to test previously proposed hypotheses on the evolution of therizinosaurs. Results of this analysis support Therizinosauria as sister taxon to all other maniraptoran lineages, and do not indicate a monophyletic grouping with oviraptorosaurs. The unusually high degree of convergence between these groups underscores the critical role of primitive taxa in phylogenetic studies of coelurosaurian theropods. Several evolutionary trends evident in basal therizinosaurs and oviraptorosaurs (e.g. marked heterodonty characterized by elongate, incisiform rostral teeth) are indicative of a dietary shift from macrofaunal predation. These features coupled with the alternative dentition of basal ornithomimosaurs and alvarezsaurids suggest that dietary experimentation may have been a primary driver in the rapid diversification of Coelurosauria.

Poster Session III (Friday)

**A NEW CRETACEOUS SALAMANDER FROM HEBEI, CHINA**

ZHANG, Guilin, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; WANG, Yuan, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; JONES, Marc, Research Department of Cell and Developmental Biology, University College London, London, United Kingdom; EVANS, Susan, Research Department of Cell and Developmental Biology, University College London, London, United Kingdom

Recently a large number of exquisite caudate fossils preserved as articulated skeletons and imprints have been reported from the Upper Jurassic to Lower Cretaceous of northeast China. These include seven species in six genera: *Lacrotitron subsolanus*, *Liaoxitriton zhongjiani*, *Jeholotriton paradoxus*, *Sinerpeton fengshanensis*, *Chunerpeton tianyiensis*, *Liaoxitriton daohugouensis*, and *Pangerpeton sinensis*, all taxa associated with the well-known Jehol Biota. Here we describe a new salamander, the eighth species unearthed from this region. This new animal is the first tetrapod discovered from the Huajiyang Formation in Hebei Province, equivalent to the Yixian Formation of the Jehol Group in Liaoning Province. The diagnostic features include: skull wide with round rostrum; parietal with anteromedial extension, about half length of the frontal edge; prefrontal and lacrimal absent;

vomerine tooth rows long and parallel to the maxillary arcade; pterygoid with slender, inwardly curved dentate anterior process and a medial process; angular absent; external gills (including gill rakers) absent; one ossified pair of hypobranchials and two ossified pairs of ceratobranchials present; scapulocoracoid greatly expanded proximally; and carpals and tarsals ossified. It shows a close resemblance to *Chunerpeton tianyiensis*, the earliest crown salamander and the oldest member in the family Cryptobranchidae. However, several features, including the lack of external gills, prefrontals, angulars and dermal sculptures on parietals, squamosals and the dorsal aspect of the pterygoids in the new salamander are contrary to *Chunerpeton*. Phylogenetic analysis placed the new salamander as the sister group to the *Chunerpeton*+living cryptobranchids clade, although whether it can be classified as a cryptobranchid is still in question. Anyway, the new find sheds light on the character evolution and systematic relationships of this primitive caudate family and further shows that East Asia, especially Northeast China, is a significant origin center for the origin of some modern caudates.

Poster Session IV (Saturday)

**A LATE CRETACEOUS OSTEOGLOSSOMORPH FISH FROM NORTHEAST CHINA**

ZHANG, Jiang-yong, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

A recently found fossil from the Nenjiang Formation in Songliao Basin of northeastern China represents the first Late Cretaceous osteoglossomorph in China. The new fish differs from other known early osteoglossomorphs in having a relatively long premaxilla, lower dentary, short anal fin rays and a deep forked caudal fin. Osteoglossomorphs are freshwater fishes except the Eocene brackish *Brychaetus*. They bear important paleobiogeographic implications due to their Recent transoceanic distribution. The Late Cretaceous deposits in Songliao Basin were traditionally thought to be completely continental, but two phases of transgression (one recorded in Nenjiang Formation) have been proposed in recent years by both geologists and paleontologists with the discoveries of the brackish fossil assemblages of foraminifera, dinoflagellates, calcareous nannofossils, serpulidae burrows, algal stromatolith and fishes. The new specimen probably represents the second brackish osteoglossomorph fish ever found and may indicate the marine dispersal of this teleost group had occurred more common than expected.

Technical Session XVI, Saturday 11:30

**A NEW THEROPOD FROM THE EARLY CRETACEOUS YIXIAN FORMATION OF WESTERN LIAONING, CHINA**

ZHAO, Qi, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China; XU, Xing, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China

The known non-avian theropods from the Early Cretaceous Jehol Group are all posited to lie within the Coelurosauria and mostly are small in size (less than 2 meters total body length), which contrasts with other Early Cretaceous dinosaur faunas. Here we report a new non-avian theropod from the Yixian Formation, the lower section of the Jehol Group, at Lujiatun Locality, Liaoning Province, China. The specimen consists of a right humerus, right ulna, right radius and right digit I. It represents the largest known theropod from the Jehol Group, based on the size of the forelimb. Although the preserved material is limited, it displays a unique combination of primitive and derived character states, including well developed internal and outer tuberosities of humerus; well developed entepicondyle; great expansion of the deltopectoral crest on the anterior side; relative expansion of the outer (radial) condyle of the humerus compared with the internal (ulnar) condyle; a relatively longer (84% the length of the humerus) and slightly curving ulna; a smooth surface on the top of the well developed olecranon of the ulna; well developed biceps tubercle of the radius; a sub-rhombic distal end of the radius; and manual ungual I about 13 cm (46% the length of the humerus). Preliminary character analysis suggests that this specimen might represent the first known carnosaurian from the Jehol Group, though it also shares some derived features with coelurosaurians. The discovery of a new carnosaurian increases the known diversity of the dinosaur fauna in the Jehol Group and suggests that the previous apparent absence of large theropods in the Jehol Group fauna was a result of insufficient sampling.

Technical Session X, Friday 9:15

**A NEW PTERODACTYLOID FROM THE EARLY CRETACEOUS YIXIAN FORMATION OF WESTERN LIAONING, CHINA**

ZHOU, Chang-Fu, Paleontological Institute, Shenyang Normal University, SHENYANG, China

Pterosaurs flourished in the Jehol Biota as did feathered dinosaurs, early avians, mammals and angiosperms, and show a greater diversity than in terrestrial Cretaceous ecosystems. In this study, a new pterosaur fossil from the Early Cretaceous Yixian Formation of Erdaogou, Beipiao, western Liaoning, represents a new taxon of Pterodactyloidea as evidenced by the sternum, forelimb, pelvic girdle, and hindlimb. The specimen is an adult individual with co-ossification of the scapula and coronoid, the extensor tendon process and first wing phalanx, and the ilium, ischium and pubis. It is a moderately sized pterosaur, less than two meters in the wing span. The sternum is a large plate (98.3 mm wide and 125.3 mm long as preserved), with a strong cristospine (37.2 mm long). The wing metacarpal is elongated, as

is characteristic of Pterodactyloidea. The first wing phalanx is unusually reduced to shorter than the second and third wing phalanges. The ilium has an elongated preacetabular process and a "raised" postacetabular process. The puboischiadic plate is broad, and bears a tongue-like ventral process at the middle part of its ventral edge. The kidney-shaped prepubis has a peduncle to articulate with the puboischiadic plate. The metatarsals are slender and long, as in primitive pterodactyloids. The fifth digit is strongly reduced to a single, nubbin-like phalanx. This discovery not only adds a new taxon to the pterosaur diversity in the Jehol Biota, but also increases the available information on evolution of the postcranial skeleton in Pterodactyloidea.

The Cleveland Shale and Beyond: Early Vertebrate Form, Function, and Phylogeny,  
Wednesday 10:45

#### **NEW FOSSIL EVIDENCE FOR THE SILURIAN RADIATION OF PLACODERMS AND OSTEICHTHYANS**

ZHU, Min, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; ZHAO, Wenjin, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; JIA, Liantao, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

The fossil findings from the Devonian of China have filled up many previously barren sectors in the phylogeny of placoderms and osteichthyan during the last 30 years. The anatomic and phylogenetic studies of these early fishes continue to shed new light on the homology of many morphological characters, and change earlier assumptions about the origin and early evolution of gnathostomes. The high taxonomic diversity of these two groups from the earliest Devonian highlights a Silurian radiation, which is now evidenced by recent discoveries from the Silurian marine deposits of South China. The new fishes, with the accurate dating based on Silurian conodont zonation, will greatly enhance our knowledge of Silurian vertebrates, bridge the morphological gaps between antiarchs and arthrodires (two largest lineages of placoderms), and set a new calibration date for the actinopterygian–sarcopterygian split.

Poster Session I (Wednesday)

#### **ROOT DAMAGE TO UNFOSSILIZED, BURIED BONES: RESULTS OF A PILOT STUDY**

ZOOK, Ethan, Biology Department, Eastern Mennonite University, Harrisonburg, VA, USA; BEHRENSMEYER, Anna, Paleobiology Department, Vertebrate Paleontology Division, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA

We describe the results of a pilot experiment designed to document damage caused by plant roots to buried, unfossilized bones. Marks on fossils attributed to plant roots are common but not well understood. Questions include: a) What conditions encourage plants to develop root networks in close to bones? b) What plants are likely to leave these markings? and c) Are root marks produced pre- or post-fossilization? Understanding the conditions that lead to root traces will lead to a better understanding of environmental constraints on bone preservation vs. destruction. The experiment involved a metapodial (*Bos taurus*) cut into four sections; bone surfaces were molded before burial. Two were buried in sand and two in potting soil to test whether lack of soil nutrients influences root damage. *Paspalum notatum* (snow peas) and *Pisum sativum* (lawn grass) were grown in the pots with the bones and in bone-less controls; after a two month period the surface growth was harvested and weighed to determine if bones in the soil/sand affected surface biomass (no discernable effect). The bones were exhumed and examined for root damage using light microscopy. Pre and post-burial surface molds were used to make epoxy resin casts for SEM imaging. Burial/root action resulted in surface degradation in all bones, with the outermost cortical bone stripped away, leaving a roughened surface. A shallow root trace network was visible using light microscopy and SEM analysis on the bone buried in sand and subjected to grass growth. Additional specimens with obvious root/fungal damage were also examined using light and SEM microscopy. A network of shallow channels over post-fossilization cracks combined with the smooth interior channel profile suggests post-fossilization root damage. In contrast the deeper channeled markings on the second semi-fossilized specimen as well as the similar appearance of its surface to the test bones suggest pre-fossilization damage. This study provides evidence that root damage can be both a pre- and a post-fossilization process. Patterns of damage may vary with soil type and plant, and root damage can be significant within 2 months of burial.

Poster Session II (Thursday)

#### **GLYPTOTHERIUM-GLYPTODON (XENARTHRA, GLYPTODONTIDAE, GLYPTODONTINAE): ANATOMY AND PALAEOBIOGEOGRAPHY**

ZURITA, Alfredo, Centro de Ecología Aplicada del Litoral (CECOAL-CONICET) and Universidad Nacional del Nordeste, Argentina, Corrientes, Argentina; CARLINI, Alfredo, Paläontologisches Institut und Museum, Universität Zurich, and Departamento Científico Paleontología de Vertebrados, Museo de La Plata, La Plata, Argentina; GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ, USA

The clade Glyptodontidae Glyptodontinae are glyptodonts which actively participated in the Great American Biotic Interchange. During the interval late Pliocene–Pleistocene (~2.7–0.0010 Ma) it is possible to recognize two genera: *Glyptodon* Owen (1.07–0.008 Ma)

and *Glyptotherium* Osborn (~3.9?–0.0010 Ma). From a palaeobiogeographic viewpoint both taxa are characterized by a great latitudinal range: *Glyptodon* from 47° S to 10° N; *Glyptotherium* from 11° N to 37° N. Despite the fact that both taxa are relatively common, no modern contributions have established morphological differentiation between them and, in fact, they are commonly wrongly identified. Preliminary studies suggest that both genera can be characterized (and differentiated) by the following characters: (1) skull: in *Glyptotherium* the rostral area is narrower, and the infraorbital foramina and the zygomatic process of maxilla are placed more internally than in *Glyptodon*; (2) morphology of the dorsal carapace: in *Glyptotherium* (except probably in *G. texanum*) the carapace has an arched (convex) dorsal profile in lateral aspect and is more highly arched than in *Glyptodon*, in which the carapace is lower and more elongated; in *Glyptotherium*, the posterior region is recurved upward in lateral aspect, morphology not recognized in *Glyptodon*; the angle between the most ventrolateral margin of the carapace and the caudal notch is approximately of 90° in *Glyptotherium*, whereas in *Glyptodon* this angle is greater than a right angle; (3) osteoderms: in *Glyptotherium* the sulci that delimit the central figure are shallower and narrower than in *Glyptodon*; the thickness of the osteoderms is greater than in *Glyptodon*; the central figure of the carapacial osteoderms is flat or concave in *Glyptotherium*, whereas in *Glyptodon* this exposed surface is convex and the peripheral figures are less developed. The characters observed in *G. texanum* (~2.7 Ma) could support the idea that it belongs to a different (presently undefined) genus. On the other hand, the presence of *Glyptotherium* in the Pliocene (~3.9 Ma) of central Mexico must be confirmed by more precise studies.

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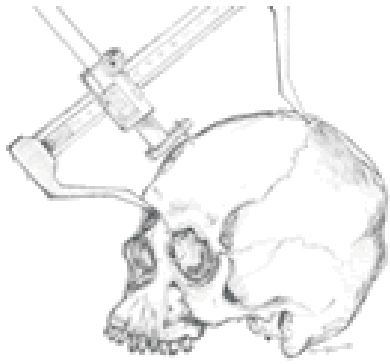
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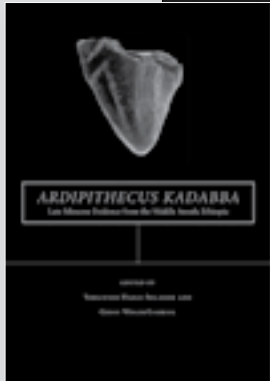
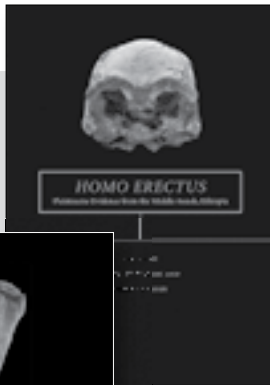
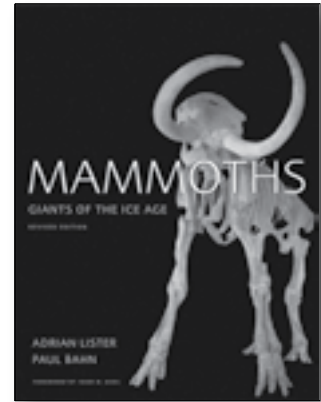
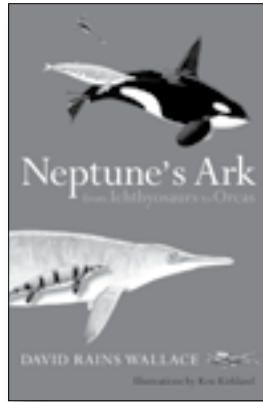
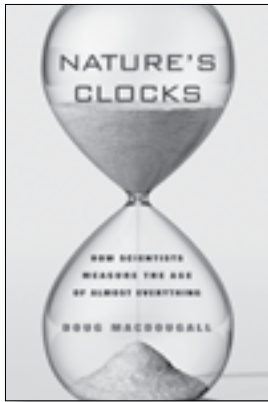
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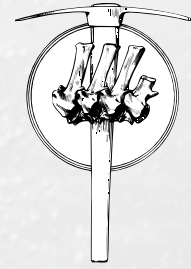
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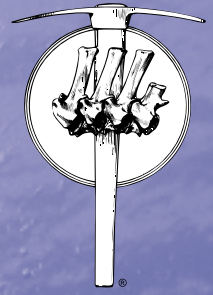


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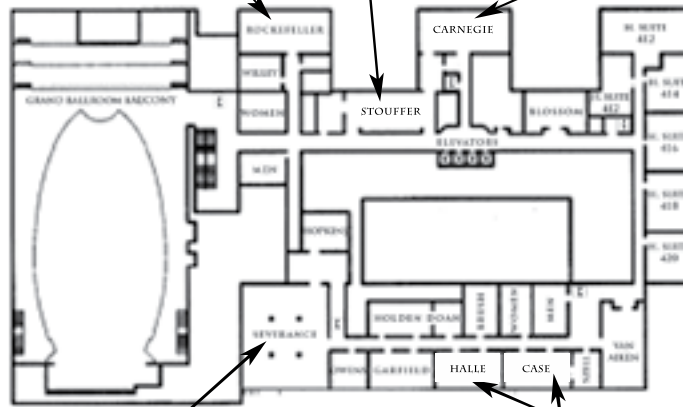


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