Guidance Document

# Pest Management in Museums

When managing heritage collections of any size and complexity, prevention is always better than cure. A pest can be any creature that has potential to cause harm to objects. This document will focus on insects, but the direct and indirect impact of birds and rodents should not be ignored.

**Pest Prevention**

Pest management should not be a reaction to the discovery of insect activity and damage. Success comes from identifying risk and implementing a strategy to best minimise those risks and avoid a pest situation from escalating. Every museum or collection can reduce the risk by adopting an integrated pest management (IPM) programme. This includes adopting good building practice to keep pests out, monitoring for pest activity and targeting treatment only where and when it is needed.

Pest management is also not the exclusive responsibility whose role includes this function but should be communicated to, shared with and understood by all those who use and work within the museum space.

To stop insects getting in consider

1. Pest proofing buildings
2. Housekeeping
3. Quarantine procedures

**Building proofing**

Seal external windows and internal and external doors. Place signs to ensure doors to collection areas are not left open. Deny birds the opportunity of roosting and nestng by ensuring chimneys are capped and sills are bird proofed. Electrical wires and conduit and plumbing services can provide access points for insects and rodents if not well sealed. Dear birds and rodents can encourage insects.

**Improve housekeeping and limit food sources**

The vacuum is the pest manager's best tool. Collection spaces should be clean and dry to deter pest activity. Identify any difficult to treat spaces such as under plinths in galleries or behind cabinets in stores, especially those that may encourage the build-up of dust and fibres. All spaces should receive at least one deep clean each year. Remember to empty cleaning equipment after each use and dispose of material away from the building.

Classify areas within the building according to the risk they present to the collection and aim to limit activities within high-risk areas. Designate specific areas for food storage and consumption (staff and public) and implement strict and regular cleaning regimes in these areas.

**Quarantine procedures**

There is always a risk that new items being added to the collection, whether permanent or on loan, could harbour pests. Isolate objects in a specially identified space or area to ensure you are happy they can be added to the collection. A higher risk is posed by organic materials that are similar in nature to the collection and those that have come from unknown environments. Do not ignore inspecting the packing cases and wrapping materials

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## Identifying an infestation

In addition to trapping, it is a good policy to adopt a process of visually checking the environment for pests. Everyone who works in the building can play an active role and training and materials should be made available to educate others in what to look out for. Finding any insect or signs of insect activity within a museum can be a worry but it is not necessarily a cause for panic. Spiders, woodlice, and flies can often find a way to enter and may simply highlight the need to improve building proofing.

Should the insect or activity be a pest species and is dead the key question is whether it is new to the building or historic in appearance. A sudden increase in insect numbers is likely to indicate an active population.

## Insect Traps

The use of insect traps for monitoring is the first priority in setting up an IPM programme in historic houses or museums.

### Sticky blunder traps


Non-specific sticky traps should be used as basic monitoring devices for insects such as silverfish, booklice, ground beetles, carpet beetles and other crawling insects. Sticky blunder traps are good for monitoring the residual population of insects in a building to assess the risk to the collection. They can also give a useful indication of the number of crawling pests which are invading a room or building.

Traps should be placed in a regular grid pattern against wall floor angles, preferably in corners where they will catch more wandering insects. Plastic floor traps are low in height and can be tucked under shelves and storage units. Numbers should be matched to the priorities of the collection and a trapping programme should not exceed the resources available to check the traps.

As the traps do not contain an attractant, they will continue to be effective for as long as the glue remains tacky (affected by dust).

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**Pheromone traps**


Pheromone traps baited with the synthetic attractant lure for Webbing Clothes Moth *Tineola bisselliella* or Case-bearing clothes moth *Tinea pellionella* can be very effective. The flight activity of the males is stimulated by the pheromone and suspended traps provide a very useful early warning of infestation. When temperatures are high enough to promote flight, up to 20 times as many moths may be caught on traps with pheromone lures as on unbaited ones. When temperatures are below 18°C, the males are reluctant to fly, and the suspended traps may be less effective. In these situations, the pheromone trap can be placed on the floor, especially if the floor is carpeted, when the traps with lures will catch more male moths. Pheromone traps typically last 12 weeks and need to be replaced.

Placement of these traps is more complex than simple sticky traps. Individual lures are available for certain moth species and other museum pests such as carpet beetles. Baited traps should be used in areas where there is a high risk to valuable objects or where a particular pest insect species is suspected to be present.

**General principles of insect trapping in museums:**


- Survey the site and use a map of the building to prepare a plan to place traps
- Traps should normally only be placed in areas where there are collections at risk.
- Place sticky traps in a regular grid pattern with all traps date-labelled and their position marked on a plan.
- Place traps on floors in corners and near walls, at wall-floor junctions, not in the middle of open areas. Insects will often travel around the periphery of rooms.
- Place also near windows, at either side of doors and other access points such as chimneys.
- Check traps at regular intervals. A suggested frequency of trap check is four times a year in March, June, September and December.
- Identify and record insects caught on traps. It is also useful to record whether insects caught are larvae or adults.
- The more traps that are used, the greater the chance of finding insects but the workload should not be underestimated, and trapping programmes should be designed to be manageable.
- Pheromone lures and traps will catch far more moths than unbaited traps. This may cause panic initially. They are valuable for accurate monitoring and early warning in sensitive areas.
- Large numbers of non-pest insects may be caught on traps if they are near outside doors. When this happens, the traps should be replaced more frequently, or the trapped insects will become food for pests.
- Over time, a record of catch will help create a picture of the distribution of insects. Additional traps should be placed in areas where pests need to be more accurately pinpointed.
- Traps should be used to supplement regular visual inspection of vulnerable objects and the information can be used to target preventative and remedial measures.

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## Which are the key insect pests?

The following is a short list of the principal insect pests found in heritage situations.

A growing collection of insect pest factsheets for these and other insect pests are available at https://historyonics.com/insect-fact-sheets/

Furniture Beetle
(*Anobium punctatum*)

Wood borers will infest both wooden objects and timber structures. Furniture Beetle is one of the most destructive pests of buildings, while older timbers are at risk from Deathwatch Beetle, particularly oak and elm.

Adult Furniture Beetles are dark brown beetles, 2.5-5mm long. The head is not visible from above. Larvae are not often seen, living in tunnels for 2-5 years (Woodworm).

Damage
Outbreaks are often found in outbuildings or areas that are damp due to leaks, condensation or poor air circulation. New holes produced by insects emerging will appear clean, fresh, sharp and light in colour. Furniture beetle larvae will attack most wood except heartwood, preferring starchy hardwood and softwood. Books and compressed wood pulp paper may also be attacked.

Management
Learn to identify the difference between active and historic infestations. Management is a combination of good housekeeping, regular building maintenance and targeted treatment. Objects suspected of infestation should be brushed or vacuumed to remove dust and isolated and checked regularly from March to June. Eliminate damp conditions and ensure leaks are remedied.

Treatments include heat, freezing or microwaving affected materials and the use of residual insecticides such as Constrain to affected areas to provide residual protection.

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Varied Carpet Beetles

Carpet Beetles cause serious damage. The most common species found in buildings in the UK is the Varied Carpet Beetle. Adults are small round beetles, 2-3mm long with a pattern of white, brown and gold scales. In older adults, the scales can appear brown or black in colour. Larvae, often referred to as woolly bears, have alternating light and dark brown stripes, hairy with a tuft of dark hairs at the rear. They grow from 0.5mm long to 5mm.

During the summer, adults are often found on plants outside. After mating, the females fly through open windows into buildings to lay eggs on material of animal origin. They will also infest bird nests.

Damage
Often the first sign of an infestation is the empty, hairy cast pupal skins or adult beetles on indoor windowsills. The larvae are voracious feeders and will rapidly damage a wide range of protein-based materials, making small, neat holes in the materials under attack. They will attack fur, feathers, taxidermy and wool textiles, they will also graze on animal glue in book bindings, mounts, and picture frames and will also eat horn and tortoiseshell. Most

larval feeding activity takes place in dark, undisturbed locations. They can move long distances from their source in search of food.

Management
Control is a combination of good housekeeping, regular maintenance and targeted treatment. The Historyonics Museum Trap can catch adults and larvae, and can give an indication of the severity of an infestation, and the species involved. Add a food general attractant or specific pheromone lure to improve catch.

Remove birds' nests and the carcasses of dead animals from lofts, chimneys, eaves, etc. Rigorously clean vulnerable areas, vacuuming edges of fitted carpets and under furniture. Deep freeze affected materials and use Constrain or diatomaceous earth to provide residual protection.

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The most common Attagenus species found across the UK, it is most often found in historic houses. They are difficult indoor pests to control as the larvae can forage widely.

Adults are black, oval in shape, 4-6mm in length and have a characteristic white spot on each wing case. Larvae are up to 10mm in length and carrot shaped. They are covered in hairs that lie flat along the body, white with dark brown bristles and long tail hairs. Adults are active flyers and as they are attracted to light sources they are often found on windowsills. Adult females lay batches of eggs secreted in cracks and crevices in dark, undisturbed areas directly on the food material. They often gain entry into buildings through birds' nests lodged in blocked chimneys.

Two Spotted Carpet Beetles (Attagenus pellio)

Damage
Larvae feed on dead insects and will attack protein-rich materials such as wool textiles, feathers, fur, mammal and bird skins and natural history collections, causing serious damage. Wool curtains and carpets are also at risk.
Often the first sign of an infestation will be the empty, striped cast skins left behind on infested material due to pupation. Damage takes the form of holes and bare patches.

Management
Control is a combination of good housekeeping, regular building maintenance and targeted treatment. The Historyonics Museum Trap will catch adults and 'woolly bears', and can give an indication of the severity of an infestation. Adding pheromone lures can be very effective in attracting adult males. Dermestid attractant tablets will also help monitor for both adults and larvae.

Remove birds' nests and the carcasses of dead animals from lofts, chimneys, eaves, etc. Rigorously clean vulnerable areas. Treatments include deep freezing of affected materials and the use of residual insecticides such as Constrain and diatomaceous earth in voids.

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Biscuit Beetle
(Stegobium paniceum)

Also known as the Bread or Drugstore Beetle, this is a common pest of stored food, feeding on plant and animal products such as bread, flour, rice, animal feed, and even spices and drugs. In heritage settings, larvae can also attack horn, wool, hair and book bindings.

Adults are smaller and lighter in colour to Furniture Beetles but can also be confused with Tobacco Beetles. Adults are excellent fliers above 20C and are attracted to lights.

Eggs are laid on or near food which may be in places where it has been badly stored, dropped or forgotten. Adult beetles may also be seen around disused fire-places which have nests of wasps or birds.

The life cycle ranges from 2-7 months depending on temperature. Several generations can occur per year depending on climate storage conditions.

Damage
Telltale signs of infested items are holes puncturing packaging of food items and pockmarking of food items like crackers and pasta, as well as loose powder at the bottom of storage bags. While adult beetles do not feed, they are adept at chewing holes.

Management
Biscuit beetle larvae like dark, warm, undisturbed places. Search for the food-source if adults are found. Rarely-used dried-food is often the source of an infestation.

Remove disused and old foodstuffs and block access into the attic by birds and wasps. Store food in airtight glass, plastic, or metal containers. Certain infested food can be frozen to kill all life stages.

The use of an appropriate pheromone trap and carrying out thorough inspections can help determine the location and degree of a Biscuit Beetle infestation.

Australian Spider Beetle,
Ptinus tectus

Golden Spider Beetle,
Niptus hololeucus

There are many species of these general scavengers, that feed on dried foodstuffs, and organic debris. If populations are allowed to build up, they can pose a nuisance and be a cause for serious concern. They are increasingly prevalent in historic houses and once established are difficult to eradicate.

They resemble small spiders, with their long antennae mistaken for a fourth pair of legs. The dark brown Australian Spider Beetle is easily distinguished from the Golden Spider Beetle, which has a shiny gold round body and is slightly larger. Adults are 3-5 mm long. Larvae of both species are similar in appearance, but are rarely seen, as they live in the food.

They are increasingly common in older buildings where they live in birds' nests and organic debris in attics, and chimney flues. Spider Beetles are long lived and are slow breeders and can take up to a year to complete their lifecycle.

Damage

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Larvae will tunnel through the food as they eat, gnawing cavities in hard materials before pupating in whitish silk cocoons. They are pests of starchy food, organic debris and vegetable and animal detritus. They will attack insect collections, animal skins, dried plants, herbarium specimens, textiles and books that contain a high starch content or animal glue. Adults will occasionally chew through packaging material. They will feed on dead insects such as cluster flies, that can provide a good food source if not removed regularly.

Management
Control is a combination of good housekeeping, regular building maintenance and targeted treatment with insecticides like Constrain.

Identifying their source of food is critical to preventing and controlling infestations. Blunder traps will catch adults and larvae, and can give an indication of the severity of an infestation.

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A serious insect pests of fabrics and textiles. Adult moths are small with shiny, silvery-gold scales approximately 5 - 8mm in length with a tuft of orange hair on the head and long thin antennae. The larva is whitish-transparent in colour with an orange-brown head, reaching 10mm. The larvae produce tiny gritty pellets of excreta called frass and are often hidden within strands of webbing. Moth eggs are very small and difficult to find.

Common (or Webbing) Clothes Moth (Tineola bisselliella)

Adults fly poorly when cool, usually near the floor running over surfaces with a scuttling motion. When warmer they can fly well and may sit on walls. They avoid light and seek dark concealed areas. Adult females can lay up to 100 eggs on fur, feather, skin, wool or silk. In heated buildings there may be two to three generatios (egg to adult).

Damage
Adult moths do not feed. Larvae will feed on a wide range of protein-based materials, including fur, feathers, taxidermy and wool textiles. This occurs most in dark, undisturbed areas or crevices or creases. Larvae will cause irregular holes with quantities of silk webbing tunnels across the surface of the material. Larvae prefer soiled materials.

Management
Look for signs of moth in clothing. Wool carpets are often attacked at the edges and under furniture which is not often moved. Items in storage or infrequently used are at higher risk, as they may be undisturbed for a long time and are vulnerable.

The ready to use Pheromoth Trap will catch adult male moths for 3 months. Constrain can be sprayed around the edges of carpets and inside wardrobes to kill both adults and larvae.

Good housekeeping will help prevent infestations. Regular and thorough vacuuming removes dirt and debris that insects live, feed and breed in. Check unused clothing and other textiles. If clean, uninfested items are best stored in sealed containers to prevent moths causing damage.

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Case-bearing Clothes Moth
(Tinea pellionella)

A moth that has adapted to feed on stored fabrics. Adults are 5-8mm in length, silvery grey, with two faint dark coloured patches on each wing and orange-brown hairs on the head. The whitish-transparent larva has an orange-brown head and characteristically spins a silken cocoon around itself, hence the common name. They never leave this silken case behind but enlarge it as they grow, leaving a trail of grazed material and gritty frass pellets. The case takes on the colour of the fabric upon which they feed, making it difficult to identify.

Damage

Adults generally do not stray far from where larvae are feeding. They shun the light and hide in dark undisturbed areas. Females lay batches of 40-50 eggs onto fur, feathers, skins, wool or soiled silk. Damage is most often found in hidden locations such an underneath collars or cuffs of clothing, in crevices of upholstered furniture and in carpeted areas beneath furniture. Eggs hatch in 4-10 days and the larvae then seek out a food source and eat until they transform via a pupa into adults. The larvae and pupa can survive for months without food, which makes eliminating an infestation difficult. There may be two or more complete lifecycles (egg to adult) per year.

Management

Sources of infestation often originate from birds' nests from where they can spread rapidly into buildings. Control is a combination of good management, housekeeping and targeted treatment. The more pressure that can be applied to clothes moths to disrupt the population, the more success can be achieved. Rigorously clean vulnerable areas, vacuuming edges of fitted carpets and under furniture. Treatments can include deep freezing of affected materials (two weeks at -20°C) and the use of insecticides such as Constrain® or diatomaceous earth around skirtings, inside wardrobes and drawer linings etc. Speciality pheromone dispensers and traps can help detect new infestations. Use impregnated hangers and strips in wardrobes and drawers to protect clothing and deter moths from becoming established.

Booklice

These fast moving, tiny, cream-coloured or light brown insects, occur in small numbers in many premises. Psocids are scavenging insects. The species known as booklice are so called because they are commonly found amongst old books. They feed primarily on fungi, algae, lichen, and organic detritus in nature but are also known to feed on starch-based items like grains, wallpaper glue and book bindings.

Booklice range from approximately 1 mm to 2 mm in length. Eggs take two to four weeks to hatch and the insect matures through four recognisable nymphal stages becoming adults approximately two months later. Adult booklice can live for six months.

Damage

Booklice are always associated with damp. It could be caused by new plaster drying out, condensation from not having enough ventilation in buildings or leaking water systems.

Booklice stick their eggs on crack and crevices and emerging young feed on mould caused by damp. They are also believed to feed on microscopic moulds that grow on the glue of book-bindings or on damp cardboard, damp

food (especially cereals) or on surfaces close to damp plaster inside buildings; very common with new premises.

Booklice do not leave behind a great deal of evidence of their presence, so it might be difficult to know there is an infestation unless seen.

Management
The major problem posed is the nuisance they cause, especially when found in large numbers. Prevent creating conditions they like and keep susceptible rooms well ventilated and dry.

The tape on the underside of Historyonics Museum traps can help monitor for small insects such as booklice.

Silverfish are frequently found in areas of high humidity (above 75%-80%) which they need to breed. They can cause serious damage to paper and cellulosic materials. The Grey Silverfish (Ctenolepisma longicaudata), a much larger species, common in Europe, and recently found in the UK, can survive in much drier conditions.

Silverfish

Adults have long, tapered, segmented bodies, covered with silver scales, 10-15 mm in length. They have 2 long slender antennae and 3 long, thin, tail-like appendages. Rarely seen nymphs, are similar to adults but smaller and translucent. They are nocturnal, emerging at night to forage. If disturbed, they will quickly disperse looking for a further secluded place to hide.

Damage
Silverfish can live on starch, animal glue, surface organic material and moulds on paper, household dust and debris. They will scrape, instead of bite, the surface of paper, creating irregular, ragged holes. This mechanical action erodes the paper, resulting in thinned and weakened material and irregular and thinned edges.

They can also damage photographs by eating the gelatin layer. Other objects attacked include postage stamps, historic labels, paper currency, wallpaper and clothing. Paper discolouration often occurs as a result of fungi associated with their feeding habits.

Management
Control of Silverfish is a combination of regular building maintenance and good housekeeping. Aim to eliminate damp conditions. Ensure foliage is removed from building exteriors to prevent moisture ingress and to facilitate air circulation.

Moving books, magazines and papers around bookcases is an effective method to disturb and prevent Silverfish establishing harbourages in these areas. Monitor with low profile traps such as the Historyonics Museum Trap with added Silverfish attractant if required.

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**Pest Management Solutions**

To effectively tackle an infestation there are three steps:

1. Treatment of objects
2. Treatment of the environment

The last option of any IPM approach is to employ a pesticide. Also biological products are now available to consider to minimise residues and leave no long term effects. Non-pesticidal treatments can include physical approaches to alter the conditions to create a situation which the pest cannot survive but these often only help to clean or rid an object of a pest and offer no long term protection.

If you discover an insect infested object, it is important to thoroughly bag and wrap these in the place where they are found to avoid transferring the pest to other parts of the building.

**Temperature - Freezing**

Low temperature treatment or freezing is common in museums. Many materials can be treated with this method. The low temperature needs to be maintained for the correct period of time, remembering that the core of the object may take some time to drop to the desired temperature. Insect eggs are resistant to temperature changes and can survive short periods at sub-zero conditions.

- -30°C; minimum of 72 hours maintained throughout the object
- -18°C; minimum of two weeks maintained throughout the object.

Some items should not be frozen: Material under tension such as musical and scientific instruments; any material that is damp or wet; rubber and plastics.

To ensure no damage occurs to the object during freezing, ensure they are dry; wrap in polythene as closely as possible to the objects form, using materials such as tissue to fill voids.

Once freezing is complete, allow to acclimatise to room temperature before unwrapping.

**Temperature - Heat**

Insects cannot survive temperatures more than 52°C. Even slightly lower temperatures could render the insect incapable of normal growth, depending on the stage exposed to the heat treatment. Heat can be delivered by convection process (heating the room) or microwave (targeting the moisture within an object – typically the insect larva) and can be used for moth and beetles. This treatment is not suitable for material such as wax, or anything that may melt, and caution should be applied if objects have undergone conservation treatment. Chambers and equipment are now available to allow rooms and objects to be heat treated. Some chambers regulate the RH at the same time.

**Anoxia and Adjusted Atmosphere**

Anoxia treatment reduces the oxygen level below a threshold for a period of time long enough to kill the insect by drying it out. Small scale treatments can be carried out by sealing an object with an oxygen barrier film and placing oxygen scavengers in the package. A good seal is essential as is a temperature of around 22°C to ensure the insects are active. The treatment time is around 5 weeks.

As an alternative to removing oxygen, gases such as Nitrogen and Carbon dioxide can also be used to change the atmosphere around sealed objects. This is a process largely carried out by specialised contractors.

**Insecticidal treatments**

Should an insect situation require treatment there are many treatment and application options available to museums. Historyonics products are designed for properties to carry out their own treatment but in some cases, such as dealing with rodents and birds, pest control contractors may need to be employed. In this case look for those registered with the BPCA (British Pest Control Association) or NPTA (National Pest Technicians Association).

Insecticidal products can be loosely identified as

1. Residual or surface treatments
2. Space treatments
3. Protection devices

**Residual**

Insecticidal sprays can be used to treat rooms and spaces to directly target insects or leave a deposit that control the insect as they walk across treated surfaces or when larvae try to eat treated materials. Constrain contains cypermethrin in a micro-emulsion which protects the insecticidal active ingredient and provide a long period of effective insecticidal use when applied to surfaces.

Desiccant dusts based on DE or diatomaceous earth, kill insects by abrading the cuticle which causes the insects to dehydrate. DE has a long residual life and are ideal for use in voids or hidden spaces.

**Space Treatments**

If a room has a cryptic or hidden insect presence or the insects are located in difficult to reach areas, a mist or fog treatment will generate very small droplets that can be directed into the required area. An electrical aerosol generator can be used to treat large areas, but for smaller spaces, total release aerosol cannisters provide a flexible and easy to sue alternative. Products containing pyrethrum provide a non-residual treatment option.

**Protection Devices**

Textiles and other keratin containing museum items left for long period undisturbed such as in storage can become target for pests such as clothes moths and dermestid beetles. Strips and hangers impregnated with the volatile insecticide transfluthrin, allow for simple treatment for 4-6 months. The treatment works best in enclosed spaces such as drawers and cabinets.

*This document is intended as a guide and further advice and guidance is available from Historyonics as required.*