Cleaning Skeletons with Dermestid Beetles—Two Refinements in the Method

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Among the methods that may be used for cleaning skeletons are cooking, bacterial maceration, chemical solutions, and dermestid beetles. The last method is best for most preparations and is widely used in museums where large numbers of small- to medium-sized specimens need to be cleaned economically, completely, and with minimum damage to delicate parts. Beetles of the family Dermestidae have been used for this purpose since 1922, and some of the techniques have been published (Hall and Russell, 1933; Tiemier, 1940).

Two techniques developed in the Osteology Laboratory at the American Museum of Natural History expedite subsequent processing. First, using a cotton bed, specimens are kept relatively free of debris while in the dermestid colony. Second, using formalin, the preparator can control the rate of feeding by the beetles on selected tissues so that articulations will be maintained and loosely seated teeth will be retained in the alveoli. These specific techniques and the general procedures used in our laboratory are described here.

DERMESTID COLONY

The dermestid or "bug" colony at the Museum is kept in a small, dark room having independent temperature control. A separate colony is maintained in each of six wooden boxes. Each box is about

Temperature-controlled "bug house" where the dermestid colony is contained in six chests. A few small skeletons are in an open enameled tray.

109 × 51 × 46 centimetres in size and is fully lined with polished aluminum, which must be kept clean to prevent the beetles or larvae from ascending the walls. The hinged lid has a locking mechanism to ensure tightness when closed. The lid has a 46 × 23 cm opening to

permit essential air circulation. The opening is covered with a fine-mesh screen. Air circulation is regulated by an adjustable cover over the opening (a similar chest was described by Vorhies, 1948). The basic requirements for a "bug" box are the sure confinement of the bugs, ready access for the preparator, ample work space, good ventilation, and darkness.

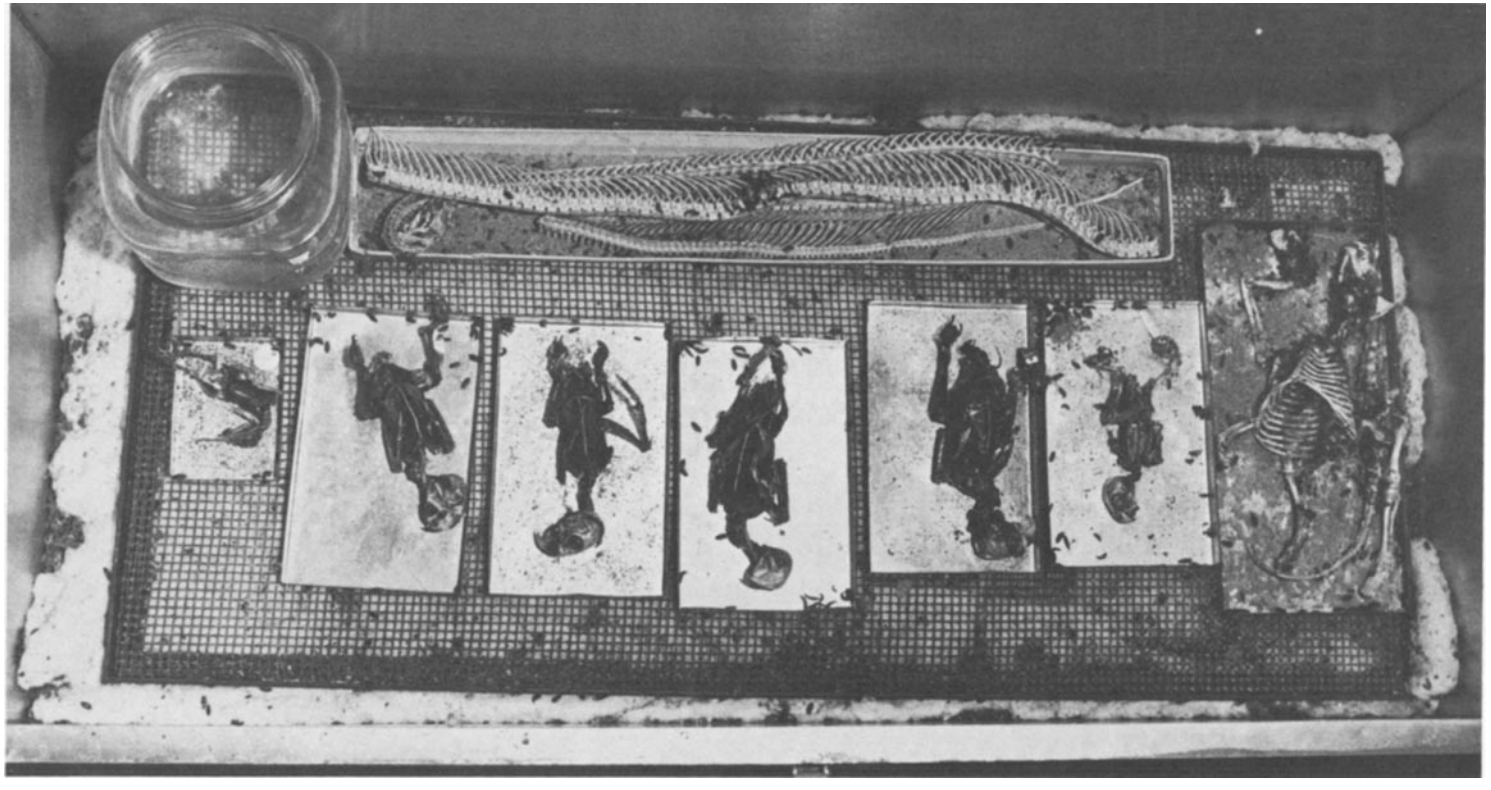
To maintain the environmental conditions at which the bugs work best (Russell, 1947), the colonies at the Museum are kept at an ambient temperature of 27-29° Centigrade with the aid of a twenty-four-hour steam line regulated by a sensor. A one-gallon jar of water is placed within each box if needed for greater humidity.

While various environmental factors affect the population, food supply is the major one. In the absence of skeletons to be prepared, it is essential to maintain a small breeding population with outside foodstuffs. Saving muscle tissue from previously prepared specimens is economically advantageous. It may be noted that the most effective cleaning is performed by bugs in their larval stage when they are most voracious. Care should be taken to confine the insects to their boxes; once free they can be destructive and a general nuisance.

COTTON BED TECHNIQUE

A 70-80 millimetre layer of cotton comprises the bedding to start a new colony. A glass jar about 100 mm high is placed in each corner of the box. On the jars rests a framed mesh screen, having 6 mm openings. The cotton layer beneath the screen provides a place for the larvae to pupate. It will also keep the frass (beetle sheddings and general debris) from accumulating in the tinned specimen trays resting on top of the mesh screen, thus allowing the work in progress to be clearly visible at all times. In time it may become necessary to elevate the screen due to the heavy accumulation of debris beneath it.

The first step in skeletal preparation is the evisceration and roughing out of the raw specimen. The muscles and tissues are cut and carefully scraped away from the bone, as much as the delicacy of the skeleton permits. Medium to large skeletons have to be decapitated and the brain removed. The roughed-out material then must be thoroughly dried. It is sparsely placed on a framed screen with fans forcing air around and over it, attaining quick, even drying. Depending on size, drying time is generally 24-48 hours. Quick drying is essential to prevent maceration and undesired insects such as maggots. It also inhibits mold formation—mold being a strong bug repellant. It is wise to differentiate old dessicated museum material from freshly dried specimens. Very dry specimens should be somewhat softened before being introduced into the colony to make them



Working dermestid colony. Skeletons of several parrots, a snake, and a raccoon are laid out in trays, showing metal lining, cotton bed below mesh screen, and a jar of water for humidity. The birds have just been put in; the snake is nearly clean.

more desirable for the bugs. Special drying techniques for field use should have the same goal but will vary depending on the circumstances.

Within the bug box each specimen rests on an individual tray with a 6 mm lip. A variety of tray sizes is kept readily available. To each specimen is attached a soft tin identification tag which cannot be destroyed by the insects and which is easily marked by ballpoint pen with the catalog number.

To facilitate the removal of finished material, newly prepared dried specimens are introduced. This draws the bugs to a new feast, leaving the bones of the last behind. The remaining bugs are brushed off the completed work and returned to the colonies.

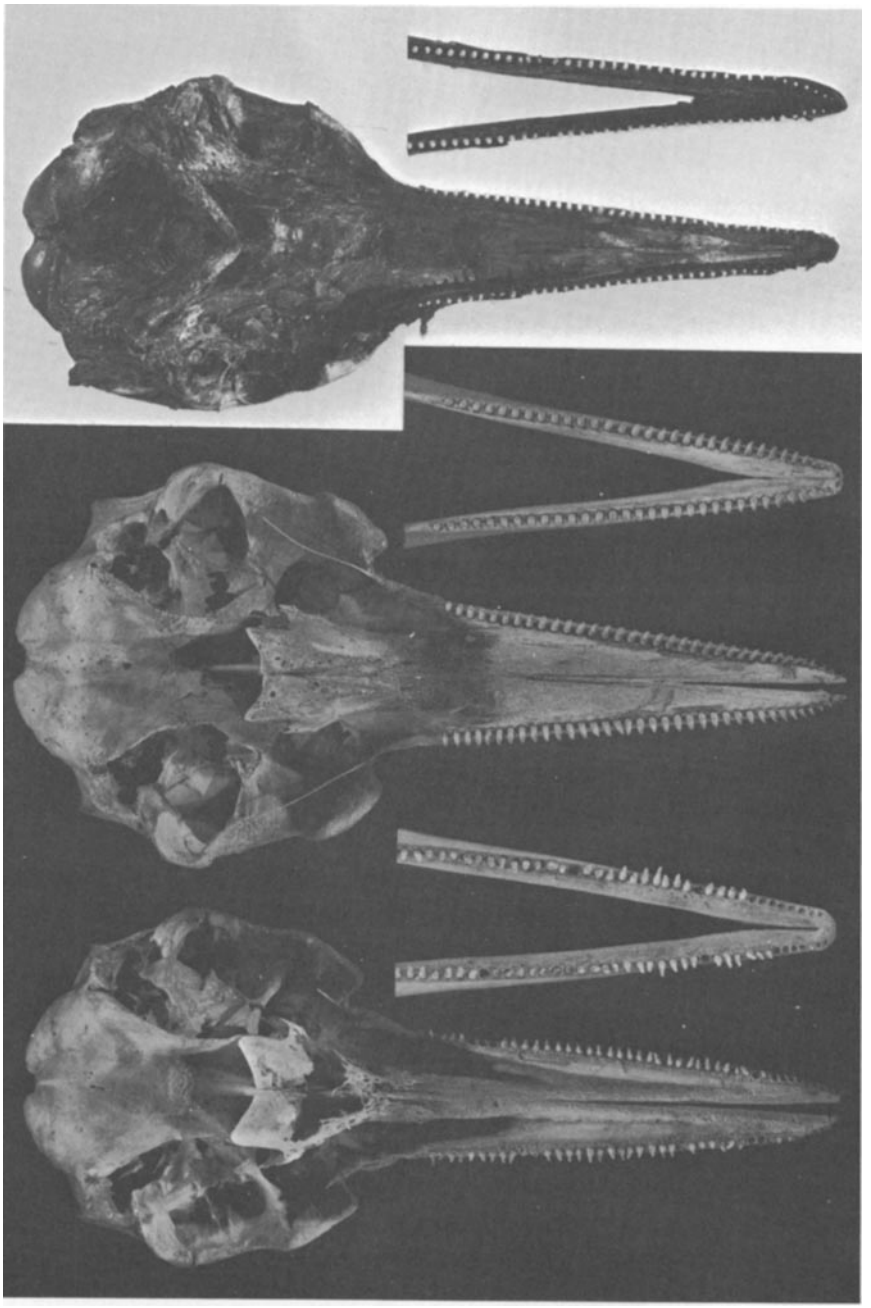
The next procedure involves all skeleton material cleaned by the bugs, with the exception of fishes, which are exempted from this process as it may cause unwanted disarticulation. The specimens are soaked in a hot ammonia solution (one part concentrated ammonia solution to four parts of hot water). After the mixture has cooled, the skeleton is removed and rinsed with cold running water. Any tissues or ligaments remaining are now soft and swollen, allowing their immediate removal with scissors, cuticle clippers, or splinter forceps. This procedure will finish most small skeletons and render them white and free of debris and grease. Larger specimens will require some brushing to remove adhering debris that may become lodged in crevices and rough surfaces.

Basically the bug cleaning method is reserved for small- to medium-sized skeletons. Large specimens may be disarticulated and introduced to the bugs. After the ammonia treatment, skeletal specimens, the larger ones in particular, may require further degreasing.

For degreasing we use inhibited trichlorethylene (metal degreasing grade). We have a highly functional Detrex vapor degreaser (designed for commercial metal degreasing), but its initial cost and operation are costly, and it is only used for large sizes and quantities of specimens that need to be degreased.

It is more economic for small batches of skeletal material to soak passively in trichlorethylene. Oily fish are degreased exclusively by this method to avoid separating delicate articulations. Skeletons are individually wrapped in cheesecloth and submerged in trichlorethylene for about a week. The trichlorethylene is kept in stone crocks or glass containers having tight-fitting covers. Metal containers are unsuitable. These containers must be kept in a well-ventilated area because trichlorethylene is volatile and highly toxic.

Bleaching is generally undesirable except for display material. If



Skulls of dolphins in ventral view. Results of various stages of preparation are illustrated in views of lower dentition. Top, roughed-out and dried specimen; middle, specimen prepared with the formalin inhibition technique to keep dentition intact; bottom, specimen prepared without formalin treatment.

bleaching is desired, a four percent hydrogen peroxide solution is prepared. The skeletal material attaining the desired whiteness is taken from the solution and thoroughly rinsed in cold running water to remove all residue of the peroxide.

FORMALIN INHIBITION TECHNIQUE

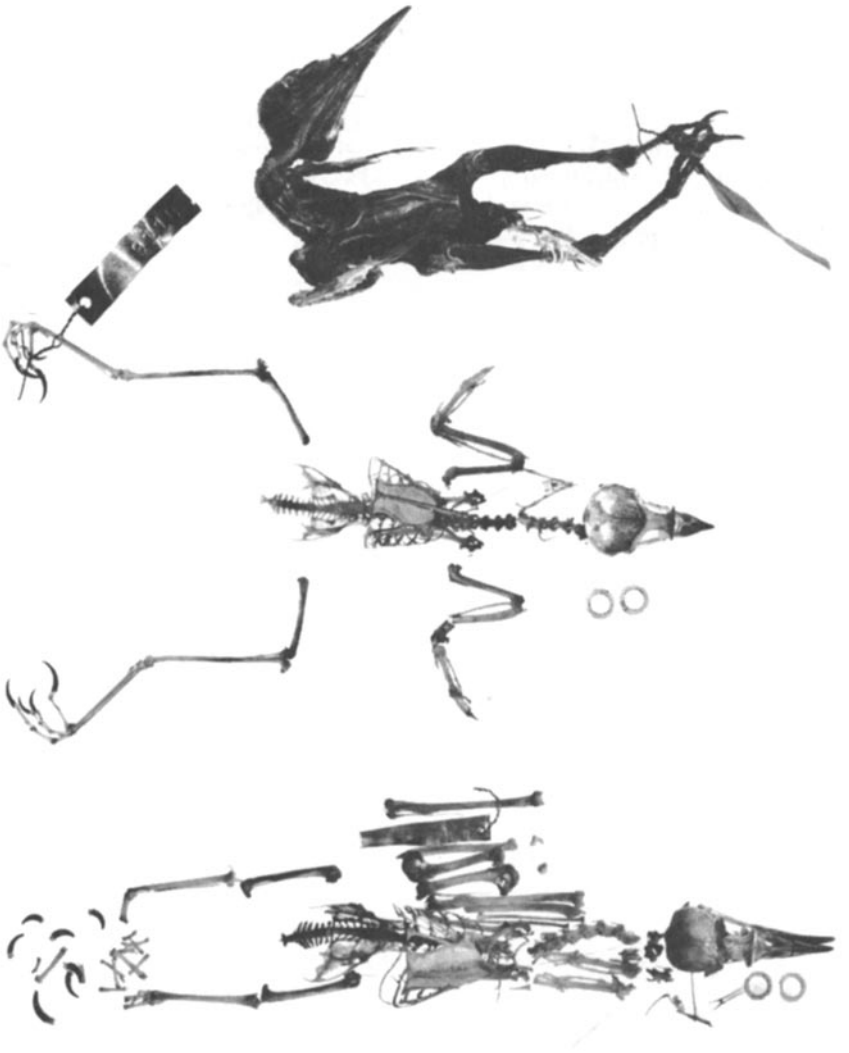
Prior to the drying process, the preparator decides whether certain areas of the specimen need to be kept articulated. For example, the dentition of a dolphin is better kept in place than replaced after teeth have fallen out. In preparing a dolphin skull, the palate and lips are removed by cutting as close to the teeth as possible. This palate material is easily removed in its fresh state; however, once dry it will become almost impossible to remove later without loosening the teeth. A strong formalin solution (one part water to one part formalin) is carefully applied with a fine brush to the area immediately bordering each tooth. Three to four applications are necessary to fix the teeth in place. This procedure ensures that the teeth will remain in their proper position and sequence. In contrast, the maceration process would make this result totally impossible. The formalin procedure lends itself to a host of other delicate preparations, but each preparation is an individual case involving judgment.

In the skeletal preparation of birds, where it is desirable to keep the foot bones and claws articulated, the skin is removed from the feet of larger specimens. In the case of smaller birds, this step is unnecessary. In either case, the feet are dipped into the formalin solution. The solution should be allowed to dry on all specimens before they are given to the bugs. The formalin application will keep the parts so treated unmolested by the bugs, and the joints will maintain their articulation throughout the process.

It is important to realize that formalin should be used only in carefully selected areas and not indiscriminately applied. Care should be taken not to touch other parts of the skull or skeleton with the solution because of the reluctance of the bugs to work in treated areas. Keeping the soft parts of the palate in bats complete for taxonomic studies is one area where success has been limited. More experimentation in this field is required.

SUMMARY

The preparation of skeletal material by the use of dermestid beetles is an efficient, economically advantageous method of preparation, especially suitable for small and delicate vertebrates. The cotton bed technique is useful in keeping frass from accumulating on the speci-



Particular methods of preparation of bird skeletons result in: top, roughed-out and dried specimen; middle, specimen prepared with the formalin inhibition technique for feet and wings; bottom, specimen prepared without the formalin treatment.

mens, and we have had great success over several years treating several dozen specimens with the formalin inhibition technique, which is especially recommended for dolphin skulls, bird feet, and certain other delicate preparations needed for taxonomic studies or for exhibition.

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