

ADHESIVES FOR VERTEBRATE PALEONTOLOGY

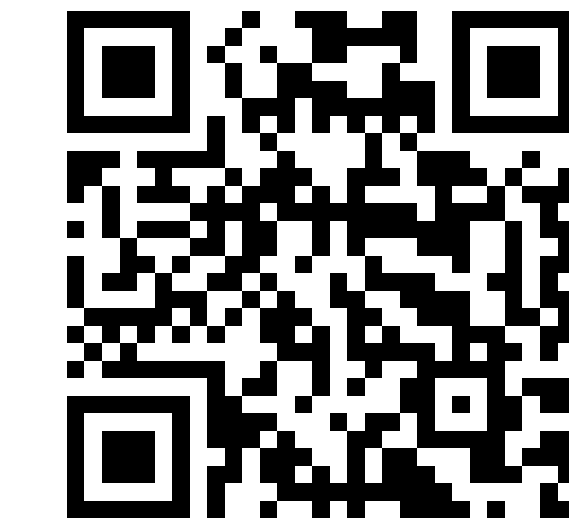
AMERICAN MUSEUM OF NATURAL HISTORY

AN ILLUSTRATED WALL CHART

AMERICAN MUSEUM OF NATURAL HISTORY




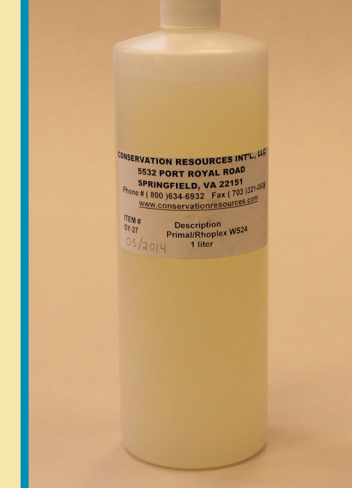
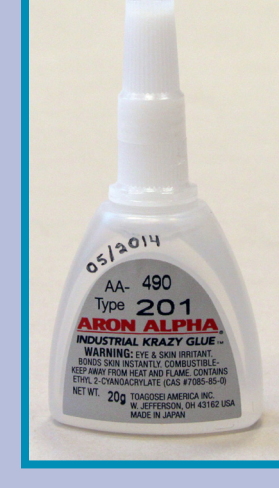



A Poster Presentation, SVP 2014, Berlin, Germany
 By Suzann Goldberg and Amy Davidson
 Division of Paleontology, American Museum of Natural History
 New York, New York, United States of America



References available at:
amnh.academia.edu/AmyDavidson



| | Sets by Evaporation of Solvent | | | Sets by Evaporation of Water, then Coalescence of Droplets | Sets by Chemical Reaction | |
|---|--|---|---|--|---|---|
| TRADE NAME & GRADE | PARALOID™ (Acryloid™) B-72 | BUTVAR® B-76 | BUTVAR® B-98 | PRIMAL® (Rhoplex™) WS-24 | ARON ALPHA® 201 | DEVCON® 2TON® |
| DECLARED CHEMICAL COMPOSITION w/Reference | Acrylic Copolymer <small>Material Safety Data Sheet 1991 Rohm and Haas Co., Subsidiary of Dow Chemical Co. Coventry, UK</small> | Terpolymer of Vinyl Butyral, Vinyl Alcohol, & Vinyl Acetate Monomers <small>Material Safety Data Sheet 2013 Solutia Inc., Subsidiary of Eastman Chemical Company St. Louis, Missouri USA</small> | Terpolymer of Vinyl Butyral, Vinyl Alcohol, & Vinyl Acetate Monomers <small>Material Safety Data Sheet 2013 Solutia Inc., Subsidiary of Eastman Chemical Company St. Louis, Missouri USA</small> | Acrylic Copolymer Colloidal Dispersion with Added Ammonia <small>Supplier Data Sheet and Material Safety Data Sheet 1999 Conservation Resources Ltd. Cowley, Oxford, UK (Sometimes marketed as "Acrysol WS-24")</small> | Ethyl 2 - Cyanoacrylate with Added Hydroquinone <small>Material Safety Data Sheet 2009 Krazy Glue Co., Division of Toogost America, Inc. West Jefferson, Ohio, USA</small> | Epoxy (Diglycidyl Ether of Bisphenol A Resin and Polyoxypropylene - Diamine Hardener) <small>Material Safety Data Sheet 2002 ITW Devcon Inc. Danvers, MA, USA</small> |
| DESCRIPTION |  Supplied as Polymer Beads [Unlimited shelf life] Dissolve in Acetone or Ethanol |  Supplied as Polymer Powder [Unlimited shelf life] Dissolve in Acetone or Ethanol |  Supplied as Polymer Powder [Unlimited shelf life] Dissolve in Ethanol Only (Not Acetone) |  Supplied as Aqueous Dispersion [Limited shelf life] |  Supplied in a Bottle of Liquid Monomers (Does not contain solvent) [Limited shelf life] |  Supplied as Liquid Resin & Hardener [Limited shelf life] |
| USEFUL PROPERTIES | ** Most Versatile Adhesive & ** Most Commonly Used Adhesive * Excellent aging properties * Re-workability over time | * Coatings more easily removed than Paraloid B-72 * Consolidated matrix easy to remove mechanically * Dissolves in most solvents available in Mongolia | * Penetrates better than Paraloid B-72 or Butvar B-76 , especially with ethanol pre-wetting * Finish less glossy than Paraloid B-72 | * Compatible with damp specimens | * Superior wicking & penetration * Easy to apply in tiny drops | * Alt. to Paraloid B-72 if great strength required for heavy or dense specimens * Slow setting in tiny drops |
| PRIMARY USE AT AMNH | * Preferred for almost every task * Exceptions: - field consolidation - very heavy, very tiny, or damp specimens - where a glossy surface is not desirable - coatings for molding | * Used extensively as a field consolidant for porous Gobi specimens in loose sandstone * Consolidation during prep * Used to coat specimens before molding | * Used to consolidate porous Gobi specimens in loose sandstone | * Used for consolidation of damp specimens after extraction from wet mudstone, lignite, & clays, Amazon riverbank, Peru | * Micro consolidation during preparation of small specimens * Used to spot consolidate small Chilean mammals, Gobi lizards & Gobi mammals | * Used to join broken sauropod bones & quarried blocks of dense, volcanoclastic, Chilean matrix * Micro repairs requiring slower working time than Paraloid B-72 , e.g. to reattach broken cusps on tiny mammal teeth |

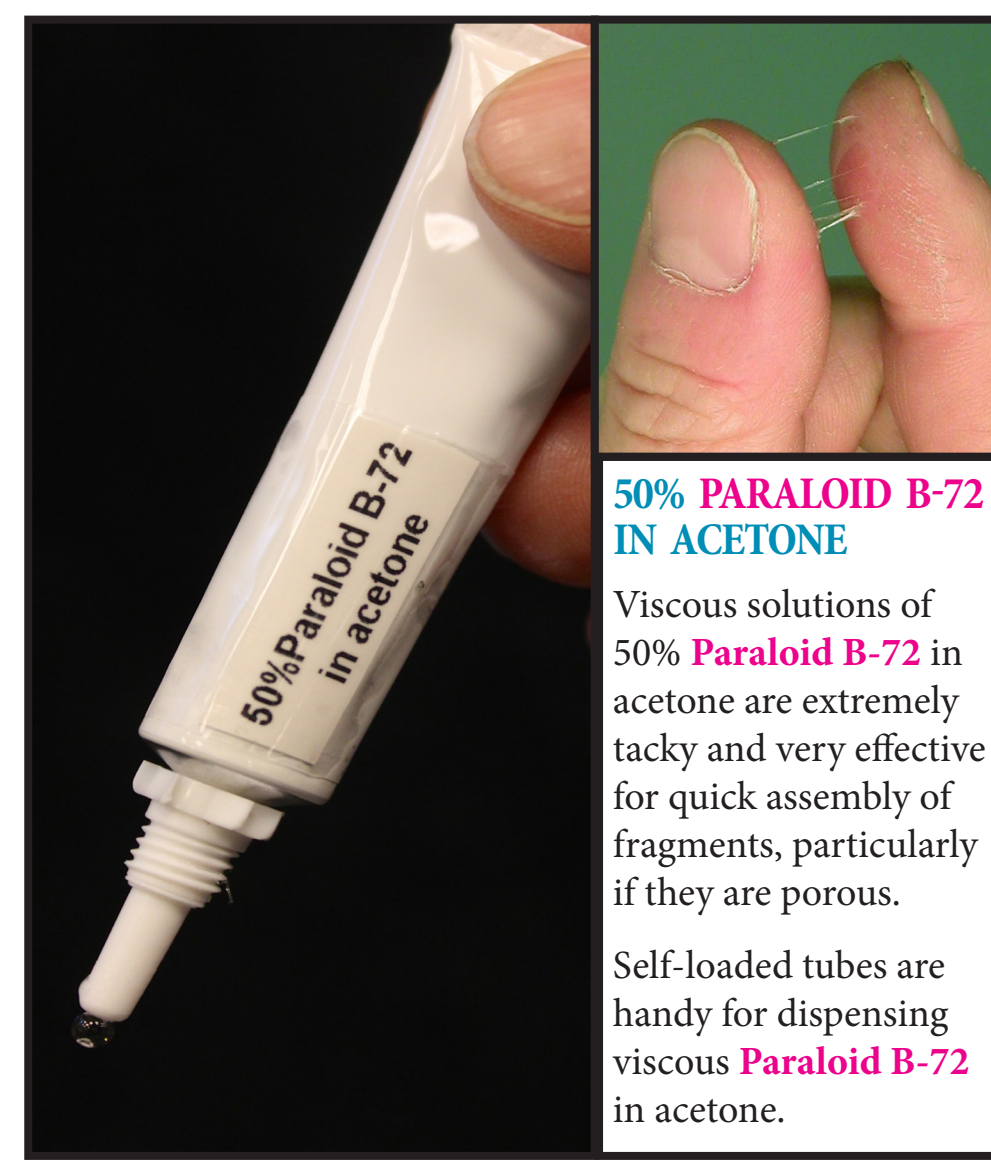


PARALOID B-72 IN DIFFERENT SOLVENTS FOR CONSOLIDATION, JOINING AND GAP-FILLING
 To prepare this oviraptor forelimb, 50% Paraloid B-72 in acetone was used for joints and 0.5% Paraloid B-72 in ethanol was used for consolidation. Gaps were filled with ground matrix mixed with Paraloid B-72 in ethanol. Ethanol is less volatile than acetone, allowing better penetration and a longer working time. Acetone solutions set faster and are better for joints.

BUTVAR B-76 IS VERY COMPATIBLE WITH GOBI MATRIX
 This lizard was consolidated in the field with Butvar B-76. During preparation in the lab, the matrix was consolidated with more Butvar B-76. Small areas of matrix supporting the bone were built up, shaped and reinforced by adding a cement of matrix mixed with Butvar B-76. This additive technique is very useful for Gobi specimens. Like Butvar B-98, Butvar B-76 has a pleasing matte finish, unlike Paraloid B-72 which tends to be glossy.



Saichangurov davidsoni IGM 3/8/88
 Photo by Mick Ellison © AMNH



50% PARALOID B-72 IN ACETONE
 Viscous solutions of 50% Paraloid B-72 in acetone are extremely tacky and very effective for quick assembly of fragments, particularly if they are porous. Self-loaded tubes are handy for dispensing viscous Paraloid B-72 in acetone.

ABSTRACT
 The decision to apply adhesives to fossil vertebrate specimens should be guided by an ability to assess the specimen and the task at hand, determine the desired end product, & choose the most appropriate adhesive.
 At the American Museum of Natural History, while some specimens are not treated (to avoid chemical contamination), most specimens require one or more of the following: (1) Consolidants during excavation and/or preparation (2) Adhesives for joining (3) Coatings for molding.
 This chart illustrates the most widely used adhesives at the AMNH with details as to why preparators choose specific adhesives for specific tasks, based on their different properties. Some of these important properties are long-term stability, solubility, removability, penetration, strength, set-time & glossiness.

CONSOLIDATION OF GOBI SPECIMENS - BUTVAR B-76 vs. BUTVAR B-98 vs. PARALOID B-72



Butvar B-76 tends to form coatings that are cohesive, gap-spanning, flexible and weakly adhesive (removable by peeling), & also easily re-dissolved in acetone. These properties make Butvar B-76 very useful as a temporary, removable consolidant for Gobi specimens in the field and during preparation in the lab. Paraloid B-72 by comparison, adheres more strongly to the surface, is slower to re-dissolve and more difficult to remove from Gobi specimens.



Butvar B-98 is soluble in ethanol and is insoluble in acetone. Butvar B-98 tends to penetrate porous Gobi bone and loose sandstone matrix better than Butvar B-76, especially if the surface is pre-wet with ethanol.

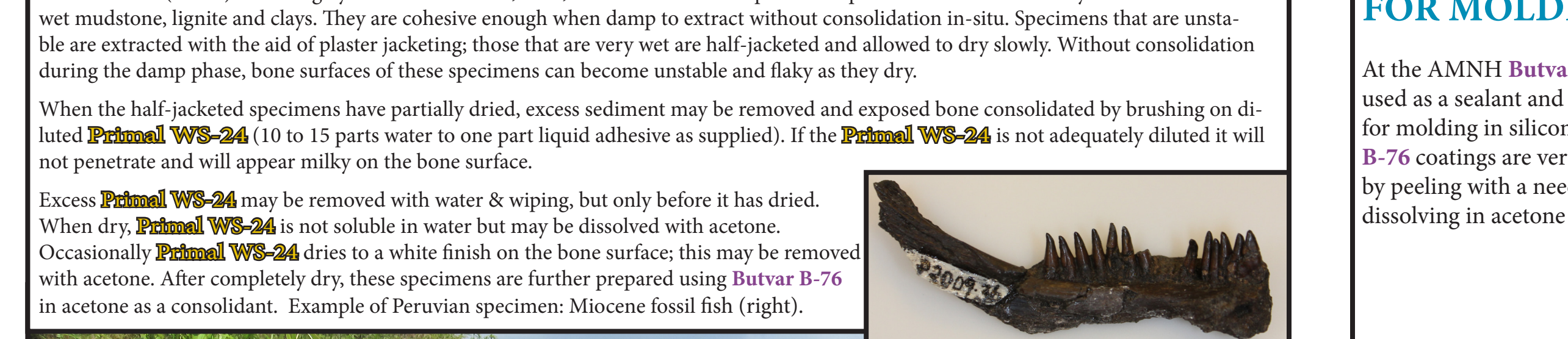
ACKNOWLEDGMENTS: Thanks to our Preparators in the AMNH Vert Paleo Prep Lab: Ana Balcarcel, Robert Evarner, Verne Lee, Amy Davidson, and all of our Paleo Prep Volunteers. Thanks to Pat Saigo, aka PIV, for poster consultation. Thanks to Mick Ellison for some beautiful images. Thanks to John Flynn, Michael Novacek, and Mark Norell for permission to use images and for support of this project. Thanks to the Mongolian Academy of Sciences and the Peruvian UNMSM for joint expeditions and loans of specimens. Thanks to Jim, Ariella, & Hadassa for giving us time & encouragement for this poster.



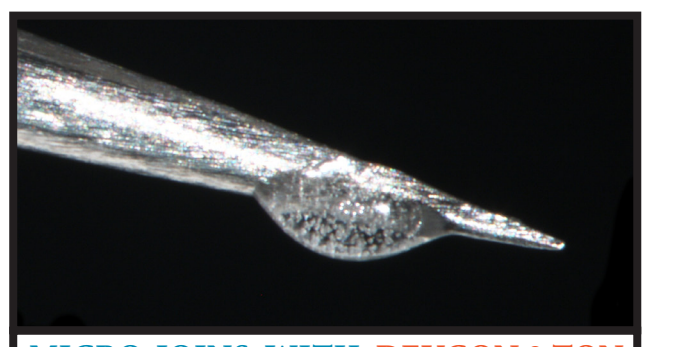
CONSOLIDATION WITH BUTVAR B-76 & BUTVAR B-98; JOINS WITH PARALOID B-72
 This tyrannosaurid was excavated from the Gobi Desert of Mongolia. It was first consolidated in the field with Butvar B-76 (left). Matrix consolidated with Butvar B-76 is easy to remove mechanically (above). For consolidation during preparation, Butvar B-98 was found to penetrate this specimen better than Butvar B-76. Fragments were joined with Paraloid B-72 (below).



CONSOLIDATION OF DAMP SPECIMENS WITH PRIMAL WS-24
 Ana Balcarcel (below) collecting by the Amazon River, Peru, UNMSM-AMNH expedition. Specimens from this locality are collected from wet mudstone, lignite and clays. They are cohesive enough when damp to extract without consolidation in-situ. Specimens that are unstable are extracted with the aid of plaster jacketing; those that are very wet are half-jacketed and allowed to dry slowly. Without consolidation during the damp phase, bone surfaces of these specimens can become unstable and flaky as they dry.
 When the half-jacketed specimens have partially dried, excess sediment may be removed and exposed bone consolidated by brushing on diluted Primal WS-24 (10 to 15 parts water to one part liquid adhesive as supplied). If the Primal WS-24 is not adequately diluted it will not penetrate and will appear milky on the bone surface.
 Excess Primal WS-24 may be removed with water & wiping, but only before it has dried. When dry, Primal WS-24 is not soluble in water but may be dissolved with acetone. Occasionally Primal WS-24 dries to a white finish on the bone surface; this may be removed with acetone. After completely dry, these specimens are further prepared using Butvar B-76 in acetone as a consolidant. Example of Peruvian specimen: Miocene fossil fish (right).



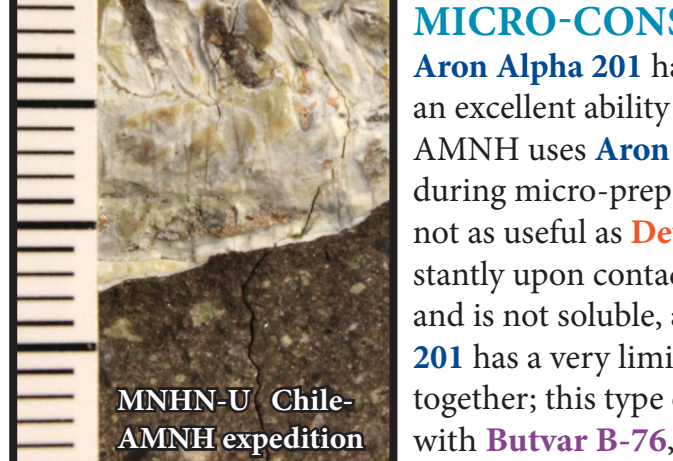
Butvar B-76 FOR MOLDING
 At the AMNH Butvar B-76 is often used as a sealant and separating coating for molding in silicone rubber. Butvar B-76 coatings are very easily removed by peeling with a needle or by dissolving in acetone or ethanol.



MICRO-JOINS WITH DEVCON 2TON
 For most micro-joints on Gobi specimens (e.g. below), slow set-time is a priority for manipulating and adjusting the joint before the adhesive sets. Devcon 2-Ton is not as removable as any of the solution adhesives (e.g. Paraloid B-72), but it is easy to apply in tiny drops (above) that set slowly regardless of amount. Solution adhesives dry up very quickly in tiny drops & are more difficult to manipulate for micro-joints.



LARGE SCALE JOINS - DEVCON 2 TON VS. PARALOID B-72
STRENGTH VS. REMOVABILITY:
 Great strength was a priority for assembling this heavy, dense sauropod fibula (above) from many pieces. Devcon 2-Ton sets by irreversible chemical reaction and, unlike Paraloid B-72, is not dissolvable or easily removed (although it can be softened with heat). For optimum performance, all epoxies must be fresh, measured carefully and mixed thoroughly.
SET TIME:
 Joints made with Paraloid B-72 on very heavy, dense specimens may slump if not well supported before setting completely. After initial "grab" Paraloid B-72 releases the solvent very slowly, becoming less pliable and stiffer. Complete evaporation and setting may take months, especially if the solvent is trapped inside a large joint. Devcon 2-Ton sets in 30 min. & cures completely in 12 hours - an advantage for large scale joints.



MICRO-CONSOLIDATION WITH ARON ALPHA 201
 Aron Alpha 201 has an extremely low viscosity, low surface tension and an excellent ability to wick into hairline cracks (left). For this reason the AMNH uses Aron Alpha 201 in tiny amounts for spot-consolidation during micro-preparation of small specimens (above). Aron Alpha 201 is not as useful as Devcon 2-Ton for micro-joints because it sets almost instantly upon contact with the specimen. Aron Alpha 201 sets very hard and is not soluble, although it will swell and soften in acetone. Aron Alpha 201 has a very limited ability to span gaps and cracks to hold fragments together; this type of consolidation may be more effectively accomplished with Butvar B-76, Butvar B-98 or Paraloid B-72.



Micro-rodent jaws, Chucal Fm., Chile, MNHN-U Chile-AMNH expedition (right)



Miocene rodent jaws, Chucal Fm., Chile, MNHN-U Chile-AMNH expedition (right)

We love our adhesives! Suzann Goldberg packing Butvar B-76 for the Gobi Expedition in 2013 (left). Amy Davidson found the best solution in Ulaan Bataar in 1995 (right).

