three of the Canadian members of the audience had visited Whitby Museum and knew the specimens. The talk by two private conservators on ethics and costs of conserving (in situ) a Japanese Buddhist alter to a state in which it could be used daily raised some interesting points on compromises between full conservation and a workable and affordable project. The final session of the meeting included a talk on the development of a training course in preventative conservation, using a combination of risk-assessment workshop, a workbook and NVQ-style work place assessment. I t that a similar model could be usefully developed in the UK as part of attaining NVQ at around levels 3 to 4 in conservation.

Facilities visited

I was able to tour three new buildings in the region, the CMN Aylmer building the Parks Canada building and the National Archives of Canada building. I o paid a return visit to the Canadian Conservation Institute, CCI, which has n a re-arrangement of labs and offices since 1991.

All three buildings were new since my internship in 1991, although surveying, sign brainstorming and staff training for the move to a new CMN building was fairly well advanced in-house by 1991 and the initial design for the Parks build had been worked up in the mid 1980s.

The three buildings provided quite a contrast. The National Archives building as a very architect led, innovative and striking design; a glass sided building with a huge curved roof (like a railway station) with an inner five storey building, three stories of concrete "bunker" containing the collection vaults, an office suite on top and then an "oil rig" platform above open to the outer roof containing the conservation and record copying suites. The airy feel and panoramic views from the conservation platform had a similar ambience to a roof garden.

The Parks Canada building was a modification of an existing standard two storey office building with architectural embellishments to the entrance hall area a the exterior of the building. This building houses conservation and research labs the library and administration.

The CMN building was a new build using standard building materials and methods yet it achieved an interesting appearance and functional layout. The building

The Ten Agents of Deterioration

An issue by issue guide to the risks facing museum collections

3. Pests

Introduction

This is the third in our series of pull-out guides to risks facing museum collections. In this issue we look at 'pests'; their monitoring, effects and prevention.

We are very grateful to the authors and the Natural History Museum for providing us with the first eight of our articles. These are post-prints from a meeting held in December.

Our next issue will look at Theft & Vandalism. Articles are invited relating to experiences of dealing with both. Pieces on 'preventative' measures implemented would be very welcomed, as would case studies of repairs and 'remedies' adopted following an incident.

The Insect Pest Problem at The Natural History Museum, London

Over a 2-year period, 1994-1995, a pest survey was undertaken on a consultancy basis of the Natural History Museum's wide-ranging stores and galleries. The final report highlighted primary areas of concern and made eleven specific recommendations. This summary is published with the permission of the NHM.

Insect pests were found to be endemic within the structure of the museum. Due to the age of the South Kensington buildings and subsequent structural modifications and additions, there are countless ducts, cavities and other dead spaces which harbour organic debris. This debris, which includes dead birds, bird nests and rodents, supports a population of Dermestid beetles. The major pest present is the Guernsey carpet beetle, *Anthrenus sarnicus*. The larvae of this species move freely, becoming established in specimens within the collection. Heaviest concentrations of *Anthrenus sarnicus* were found in mammals and reptiles in Zoology Storeroom 1 and in the Entomology building; this species was also a notable pest on the dried Crustacea, mammal skins and skeletal material. The biscuit beetle, *Stegobium paniceum*, occurred in parts of the Herbarium; the brown carpet beetle, *Attagenus smirnovi* and the American wasp beetle, *Reesa vespulae* occurred in some of the galleries and the Entomology building. Damage to objects in the galleries was very limited because of widespread use of DDVP (2,2-dichlorovinyl dimethyl phosphate) slow release strips. At the time of the survey many gallery areas were very dirty. This accumulated dirt was supporting populations of *Anthrenus sarnicus*, *Attagenus smirnovi* and the clothes moth *Tineola bisselliella*. The design of many displays did not seem to provide for efficient routine cleaning.

Of the outstations, the Wandsworth store has the facility to maintain temperatures below 16°C and at the time of the survey there was no evidence of active pests. But there is great potential for future problems if temperatures cannot be kept low. At Tring, old parts of the building showed signs of infestation. The use of DDVP slow release strips in the bird cabinets since 1975 has prevented any damage to specimens.

Both South Kensington and Tring have a Dermestarium for cleaning skeletal material. The one at Tring was well managed whereas the other, at the time of the survey, was disused and acting as a major breeding source of *Anthrenus sarnicus*.

Recommendations for pest prevention and control

The Museum has potentially more material at risk from infestation than many other museums. Staff vigilance and effort has helped to maintain high standards in some areas. This and the use of DDVP strips has prevented serious damage to collections. However, instigation of a museum-wide policy of pest prevention is essential to prevent pests from reservoirs within the museum from spreading into other parts of the collection and causing problems. Such a policy is evolving within the museum and considerable progress has been made since 1994, but to continue this evolution towards a successful strategy, certain key points must continue to be addressed. Although specific to the NHM, these points could form the basis of a strategy in many museums.

1. Continue to increase staff awareness and discipline by education and training in pest management by means of seminars and information exchange. There is also a need to develop this training as part of a museum-wide

pest management strategy, as pest problems are not specific to individual departments.

2. The level of routine cleaning in galleries, working and storage areas must be consistent and effective. Financial pressures that dictate team cleaning rather than dedicated areas for specific cleaners might lead to reduced standards. The concept of "deep cleaning" must be taken on board by the Museum to tackle difficult areas in galleries and stores. Experience in other museums has shown that this can be very effective when it is properly organised and there is adequate equipment to do the job.

3. When there are provisions for controlling the environment, the temperature should be maintained below 18° C, or as low as possible, to prevent insects breeding.

4. The pest monitoring programme has revealed pest insect activity in unexpected areas. Monitoring should be widespread and regular with records co-ordinated through the pest control sub-group.

5. Although chemical treatments should be seen as only one aspect of an integrated approach, localised treatments by trained staff using Drione desiccant dust are valuable for control of insects in dead spaces. The need for occasional remedial treatments with other residual insecticides such as Empire 20 must be evaluated on a case-by-case basis and may require the employment of an outside contractor.

6. The use of DDVP slow release strips is a crucial component of the current pest control programme. The use of such strips in gallery cases and storage areas has prevented what would have otherwise been serious damage to collections both on display and in store. The use of DDVP strips should continue in closed areas but care must be taken regarding the safe storage and disposal of strips.

7. In the current climate of pesticide registration, it is possible that the approval and use of DDVP strips may be restricted in future years. As these strips are such an important component in the Museum's policy, serious consideration must be given to alternative methods. There is no direct chemical replacement for DDVP and therefore any loss of this product will have to be met with a new approach involving increased inspection and use of methods such as freezing, heat or gaseous nitrogen.

8. All incoming material must either be treated by freezing at -30° C or examined in a quarantine area.

9. Investment in new storage furniture by some departments has definitely decreased the risk to specimens. Specifications for new furniture should include adequate protection of specimens by pest exclusion.

10. Any proposals for new buildings should include provision for pest exclusion and prevention at the design stage. Any alterations within the existing building should take account of the overriding need to separate collection storage, working and library areas.

11. Museum collection policy (through Collections Impact Statements) should take account of future care of collections, and adequate resources must be available to process new material. Risk assessment by means of condition surveys should be used to determine priorities. Careful consideration should be given to a long term programme of "disposal', and re-housing of currently exposed and vulnerable material.

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Since the Pinneger Consultancy - Progress and problems

Pest control in The Natural History Museum's life sciences departments has traditionally relied on insecticides - Naphthalene (discontinued since 1989) in Entomology, Lauryl chloropentaphenate (discontinued since 1992) for flowering plants, and Dichlorvos still in use in Zoology. Concerns regarding Health & Safety have necessitated re-assessment of such routine blanket treatments, and in turn focussed attention on the need for 'Integrated Pest Management', an approach that requires an appraisal of each aspect of museum life as it impinges on pest control. In The Natural History Museum, the initial impetus for this [for us] novel approach was provided by the 'Pinniger Consultancy - 1994-5'.

As noted above, the consultancy resulted in eleven principal recommendations. In some areas, there has been notable progress - formal course training, a widespread monitoring programme and consequently more targeted use of insecticides, the introduction of quarantine procedures, investment in new

storage furniture, consideration of the needs of pest control in the design of proposed new buildings, and the on-going development of condition surveys. But major areas of concern remain. Whatever the financial gains of recently introduced out-of-hours cleaning, from the point of view of pest control the consequent loss of contact between curators and cleaners can only be seen as retrograde. And concerns remain regarding safe use of Dichlorvos, its long-term availability, and the lack of a suitable alternative.

Future progress might centre on the crystallisation of the Pinniger Recommendations into a formal pest control policy supported by museum management and readily available to all staff. Such a policy should include the following considerations:-

1. Everyone working in the Museum or acting as an agent for the Museum, should be aware of their responsibilities regarding care of the Museum's collections.

2. The specifications for collection furniture, display furniture, buildings and environmental conditions, should meet standards that do not place specimens housed therein at risk from pest attack.

3. Procedures must be in place to reduce the probability of pests being introduced through contaminated materials.

4. Associated collection practices, e.g. research, cleaning, estate management, should reflect the needs of pest control.

5. Working practices should be adopted that eliminate unnecessary exposure of specimens.

6. Pest monitoring programmes must be in place and maintained, and the results documented and acted upon as appropriate.

7. When remedial measures prove necessary, they should be carried out within the constraints of current Health & Safety legislation and documented as appropriate.

8. Any remedial measures should minimise/avoid chemical/physical changes in objects.

Phillip Ackery (Convenor - Pest Control Subgroup)
The Natural History Museum

The Thermo Lignum Process

Environmental health concerns have caused a radical change in the popular perception of chemical pest control methods. Governmental and environmental agencies seek to further limit the uses of chemicals in areas that have, till now, accepted them as routine treatments.

As an example, the German 'Dangerous Substances Act' requires that "toxic gases may no longer be employed if a toxin free procedure is effective and reasonable". Because of these concerns, non-chemical solutions to common pest problems have become a particular goal. This has led to the development of essentially two new processes designed to treat insect-pest infested objects - warm air treatment with controlled humidity, and inert gas "fumigation".

The treatment and restoration of rare and valuable objects in a sensitive and non-invasive way is a priority for anyone concerned with conservation. Insect pests account for much loss and damage every year and are responsible for the slow erosion of our cultural heritage.

In the field of building and monument preservation the basic hot air method has been applied successfully for several decades. Using high pressure heated air, roof timbers and building frames can be raised to over 55°C. At such temperatures animal protein within the insect cells becomes irreversibly denatured resulting in the insect's death. The main problem encountered in applying this sound biological principle to the treatment of high value works of art, antiques etc. has been resultant dehydration of the piece causing irreversible damage through shrinkage and cracking.

The eradication of insect pests in such a sensitive area requires precise control over all environmental parameters. This is especially true of relative humidity. The development task was to find a treatment which could guarantee the destruction of the insect pest at all stages of development while being completely harmless to the object and posing neither health nor environmental risks.

The thermal solution is a technically refined version of the previously discussed heat treatment. A chamber was designed in which objects could be placed and the environment

modified precisely by computer. In both the warming-up and cooling-down phases of the treatment the relative humidity is controlled in such a way as to ensure that the humidity balance is maintained. As a result, no dehydration can occur.

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The Use of a 'Dynamic' System for Fumigating Museum Objects

The fumigation of pest-infested objects has been carried out at the Science Museum for a number of years. In April 1997 a pest strategy was written to support the Museum's Collections Management Policy Statement. The Conservation Section, in conjunction with setting up an Integrated Pest Management programme (IPM), had begun to investigate methods of fumigation which presented a non-harmful treatment for the objects but did not create a health and safety hazard to its staff.

The most common insect pests identified as harmful to the Museum's collections are *Attagenus smirnovi, Anthrenus sarnicus, Stegobium paniceum* and *Anobium punctatum*. In the past, methyl bromide had been used to fumigate infested objects coming into the store. This is still an acceptable treatment for many wooden items although it is not appropriate for most composite objects as methyl bromide will react with sulphur-containing materials and also attacks metal surfaces. Methyl bromide is known to deplete the ozone layer and can create a health hazard to those exposed (methyl bromide is specified as a Part 1 poison, Poisons Act 1972). Therefore an alternative treatment was explored.

Initially, the use of high levels of carbon dioxide was investigated. When exposed to high levels of carbon dioxide, insects open their spiracles allowing body moisture to escape, so causing them to die from dehydration. Two fumigations were carried out with good results. Although treatment using carbon dioxide appeared successful, there were a number of reasons why another method was explored, not least Health & Safety issues, availability and cost. Following a course on "Pest Management and Control For Museums", organised jointly by The Getty Conservation Institute and The Conservation Unit of the Museums & Galleries Commission, I was encouraged to investigate the use of a 'Dynamic' system using nitrogen. A 'Dynamic' system refers to a method of fumigation where an inert gas is used to flush out air from a bag/chamber until low levels of oxygen are attained. These levels are then maintained for a specified period of time.

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Science Museum, London

The Pest Problem Within The Dry Arachnida and Myriapoda Collection

Arachnid and Myriapod specimens are preferably stored in 80% methyl alcohol as this preserves soft-part anatomy, lost if specimens are dried. The Natural History Museum additionally has significant dry-pinned material dating back to the early 19th-century and housed in 208 entomological drawers (mostly Hill units). The dry collection is now not of great scientific importance as in recent years much of the type material has been restored in spirit; many specimens are just large and showy with little data. However, most of the dry specimens were donations and some have an important historical component, so the collection has been largely maintained in its original form. Unfortunately, in some parts of the collection, specimens are poorly preserved, especially tarantulas with soft abdomens, and brittle millipedes. Scorpions and centipedes with their flattened, highly keratinized bodies, appear to have fared much better. Parts of the dry collection have been subject to the ravages of the Guernsey carpet beetle - *Anthrenus sarnicus* - the larvae of which have reduced some spider specimens to a mere pile of legs and frass!

At first glance, it is not apparent how pests were able to gain access to the collection. The dry collection is separated into three discrete blocks to the rear of the store room away from the interior doors. There are no windows through which beetles can fly. However, there are several air ducts leading out of the storeroom to the roof, along with a 'dumb

waiter' lift shaft, which present ideal routes of entry, as well as dead areas in which detritus can accumulate and where pests can breed. Also, but less likely, specimens could have been infested when drawers were opened for study elsewhere. Other factors have also contributed to the pest infestation problem. Because the dry collection is not often used, infestations are likely to go unnoticed for long periods of time. A change in housekeeping policy meant that the storeroom was no longer cleaned. The effect of the preventative chemicals added to the collection in the past (probably BM mixture - a cocktail of saturated solution of naphthalene in benzene, often with a proportion of beechwood creosote and even phenol), has also worn off. This has all occurred against the background of reduced staffing levels.

But, with greater emphasis now placed on Collections Management within the BMNH, it was recognised that priority should be given to the problem. It has been tackled in various ways. Removal of extraneous items has provided a less cluttered environment. All collection drawers have been frozen and cleared of frass. Any remaining type specimens have been removed and placed into methyl alcohol. Cabinet interiors and bases have been treated with 'Constrain', a permethrin-based insecticide approved for museum use. The collection is also being monitored by sticky traps and three-monthly visual checks. Drione dessicant dust may be used in the future in dead spaces as an additional measure. Hopefully, such a strategy should spell the end of *A. sarnicus* in the dry Arachnida and Myriapoda collection.

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The Natural History Museum

Control of *Stegobium paniceum* in the Economic Botany Collections at RBG Kew.

The Economic Botany Collections (EBC) at the Royal Botanic Gardens include more than 30,000 timber samples, and 44,000 specimens of economic plants, spanning the whole spectrum of uses, such as food, forage, fuel, fibres, medicines, poisons, dyes, gums and resins. Specimens range from dried plant parts - medicinal roots and herbs, to artefacts manufactured from plants. All specimens are now stored in taxonomic order, in an open shelf, wheel-to-compactor system, in an air conditioned and purpose built storage space in the Sir Joseph Banks Building at Kew. All items were repackaged in acid free boxes, plastic topped glass jars, or punctured plastic bags. The move of specimens to the store was completed in 1993.

The first *Stegobium paniceum* (Herbarium or drug store beetle) appeared in the store in August 1993, and collected by the windows, and the following July numbers reached epidemic proportions. Spot checks revealed some heavily infested families, with a poison and starch bias. Consultation suggested several methods of management of the problem within the store: regular cleaning, greater insulation of fire exit and connecting doors, placement of traps and regular monitoring. The main method was to be through temperature control, with the presumption that sustained low temperatures would prevent the *Stegobium* completing their life cycle. The air conditioning system was capable of lowering to 15°-16°C (with the RH around 60°C acceptable for organic collections). Traps were placed at intervals throughout the compactors - a mixture of pheromone lured and non-lured Fuji traps, and museum traps. Very severe infestations were found on the shelves containing certain families, genera and species - notably *Ricinus communis, Castanea sativa, Manihot esculenta, Papaver somniferum*, and *Myristica fragrans*. Major infestations were in concentrated areas around the main collections. All infected specimens were removed and frozen for a minimum of 3 days at -30°C.

With the lowering of the storeroom temperature, there was an immediate drop in *Stegobium* activity. Some trap catches were made, with higher numbers on the pheromone lured than non-lured traps, but this was not an accurate indication of activity. In most cases, insects preferred the specimens to lured traps placed among them - perhaps due to reduced attractiveness of the pheromone lure at lower temperatures.

In July 1995 activity was much reduced, but it was decided that a temperature below 13°C would be more effective in preventing the *Stegobium* completing their life-

cycle. In October 1995, the floor space was sprayed with encapsulated Empire 20, as a further precaution to stop the spread of beetles.

Although activity is negligible, a spot check in May 1997 revealed some heavily infested jars of *Plantago* and *Chenopodium* seeds (with close fitting plastic lids). There was no apparent activity, but on removal from the store to a warm office for a few days, two live beetles emerged. This suggests that the pupae can survive for long periods of time in a dormant state.

The method has proved a successful management technique, involving minimum interference with specimens, for a severe pest problem in a difficult storage space.

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Sir Joseph Banks Building
Royal Botanic Gardens, Kew

Pesticide Residues on Herbarium Sheets Housed Within The National Museum and Galleries of Wales

The National Museum and Galleries of Wales (NMGW) Biodiversity and Systematic Biology department houses 250,000 vascular herbarium specimens, many dating back to the 18th century. Vascular material is prone to attack from pests. If the conditions are suitable the pest will spread very quickly, stripping the dried material. This can be devastating to a collection, as important characteristics and data can be lost. Institutions and collectors have overcome this problem through applications of pesticides. However, the types of chemicals applied since the beginning of the 20th century are now known to be harmful and could present a possible risk to staff and visitors handling the collections.

The aim of this project is to attempt to identify organic and inorganic pesticide residues found on herbarium sheets. These will relate to what the specimen itself has been treated with. The preferred analytical techniques to be used include spot tests, Atomic absorption spectroscopy (AAS), Mass Spectrometry (MS) and Energy Dispersive X-rays (EDX). The results should correlate certain pesticides with dates, collectors, institutions or even species. The results will be accumulated and a comprehensive data list made available, informing other institutions of what may be on their own herbarium sheets.

Prior to analysis, various herbarium specimens, including type specimens, were remounted using conservation grade materials and the original sheet was taken for testing. Numerous heavy metal spot tests were conducted to determine presence of arsenic and mercury and initially, these results appeared ambiguous. It was decided that a more precise method of analysis should be used on a few samples to determine the exact concentrations of residues present. Dr Trevor Brown of the Department of Chemistry, Derby University, carried out Inductively Coupled Plasma-MS and EDX analysis on five small samples of herbarium paper to verify presence of inorganic material. EDX is a surface technique which has been used in the past to verify the presence of arsenic and mercury residues found on taxidermal specimens. This method was found to be far too insensitive for analysing herbarium specimens as the pesticide was often applied as a liquid or spray which would then soak into the specimen and the sheet below becoming an intrinsic part of the fabric and not simply remaining on the paper surface. ICP-MS requires complete digestion of the paper and identifies all inorganic material throughout the paper, allowing an accurate measure of concentration to be made. The ICP-MS results were conclusive. The five herbarium samples were dated from 1848-1964 and each gave a positive result for both mercury and arsenic. Mercury was present in high concentration but the arsenic was generally much lower. Further spot tests were carried out and this time it was possible to measure, by eye, the very slight difference in colour intensity of the reagent and the samples. The spot tests did correlate with the ICP-MS results, but the sensitivity of these spot tests is far less than those carried out on taxidermal specimens. The sensitivity for the taxidermal tests should be 0.05 ug of mercury, but the value for these experiments was closer to 6 mg of mercury.

Future plans will involve providing standards of well-known pesticides

and comparing these with the organic results of the sheets using ICP-MS. Also a questionnaire will be drawn up for institutions around the world to relate their pest control procedures with the findings of this project.

Vicky Purewal
National Museums & Galleries of Wales

Low Temperature Treatment at the Victoria and Albert Museum

Textiles are routinely treated by freezing at the Victoria and Albert Museum. This is an integral part of the Museum's insect pest management strategy. Our strategy for the control of insect pests has evolved since 1989. It includes a trapping and monitoring programme, where sticky insect traps are placed in the galleries and stores of the Textiles and Dress collections, along with the Furniture and Woodwork collections. All other disciplines have been involved but there are insufficient resources available to fully monitor the whole museum site. Insect activity is recorded for two species of carpet beetle, the Guernsey carpet beetle, *Anthrenus sarnicus* and the brown carpet beetle, *Attagenus smirnovi*. In addition, there is an ongoing programme of deep cleaning in galleries and stores, with the use of insecticides where appropriate.

Two exhibitions recently opened at the V & A, contain material treated by freezing, 'The Colours of the Indus', an exhibition of textiles and costume from Pakistan, 9 October - 29 March and 'Carl and Karin Larsson, The Swedish Style', 23 October - 18 January 1998. The inclusion of exhibition items in a freezing programme controls infestation and prevents insect pests from being transferred within and between exhibition/storage sites. All new proteinaceous and textile acquisitions are treated similarly.

Low temperature treatments were initially introduced at the V&A as an alternative to using chemicals hazardous to health. The first freezing project in 1990 was implemented in direct response to an infestation of carpet beetle larvae. The following year there was a much larger programme of treating over 500 tapestries and carpets, prior to their move from an old basement store to a newly outfitted store at Blythe House, which was insect-pest free. Several freezing programmes have been carried out since then, either using a large, hired freezer unit or a domestic chest freezer. The chest freezer is situated at the Blythe House store in a room with sufficient space for the preparation of objects for freezing. The chest freezer is left on at all times and can therefore be used either for emergency treatments or for planned programmes.

Methodology for treatment using the large hired unit and the chest freezer is similar. All the textile objects are first wrapped in acid free tissue or polyester wadding. They are then wrapped in stout polythene which is secured with parcel tape over a double seam and then clearly labelled. In the large unit, objects are placed on racking shelves or palettes and in the chest freezer they are laid on to sheets of Plastazote. All objects are treated for a period of four days at a temperature of -30°C. After the objects are removed from the unit they are left untouched and unopened for a further two days. Any condensation forms on the outside of the packet and not on the inside. The objects are then unwrapped, condition checked and, where possible, vacuum cleaned to remove any insect remains that may provide an additional food source for insect larvae. The textile objects are then prepared for storage or display.

Val Blyth
Textiles Conservation
Victoria and Albert Museum

Pesky Moths! -controlling an outbreak with the aid of pheromones.

Introduction

At the end of 1995 an outbreak of the clothes moth *Tineola bisselliella* occurred in an open natural history diorama exhibit at the National Museum and Gallery of Wales (NMGW). What immediately followed was an example of poor communication and poor protocol. Eventually the infestation was controlled with a combination of pesticide treatments and pheromone traps, and without the need to close the gallery for more radical treatments. However a number of specimens were lost and the infestation

highlighted the vulnerability of specimens on open display.

The Infestation

During October 1995 warding staff noticed small white 'worms' moving on the surface of the lake in a diorama representing the wildlife of Llangorse Lake. Closer examination revealed damage to the water birds on the 'lake'. The information was reported, but the channels of communication were not clear. The result was it was not until early November that efforts to deal with the problem were started. The initial response was to spray the gallery specimens with a permethrin based insecticide, although this action was not properly recorded, while a resident entomologist identified the infestation as the clothes moth.

Despite the initial pesticide treatment live caterpillars were still being noticed by the warding staff. The situation obviously needed a co-ordinated response, otherwise the gallery would have to have been shut down and fumigated to prevent the infestation reaching other galleries and collection areas. The first stage was to remove the damaged specimens. The remaining specimens were then treated with a bendiocarb based insecticide, Ficam W, chosen for it's relatively low toxicity and water based application. Monitoring was then started through out the gallery by placing a grid of 'No Survivor' sticky traps. Each trap had a pheromone lure designed for the clothes moth. Additional 'Agrisense' sticky blunder traps were also placed around the infested diorama, and near any remaining floor-based specimens.

Results

Figure 1 shows the monthly catches for the pheromone lure traps. Despite the initial pesticide treatments the number of adult moths caught rose sharply from December to April, although these catches were all limited to the traps placed around the infested diorama (figure 2), and not on the traps placed in the further reaches of the gallery, or in an adjacent gallery.

The increase in moth numbers from December to April caused concern. This lead to the removal of all remaining ground level specimens in the diorama, the replacement of the pheromone lures and further treatment of the remaining specimens with a permethrin based insecticide spray. From May onwards the numbers crashed, with very few moths being caught. By September 1996 there was no sign of the infestation.

During the December to March period the blunder traps also picked up a low level infestation of the beetle *Adistemia watsoni* (family: Laphridiidae). These are very small beetles which feed on micro-fungi and were probably secondary to the moth infestation.

The effectiveness of the treatments

This infestation highlighted a key number of problems in the way such problems were initially dealt with at NMGW:

- The lack of structure in the reporting mechanism for pest infestations. Whilst the warding staff had been vigilant and had noticed and reported the problem to their line managers, it was unclear who was then responsible to receive and act on the information.
- When the initial response was carried out, it was done without proper consultation and the recording of actions and treatments.
- Once the process to treat the infestation started it did so assuming that the infestation was on a small scale. The result was potentially infected specimens remained on display, instead of being removed and placed in a deep freeze.

A key factor in making the decision of how to treat the infestation was the fact that the diorama displays were open, and in a public access area. It was thus highly undesirable to use high toxicity pesticides or to carry out fumigation.

The first pesticide treatment of a permethrin based spray was a 'panic' response which would have done little as it would have only been a surface treatment. The caterpillars initially live under the skin of the mounted specimens, and usually only emerge when food is short or as adults to mate. The second treatment of Ficam W would have again only formed a surface treatment but was carried out to deter resettlement of adult moths to lay eggs. However there is little evidence to suggest that any insecticide will repel clothes moths to the extent of preventing ovipositing (Busvine, 1980). The pesticide treatments would have not penetrated beyond the surface of the fur or feathers of the specimens. Hence the treatments would have done little in controlling the bulk of the infestation, although they will have killed migrating caterpillars and

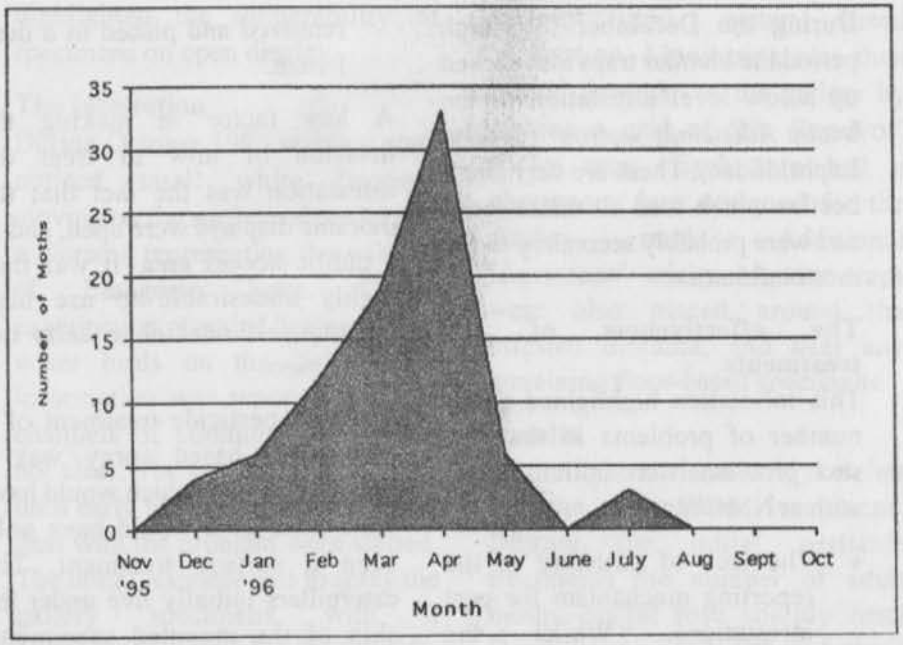

Figure 1: Total number of Clothes Moth caught each month

aided in the control of secondary problems such as the Laphridiidae beetle. Permethrin based sprays are primarily contact pesticides and degrade quickly (Zycherman and Schrock, 1988) although permethrin can persist especially when out of direct light (Pinniger, 1994), whilst Bendiocarb (used in Ficam) remains as a dust on the specimen and is more persistent (Pinniger, 1994). However there was little evidence to suggest that these pesticide treatments were killing off the moths as they emerged, indicating that the pesticides had little direct effect or that the moths were occurring from non treated areas.

The importance of the pheromone traps in this treatment is that they effectively removed the emerging adult male moths from the gallery enabling both monitoring and control of the infestation in the gallery. The traps were passive and did not require the infested material to be directly treated in any way. It is also almost certain that the pheromone traps helped to contain the infestation to the area around the infested diorama. This was especially important when

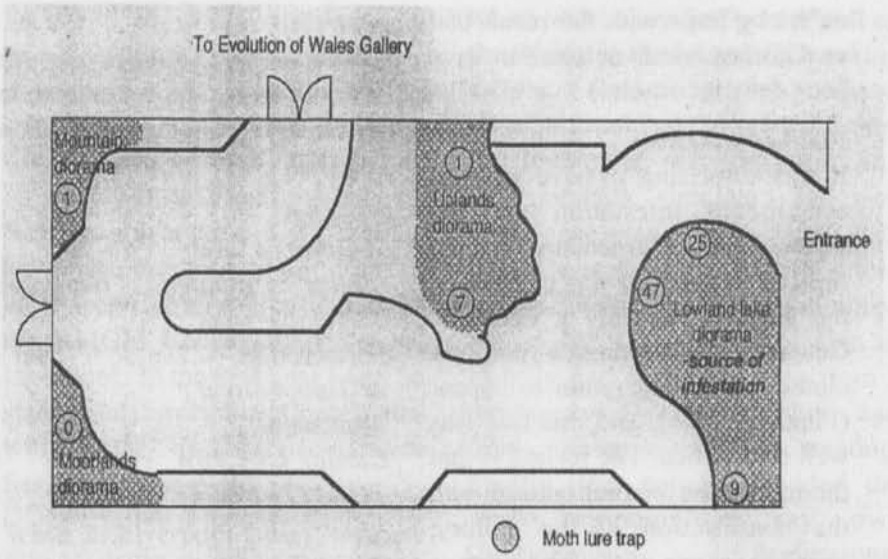

Figure 2: Gallery 27 plan to show the position of the open dioramas and the moth lure traps. Numbers in the circles indicate the total number of moths caught in each trap.

considering that possibly infested items remained on gallery. This not only included specimens but vegetation such as reeds and birds nests which could have been the primary source of the infestation. The effectiveness of the pheromone lures was further demonstrated by traps which had been suspended from the ground. These traps were catching adult moths which are not known for their willingness to fly (Busvine, 1980).

The sharp fall in moth numbers during May 1996 was almost certainly down to a combination of factors:

- The removal of the adult male population by the pheromone traps.
- The removal of all potentially infested specimens (where practical).
- The treatment of the remaining specimens and possible egg laying sites with a residual pesticide by aiding in the control of newly hatched caterpillars.

Monitoring has continued to the present day using pheromone lures

on sticky traps with the result that no Clothes moth or similar have been detected since.

Final comments

It was surprising to have such an established infestation in the affected gallery, especially as at the time the infestation was discovered the gallery was only a year old. Generally it takes about a year for a clothes moth generation to appear (Pinniger 1994), and this one was well established. The feeling is that the infestation was introduced with the construction of the gallery, possibly in one of the bird nests, a point to consider more carefully in future gallery construction projects.

Overall it was felt that the use of the pheromone lures resulted in successful pest control with limited pesticide application. It also demonstrated that the clothes moth pheromone lures have great potential as part of a general monitoring programme, especially in little used storage areas.

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Suppliers

Pheromone lures
Insects Limited Incorporated, obtainable from:
Historyonics
17 Talbot Street
Pontcanna
Cardiff CF1 9BW
Tel 01222 398943

Sticky Traps
Historyonics
as above

AgriSense-BCS Ltd.
Pontypridd
Mid Glamorgan CF37 5SU
Tel: 01443 841155

Pesticides
Many available, but a good recommendation is an water based permethrin spray which has become available since this infestation occurred. This is called Constrain and is available from Historyonics (contact address above).

Julian Carter
Conservation Officer
National Museum and Galleries of Wales

Insect Pest Control in Collections Course

Since graduating with an MA in the Conservation of Fine Arts, Works on Paper, from the University of Northumbria at the end of August, I have been working as an intern in the Paper Conservation Section at the NMGM Conservation Centre, Liverpool. In the new year I will be starting my new job as Conservator with West Yorkshire Archives Service in Wakefield.

While at Liverpool I was fortunate to receive a bursary from 'International Academic Projects' in London to attend the above course at the Liverpool Museum on the 4th and 5th December.

The two-day course was an informative, lively and practical introduction to the prevention, monitoring and handling of infestations. This is a problem or issue that I am almost guaranteed to come across, to a greater or lesser extent, throughout my career as a paper conservator. David Pinniger, Tracey Seddon and Steve Judd lead excellent informative, visual and interactive sessions focussing on key areas such as pest identification, eradication and health and safety. A useful resource pack was also provided which will be my first port of call on the subject in the future. By working in teams (and so getting to know other professionals in related fields) and looking at real specimens and environments, simulated hands-on experience was gained which will translate well into a real situation. Indeed, with my newly acquired knowledge I was recently able to identify part of a larva case from a previously infested leather and fabric miniature case I am treating. Finally, this course provided the ideal beginning to my own Continuous Professional Development at the outset of my career as a paper conservator, and one which will be a hard act to follow.

Shirley Thomas

Paper Conservation, The Conservation Centre, Liverpool

Insect Pests at Willis and other Hampshire Museums, 1996-7.

In my Springtime editorials I was always warning about ingress of pest beetles and moths, and although the biology collections at Hampshire County Council Museum Service have remained largely insect free, taxidermy specimens on static

display in the Hampshire Museums have suffered at the mandibles of *Anthrenus* and *Attagenus* larvae.

The Willis Museum in Basingstoke has a large panoramic display showing an oak woodland merging into heathland, complete with fur and feathered specimens. Early last year a jay specimen was reported to be "looking rather tatty". In fact it had been munched to a heap of feathers by both *Anthrenus* and, especially, *Attagenus* larvae. Once the specimen had been fumigated it was consigned to a jar, in my Black Museum. This year a hedgehog became the next victim to an attack, solely by *Attagenus* who munched their way through the skin and even reduced many of the hedgehog's spines to dust! Since this specimen had been freeze-dried, I have kept the larvae together with the specimen in a sealed container in the hope that, over the next year, they will make a fine skeleton!

Despite vigilance on behalf of the Museum Assistants who know what to look out for, the Red House Museum in Christchurch has also had its fair share of pests. This year. *A. verbasci* larvae managed to tunnel inside a field mouse and hide all their cast skins under a nearby piece of lichen!! Does this suggest that this beetle's larvae are evolving a certain cunning against detection? So far, at least, I have been lucky that nothing rare or expensive-to-replace has been hit and which would beg the awful question of whether the specimen was worth replacing - "Rather an expensive meal" I heard a curator saying at a recent meeting.

Display cases, large or small, always seem to have openings for pest moths and beetles especially, to get through - how an *Anthrenus* beetle manages to enter through a gap that would barely accommodate a postage stamp edge-on is both amazing and worrying.

HCCMS has recently improved its Mk 1 nitrogen fumigator prototype and results have shown a 100% knock-down of all insect pests. A larger tank is to be purchased in 1998. This has proved infinitely more effective, safe and convenient than fumigation by methyl bromide, with all its problematic side effects, and CO_2:, (expensive).

Pests - some less usual occurrences

Beetle larvae that survived freeze-drying

I have heard of some insect larvae being frozen to -30°C and put under a vacuum to 0.01 atm and then walking away after reaching room temperature. Certain invertebrates have their own built-in antifreeze system; spiders are well-known for this which makes them difficult to freeze dry. The present instance involved a large specimen of the birch polypore *Piptoporus betulinus* which underwent freeze-drying over a 3 week period. Four days after the process had been completed, a small amount of frass was observed in its storage polybag, which was put down to an unclean bag. The next day there were about 20 beetles, which proved to be *Cis bilamellatus*, wandering around in the bag with increased amounts of frass. The fungus was quickly frozen and the beetles were killed. Since then there has been no further infestation to this specimen. So beware that freeze-drying may not necessarily kill off any lurking pests!

Mice

Last year the Red House Museum in Christchurch also reported a rodent infestation: one of the displayed mannequins in Victorian dresses had suffered the indignity of having its shoe nibbled quite severely during the night. Although no mice were caught, their mode of entry to the case via a ventilation panel was effectively blocked off and the problem was solved until a contractor moved it and the mice came back. Despite tempting them with milk chocolate none were caught and once again the mannequins had to undergo the further indignity of having their long skirts lifted over their heads!

The incident of the chocolate was puzzling since, some years ago, my Mother had left some chocolate digestive biscuits in our beach hut only to find, a few days later, that mice had carefully nibbled away the biscuit half leaving a thin chocolate slice reminiscent of an after-dinner chocolate! These were of plain rather than milk chocolate however.

Dogs

Dogs will often enjoy a piece of leather whether it's a dog-chew strap, your belt, even a knife sheath. A personal tragedy: a beautiful late 17th century personal eating knife in its original shagreen-veneered sheath and fitted with decorative silver mounts. The sheath and knife were removed from the middle of a (large) kitchen table during the night. The knife was recovered from the dog's bed the next day with some blood stains on the blade, no sheath until, during breakfast (!!!) the dog vomited up its nocturnal booty. Unfortunately the semi-digested sheath was irrecoverable but a rather unpleasant search revealed the silver

mounts all bright and sparkling. The blood stains occurred when the dog cut its lip on the knife blade! Is there a moral here?

S.J. Moore
Conservator of Natural Sciences
Hampshire County Council
Museums Service,

Pests in Geological Collections

I suspect that most articles in this issue will concern insect pests and biological collections. I felt it might be useful to describe a few instances of pest infestation in geological collections.

Mice infestation in a palaeontological collection

I encountered a mice infested fossil collection on a work experience placement from my Museum Studies course. My task for the two weeks was to go through wooden drawers housed beneath display cabinets, check the collection against an existing register, check identifications and taxonomy, then clean, accession, re-bag and complete computer catalogue entry cards for someone else to copy type onto the local authority mainframe computer.

Specimens had old paper labels attached with animal glue and most were housed in thin polythene bags. As work proceeded, it was found that several of the shallow drawers closer to the floor had a pest problem. A colony of mice had had a field day, the polythene bags were chewed to shreds to make nests, some labels had also been chewed up, possibly with the added benefit of tasty animal glue to eat, drawer bases were stained with urine and there were mice droppings all over the place. The general stirring up of the collection had caused some specimens to break and pieces to become disassociated, a few specimens had also been gnawed.

Fortunately, the existence of an earlier catalogue and the systematic ordering of specimens meant that it was possible to sort out each drawer fairly easily. The mice had not managed to move specimens between drawers.

The museum was heated by large pipes running beneath the floor with cast iron grills on top.

Presumably, the mice had entered the building via these heating ducts.

Rats!

A friend of mine was forced to discard their geological collection for similar reasons. The collection was housed in an old chest of drawers, carefully wrapped up in newspaper, and kept in the workshop in the garden.

Due to the neighbours habit of keeping a sheep in the back garden, rats became a problem in the area. Some considerable time after the rat man had been to put down poison bait, my friend decided to have a look at his collection. The rats had returned to their nesting spot inside the chest of drawers to die, leaving an most unpleasant mess of shredded newspaper and rotted rat. The collection was a complete write off.

Invertebrate pests in geology collections

Poor storage conditions for collections, such as sheds and temporary buildings, often means that cabinets are infested with woodworm and cabinet contents with museum beetle, silverfish, spiders etc. regardless of the contents. If such an old collection is acquired by a museum, it should not be assumed that just because it is a geology collection, it won't have a pest problem. I have spent many hours cleaning shed skins of museum beetles off geology specimens, picking off remains of insect bodies and then treating cabinets for woodworm.

Recently, I have encountered similar problems in an old egg collection. Fortunately, in both institutions, all incoming material is quarantined and fumigated (either by methyl bromide or freezing) so pests were dead by the time the collection came to be conserved and curated.

Prevention

Most of the problems described above could have been prevented by housing collections in good conditions rather than poor quality sheds and temporary buildings. A regime of housekeeping, tidy storage of packaging materials, regular inspection of collections and very strict enforcement of locations in which food and drink can be consumed within the museum environment would have prevented problems from escalating. Preventing access to buildings by keeping windows closed, blocking holes to the outside and ensuring that doors and loading bays close properly will prevent pests from entering in the first place. Rubbish bins with food waste stored close to entry points will encourage rodent pests.

Many larger museum stores have trays or boxes of poison bait in place in stores, but if present, the creatures are likely to die somewhere inaccessible. Having collection furniture raised to allow easy access for cleaning underneath will reduce the rotted rat risk. (Williams & McLaren 1990).

Routine quarantine and "fumigation" of collections, either newly acquired material or specimens that have been out of the building for some time before they enter main stores will prevent problems from spreading into museum stores.

References

I have included a few references that may not be that well known in the UK:

The well written series of CCI (Canadian Conservation Institute) Technical Bulletins include three of relevance for reducing the risks of biological agents.

Strang & Dawson, 1991 Controlling museum fungal problems - *CCI Technical bulletin no. 12*

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Williams & McLaren, 1990, Modification of storage design to mitigate insect pest problems. *Collections Forum* Vol 6 no 1 pp27-32

Katherine Andrew

INSECT PEST CONTROL IN COLLECTIONS SUPPLIERS

Insect traps	**ICS Group Industrial Pesticides North West** Hygiene House, 21-29 Brasenose Road, Liverpool L20 8HL Tel: (0151) 922 4149
	Killgerm Chemicals Ltd P.O. Box 2, Ossett, West Yorkshire WF5 9BW Tel: (01924) 277631 Fax: (01924) 264757
	R E Child 17 Talbot Street, Pontcanna, Cardiff CF1 9BW Tel: (01222) 398943
Sample vials/ centrifuge tubes (for containing insects not in traps)	**Oakes Eddon & Co Ltd** Scientific House, Dryden Street, Liverpool L5 5HH Tel: (0151) 207 3062/3/4 Fax: (0151) 298 1206
	Fred Baker Scientific 6/7 Dalton Court, Astmoor Industrial Estate, Runcorn, Cheshire, WA7 1PU Tel: (0928) 566976 Fax: (0928) 580438
	Or any laboratory suppliers
Insecticide formulations:	
Dethlac(lacquer spray	**ICS Group Industrial Pesticides North West**(see above)
Drione (dessicant dust)	**Killgerm Chemicals Ltd** (see above)
Vapona/similar dichlorvos-based insecticide strips	**Boots, Superdrug, largesupermarkets**, etc...

Hazard Data Sheets	Your product supplier
Hazard labels	**Seton Ltd** Department B, P. O. Box 77, Banbury, Oxon OX16 7LS Tel: (01295) 269955 Freephone: 0800 585501 Or any chemical supplier
Protective clothing (gloves, masks, etc)	**Advanced Industrial Supplies Ltd** Sir Thomas Longley Road, Medway City Estate, Rochester, Kent ME2 4DP Tel: (01634) 719422 Fax: (01634) 2902269 **Kimberley-Clark Ltd** Service and Industrial Division, Larkfield, Maidstone, Kent ME20 7PS Tel: (01622) 777000 **Oakes Eddon** (see above) **Preservation Equipment** Shelfanger, Diss, Norfolk IP22 2DG Tel: 01379) 651527 Fax: (01379) 650582 Or any laboratory suppliers
COSHH Information Management System	**Seton Ltd** (see above)
'Ageless' and equivalent oxygen absorbing sachets	**Conservation by Design** Timecare Works, 60 Park Road West, Bedford MK41 7SL Tel: (01234) 217258 **Preservation Equipment** (see above)

Oxygen barrier film	
BDF 200	**Conservation by Design** (see above)
ATCO	**Emco,** The Coach House, Felder Court, Worth, Deal, Kent CT14 OBD Tel: (01304) 620400 Fax: (01304) 614422
Marvelseal	**Preservation Equipment** (see above)
Moistop foil	**Protective Packaging** Dane Road Industrial Estate, Dane Road, Sale, Cheshire M33 1BH Tel: (0161) 976 2006 Fax: (0161) 976 3330
Poly bags (sealable)	**Oakes Eddon & Co Ltd** (see above) **Preservation Equipment Ltd** (see above) Or any laboratory or plastics suppliers
Polythene sheeting	**Westaway Polythene** North Cheshire Trading Estate, Prenton, Merseyside Tel: (0151) 608 8046 Or any plastics company
Heat sealers	**Conservation by Design** (see above) **Key Industrial Equipment Ltd** Blackmoor Road, Ebblake Industrial Estate, Verwood, Wimborne, Dorset BH13 6AT Tel: (01202) 872371 Fax: (01202) 826453 **Power Plastics** (see above) **Preservation Equipment Ltd** (see above)

Freezers	**Froscold Refrigeration Ltd** Ormskirk, Lancashire Tel: (01695) 576139
	Payne Scientific P.O. Box 1769, Slough, Berks SL3 9YN Tel: (01753) 582441 Fax: (01753) 591353
	Strevens Ltd 2nd floor, 34 Ash Street, Bootle, Liverpool L20 3HA Tel: (0151) 933 2552 Fax: (0151) 933 2761
	James W Turner (Liverpool) Ltd Fleming Road, Speke, Liverpool L24 9LS Tel: (0151) 486 5707 Fax: (0151) 448 1204
Fumigation bubbles	**Power Plastics** Station Road, Thirsk, North Yorkshire YO7 1PZ Tel: (01845) 525503 Fax: (01845) 525485
Portable Museum Vacuum Cleaner	**Preservation Equipment Ltd** (see above)
Micro Vacuum Attachment Kit	**Preservation Equipment Ltd** (see above)

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Tracey Seddon
The Conservation Centre
NMGM

houses the library, research and collections and administrative staff, conservation, preparation and research laboratories and the National Natural History Collections.

Funding regimes were also very different, both the Parks and Archives building ere briefed and equipped from a wish-list and much to the surprise of Parks staff, the wishes were largely granted. The Parks building internal arrangements re designed by individual lab teams with certain specialist pieces of equipment re-used, but new benching , whereas the Archives building seemed to be design to one concept and seemed to be all new. The CMN building was equipped from an entirely different stand - that of re-using as much as possible existing equipment and furniture (including items such as fume cupboards and elephant trunking but upgrading to a standard range of new storage furniture based on good quality units already in use in many of the collection areas. The upgrades and re-packing of specimens into good quality specimen containers as part of the move preparation resulted in a huge saving on temporary packing materials and time, unpacking once moved in was largely unnecessary because of these upgrades.

Problems with the building on moving in were very different. At the National chives, the uncompromising design of unfinished concrete in the storage vault has led to retrospective sealing and in one case painting inside the vaults; corridors remain unsealed and rather dusty. A last-minute modification to the design of the fine art vault had to be made at the concrete pouring stage when it s realised that the ceiling height would not be high enough for large pictures.

The building seemed to incorporate a huge amount of expansion space, however, collecting policies include all Canadian broadcasting, government paperwork an so the rate of accrual of material must be high. The conservation suite was breathtaking - it resembled a show room packed with the most modern equipment rather than a working space, however the conference tour did take place a few days fore the official opening and staff were clearly preparing for this event.

At the Parks building, problems arose due existing structures within the building, such as pillars and a rusting floor, but modifications to improve spaces we made as building progressed. Flow and movement of