NATIONAL PARK SERVICE

Conserve O Gram

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Vertebrate Skeletons: Preparation and Storage

Introduction

Vertebrate skeletons or parts of skeletons are often included in museum collections. Your park may acquire them for many reasons, some of which include specimens:

- recovered during a research project
- used as general reference samples
- that document the occurrence of a species at a given place and time
- for exhibit and other interpretative uses

Examples of vertebrate skeleton collections include:

- a skull or skeleton which is part of the whole animal (as in the case of mammal skins and their associated parts)
- isolated pieces such shed deer antlers
- incidental collections obtained as part of a larger project such as:
  - moose bones recovered from a wolf den
  - rodent and shrew bones picked out of an owl pellet or carnivore scats

Commonly, researchers collect only the skull and jaw—the most easily identifiable parts of the skeleton. Museum collections can include other post-cranial bones (all of the other bones in the body behind the skull) too.

Because they do not decompose as rapidly as other body parts bones are often the only tangible documentation of a species.

Note: This *Conserve O Gram* specifically applies to bone. Don't use it for ivory.

Bone: Some Background

Bone is composed of two parts:

1. **Organic:** a collagen and protein matrix
2. **Mineral:** a hydroxyapatite (a calcium phosphate) mineral which forms a hard outer covering over the collagen and protein matrix

Combined together, these two elements form a composite material that gives bones the desired combination of strength with flexibility. Bones are strong but deterioration can occur if either of these components is removed.

Like all other organic material, bone will eventually break down, under the right circumstances in nature or the wrong circumstances in your collection. For instance:

- Acids will attack the mineral component of

bones, leaving only the collagen.

- Acids damage the collagen and proteins too.

- Collagen also deteriorates when exposed to:
  - ultraviolet light
  - heat and temperature fluctuations

  These environmental factors work to break down collagen, making the bone more brittle and fragile.

Pest Issues to Consider

Museum pests LOVE feasting on improperly prepared skeleton and bones collections. To discourage such unwanted attention, be sure that all bone specimens have been properly cleaned **before t**hey're added to the rest of the collection. Pests are primarily attracted to fat or grease in the bone and/or in any attached skin, meat, or tissue.

Bones of freshly killed animals will still have fat or grease in the marrow cavity that will need to be removed. The amount of fat varies depending the on the type of animal and the time of year that it died. A bear that dies in the spring after hibernation will not have as much fat as a bear in the late fall that is ready to hibernate. Marine mammals are notorious for having a lot of fat in their bones that can migrate to the surface for years after they were first cleaned.

Bones that have been lying on the ground and exposed to the weather for any length of time probably will have lost most of their fat/grease content. You won't need to remove any fat/grease—Nature does a great job of this. However, you'll still need to remove any attached pieces of dried skin, meat, ligaments or similar tissues.

Removing Fresh or Dried Tissues

Completely clean off all dried tissue that might attract pests before you place any skeletal material in the collection. You may only need to remove a few pieces of dried tissue. Or, you might have to remove all of the meat and tissue from a fresh specimen.

There are many techniques for cleaning skeletons, in addition to those cited in this *Conserve O Gram* (see References, below). If your collection includes skeletal materials, you should have some general familiarity with these techniques. Also, you need to ensure that there is a record of the preparation method, particularly if any chemicals were used. Include this information in the specimen's ANCS+ catalog record. If the specimen was prepared by someone outside the park, be sure to acquire all preparation data as well as the specimens from them.

Before accessioning any skulls or other bones found in the field, be sure to carefully examine them for dried tissue. Remove and dispose of all tissues before cataloging and placing the skull and bones in the collection. There are a number of ways to remove remaining tissue:

- Sometimes you can remove dried tissue by hand.

- Other times you'll have to soak the specimens in water or an ammonia solution.

- Simmer the specimen in a pot of warm water to facilitate removal.

- Simmer the specimen in a pot or treated with enzymes or chemicals such as sodium perborate or sodium hydroxide.

- Use the larvae of the dermestid beetle (Dermestes spp.) to remove dried tissue from a skeleton (see below).

Using Beetle Larvae to Remove Tissue

Dermestid beetle larvae are a common pest in museum collections. They feed on a wide variety of material— particularly bird and mammal skins, as well as textiles and leather. You can, however, use these pests to your advantage. They gladly assist you by "cleaning" your specimens of any remaining dried tissue. Mammal skulls associated with skins are often prepared this way but this technique is also used to clean whole skeletons of smaller animals.

You'll have to be very careful if you use this technique—you don't want to accidentally introduce any of these pests into the collection. Follow these steps:

1. You will need a closed container that will prevent the dermestids from escaping but that allows air flow. It should be kept in a warm dark area, away from the collections. The bottom of the container should contain cotton or corrugated cardboard to provide a place for the dermestids to pupate.

2. All specimens should be skinned, excess tissue and organs removed and then dried.

3. The dried specimen is placed in a tray or other similar holder in side the container, along with an identification tag with its field number.

4. Small specimens like mice should be checked daily in an active colony, larger specimens can be checked less frequently.

5. When the skeleton is clean and before the bones become separated they should be removed from the bug colony.

6. Once the larvae have completed their work and the specimen is clean, you'll need to kill any remaining larvae. Your options are to place the infested skeletal material in a:

    - sub-zero freezer at minus 18º to 20º C for 72 hours.

    - confined area with a heat source. (Use 2 x 150 watt bulbs or heat lamp to kill dermestids without damaging the specimen.) This is preferable since the dermestid will leave the skeleton to find a cooler spot. They won't die inside the specimen. Place an insect trap near the killing box as a precaution to capture any dermestids that might escape.

    - sealed bag with oxygen scavengers.

    See *Conserve O Grams* 3/6, 3/7, 3/8, and 3/9 for additional information regarding insect pest control.

Larvae can hide in the braincase, the neural canal of articulated skeletons or any small cavity in a bone. Be sure to follow Step 4 above to kill all remaining larvae. If you don't, the larvae can establish a colony in the specimen cabinet.

Degreasing Bones

Bones contain fat—particularly in the long bones, where it is known as marrow. You can remove this fat or grease using a number of solvents. The best technique for your project depends on two factors:

1. Availability of space.

2. The type of solvent selected. Some are toxic and will require special disposal as hazardous waste. Others may be flammable.

The easiest way to remove bone grease is to soak the bones in ammonia. You can use regular household ammonia, and there are two options:

Option 1: Soaking in Ammonia

This is the slower technique of the two. Follow these steps:

1. Soak the bones in an ammonia/water mixture (equal parts water and ammonia).

2. As the solution becomes discolored, change it on a regular basis. **Note:** Check with your park's hazardous waste coordinator concerning proper disposal methods.

3. If there is any tissue left on the bones there also may be some maceration resulting in an unpleasant smell.

4. Occasionally, you should let the bones dry slowly for a few days. Then examine the surface to see if they have a greasy appearance.

5. If the bones appear greasy, place them back in the ammonia solution (Follow Steps 1-4) and repeat the process.

Option 2: Cooking Bones in Ammonia

This technique is faster. Downsides: it's more labor-intensive, there are the risks of burning the specimen or starting a fire, and sometimes it can cause unpleasant odors. If you choose this option, be extremely careful and always monitor the cooking solution. Follow these steps:

1. Simmer the bones at a low heat **(DO NOT BOIL THEM)** in an ammonia solution (50% ammonia, 50% water) on a stove, hot plate or other heat source.

2. Remove the fat as it collects on the surface.

3. Periodically, you'll need to change the solution on a regular basis. Once again, check with your park's hazardous waste coordinator concerning proper disposal methods.

4. As noted in Option 1, above, you may need to allow the bones to dry for a couple of days to see if all of the fat has been removed.

5. Examine the bones. If they appear greasy, place them back in the ammonia solution

(Follow Steps 1-4) and repeat the process.

6. Once the bones are degreased, rinse them off in clean, WARM, water. (Rinsing in cold water can cause teeth to crack.)

IMPORTANT SAFETY NOTE: With Option 2, you must monitor the cooking bones closely. Periodically check the water level. You don't want it to go down too far and burn the specimen or start a fire.

Other Solvents for Degreasing

In the past, carbon tetrachloride and white gas (camping stove fuel) were used as degreasers. These are no longer popular options, as:

- Carbon tetrachloride is toxic and is difficult to obtain.
- Both must be disposed of as hazardous waste.
- White gas is flammable. If you use it, you'll need an approved fireproof cabinet to store it in.

Other options for you to consider are detergents:

- **Degreasing Detergents.** Some of the newer household detergents designed to remove grease work quite well to remove fat from bones.
- **Enzyme detergents.** These work well for degreasing the skeletons of birds and mammals. They don't perform as well with fish and have resulted in the destruction of fish bones.

For additional information concerning the use of detergents for degreasing specimens, refer to the References, below.

To Expedite Degreasing of Large Bones: Drill one or two small holes on opposite ends of the shaft of large bones before soaking them in any of the solvents noted above. This will allow the solvent to penetrate the bones' interiors resulting in a more rapid removal of fat. The hole should not be large, no more than 1/8". Don't drill it in a location that will damage any of the specimen's distinctive features. You can drill two holes, one at each end of the shaft.

To degrease a particularly greasy specimen, such as a marine mammal, you may have to bury it. Bury the specimen in clean sand that will allow complete drainage. (If you bury the specimen in clay or poorly drained soil, standing water can collect around the specimen and cause deterioration.) To ensure that no parts are lost during the process, you can place the specimen in a mesh wire basket prior to burial.

Note: It's very easy to lose track of buried specimens. Make sure you note and document the exact location in the files. (You can use a GPS unit, if necessary.)

Storage of Specimens

Store cleaned skeletons or skulls in either boxes or trays. As with other collections, use closed-cell polyethylene foam to cavity-pack and pad specimens. Additional storage techniques include:

- For larger specimens, you may need to construct foam-lined cradles.
- To facilitate research access, you may find it helpful to store the bones from the same hand/foot together in a box or container separate from the other bones, and give it the same catalog number.
- Some museums place all vertebrae together on a

string in their proper order.

- Store skulls and their associated jaws together as an articulated specimen. Place polyethylene foam between the teeth to prevent chipping.

- You can store large skulls such as bison or elk on open shelves.

- Another option for large skull storage: "wall mount" the skull. Attach a length of padded or coated wire through the foramina at the back of the skull. Bend the wire ends together to form a closed loop, and then place the wire over a wall hook.

Bones are fairly durable but they are vulnerable to physical damage. Handle all bones with care, especially teeth.

Labeling Specimens

If a complete skeleton is prepared all bones should be labeled with the same catalog number using black India ink. Given the number of bones present in a skeleton this can be time consuming but if a skeleton is actively used this may be critical in order to ensure that all bones of the same animal stay together. The catalog number can be written directly on the bone but should not obscure any anatomical details.

If the bone is still greasy the ink will not adhere to the bone and more degreasing may be necessary.

Some collections will label the individual bones on larger animals as to side and position such as the individual bones of the fingers of the hand or foot, for example, the left second metacarpal may be labeled L MC 2 (or II) with all of the individual phalanges (finger bones) given an anatomical position identifier which is alphanumeric in sequential order or the right fifth metatarsal as R MT 5 (or V).

Make sure that the person doing the labeling knows how to identify the bones correctly and that bones from either side or the hands and feet have not become mixed during cleaning.

For additional information concerning labeling natural history collection, see *COG* 11/6 "Labeling Natural History Specimens."

Some Final Notes

1. As with all museum specimens, be sure that all skeletal material going into the collection is accompanied by its associated data. Associated data (such as field notes, journals, maps, drawings, photographs, videotapes, sound recordings, reports, etc.) is just as important (sometimes even more so) than the specimens themselves.

2. **NEVER use bleach (sodium hypochlorite) to clean a skeleton.** It is not necessary to bleach a skeleton if it has been properly cleaned and degreased. Bleach, (sodium hypochloride) will whiten bones initially but the chemical reaction won't stop. This chemical reaction will break down the collagen; eventually the bones will turn to powder.

3. In the rare event that you need to whiten a bone (such as for an exhibit), you can use one of the following techniques:

    - Spray the specimen with a dilute (1%-3%) solution of hydrogen peroxide under a heat lamp.

- Soak the specimen in the dilute hydrogen peroxide solution for short periods until the desired lightness is obtained.

Note: Researchers may find it difficult to observe key anatomical details in an overly whitened bone. This decreases its usefulness for research, so be careful whenever whitening bone specimens.

4. Bone and ivory are similar in chemical composition but have a different physical structure. **Do not use this Conserve O Gram for ivory.** Ivory is dentine–the part of the tooth that is often covered by enamel. The two most common types of ivory are from elephants and walruses. Ivory is:

    - often deposited in layers
    - is hygroscopic (sensitive to changes in humidity)
        - ivory absorbs and releases moisture
        - this causes ivory to swell and shrink, which can cause separation of layers

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