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Author(s): Carter, J.

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or bamboo to suit your own needs and are less likely to do any damage.

Take great care when cleaning bones not to damage the surface or any delicate parts. Also be very careful not to lose any bits down the drain. Always use a fine sieve when disposing of the water and sludge. It is very embarrassing being caught dismantling the sink trap trying to recover lost teeth etc. When cleaning is finished always rinse well.

Degreasing and bleaching is usually unnecessary on small mammal skulls when using this or the sodium perborate methods.

Whichever method is used please take care of yourself as well as the specimens. There are obvious risks attached to this work. Use protective clothing and have good ventilation. There is nothing like the smell of rotting flesh for making you unpopular with workmates so as well as a good extraction system I can also recommend NEUTRADOL room deodorisers. They are very good at counteracting bad smells.

OBSERVATIONS ON THE TREATMENT OF AN INSECT INFESTED OSTEOLOGICAL COLLECTION.

Julian Carter, Conservation Officer, National Museum and Galleries of Wales, Cathays Park, Cardiff, CF1 3NP

ABSTRACT

A large collection of bone material which had been donated to the National Museum of Wales was found to be heavily infested with a number of insect pests and was rapidly falling into serious decay. This paper describes the means of dealing with the collection and the measures taken to prevent further infestation.

Introduction

The Barbara Noddle collection of disarticulated skeletal material was donated to the National Museum and Galleries of Wales, Cardiff (N.M.G.C.) Zoology department in 1988. The collection essentially consists of agricultural animal bone specimens, but does have a component of 'wild' mammal bone material. Much of this material represents endangered or lost agricultural breeds giving the collection an important diagnostic base.

The collection is particularly dominated by various sheep breeds, taking some 63% of the catalogued material. The rest of the collection is of cattle(15%), goat(4%), pig(4%) and the remaining being a miscellaneous cross section of mammalian material.

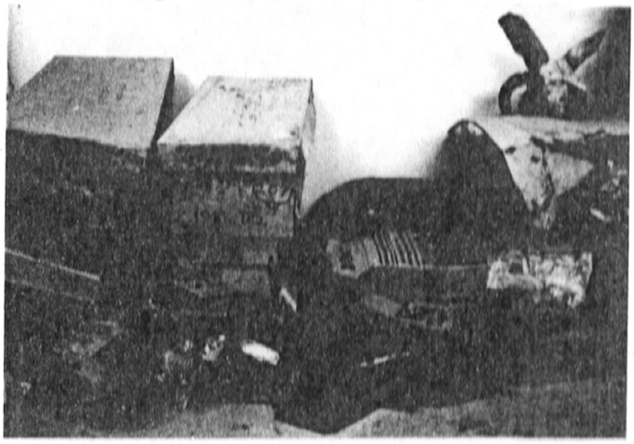
With the 1988 inventory of the collection it was realised that serious problems existed with the state of conservation of the bone material which had suffered from a combination of poor preparation, inadequate storage conditions and heavy insect infestation. This resulted in 75% of specimens showing some sign of damage which varied from some mild surface insect boring to the complete destruction of some specimens.

Thus in 1992 a complete cleaning and sorting project was initiated on the collection in order to conserve, identify and catalogue the bone material.

History

The bone material in the Noddle Collection was predominantly prepared by hot water maceration (Noddle personal communication) which involved skinning and eviscerating the animal and then dividing up into manageable proportions which were then simmered in a heated water vat until the bones were free. It appears no standards were involved in the method, relying on intuition and experience to determine when the material was prepared. Once cleaned the bone material was simply rinsed in water and allowed to dry before being packed loosely into plastic bags and boxed. In many cases excess animal tissue has remained on the bone material and has become encrusted by the drying process.

Much of the collection later came under storage pressures at the University College of Cardiff. This resulted in the boxes being stored in damp basements causing extensive mould growth and insect invasion affecting the stored bone material, adding to future conservation problems.



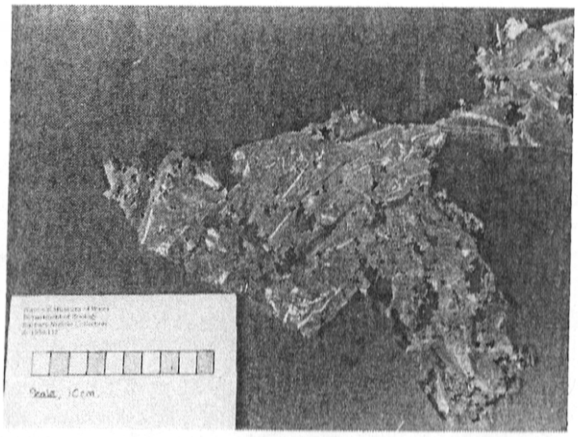
A Sample of the collection in its original state.

Observations

Much of the previous treatment of the collection has not been beneficial to the bone material. This relates to both the preparation methods and subsequent storage. From this a number of points have been noted;

- The original bone material has often not been completely devoid of remaining pieces of muscle and tendon.
- Previous storage by loosely packing the bone in open plastic bags and then placing in cardboard boxes has failed to give adequate protection. The boxes have often been over packed, which coupled with acidic attack from the cardboard and insect invasion has resulted in abrasion, crumbling and overall physical deterioration of the material. Improper storage has also opened the material to effects from temperature and humidity fluctuations.
- The preparation methods used may well have affected the long term stability of the bone material (Shelton and Buckley, 1990, William's 1992) especially if over treatment has occurred. Although initial treatment has failed to degrease much of the bone material, this grease content does now appear to be helping to keep some of these specimens intact but does present the problem of grease seepage over the coming years.

Any factor which weakens the bone structure increases the likelihood of insect damage by providing sites of weakness for insect action to exploit e.g. the laying of eggs in small cavities provides a site for larvae to burrow into the material. Insect boring has been noted around sites of weakness especially in sheep and goat material where the lines between the skull plates has been particularly prone to damage causing a sectional breakdown in the skull. This insect action has also been noted along the lines of fusion relating to accessory ossification, causing a breaking off of the end processes of limb bones such as the proximal epiphysis. The endochondral bone, which has a more open spongy structure, is then open to insect action presenting the problem of beetle larvae being present deep in the structure of the bone and effectively unmovable without causing damage.



A Sample of plastic packaging showing extensive damage by insect action

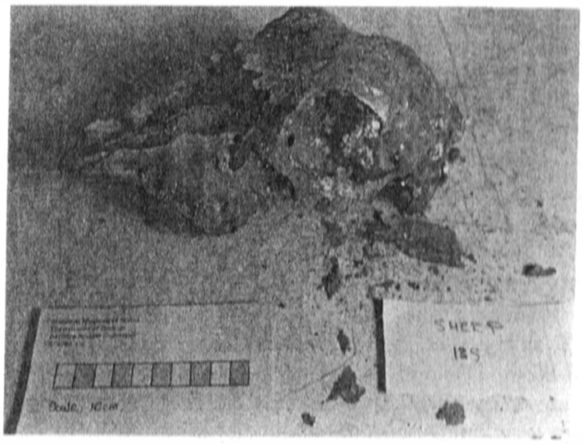
Once insect infestation had occurred there has been resulting damage to the packing bags which have then started to disintegrate causing a mixing of the box contents and damage to any contained paper labelling. This has then caused problems in identifying both the contents and separate specimens. Labelling on the individual bones has also suffered as this was usually marker pen which has started to run usually due to grease seepage from the bone or in cases where the bone is very dry and brittle the markings have been lost by surface flaking. The most successful marking in this bone collection has been pencil.

The main insect pests have been Coleoptera;

- ***Dermestes lardinius,*** L; (Larder beetle).
- ***Ptinus tectus,*** Boield.(Australian spider beetle).
- ***Necrobia rufipes,*** DeG. (Copra beetle).

Infestation problems also occurred with the House Moth, *Hofmanophilla pseudospretella* and an assortment of spiders and mites.

The beetles cause damage throughout their life cycle, starting with the feeding action of the larvae which bore into the bone causing a weakening of the bone structure and producing a great deal of frass material. In all three species the larvae will bore deep into hard and often inedible substances in order to pupate leaving further debris of pupal cases and frassplugs (Busvine, 1980). The boring actions from both larval and adult beetle types causes damage to both the bone material, which can be both food source and brood site, and to the surrounding packing material. The corrugation in some of the cardboard boxes provides a ready made site for pupating.



A Sample of the collection in its original state.

The result has been that much of the collection has been extensively weakened and physically damaged, especially the smaller herbivore skulls such as sheep and goat, and any young or foetal skeletal material. Most of this damaged material tends to be in a dry brittle condition and has needed careful handling.

The treatment of the Noddle Collection.

The problem was now to sort this large collection (initially stored in just over 500 boxes) and to carry out a level of conservation which would provide adequate future protection but within a time and cost scale. Full scale conservation would be expensive and time consuming, thus a general programme of cleaning and treatment was set up, with the idea that once the true composition and state of the collection had been established then it would be possible to go back and further conserve any material in poor condition.

Sheep Skull: the insect frass and general debris has been removed from the original storage box showing damage from mould and insect action.

It was also important to ensure that the problems occurring with insect infestation were properly dealt with, especially to prevent any re infection of cleaned and packed material from any larvae or eggs present in cavities in the bone material and to prevent any pest types re-establishing themselves in the bone material. The effects of not properly treating the insect problem has already been demonstrated with material from the Noddle collection which was cleaned and sealed in two layers of polythene but not treated with any means of pest control. Insect action has continued in these sealed specimens causing almost complete destruction within a two year period.

Sheep skull which had seen prior cleaning and then sealed in polythene, but which had received no form of pest treatment. Note the insect frass around holes in the skull arising from continued insect action. This specimen had been cleaned prior to the start of this project.

The cleaning of the Noddle collection took place in the N.M.G.C. Zoology departments preparation rooms which are away from the main museum and have several coldstore rooms. This enabled infected material to be brought out of the way of the main museum and placed in coldstore to slow down the insect pests present in the boxes. Subsequent material received was treated by placing in a Rentokil bubble and exposing to Phosphene for a period of 7 days, and then placing in coldstore to prevent any re-infection until treatment could be carried out. This helped to reduce the movement of any infected bone material.

It was then necessary to attempt to identify the contents of the boxes and to cross-check with a card file. Often this proved difficult since the surface markings on the bone had become faded or eaten as had any card labels placed with the specimen. The process then involved trying to keep the separate specimens apart since the bags the bones had been contained in were falling apart causing a mixing of the contents. Subsequent attempts to sort the mixed up specimens proved to be time consuming.

The general cleaning was a straight forward process of separating the intact bone material from the debris and insect frass and removing this material by vacuum cleaning. The bones were then carefully brushed of any surface debris and dust. Problems occurred with removing debris from the very greasy material. In such cases the material would be treated by wiping with alcohol (in the form of I.M.S.), or in very stubborn cases using toluene. Skulls needed particular attention in order to ensure as much material as possible was removed from the bone cavities which provided an ideal site for insect eggs and larvae.

Once the bone was cleaned, some form of pest treatment was carried out. All the specimens were treated with a Bendiocarb-based pesticide prior to packing. The Bendiocarb was deposited on the surface of the bone in order to give long term protection by hopefully dealing with any insects emerging at a later date. Initially the material was briefly immersed in I.M.S., but this was both messy and required a very well ventilated area. Particularly badly infected material, especially skulls, were placed in the evacuated chamber of a freeze dryer and subject to low temperature, -25°C for a suitable period, followed by pesticide treatment prior to packing.

Packaged and sealed specimen.

Once treated the material was packed into polythene tubing which was then heat sealed, with a second layer of tubing then being added and sealed, effectively double bagging with the labelling being contained between the two layers. This effectively;

- Traps the material in a cushion of air, helping to prevent mechanical damage.
- Prevents damage from contact with acidic materials such as the cardboard boxes used for storage.
- Lessens the impact from any environmental fluctuations.
- Prevents any re-infection of the collection.

Once packed the material was placed in cardboard boxes of uniform size, cut to suit the storage racking available for the collection. The collection has since had regular checks to ensure that the preventative measures are working.

Discussion.

The damage which has occurred to the Noddle collection has unfortunately affected the overall level of preservation, thus affecting the scientific integrity of the specimens in the collection. It has hence been essential to halt the level of decay occurring and to attempt to preserve the material in order to protect the collections research value.

The whole problem associated with the long term stability of the collection can be related back to the initial preparation and storage of the bone material. Some studies have suggested that the soaking and washing of osteological material with any kind of aqueous solution could be destructive due to the hydroscopic and anisotropic nature of the bone (Lafontaine and Wood 1982; Williams 1991 and 1992) but as details are lacking and much of the material came from agricultural research centres it is difficult to say exactly how the original treatment affected the material, although in a personal communication Barbara Noddle mentioned that since the vats used had no thermostatic control, then the material often became over boiled and thus exposed to a prolonged period of excess heat and solution. Thus it is certain that some of the material has suffered from initial over-treatment weakening the bone structure. Insect pests have exploited sites of weakness as egg laying and larval feeding sites. This is particularly evident with *Necrobia rufipes* whose larvae are found deep in the bone material and can quickly honeycomb the more spongy structure of the endochondral bone. The larval forms of both *Dermestes lardinius* and *Ptinus tectus* can feed on dry animal matter, often left over from the preparation process, as well as hair, horn and paper. *Ptinus tectus* tends to be a scavenger of miscellaneous debris throughout their life cycle. Once the adults have emerged then their continued feeding actions can cause further damage especially with adult females who need to feed for the maturation of their eggs.

When the collection transferred to much dryer and warmer storage conditions it appears both the beetles *Dermestes lardinius* and *Ptinus tectus* died off, whereas *N.rufipes* persisted with specimens regularly being found alive. *N.rufipes* is not usually a widespread pest in this country as requires all year round high temperatures (Busvine), whereas the other two beetle types are more tolerant to British conditions and certainly *Dermestes lardinius* is a well known pest of natural history collections. It is probable that both the spider and larder beetles were more dominant in the former damp storage conditions but have become less persistent as desiccation has decreased the food availability. Also they may have responded to previous pesticide treatments which *N.rufipes* was either more resistant to or as the larvae can occur deep in the bone unaffected by treatments. Thus *N.rufipes* has remained an active pest being the most adaptive to these conditions and the most capable of feeding on the bone material.

Necrobia rufipes: a persistant pest of the collection.

In looking at the effectiveness of the treatment methods one year on from when the initial material was cleaned and sealed it is encouraging to note that although there have been signs of insect activity in some of the bone material, it has mostly not persisted. A survey of boxes revealed a *N.rufipes* emergence of adult beetles in 10% of boxes. In most cases these have died off, presumably due to residual pesticide deposits. However in about 2% of cases the live adult beetle has persisted. This has been dealt with by putting the affected specimens in prolonged cold storage and this has proved effective.

Although various methods of pest treatment have been used with this collection, thought must be put to the future effects of this treatment. Alcohol in the form of I.M.S. has been used throughout the treatment of the collection. Ethanol is considered to be one of the less intrusive solvents (Matienzo and Snow, 1986) but concern has been expressed over its effects as a desiccant and as a solvent that may cause mobilisation of lipids along with possible material reactions with the ultra structure of bone (Williams, 1991). Other future problems may also relate to the use of pesticide which will remain on the surface of the bone. Thus warnings will have to be placed on the boxes in case of future handling by any person working on the collection.

A further concern was with the sealing of the bone material in two layers of polyethylene with the establishment of micro climates within the polybags. This concern was monitored by placing ACR stick-on loggers with the sealed bone material. So far the results have been very favourable with internal storage temperature of less than 20°C and a relative humidity of around 45%.

Packaged and sealed specimen.

The whole collection is now stored in clean, stable conditions with clear type written labels on the outside of all the boxes making the collection accessible and it's various specimens identifiable. If the material had been left in its previous condition then the extent of decay would have certainly destroyed a great proportion of the collection within a few years. As it was some 20 boxes of specimens were deemed in too poor a state to be considered saving, with several specimens totally reduced to fragments of bone, insect frass and pupal cases.

Conclusion.

The conserving of this collection has demonstrated the level of damage biological decay can cause on research material which has not been properly treated or stored. The collection was donated to the National Museum of Wales in a poor condition and thus required conserving in order to ensure that the pest problem and long term stability were dealt with. During the cleaning work it was important to keep the collection as isolated as possible so that it did not affect other specimens. This level of treatment is highly recommended before moving and treating any suspect material. The preventative measures taken appear to be working well, but will involve long term monitoring as part of a pest management programme.

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LEEDS CITY MUSEUM - its Natural History Collections
Part 2 : The Invertebrates

Adrian Norris, Assistant Curator Natural History, Leeds City Museums, Municipal Buildings, Leeds LS1 3AA

Abstract

The invertebrate collections held by the Leeds City Museum, in numerical terms, comprise about two thirds of the natural history department's holdings of over 300,000 specimens. The following paper describes some of these collections, the people who assembled them, and some of the staff, researchers, outside specialists and others who subsequently worked on them. The paper also discusses some aspects of their scientific and historical significance, and their importance both to Leeds, and to the charge-payers who finance their existence.

The Early Collections

The devastating effect of the bomb which fell on the Leeds City Museum in March 1941, and the resulting aftermath, caused considerable damage to the invertebrate collections. Much of the early material was lost or damaged to such an extent that only small numbers or parts can now be identified back to their specific collections and collectors. Some of the more fragile groups in particular, for example some of the insect collections, totally failed to survive this traumatic event. Included amongst these early collections, now lost, were the insect collections of John Atkinson, the first curator of the museum, and those of William Hey, one of the early presidents of the founding organisation, the Leeds Philosophical and Literary Society.

The Post-War Period

The appointment of Mr John Armitage as Keeper of Biology in 1954 proved to be the salvation of the museum's invertebrate collections. Born in 1900, he developed an early passion for both natural history and photography and also developed artistic skills which enabled him to get a place at the Manchester School of Art. After leaving the School of Art, he joined Oliver's of Manchester as an illuminating artist and worked on many illuminated manuscripts, including one for John W.Taylor of Leeds. This illuminated address was presented by the Conchological Society of Great Britain and Ireland to John W. Taylor on his seventieth birthday in February 1915, the original manuscript now being part of the Leeds City Museum's collections. John had produced the manuscript at the tender age of 15 years and details of it can be found in the Proceedings of the Conchological Society for April 1915. Vol.14 (10) 316-319.

At the age of 21 he became a full time naturalist, earning a living by giving lectures, writing articles for various newspapers, and using his artistic abilities to earn extra income as required. This freedom enabled him to travel widely, and to gain experience over a wide field of knowledge. The main drawback to his appointment in 1954 was his lack of knowledge of museums, and thus he entirely underestimated the importance of good records, and record keeping at that time. It is unfortunate, that he, and his assistant Jean Parkin (nee Mitchell), appear not to have kept any records of the many disposals of dirty and damaged material which took place at that time.

The State of the Collections in 1954

The collections proved to be dirty, infested with pest beetles, moth and mites and in need of emergency salvage, restoration and renewal. Jean Parkin undertook the task of cleaning, re-lining as required, re-papering, and the laying out of all the insect collections. This was a formidable task which must have taken many years to complete. The style chosen for the layout of the drawers did, however, restrict the subsequent expansion of the collections. For example, the allocated space given for any group of beetles within the cabinets was the same regardless of the size of the beetle. Thus only one, or at most two, examples of the larger beetles could be stored within the collection. This was repeated throughout the insect collections, with the exception of the lepidoptera, and all species regardless of their rarity or existence within the collection were allocated the same amount of space. This resulted in some drawers being over crowded whilst others remained empty. Jean Parkin, under John Armitage's expert guidance, developed an ability to card- mount insects almost faultlessly, an admirable skill which was put to good use. Over the years, she must have mounted in excess of 10,000 specimens, mostly British beetles.

The Present Position

Over the past two decades efforts have been directed to fully documenting the collections, and advertising their scope and size to individuals and outside bodies. The production of registers of natural science collections, and in particular the register for Yorkshire and Humberside, (Hartley, et al 1987), has considerably helped with both aspects of this work. The production of the register made us examine the collections against the registers, and try to establish which of the several hundred received over the years were still extant. The sorting of collections, usually amalgamated in the past without any lists or identification marks, proved difficult and in some cases impossible. The whole exercise did however, produce results as several collections believed to have been lost were eventually re-