

Care of Shells, Eggs, Bones and Related Material



(Clockwise from top left): Small avian eggs in storage at Nantgarw (image by J. Carter); mounted primate skeletal specimens at the National Museum of Wales (image by A. O'Neill); historical Mollusca collection at the National Museum of Wales (image by A. O'Neill).

1. Introduction to Shells, Eggs and Bones

Shells, eggs, bones and other related materials, such as ivory, horn, teeth and antler, are often found in museum collections. They may be unaltered, as in natural history museums, or part of composite objects (for example, mother-of-pearl is often inlaid into wood). These are all primarily formed from calcium compounds bound with protein. Shells, eggs and bones are susceptible to both mechanical and chemical damage. While this may often be permanent, it can often be mitigated by taking simple steps in controlling the environment.

2. Collection Issues

2.1 Pests

Calcareous materials are not typically susceptible to pests, but rodents and other small mammals may gnaw on them. Good housekeeping and integrated pest management systems in display and storage areas will minimize infestations.

2.2 Relative Humidity and Temperature

I. Mould

Relative humidity in excess of 60% can cause the growth of mould on the surface of bone and skeletal material. Ensuring that air can circulate around objects will lower the risk of a mould infestation. Some mould spores are toxic to humans and can pose severe health and safety concerns.

II. Warping and Cracking

Maintaining stable RH and temperature is important for protecting collections. Very low humidity or high temperatures can cause cracking and delamination (the flaking away of the surface in thin layers) in shell, egg, and skeletal material. Fluctuations in RH can cause objects to swell and contract, resulting in splits and cracks. Bone and ivory are especially hygroscopic (water-absorbing) and so must be kept in stable environments so that they do not become cracked and warped.

2.3 Handling

Shells, eggs and bone are very fragile, and careless handling can lead to irreversible breakage. Oils and sweat from hands will chemically react with specimens.

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Byne's Disease



These shells exhibit the cloudy surface that is indicative of the first stages of Bynesian Decay. Image by A. O'Neill, National Museum of Wales.

What is Bynesian Decay?

Acidic vapours released from wood and paper materials can attack shells and eggs, causing them to develop a chalky or powdery efflorescence called "**Bynesian Decay**" (commonly known as "**Byne's disease**"). Acids interact with the calcium carbonate within shells, eggs and some rocks or fossils to form calcium acetate or calcium formate crystals on the specimen's surface. Affected specimens initially show white streaks or patches on the surface, which progress into a mouldy-looking growth. Because the crystals grow from and through the specimen, Bynesian decay leaves objects weakened and fragile. An indicator of Bynesian decay is the smell of vinegar, caused by acetic acid.

Treatment of objects affected by Bynesian Decay

Immediately remove an affected specimen from its damaging storage environment. Under running water, gently brush away crystals from the surface then allow the specimen to dry.

DO NOT USE alcohol, antiseptics, boiling, freezing, or microwaving to attempt to remove Bynesian Decay.

Preventing Bynesian Decay

Store shells in conservation-grade containers, which are acid- and lignin-free. If this is not possible, sorbent paper liners, such as carbon or KOH-impregnated paper, in the drawers and shelves of wooden cabinets can help reduce acetic acid attack. Avoid using non-archival quality materials as these can release harmful acidic vapours.

2.4 Dust

Dust attracts moisture, which can lead to problems with pests, mould, and the water damage described above. In the presence of high RH, undisturbed dust can form solid concretions, which are difficult to remove, especially from fragile specimens or labels. Improperly cleaned bones or oily samples are especially prone to collecting dust.

2.5 Light

Damage caused by light is cumulative and irreversible, and can result in the discolouration of artefacts--ivory is vulnerable to bleaching and any dyed objects are especially sensitive. A side effect of illuminating artefacts, especially in closed cases, is that the radiant heat from the bulbs can cause high temperatures and rapid fluctuations in relative humidity.

2.6 Yellowing and Discolouration

Inherent reactions within specimens can cause them to become yellow, darkened, or bleached over time. This is normal and irreversible, though it can be alarming. Oils and fats on the surface of objects can also turn yellow with age, although this can be reversed to an extent by careful cleaning.

3.2 Location

Objects made from shell, eggs, bone and related materials should be stored in a dark stable environment, free from dust and air pollution. Avoid storing objects near radiators and heating pipes, incandescent lighting and windows as these cause fluctuations in temperature and humidity. Tightly sealed storage drawers or cupboards are ideal to prevent light and dust reaching objects, but still allow easy access to the collection when required. Stores should only be lit when people are working in the area.

3.3 Light

Artificial light should always be used in display cases, as high UV levels in daylight causes discolouration. Light levels should not exceed 200 lux reading on a light meter, or 75 micro-watts per lumen (level of UV). For dyed or coloured objects, a maximum of 50 lux is needed to prevent or reduce fading to colours. Ensure lighting has no effect on internal temperature, as very high temperatures can be reached in sealed cases in a relatively short time. Energy-efficient bulbs are safer for display purposes as they produce minimal amounts of excess heat.

Consider the length of display time in terms of each individual object. For particularly fragile materials, contact a conservator.

3. Storage & Display

3.1 Relative Humidity and Temperature

All collections should ideally be stored in environmentally controlled conditions. **RH between 45% and 55%** is ideal for these materials, with **temperature between 16 and 22 degrees Celsius**.

However, if these conditions cannot be met realistically, both temperature and relative humidity should be kept as stable as possible to prevent delaminating and cracking in very dry environments. Simple measures such as resealing windows and doors and installing stand-alone dehumidifiers help retain stability.

Table.1 Key RH Ranges for Shells, Eggs and Bones

RH	Effect	Materials at risk
<40%	Cracking, shrinking, warping	Bone, ivory, horn, teeth
45-55%	Ideal environment	
>60%	Moisture absorption, warping	Bone, ivory, horn, teeth
65-70%	Mould growth	Organic materials

Mounted Skeletal Specimens



Mounted bird specimens at the National Museum of Wales. Image by A. O'Neill

Many collections may contain historical curiosities such as mounted skeletons. These intricately articulated objects are very delicate—small bones may only be attached by fine tendons or tissue. Larger skeletons, with heavier bones, require structural support.

Issues

The porosity of bone and related materials means they are readily stained by corrosion products and non-fast dyes. Staining can result from other materials used within an articulated mount, such as iron, copper-alloys and coloured materials.

Some small bones may be attached by tendons or tissue, which can become dry and brittle with age. Take care when handling and transporting specimens, and keep all disassociated bones in a small bag with the skeleton until they can be reattached.

Handling

Never lift an articulated specimen by its bones; always lift it by the base or mount. Use both hands, providing even support and making sure that the skeleton is balanced. If a mount is large or awkward, lifting it may require two or more people. Be careful not to jolt the specimen, as this may cause bones to fall off.

Display & Storage

Mounted bone should always be displayed in showcases to protect against dust and buffer environmental conditions.

Metal pins within an articulated specimen should be isolated from direct contact with bone and related materials. Plastic sleeving can be used, or non-metal material, such as Perspex.

Follow the environmental guidelines for temperature and relative humidity as described for shells, eggs and bones.

Conservation

Mounted skeletal specimens in good physical condition may only need dusting with a soft brush. If this is not sufficient to remove dust and grime, ask a conservator for further treatment.

Repairing articulated skeletons is a specialist's job, requiring fine motor skills and an extensive knowledge of anatomy. Contact a taxidermist or biologist for repairs.

3.4 Support

I. Storage

Objects should be individually stored to prevent abrasion as shells, eggs and bones are usually brittle and easily damaged. Drawers can be divided into compartments using strips of acid-free cardstock or foam. Inert foam can be used to line drawers to provide cushioning, and additional support at the base of the object depending on its shape can be given by acid-free tissue or undyed cotton wool. Always open drawers carefully to avoid jarring the objects.

II. Display

When on display, avoid all contact between objects. Artefacts can be stained from contact, and abrasion damage can occur. Objects should be supported by mounts made from Perspex, inert foam or acid-free tissue. Avoid resting objects on sharp edges (whether this is a mount or the object itself!).

III. Materials

Avoid using rubber-based materials, as these emit sulphur which induces discolouration in ivory. If not using drawers, acid-free tissue or cotton wool nests in clear polystyrene lidded boxes provide adequate support and buffer against external RH and temperature changes. Clear lidded boxes reduce handling and dust.

Perspex mounts are recommended for display, as metal pins and mounts must be isolated from the object to prevent contact, and may alter environmental conditions. Metals can also form corrosion products with dry zoological specimens and these products will permanently stain the objects surface. Perspex and plastic can be shaped for individual objects. Foam or acid-free tissue may also be used to make mounts.

Avoid using wooden storage and display cases, as these can release acidic vapours which can cause Byne's disease and other corrosive action on shells, eggs and bones. Sorbent paper liners can mitigate this if wooden shelves must be used.

3.5 Handling

Always wear disposable nitrile gloves when handling objects made of shell, egg or bone materials. This not only prevents transfer of natural fats and oils that may permanently damage the object, but also provides a barrier for you from any harmful substances that have been used on the object in past conservation and may remain. Zoological collections are often stored together and other artefacts, such as taxidermy, may have been treated with toxic arsenic or heavy-metal pesticides. Please seek advice from a curator or conservator if there is any cause for concern regarding the use of pesticides in your collection.

When transporting artefacts, always ensure that they are properly supported. Use a hand basket lined with foam and tissue for small objects, and a cart for larger ones. Always pick objects up from the bottom with both hands, never from the edges. Multi-part and fragile specimens, such as mounted skeletons, should be handled in their upright positions; ensure that joints and weak areas are supported adequately. Always ask for help if you need it.

Do not...

...Use abrasive materials (such as abrasive powders or pastes, stiff brushes, or steel wool) to clean shells, eggs and bones

...Store shells, eggs, bones and related materials in containers that release acidic vapours—only use conservation-grade containers and cushions

...Be afraid to ask for help!

4. Conservation

Even in the best museum environments, materials can become dirty, broken or damaged. Should shells, eggs, bones and related materials need treatment, it is always best to consult a conservator. However, there are some simple steps that can be taken to improve object conditions within the museum.

4.1 Cleaning

Dusty shells, eggs and bones may be cleaned with a soft brush or cloth and a variable-speed vacuum. Vulcanized rubber sponges or vinyl erasers may be used to remove heavier surface soiling, though care must be taken around any fragile areas or decorations.

Ivory and non-porous bone or shell can be cleaned sparingly with water and a mild soap [**example of brand of soap**]. Apply the soapy solution to the surface with a cotton swab, cleaning only a few centimetres at a time and drying immediately with a clean swab or soft tissue. Afterwards, repeat the process using only clean water to remove any soapy residues. **Never soak shells, eggs, bones or any related materials such as horn, antler or ivory!**

Greasy stains may be carefully removed using saliva and a cotton swab, as the enzymes in saliva effectively break down grease (Romão et al 1990). Rinse your mouth with water and lightly moisten the swab. Dispose of swab after one cleaning motion; never attempt to remoisten a used swab.

4.2 Mould

While mould is not a concern for most examples of shells, eggs, bones and related materials, improperly cleaned artefacts, composite artefacts and dirty artefacts can become infested. Mould can often be confused with Byne's disease, but can be distinguished under a microscope—Byne's disease is clearly crystalline.

Mould spores can be harmful to humans; always wear a mask and nitrile gloves when handling mouldy objects. Very carefully touch the mould with a paintbrush: if the mould is dry and powdery, it is dead and can be brushed away into a museum vacuum equipped with a HEPA filter. If the mould smears, it is still alive and can spread. If so, seal the object in a plastic bag and call a conservator for treatment. Check the case and any surrounding materials for signs of an infestation.

4.3 Repair

If a specimen breaks, collect all of the fragments and store them together until a conservator can be contacted.

Consult a conservator for the repair of shells, eggs and bones. Store-bought adhesives and coatings can discolour and embrittle over time and often do more harm than good.

5. Health & Safety

5.1 Safe Handling

When moving an object, ensure correct lifting procedure and posture is used. Only move one object or specimen at a time, and handle all objects with two hands. Do not attempt to move large or heavy objects by yourself, as this will cause unnecessary strain and pressure on the object, and increase the risk of damage.

Particularly old specimens of shell, egg or ivory will be extremely fragile and delicate. Always remove these objects from storage very slowly and carefully.

5.2 Cleaning

If cleaning or dusting an object, always wear gloves and suitable personal protective equipment. This may include a dusk mask and use of a fume cupboard. Use museum-grade vacuums (eg., Museum-Vac brand) equipped with HEPA filters.

5.3 Mould

Some mould spores are toxic to humans and can pose severe health and safety concerns. Isolate the affected objects and seal them in plastic bags, then consult a conservator or specialist.

Ivory and Rhinoceros Horn

The sale and trade of ivory, rhinoceros horn, tortoiseshell and other endangered species is controlled under the United Nations Convention on International Trade in Endangered Species of Wild Flora and Fauna. Please ensure that all items of this type acquired after 1947 have proper documentation proving their legal status and ownership.

Due to their rarity and desirability, rhinoceros horns are currently worth more than gold. If your collection contains ivory or horn artifacts, keep them secured in a locked safe as they can be targets for theft.



Illegal horn and ivory seized from smugglers. Image by Reuters.

6. Further Advice

A variety of issues can arise in collections of shells, eggs and bone related materials. This is particularly true when the piece is made of a variety of different materials. If you are unsure about something, please contact your on-site or local conservator. If this is not possible, please contact regional and county museum conservators or larger institutions for advice.

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