= Byne 's disease =

Byne 's disease , more accurately known as Bynesian decay , is a peculiar and permanently damaging condition (resulting from an ongoing chemical reaction) which often attacks mollusk shells that are in storage or on display for long periods of time .

Bynesian decay is a form of efflorescence of salts formed by the reaction of acidic vapors with the basic shell surface . The efflorescence can sometimes superficially resemble a growth of mold . Although first described in the early 19th century , Bynesian decay was not well understood until almost a hundred years later . The condition is named after the man (L. Byne) who is best known for describing it in the late 19th century , even though he was not the first person to describe it in print . In addition , Byne mistakenly assumed that the condition was caused by bacteria , and thus the condition came to be referred to as a " disease " .

In addition to mollusk shells , various other natural history specimens are susceptible to this form of decay , including eggshells and some fossils and mineral samples that are composed of calcium carbonate . This condition is of concern for museum scientists , and also for anyone who has a private collection of specimens of these kinds . In order to avoid Bynesian decay , the use of metal , non @-@ reactive polymers and acid @-@ free materials of archival quality are preferred over common paper , wood @-@ based materials , ordinary glues and varnishes in collection environments . Management of affected specimens includes washing and thorough drying , with a subsequent realocation to an archival setting .

= = Appearance = =

Byne 's disease can appear as a powdery white coating on a shell . It also often looks as if a shell has been " infected " with mold ; however , under magnification the mold @-@ like appearance is revealed to be a crystalline growth of salts .

= = History = =

In 1839 , the British naturalist and malacologist Thomas Brown (1785 ? 1862) briefly mentioned this form of deterioration in his book A Conchologist 's Text @-@ Book . Agnes Kenyon also described the condition in 1896 , suggesting that " saline particles in the atmosphere [were] evidently exerting a corrosive effect " .

Origin of the name

In 1899 , the British amateur conchologist and naturalist Loftus St. George Byne (1872 ? 1947) described this condition , in a presentation to the Conchological Society of Great Britain in Ireland , and did so again in another presentation in June of that same year .

Byne was convinced that butyric acid was present together with calcium acetate in the affected shells , although he never really described the methods he used in the so @-@ called " extensive chemical tests " he claimed to have applied to these specimens . Among other conclusions , he assumed that the butyric acid originated from bacterial activity . He also concluded that the decaying effect ' travelled from shell to shell and drawer to drawer ' , and thus the condition came to be called a " disease " .

Clarification and resolution

The true nature of the " disease " was partially clarified in 1934 , when the British government chemist John Ralph Nicholls explained that oak cabinets at the Natural History Museum in London were giving off acetic acid fumes , which were attacking the shells stored in them .

In 1985 , almost 150 years after the Byne 's disease was first mentioned in the literature , Norman H. Tennent and Thomas Baird published an extensive study on the subject . Their deep analysis , involving many complex and sophisticated techniques such as X @-@ Ray diffraction , infrared spectroscopy , thermogravimetric analysis and nuclear magnetic resonance spectroscopy , finally revealed the true nature of the decaying process . They identified the substances involved (the calcium salts) , as well as the chemical reactions that originated them . They concluded that Byne 's

disease is not actually a disease , and is in fact caused by simple chemical reactions which occur in the presence of acidic vapors originating from the immediate environment in which the specimens are stored .

= = Chemistry = =

Bynesian decay usually starts when specimens are stored or displayed for considerable periods of time in an enclosed space . The storage method itself usually causes this problem , when containers , cabinets or display cases are entirely or partially made of wood , plywood or other wood products such as Masonite , or when the specimens are surrounded by , or in contact with , various other kinds of materials that are cellulose @-@ based and can turn water vapor acidic .

Other potentially damaging materials include non @-@ archival quality cardboard , card , paper , cotton and cork , all of which give off acidic vapors over time . PVC and polyurethane plastics are also a problem , as they degrade and give off acidic vapors with time . High humidity of the air is a significant contributing factor , as is lack of ventilation of the specimens . High ambient temperatures can increase the rapidity of the decay .

Generally , in cabinets or display cases that are entirely or partially made of wood , the hydrolysis of acetyl groups in the wood hemicelluloses creates acetic acid . The rate at which the acetic acid is produced is proportional to the concentration of esters in the wood , the humidity , the temperature , and the overall acidity of the environment . Acidic fumes can also be released from formaldehyde which can occur in wood as a degradation product of lignin . Acidic fumes can also be given off from ubiquitous formaldehyde resins (commonly urea @-@ formaldehyde resins) .

In the first case , acetic acid reacts with the calcium carbonate (one of the main components of freshwater , marine and land shells , birds ' eggs and other such specimens) producing calcium acetate , a salt . Formaldehyde can be oxidized by the oxygen in air to create formic acid , which then has basically the same effects as acetic acid , reacting with calcium carbonate to produce a salt . The salts (calcium acetate and calcium formate) crystallize through the specimen 's outer surface , destroying its fine detail and exposing more areas for further reaction . As the condition progresses , the salt crystals build up over the specimen 's surface , which becomes increasingly eroded .

The calcium carbonate and acetic acid chemical reaction occurs as follows :

$CaCO3 + 2CH3COOH ? Ca (CH3COO) 2 + H2O + CO2$

Calcium carbonate and formic acid chemical reaction occurs as follows :

$CaCO3 + 2CH2O2 ? Ca (HCOO) 2 + H2O + CO2$

Calcium carbonate and sulfuric acid chemical reaction occurs as follows :

$CaCO3 + H2SO4 ? CaSO4 + H2O + CO2$

In this last reaction , calcium carbonate reacts with sulfuric acid and produce calcium sulfate , water and carbon dioxide .

= = Prevention = =

When specimens are to be placed in any size of container for long @-@ term storage or display , the consistent use of only archival @-@ quality materials prevents the development of Byne 's disease . Thus , materials such as metal cabinets and display cases , archival quality paper labels and card trays are used in museum collections of specimens that might be vulnerable to this reaction .

It is also worth mentioning that sea shells , after collecting , need to be washed thoroughly in freshwater to remove the salt that is on and in the shell , and then dried thoroughly before they are stored . Salt attracts moisture and makes shells more vulnerable to Bynesian decay .

The following is a chart that shows non @-@ archival materials and their archival equivalents :

If possible , the use of wood and cellulose derivatives should be avoided entirely . Many varnishes and paints are well known emitters of volatile organic compounds (VOCs) , some of which may be acidic , and thus have the potential to damage calcium carbonate specimens . Because of this , these coatings should also be avoided ; water @-@ based varnishes and paints are considered less

harmful , and should be preferred .

Because the reactions involved in Bynesian decay require a certain quantity of moisture in the air in order for them to take place , keeping the air somewhat dry , i.e. keeping the environmental relative humidity under control is beneficial . This is achieved by careful monitoring of the relative humidity (using instruments such as a hygrometer) , and applying dehumidifiers when necessary ; sometimes , simple air conditioning systems may suffice . Extremely low humidity can damage some specimens , so caution is recommended . Usually , a relative humidity maintained around 50 % is considered to be adequate . Applying sorbents containing a strong base , such as potassium hydroxide , inside the storage environment to protect the specimens against degradation is also possible . Copy paper or KOH @-@ impregnated filter paper are some low cost examples of sorbents which can be used . These strong bases have a preference to react with acid , thus they compete successfully with the calcium carbonate specimens for any acidic vapors that may be present . The bases also help reduce the overall acid concentration inside the enclosed space .

= = Management = =

The damage to specimens is unfortunately not reversible ; however , the decay can be arrested by washing or soaking the specimens in water , followed by a very thorough drying . The specimens must then be placed in an environment that consists of only archival materials , in a completely archival setting .

= = Pyrite disease = =

In collections which contain fossils , high humidity can also affect pyrite (or its more reactive polymorph marcasite) (iron sulphide) fossils in a somewhat similar condition , which is known as pyrite disease . The iron sulfide can react with water and oxygen to form iron sulfates and sulfuric acid , which then can produce Bynesian decay .