Archaeological Preservation Research Laboratory Report 12:

Preservation of a Dog Heart Using Silicone Oils

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Currently, many of the processes available for the preservation of human and animal tissues are either time consuming or require that specimens be stored wet. Wet storage of most tissues does not offer any degree of support at a cellular level and therefore, specimens are fragile and have a propensity to disintegrate when removed from their storage media. For this initial experiment, conventional processes of dehydration and modified silicone bulking processes will be combined in an attempt to conserve heart tissues without the need for wet storage.

After removal, the heart was flushed in a series of fresh water rinses and then stored in a 50:50 solution of alcohol and water for eighteen hours. The heart was then moved to a 100% solution of alcohol to allow further dehydration over a period of 24 hours. To ensure that all free water was removed from the tissues, the specimen was then placed into a container with fresh acetone and then into a freezer-mounted vacuum chamber. A vacuum of 28 Torr was applied to the specimen in solution for eight hours and then the heart was stored at ambient in the solution over night. The next morning, the water laden acetone was replaced with fresh acetone and the heart was exposed to a vacuum of 28 Torr for an additional eight hours. Inspection of the acetone solution indicated that no additional lipids appeared to be flushed from the heart and dehydration was considered complete.

Because no tests had been conducted to determine the penetrating ability of PS343 silicone oil into soft tissues such as this dog heart, a small quantity of dimethyl sulfoxide medical grade gel was used to encourage deeper penetration of the silicone oil into the tissues. To two ounces of the gel was folded into the silicone oil until a homogeneous mixture was achieved. Once the heart was removed from the second acetone dehydration bath and had been quickly wiped with paper towels to remove any free-flowing acetone, the organ was then placed into the PS343/dimethyl sulfoxide solution. Once placed back into the freezer-mounted vacuum chamber, the process of silicone bulking began by applying a vacuum of 28 Torr to the heart for eight hours. The vacuum was then turned off and the heart was stored in its silicone solution for eighteen hours. This bulking process was repeated twice over the next forty-eight hours so that in total, the heart had been bulked for 24 hours and stored in the silicone-dimethyl sulfoxide solution for 54

hours. At this point, the beaker containing the heart in its solution was removed from the freezer and allowed to sit at room temperature for 4 hours. Using rubber gloves, the heart was removed from the silicone solution and placed unto a mesh screen for fifteen minutes so that all free-flowing silicone could drain from the surfaces of the heart.

During the final bulking phase, a warming oven was prepared to aid in the polymerization of the silicone bulked tissues of the heart. The oven was pre-heated to 125 degrees Fahrenheit and an inverted polyethylene pail and lid was placed into the oven to act as a containment chamber in which the evaporated fumes of catalyst could be concentrated and kept in close proximity to the heart. In the center of the lid, which served as the base of the chamber, a shallow dish containing two ounces of CT-32 catalyst was placed and on top of the dish, a large section of mesh screen was positioned to form a platform on which the heart could be rested during the polymerization process. To ensure that the heart was exposed to sufficient fumes to begin the polymerization process, an external source of catalyst fumes was used. To create additional catalyst fumes, a beaker containing two ounces of CT-32 catalyst was suspended over a heat lamp to cause vaporization of the catalyst. A small aquarium air pump was used to pump air into the beaker while a second air hose ran from the beaker to the top of the containment chamber. The small amount of air pressure supplied by the air pump was sufficient to force catalyst fumes into the chamber throughout the polymerization process (Figure 1).

A. Warming Oven
B. Containment Chamber
C. Heart
D. Mesh Screen
E. Catalyst Tray
F. Heat Lamp
G. Beaker with Catalyst
H. Air Pump

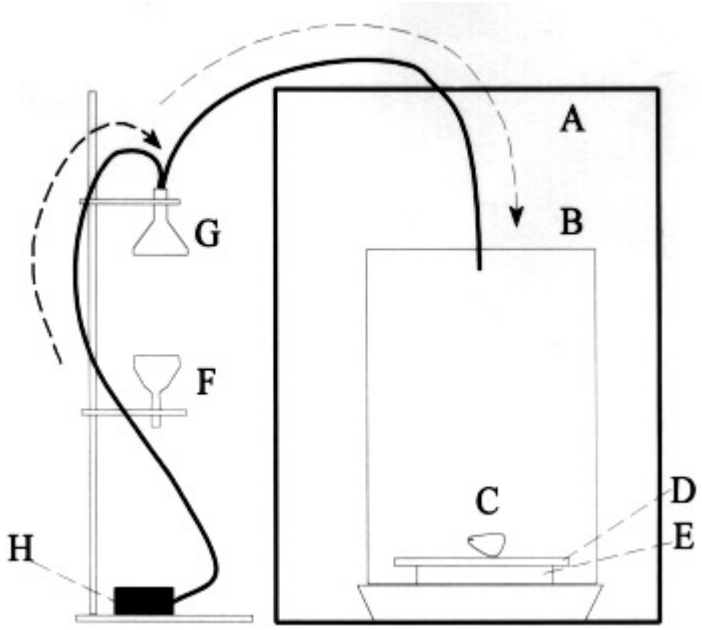

Figure 1. Set-up for polymerization of the dog heart.

With the heart positioned over the catalyst tray, the containment chamber and the oven door were closed. After 24 hours of exposure to catalyst fumes, the oven and containment chamber were opened and it was noted that the catalyst in the small tray had completely hardened, as the result of excess silicone oils dripping from the surfaces of the heart. A clean tray containing two ounces of fresh catalyst was added to the chamber and after

turning the heart over, the chamber and oven were sealed and the polymerization continued for an additional 24 hours. After 48 hours of exposure to catalyst fumes, it was noted that the coloration of the heart had become a darker brown. The heat was turned off and the heart was left in the chamber for an additional 24 hours to return to room temperature.

Observations

The decision to use dimethyl sulfoxide as a medium for aiding in the deep penetration and complete bulking of the tissues of the heart with silicone was sound in theory because this chemical is actively used by physicians and veterinarians as a means of administering medications through the skin. One side effect of using dimethyl sulfoxide is that it causes a "garlic" odor when applied to living tissue. In biological samples such as this heart, this odor is not readily dissipated, therefore; the period needed to "air" the sample is considerably longer. After two weeks of storage in fresh air, a faint garlic smell remained.

The major flaw in this experiment was that the temperature of the warming oven was set too high. Excess heat in combination with dimethyl sulfoxide caused the discoloration of heart tissues. While the heart appears to have been completely bulked with silicone oil, the polymerization process was partially obstructed because the oven temperature partially cooked the heart while polymerization was taking place. The amount of shrinkage that occurred was minimal and although the diagnostic features of the heart were well preserved, it is not aesthetically pleasing.

Additional testing has indicated that rapid dehydration using vacuum pressure to boil off acetone-laden water from tissues is very effective. Bulking dense archaeological wood samples successfully without the need for dimethyl sulfoxide as a penetration medium suggests that possibly, such a medium is not required when bulking with PS343 silicone oil. Undoubtedly, the range of temperature needed to start the process of polymerization is considerably less than had been previously expected, especially when an external source of catalyst fumes is used. While this attempt at silicone bulking appears to have been successful, future experimentation should focus on lower temperature polymerization and direct bulking of tissues without chemical interactions.

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