NATIONAL PARK SERVICE

Conserve O Gram

August 2008 Number 11/15

Byne's "Disease:" How To Recognize, Handle And Store Affected Shells and Related Collections

Many problems encountered in museum collections are caused by poor storage conditions. Over time, on exhibit or in storage, a specimen reacts with its environment. Several environmental factors contribute to the degradation of sensitive materials. This includes the irreversible breakdown of modern shells known as Byne's "disease." Here the reactive destruction of its surface irreparably damages the shell. This condition is easy to control or stop with the right environmental conditions. It is impossible to reverse.

Byne's "disease" is not a disease. Rather, it is a chemical and physical breakdown that may look like mold growth. It is an efflorescence or breakout of salts. (Fig. 1).

Figure 1. Normal shell on left, shell with Byne's "disease" on right. (Paul Callomon, Department of Malacology, Academy of Natural Sciences)

Why Is It Called a "Disease?"

Loftus St. George Byne, a British amateur naturalist first described this condition in modern shell collections. He incorrectly assumed the condition was the result of "a bacillus," or bacteria. However, research subsequently revealed that bacteria were never involved and that the condition was due to chemical reactions. But by then the term Byne's "disease" was entrenched, and is still in use.

Byne's "disease" can occur in any natural history specimen composed of, or including calcium carbonate. This includes mollusk and gastropod shells, bird eggshells, and limestone-based rocks and fossils.

What Causes Byne's "Disease?"

Byne's "disease" occurs when calcium carbonate ($CaCO_3$, the substance which makes up freshwater and marine shells, birds' eggs, and other such specimens commonly encountered in natural history collections) reacts with an acidic vapor to form salts . In museum collections, this reaction generally occurs when acidic vapors dissolved in atmospheric water, commonly acetic acid and formic acid from wood and wood products used in storage, come into direct contact with the specimens. This reaction is accelerated by high relative humidity, since that provides more atmospheric water for the

creation of acidic vapors. The salts (calcium acetate and calcium formate) crystallize on and through the specimen's outer surface, destroying it in the process and leaving subsurface areas vulnerable for further reaction. This damage is irreversible, and, if the process is not stopped, will eventually destroy the specimen.

Table 1. Acidic storage products used in museum collections that can contribute to Byne's "disease."

Materials used in case construction	**Materials used inside cases**
Hardwoods (particularly oak)	Cardboard
Softwoods	Chipboard
Masonite	Cotton
Plywood	Cork
Fiberboard	PVC plastics
	Paper

There are non-acidic, archivally stable versions of many of these materials that should be used.

How to Recognize a Specimen With Byne's "Disease"

A specimen with a calcium carbonate structure that is affected with Byne's "disease" initially shows some white, rough, chalky or fuzzy-looking patches, spots or streaks on its surface. These are easier to detect in smooth, glossy specimens than in naturally pale-colored and rough-textured specimens.

As the condition progresses, the reaction causes salt crystals to build up on the surface. These may look to the unaided eye like a mold or fungus growth. Under a microscope, it is apparent that these are mineral structures, not biological ones.

A sour or vinegary smell in the storage cabinet is another indication of Byne's "disease" (acetic acid, the basis of vinegar, is one of the acidic vapors commonly released as wood cellulose breaks down).

Other factors may cause a whitish film or streaky appearance on calcium carbonate materials, including the chemistry of the environment of the specimen in life and/or its burial environment. .

When in doubt of the nature of a white patch or growth on a calcium carbonate structure, contact a conservator.

Health and Safety Warning:
Calcium acetate and calcium formate, along with any other salts that may form, are not the same as common table salt (sodium chloride). **NEVER** taste these salts, even though you may see this recommended in older literature.

What Can You Do For An Affected Specimen?

Immediately remove a specimen with Byne's from its damaging storage environment. The salt crystals are water-soluble and may be removed with a soak or gentle brushing under running water. Other than that, there is no direct interventive treatment. Any water-based treatment should be very gentle, as even undamaged shells may be damaged by running water or prolonged soaking.

Never use alcohol or other antiseptics, and boiling, freezing or microwaving, all of which have been suggested in various publications.

After cleaning, move the affected specimen to a better storage environment, or the process will start again.

Store the specimen in a non-acidic storage system, i.e., metal cases with metal drawers, preferably steel. Avoid wood cases and drawers, and acidic cardboard boxes and trays made from wood unless they have been treated to remove the acids. Acid-free or alkaline-buffered products are usually marketed as "archival."

If there is no other storage system, isolate the specimens from the acidic environment by using micro-environmental enclosures, such as polyethylene bags, glass jars or vials, or heat-sealed Mylar envelopes. Never return an affected specimen to its original, unimproved storage environment.

Dehumidify the storage room or case with desiccants such as conditioned silica gel; or dehumidify the room within the building's HVAC systems.

Always document the specimen's problem and all treatments. Include a detailed condition report with photographs with the date, specimen name, catalog number, description of the problem, and a detailed description of the steps taken to mitigate the problem. Take before and after treatment photographs.

Table 2. Storage Solutions for Byne's "Disease"

Do	Don't
Store specimens in non-reactive metal cases (steel is preferred) with non-acidic boxes or trays	Store specimens in wooden cases or in acidic cardboard boxes or trays
Keep relative humidity in storage stable at around 50% or lower for unaffected specimens	Allow relative humidity in storage to reach 70% or above, or to fluctuate erratically
Remove affected specimens for cleaning and documentation	Allow affected specimens to stay in their original, unimproved storage environment
Store cleaned specimens in improved storage conditions, or at least in micro-environmental enclosures	Return cleaned specimens to their original, unimproved storage environment
Keep specimens clean, dry and stable	Coat specimens with any sort of oil, wax, consolidant or volatile solvent
Monitor pH and RH in storage, and take measures to mitigate acidity and relative humidity problems as they arise	Assume that pH and RH will always stay at acceptable levels, and stop monitoring
Note the problem in the permanent specimen records	Ignore the problem and fail to document it

How Can This Condition Be Prevented?

- Check all storage systems for pH levels before use with pH-indicator pens and strips.
- Keep temperature and relative humidity low and stable. Install a datalogger (preferred), or a hygrothermograph or thermohygrometer with readings recorded and analyzed weekly.
  Keep the storage system internal and external temperatures stable and as close as possible to levels recommended in the NPS *Museum Handbook.* Extreme highs and lows, as well as fluctuations, can be very damaging. The Byne's reaction is driven by relative humidity: the higher the RH, the faster the reaction goes. RH is in turn influenced by the ambient temperature.
- Store specimens in steel cases and use archival storage supplies.
- Do not store any calcium carbonate structures such as mollusk and gastropod shells, birds' eggshells, and similar specimens in wooden cases or drawers that are highly

acidic.

- Do not use high-acid, non-archival papers, foams and cardboards.
- Avoid cotton, cork, and plastics.
- Generate labels and tags on acid-free paper. Encapsulate older labels in Mylar and archive them separately. Do not laminate labels or any other museum documents. .
- Use storage or/and exhibit cases that have a low but steady air exchange at the rate of one change per day.
- Construct specialized cases for storage and display to hold specimens within a constant RH and temperature. Include filters to absorb outside pollutants.
- Do not coat or wax the specimen (even though this has been suggested in some publications as a preventative strategy.) The coating is a contaminant and will affect future studies of the specimen, and may in itself be acidic and reactive. It is always best is to control the storage or micro-environment without altering the specimen.
- Do ongoing monitoring of vulnerable specimens to prevent problems before they start. Analyze adverse monitoring results and take immediate action to correct.

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