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Cal R. Fremling
Winona State University

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A New Method of Taxidermy Using Polyethylene Glycol As an Impregnation Medium

● Calvin R. Fremling and Donald L. Hemming, Winona State College, Winona, Minnesota

Dr. Fremling and his student, Mr. Hemming, report here a new method of taxidermy using water-soluble wax as an impregnation medium.

Life-like mounts of animals are excellent visual aids for effective biology teaching because they stimulate student interest and bring realism to the classroom. If the mounts are prepared by a professional taxidermist, however, the cost is usually prohibitive. The standard price for fish taxidermy is about \$1.00 per running inch with a minimum charge of \$15.00. Even the teacher who is an expert taxidermist usually has difficulty finding the many hours necessary to mount his own specimens. Students usually contribute little because they are seldom able to become proficient in the art during the school year. The finished product of standard taxidermy procedure is extremely fragile and should be looked at but never handled.

In 1954, Lohrman and Torgerson described a simple but effective method for preserving birds and mammals in life-like poses by injecting them with full-strength formalin and arsenic and allowing them to air dry. This technique and modifications of it have been used by many teachers (Stapp and Shull, 1964). We have had excellent results with this method even though we do not use arsenic because of the danger involved. Straight formalin seems to be sufficient and our mounts have remained free from insect damage for over 5 years (Fig. 1). Unfortunately, this technique is not suitable for animals which have no hair or feathers to hide body shrinkage.

In 1950, Sills and Gold described a method for preserving gross pathological specimens such as hearts, lungs, and kidneys with polyethylene glycol 1540, and we wondered if such a technique could be used for hairless and featherless vertebrate animals. The following technique, which utilizes various molecular weights of polyethylene glycol, has been developed through extensive experimentation on a variety of fish, reptiles, and amphibians over a 5-year period.

Polyethylene glycol polymers are available in molecular weights ranging from 200 to 20,000 and are sold under the trademark *Carbowax* by Union Carbide Chemicals Company. The lower molecular weights (200, 300, 400, and 600) are viscous, water-white, hygroscopic liquids at room temperature and are soluble in solvents such as alcohols, glycol-ethers, esters, and aromatic hydrocarbons. The higher molecular weights (1000, 1540, 4000, 6000 and 20M) are solids at room temperature. *Carbowax* 1000 is a white semi-solid with a melting point between 37° and 40°C, while *Carbowax* 20M is a hard, translucent, white solid which resembles household paraffin and softens at 53°C. Liquid polymers are generally more soluble in water than are the solids. All of the aforementioned polymers are chemically stable and are harmless to human tissue. This is attested to by the fact that they are widely used in cosmetics, ointments, lotions, suppositories, and as binders for pharmaceutical tablets. Polyethylene glycol 4000 is commonly used in lieu of paraffin for imbedding histological tissue before it is sectioned with a microtome.

Polyethylene glycol 1000 has been used extensively during the past few years to dimensionally stabilize wood. Beautiful tree sections and wood carvings, without cracks or checks, may be prepared with it (Fig. 1). A review of the literature concerning this use of polyethylene glycol has been compiled by Fuglsby (1964).

The following method of impregnating fish with polyethylene glycol has proved to be very satisfactory for specimens up to one and one-half pounds in weight. Larger fish are more difficult and expensive to preserve; consequently, we usually save only the head. With slight modifications, the following technique may also be used for reptiles and amphibians (Fig. 2). The p.e.g. — impregnated

specimens have no objectionable odor and are less fragile than conventionally mounted specimens; hence they may be passed around the class for first hand observation.

Method for Whole Mounts

Remove the eyes from the fish. They should be replaced later with artificial glass eyes. Remove the gills so that the blood in them will not turn black and cause the gill covers to appear dark. Using a 10 cc metal-encased veterinary syringe, inject the fish with 70% isopropyl alcohol. Ethyl alcohol works equally well, but isopropyl alcohol is often more easily obtained. Alcohol has proved to be much more satisfactory as a preservative than formalin because it causes less color change and is less objectionable to work with. Injections should be made into the musculature on both sides of the back, into the brain and body cavity. Wherever possible, injections should be made at the base of fins so that tell-tale needle holes will

not be visible. Care should be taken so that scales are not dislodged. With a little practice, injections can be made at the base of the pectoral and pelvic fins so that they will automatically rise into a natural position. Care must be taken so that the skin is not stretched by injecting too much alcohol. Inject only until the tissue rises slightly.

Place the specimen, with fins held in place by pins, in a wax-bottomed container (a small aquarium is ideal) and add enough 70% alcohol to completely cover the specimen. Leave the specimen in the alcohol solution to harden for at least 18 hours (longer for larger animals).

After the specimen has been fixed for the allotted time, repeat the injection using p.e.g. 400 instead of alcohol (the p.e.g. 400 is a liquid at room temperature). Make a plaster of Paris mixture thin enough to pass through your largest hypodermic needle and inject it into the body cavity. Submerge the specimen in p.e.g. 400 and let it remain there for a



Fig. 1. Crappie being injected with polyethylene glycol. Also note the tree sections which were treated with polyethylene glycol. The birds were preserved by injections with full-strength formalin.

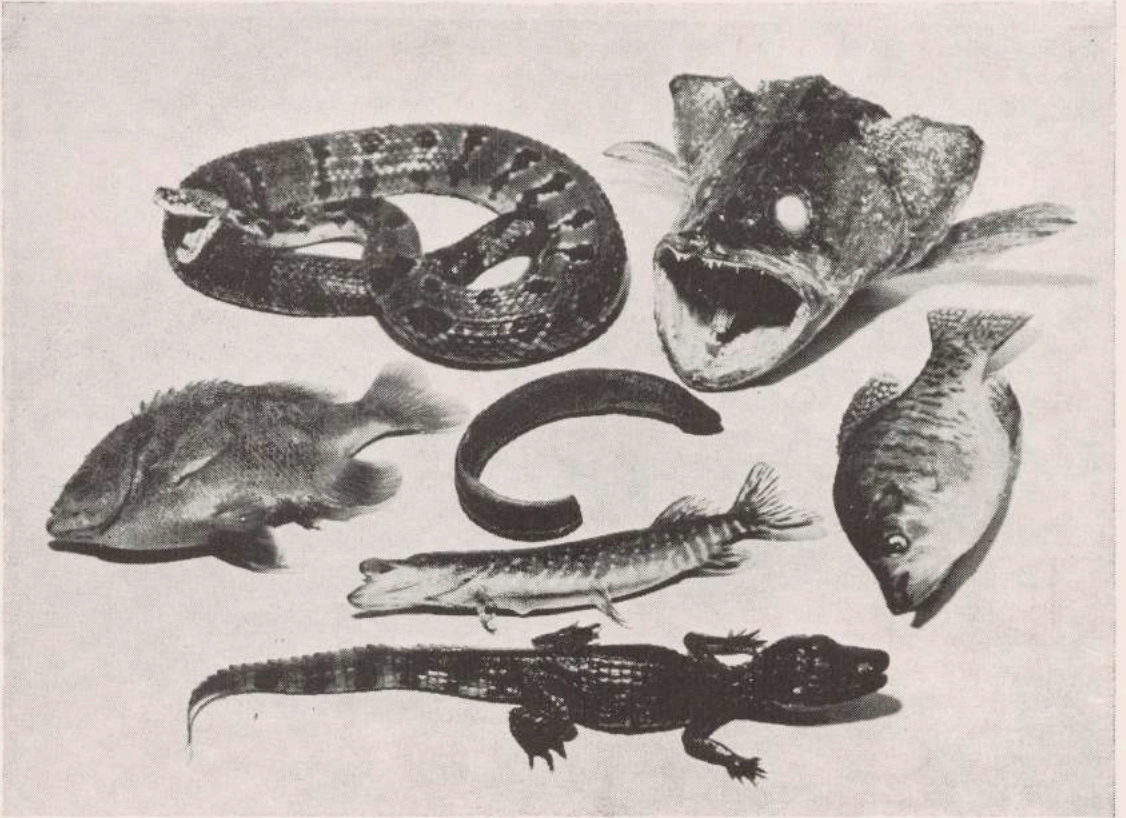


Fig. 2. Rattlesnake, walleyed pike, sunfish, lamprey, crappie, northern pike, and cayman preserved by means of the polyethylene glycol impregnation technique.

week. The water-soluble p.e.g. 400 will gradually replace the water by diffusion.

Next, prepare to replace the p.e.g. 400 with p.e.g. 1540. Warm the p.e.g. 1540 in an oven or with a heat lamp or a *very low* flame until it melts (avoid getting it hotter than necessary). Warm the needle and syringe in hot water and quickly repeat the injection procedure using p.e.g. 1540 instead of p.e.g. 400. This is the most difficult step in the whole process. Use the same injection holes to avoid damage to the specimen. If the needle plugs, bathe it with hot water. Submerge the specimen in molten p.e.g. 1540 (about 40°C) in an incubator (a kitchen stove oven with a pilot light works quite well) and allow it to stand until it is thoroughly impregnated. The degree of impregnation may be determined at any time by allowing the p.e.g. 1540 to harden at room temperature. When the p.e.g. 1540 which immediately surrounds the specimen becomes solid, the fish is thoroughly impregnated because the p.e.g. has completely

replaced the contained water. Until this happens a watery layer of p.e.g. — water solution will surround the fish. The impregnation process will take several days, depending upon the size of the specimen.

After it is impregnated, the fish is withdrawn from the p.e.g. 1540 and placed on paper towels or newspaper. The excess p.e.g. is melted off *slowly* by means of a heat lamp or an incubator. After the fish has cooled, plaster of Paris is placed into the eye sockets and glass eyes are inserted. The fish can later be attached to a plaque, if desired, by using wood screws, since the tissue is very rigid.

We have, in essence, preserved the specimen by creating a "physiological desert." The alcohol stopped bacterial growth and established rigidity by coagulating the proteins in the cells. The p.e.g. 400 was used to replace the alcohol and water in the cells. Finally, the highly soluble p.e.g. 400 was replaced with p.e.g. 1540 which is a solid at room tempera-

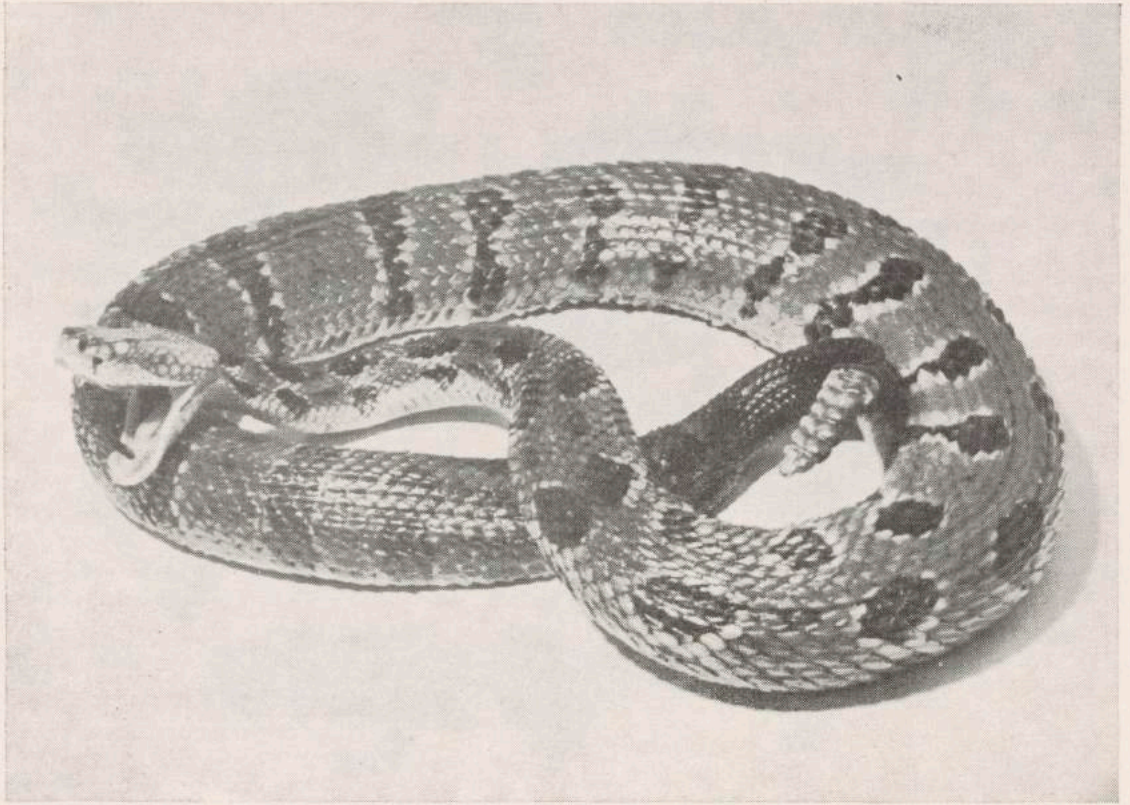


Fig. 3. This timber rattlesnake (*Crotalus horridus*) was mounted in a life-like pose using the polyethylene glycol impregnation technique.

ture. The specimen was thus rendered hard and dry. Bacteria and molds cannot grow in it because there is no water available for metabolic activity.

Method for Fish Heads

The p.e.g. method works extremely well for fish heads, regardless of size. If the head is large, inject the brain and cheek muscles with 70% isopropyl alcohol. Soak the head for a day in 70% alcohol; for three or more days in p.e.g. 400, and for three or more days in molten p.e.g. 1540. When it is observed that p.e.g. 1540 no longer liquifies upon prolonged contact with the head, it is obvious that the head has lost all of its water and is thoroughly impregnated. Upon completion of the bath in p.e.g. 1540, the head may be finished in the same manner as a whole mount.

Excellent mounts of whole specimens and heads have been made with one treatment with p.e.g. 1000 in lieu of the two treatments with p.e.g. 400 and p.e.g. 1540, but the mounts feel slightly greasy and they become

damp in hot, humid weather. Polyurethane resins (varnishes such as *Vitrathane*) are compatible with the polyethylene glycols and are widely used to finish p.e.g. — impregnated woods. We have had no success in finishing fish with these resins, however, as they inevitably blister and peel away. Oil pigments work quite well to restore lost color. The p.e.g. method works extremely well, of course, for specimens such as hearts, kidneys, fetal pigs, and invertebrates such as starfish and crayfish. It does not work on eyes, however, because they invariably become distorted as water escapes.

It is hoped that other investigators will use this technique and improve upon it. There are probably many solutions, for example, which are superior to alcohol for preserving color. Unfortunately, polyethylene glycol is expensive when ordered in small quantities from large companies. Small packagers will probably prove to be the best sources of supply. The Crane Creek Gunstock Company of Waseca, Minnesota, for

example, has agreed to supply small quantities of p.e.g. 400, 1000 and 1540 at one dollar or less per pound if a market develops.

Since this paper was submitted, we have seen a report by Waller and Eschmeyer (1965) which describes a method of preserving the natural coloration of fishes. Although we have not tested the suggested chemical antioxidant, butylated hydroxytoluene (BHT), in conjunction with polyethylene glycol preservation, it seems likely that the two procedures may be mutually complementary.

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