Challenges in the field: collecting wet vertebrate fossils with the application of Acrysol WS24, Acryloid B72, and cyanoacrylate consolidants

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Introduction

Recent field excavations of vertebrate fossils (dinosaur, turtle, fish) in groundwater-saturated, clay-rich sediments from the Chronister Dinosaur Site in southeastern Missouri, USA, presented unique excavation challenges. These conditions provided great opportunities to apply and test various consolidation methods in wet sediments (Table 1). Originally discovered in 1942, the first fossils recorded from this site belong to the Cretaceous iguanodontian *Hypsibema missouriense*. Since its initial discovery, the site was purchased by Bruce Stinchcombe to continue paleontological work. The site has been periodically excavated with efforts led by Guy and Doris Darrough. A large greenhouse currently protects the site from collecting rainwater and against vandalism. Over the past three years, field crews from the Field Museum of Natural History have carried out systematic paleontological excavations with assistance from the Darroughs and local volunteers.

Geology and fossil conditions

The Cretaceous sediments in the Chronister Dinosaur Site consist largely of unlithified plastic clay with intercalated sand lenses and are close to permanently wet conditions. Drying the sediment results in the formation of desiccation cracks, compromising the state of fossils. It is therefore necessary for the sediments to remain in a 'wet' state in order to successfully stabilize and extract fossil material from the site. The fossil elements are preserved in various states, ranging from almost pristine to dorso-ventrally crushed and plastically deformed.

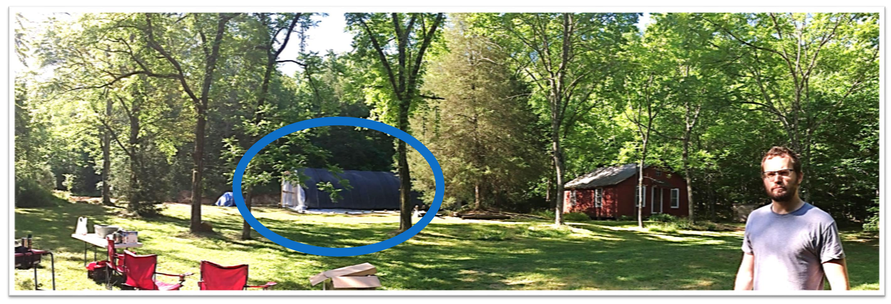
Unlithified groundwater saturated sediment.

Multiple desiccation cracks form if the site is exposed for a prolonged period, negatively affecting the fossils.

Complete phalanx (app. length 13cm).

Dorsal vertebrate with exposed trabecular bone (app. length 25cm).

Chronister Dinosaur Site, Missouri, USA.



Above: Chronister Dinosaur Site: CDQ is covered with a green house (in blue circle) to retain moisture to control the formation of large desiccation cracks. The red house on the right is the Chronister's original house. **Below**: The wet working conditions inside the green house (left). Primary excavation area (middle). Tarps are used at the end of each work day to cover the site, retaining sediment moisture to limit the occurrence of desiccation and fossil damage (right).

Table 1. Comparison of consolidants

Product	Acrysol™ WS24 Acrylic dispersion resin	Acryloid™ B72 Acrylic copolymer		Aron Alpha® Type 201 Ethyl 2-Cyanoacrylate
Properties	• 36% solid in water solution. • Dilute with water, acetone, ethanol. • Glass transitioning temp (Tg) 46°C (Information from a technical data sheet from Rohm and Haas via Dow Co. ltd.)	• 100% solid particles. • Soluble in acetone, ethanol, toluene, and xylene etc. • Tg 40°C (Information from a technical data sheet from Rohm and Haas via Dow Co. ltd.)		• 100% liquid. • Primarily bonding agent. • Vicat softening point 145°C (Information from a technical data sheet from Aron Alpha)
Primary use	Consolidant	Consolidant	Glue	Consolidant/Glue
Concentration of product used in CDQ	10% in water (3.6% solid)	10-20% in acetone	50% in acetone	As is
Viscosity	60cp	200-800cp	10,000cp	2cp
Evaporation rate	Slow	Fast	Slow	Fast
Penetrability	Excellent for water saturated fossils in wet clay sediment but the absorption rate is slow.	Excellent with porous/exposed dry fossils. Does not penetrate into wet surface due to fast evaporation rate.	No penetration at all as this is used as a gap filler or reversible glue.	Excellent with porous/exposed fossils. Optimum bond strength is achieved with a thinner film application at 0.0006g/cm^2 or 0.03-0.05mm in film thickness.
Side effect/ Disadvantages	No side effect but very slow cure. Milky solution will be absorbed and dry clear over time.	Forms white films on wet surface as it dries, indicating no penetration into matrix.	Does not cure in the high humidity and with wet fossils.	Hardens matrix when the liquid spreads out and away of fossils, making it difficult to prepare later.
Results	Wet: ✓ Semi-dry/Dry: ✓	Wet: X Semi-dry/Dry: ✓	Wet: X Semi-dry/Dry: ✓	Wet: ✓ Semi-dry/Dry: ✓
	Works on both wet and semi-dry/dry. Preferred consolidant on wet matrix.	Preferred consolidant on semi-dry/dry fossils.	Not effective to use with wet fossils. Preferred glue on dried fossils.	Works on both wet and semi-dry/dry. Preferred consolidant on exposed trabecular bone and medullary cavity.

Conclusions

The best consolidant to apply in CDQ is 10% water based WS24. Use of 10-20% B72 in acetone is effective once fossils and sediments are semi-dry or dry, but highly viscous 50% B72 in acetone is not effective to use as a glue or a gap filler in the humid environment. Application of cyanoacrylate in small amounts is excellent to stabilize exposed medullary and trabecular bones. These three types of consolidants do not negatively interfere with one another when applied one at a time.

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