

## KNOW YOUR BUGS!

Historic properties and cultural institutions should have an Integrated Pest Management Policy in order to effectively prevent damage to their collections. Having an IPM plan sets a schedule for monitoring, housekeeping, and identification of potential pests. IPM is the safest manner of pest control because it seeks to prevent infestations, where possible, and avoids the use of chemical pesticides that may cause damage to collections material and create health risks.

Proper prevention requires determining how pests might enter the building and collections areas and, once they are in, what might allow them to continue to live and breed. The identification of pests found is the first crucial step in solving the problems that these invaders can cause. Exact identification provides important information about their food sources, preferred environmental and shelter conditions, as well as their life cycles. Trapping pests can be very helpful for monitoring infestations: catching pests and evaluating increasing/decreasing total numbers. However, they are not a tool to help identify your pests or a means to eradicate the pest problem.

This technical note provides a list of the most common cultural heritage institutions pests in North America and Europe, and information about food sources and life cycles. Knowing what food pests eat helps identify collection items most at risk; knowing how and where they reproduce allows to reduce, and possibly eliminate, the breeding areas. The guide is not comprehensive and does not include vertebrates such as birds, bats, and rodents. For more detailed information on this topic, more pest images, or trap suppliers' lists refer to the resources at the end of the document.

**STORAGE NOTE:** If polyethylene bags are used and sealed properly in storage areas, collection objects are safe from pests.

**EXHIBITION NOTE:** Do not use felt for displaying objects; it contains wool which many pests prefer to lay eggs in.

### WEBBING CLOTHES MOTH (*Tineola bisselliella*)

Webbing clothes moths can often be seen running over the surface of objects when exposed to light or flying aimlessly in rooms or closets. The adult males are small, champagne-colored and do not eat collections. Items injured by clothes moths have holes eaten through them by the larvae, which is the damaging stage. Their frass is pelletized and webbed within the material (very different from carpet beetles!)



**Food:** they feed on wool, hair, feathers, furs, upholstered furniture, occasionally dead insects, dry/dead animals, milk powders such as casein, and nearly all animal products such as bristles, dried hair, and leather. Materials left undisturbed for some time or stored in dark places (such as a closet, attic, or drawer) are most severely damaged by these insects.

**Life Cycle:** female adult moths are white and vary in size from 1.5 mm when first hatched up to 9 mm when full grown. They lay 100-150 eggs. The length of the larval period depends largely on the environmental conditions and the quality of food.

**Trap use and placement:** best placed on the floor or in closets in rooms where woolen, silk fabrics, furs, or items with feathers are stored. One sticky trap, glueboard per closet or storage room can attract and catch the male moths. Hanging traps with specific sex pheromone lures are also an option for monitoring. These traps will act as an early warning tool to help prevent destruction of textiles and fabrics.

### **CASE-MAKING/CASE-BEARING CLOTHES MOTH (*Tinea pellionella*)**

Adult Case-making moths are slightly smaller than Webbing clothes moths. Body and wings are buff to golden with a brownish tinge, except for three dark spots on the front wings. The brown headed larvae will spin a silken case that it carries around with it as it feeds, essentially carrying its own cocoon. They can be found inside the material they are feeding on and in remaining frass (different from Webbing cloths moths!).



**Food:** larvae feed on wool, hair, feathers, furs, upholstered furniture, occasionally dead insects, dry/dead animals, milk powders such as casein, and nearly all animal products such as bristles, dried hair and leather. Adults do not eat. Materials left undisturbed for some time or stored in dark places (such as a closet, attic, or drawer) are most severely damaged by these insects.

**Life Cycle:** female adult moths lay 100-150 eggs. The larvae is the damaging stage. The length of the larval period can vary within 33-48 days and it depends largely on the environmental conditions. Adults are white with brown heads and vary in size from 6 mm when first hatched up to 9 mm when full grown.

**Trap use and placement:** best placed on the floor in closets and rooms where woolen, silk fabrics, furs, or items with feathers are stored. One trap per closet or storage room can attract and catch adults. Hanging traps with specific sex pheromone lures are also an option for monitoring. These traps will act as an early warning tool to help prevent destruction of textiles and fabrics.

### **VARIED CARPET BEETLE (*Anthrenus verbasci*)**

Varied carpet beetle adults are 2-3 mm in length. The dorsal side of its body is mostly black in the center, with a variable, irregular arrangement of white, brown, and yellow scales. Adults fly and are attracted by light. To look for infestations on carpets, lift a corner 15 cm as they usually like to



lay eggs in dark spots with easy access. The frass produced by these insects has the same color of the substrate they are eating.

**Food:** larvae feed upon a variety of animal products, mostly keratin based, such as carpets, woolen goods, skins, furs, stuffed animals, leather book bindings, feathers, horns, whalebone, hair, silk, fish manure, and dried silkworm pupae. However, they will also feed on plant products, such as rye meal, cacao, corn and red pepper. Specifically, in museums, they will eat insect and ethnographic collections. They are also attracted to rodent baits, so exercise caution when using them.

**Life Cycle:** The females lay eggs near possible food sources. The larval stage is the destructive stage. The period from egg to adult will last about 1 year, possibly more depending on environment.

**Trap use and placement:** Pheromone lures are available for this pest to attract the male of the species. They are good fliers, so any hanging sticky traps with fresh pheromone lures will work well.

### **BLACK CARPET BEETLE (*Anobium punctatum*)**

The adult Black carpet beetle is 2.8-5 mm in length. It is mostly dark brown to black in color. The larvae is long and carrot shaped with a tuft of hairs emerging from the rear end.



**Food:** larvae feed upon a great variety of animal and plant products, such as carpets, felt, woolen goods, skins, furs, stuffed animals, leather book bindings, feathers, horns, hair, silk, cattle hair, and insects. Also, it feeds on plant products such as seeds, grains, corn, and cayenne peppers. In museums, ethnographic collections are very vulnerable to these insects.

**Life Cycle:** females lay 42-114 eggs near possible food source. The larval stage is the destructive stage. The period from egg to adult will last about 1 year, possibly more depending on environment.

**Trap use and placement:** Pheromone lures are available for this pest to attract the male of the species. They are good fliers, so any hanging sticky traps with fresh pheromone lures will work well. Outdoor species are attracted to light so Stealth LED fly lights will also work to attract them.

### **BROWN CARPET/VODKA BEETLE (*Attagenus smirnovi*)**

The adult Vodka beetle is a good flyer and moves around fairly quickly. They can often be found in windowsills, as they seek light. They can spread throughout rooms and between floors by moving through cracks in walls, ventilation ducts, etc. Signs of Vodka beetle infestation will most likely be in the form of damage to specimens, frass, and the cast skins from larval insects, as they complete several molting stages on the way to maturity.



**Food:** eats wool, textiles, carpets, skin, feathers and fur. The larvae feed on organic materials, such as dried plants, seeds, or animal material. Their frass can cause food contamination.

**Life Cycle:** adult females lay about 50 eggs in a lifetime. At room temperature, the larva will develop into an adult beetle in 6-18 months. Larval development is dependent on environmental conditions (food, humidity and temperature) during which they shed their skin 12 times. When the larvae are disturbed, they feign death.

**Trap use and placement:** monitoring with sticky traps can be helpful to detect the presence of these beetles, pheromone lures can be used to attract males preventing them from mating.

### **WAREHOUSE BEETLE (*Trogoderma spp.*)**

This small, oval beetle is a common pest of many types of artifacts. The adult is a tiny black beetle with white or lightly colored markings on its back. The larvae are orange-brown in color and look hairy. The hairs of the larvae can cause allergic reactions in sensitive individuals especially when swallowed.



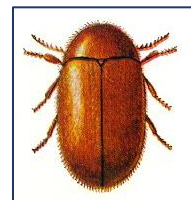
**Food:** voracious feeders, they readily feed on a wide variety of animal products such as dried food, and freeze-dried animals, but also plant materials including seeds, cereals, corn, corn meal, nut meats, and dried vegetables.

**Life Cycle:** The life cycle from egg to adult can be completed in 43 days, but they can stay in diapause (hibernation) for up to two years.

**Trap use and placement:** males are extremely attracted to the pheromone bullet lures. These traps should be hung in areas where botanicals are stored. Traps can be hung along a wall, placed on shelves, or within drawers where herbarium storage takes place.

### **CIGARETTE/TOBACCO BEETLE (*Lasioderma serricorne*)**

The Cigarette beetle is a small brown beetle measuring 2-3 mm in length with wings covered in small hairs. It is closely related to the Drugstore beetle, which can cause difficulty in identification (see below).



**Food:** they feed on a great diversity of materials. They may infest stored food products such as spices, rice, as well as seeds and pharmaceuticals. They like dried plant materials so they can cause serious damage to books and papers. They are especially attracted to tobacco products.

**Life Cycle:** females lay eggs in food; eggs hatch in 6 to 10 days. The larval period lasts 5 to 10 weeks. The pupal period lasts 2 to 3 weeks. Adults live up to a month. The entire life cycle takes about 10 to 12 weeks.

**Trap use and placement:** pheromone traps are hung in areas where foods are stored, or along a wall or can also be placed on shelves or directly on the floor. These traps should be protected from sunlight and wind during use.

### **DRUGSTORE/BISCUIT BEETLE (*Stegobium paniceum*)**

A little bigger than Cigarette Beetles, Drugstore beetles have wings with rows of punctations. Adults are innocuous but larvae are very damaging.

**Food:** plant-based materials and dried protein based substrates are the most affected. It can cause serious damage to books and preserved plant material.

**Life Cycle:** females lay eggs one-by-one in a food source. The larval period lasts from four to five months. The cocoon lasts 12 to 18 days. The complete life cycle takes about seven months.

**Trap use and placement:** the best trapping system utilizes pheromone mimic lures to attract males. Place traps at eye level within 4.5 m of desired areas to monitor.



### **FURNITURE BEETLE/WOODWORM (*Anobium punctatum*)**

This cylindrical shaped beetle is reddish brown and 4-6 mm long. It has punctures on the dorsum in longitudinal rows. The last three segments of the antennae are longer than the others. They are also known as Powderpost beetle or Woodboring beetle.

**Food:** they prefer wood with a high moisture content. Larvae feed on sapwood of many hardwoods, such as oak and ash.

**Life Cycle:** adults emerge in the spring, mate, and begin laying eggs immediately. Females lay 20 to 60 eggs on bare wood surfaces, or inside previous emergence holes in finished wood. The larvae hatch in 6-10 days and immediately tunnel into the wood. The larval stage typically lasts 2 years but can also be as long as 3-5 years. Furniture beetles pupate near the surface of the wood and chew their way out to mate.

**Trap use and placement:** usually noticed because of frass found below furniture. It is important to determine if the infestation is active or not. In case of an active infestation, isolate the infested object and vacuum surrounding areas thoroughly, including cracks and crevices. Flat sticky traps or hanging sticky traps can help monitoring.



### **LARDER BEETLE (*Dermestes Lardarius*)**

The adult Larder beetle is a dark brown to black, 7-9 mm in length, with a pale yellow six spotted band on the back of its abdomen. The undersurface as well as the legs are covered with fine yellow hairs.



**Food:** mostly protein-based materials such as dried museum specimens, wool, fur, silk, feathers, and skins but also stored tobacco.

**Life Cycle:** females lay 100-175 eggs that hatch in 12 days or less. The larvae eat constantly until it molts 5-6 times before pupating. Often times larvae burrow into textiles or even wood before it pupates. The complete life cycle may be completed within 40-50 days.

**Trap use and placement:** a simple blunder sticky trap is currently the best means to monitor for Larder beetles. The trap should be a flat design- rather than a tray design - to allow for easy entry into the trap.

### **BOOKLOUSE (*Liposcelis bostrychophila*) and PSOCID (*Liposcelis spp.*)**

Psocids and common Booklice have long, filamentous antennae and a characteristic bulging clypeus (the area just above the mouthparts). They have chewing mouthparts and no wings. They range in size from 1 to 2 mm in length. Coloration is from almost colorless to gray or light brown. Both nymphs and adults eat surfaces in damp environments.



**Food:** they feed upon microscopic molds. Thus, any manufactured material of plant origin that would support the growth of mold is susceptible. They are found in nature on the bark of trees and shrubs, preferring damp, warm, undisturbed environments. In museum settings, they can commonly be found in books and book bindings, storage boxes, paper goods, and herbaria collections.

**Life Cycle:** Psocids undergo simple metamorphosis to develop to maturity. Eggs will hatch 21 days after being laid. This nymph will reach sexual maturity in 24 to 65 days. Females lay anywhere from 20-50 eggs depending on the time of year. Their total life span is from 24 to 110 days.

**Trap use and placement:** a simple sticky trap is currently the best means to monitor for psocids. The trap should be a flat design to allow for easy entry into the trap. Due to size of this pest, close examination of the sticky trap is required to accurately check for their presence.

### **SILVERFISH (*Lepisma saccharina*) and FIREBRATS (*Thermobia domestica*)**

Silverfish and their close relatives Firebrats are characterized by three long tail-like appendages arising from the tip of the abdomen. They have chewing mouthparts, long antennae and are almost always covered with scales. When viewed from the top, silverfish have a carrot-shaped outline. They are usually a steel gray or metallic silver color and are about 12-18 mm in length. They prefer warm, damp, dark, and undisturbed areas.



**Food:** these insects may roam some distance in search of food. They consume both carbohydrates and proteins. Silverfish feed on paper and paper products as well as textiles. They are particularly fond of paper with a glaze on it, usually a starch compound.

They will also eat the glue backing in wallpaper. They also like cotton or artificial silk. They generally will not eat woolens or true silk.

**Life Cycle:** females adults lay one to two eggs a day. They can live up to 3 and a half years passing through an unknown number of molts.

**Trap use and placement:** a simple sticky trap is the best means to monitor for silverfish and firebrats. The trap should be a flat design to allow for easy entry into the trap. If silverfish damage is suspected, place an index card covered in flour paste in that area. If they are present, feeding marks on the card will reveal their paths. Silverfish baits are also a option for control; they can be placed in a distance of 6-10 cm in areas where there are signs of infestation.

### **GERMAN COCKROACH (*Blattella germanica*)**

The German cockroach is 13-16 mm in length and is brown in color. There are two prominent black stripes running down the broad shield behind the head.

**Food:** they eat almost anything - even hair and fingernails. This insect is common in areas with access to food and water (i.e. break rooms/bathrooms/kitchens).

**Life Cycle:** cockroaches take about a month to grow from egg to adult, and populations can become huge if not kept under control.



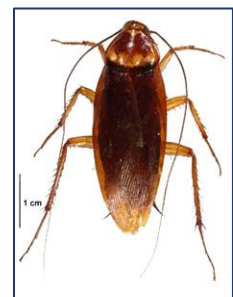
**Trap use and placement:** pheromone traps are available, but sticky traps would work too. These traps should be placed in areas where cockroaches are likely to be encountered concentrating on the kitchen and bathroom. The traps work best when placed along the edges of the floor and in corners. They also should be placed in the cabinet under the sink as cockroaches are usually attracted to water sources.

### **AMERICAN COCKROACH (*Periplaneta americana*)**

American cockroach adults are 34-53 mm long; they are reddish brown in color with a pale brown to yellowish band around the edge of the pronotal shield. The last segment of the cerci is at least 2 times longer than wide. Both sexes have full wings but are poor to moderate fliers.

**Food:** they feed on most any food with a preference for fermenting foods.

**Life Cycle:** females glue or drop an egg case (ootheca) within 4 days of forming. A female produces 6 to 14 ootheca in her lifetime and each ootheca contains 14 to 16 eggs. Average development time from egg to adult is 600 days but can range from 168 to 786 days depending upon temperature and humidity. Adults live



440 days at room temperature but only 225 days at 29°C on average. Cockroaches experience gradual metamorphosis and have no larval form.

**Trap use and placement:** adults travel fair distances along plumbing and heating piping paths from infested basement areas to random rooms. They are then usually noticed near janitor closets, bathrooms, radiators, and other piping areas. Sealing areas related to building piping systems is helpful. Dry floor drains can be screened with fiberglass to prevent cockroaches from entering directly into a room from the drain. If pheromone traps are used, they can be filled with water and topped with a food grade oil to minimize evaporation.

## MUSEUM PESTS SUMMARY TABLE

Type of food sources	Type of pests
Keratin based material (fur, wool, feathers, silk, skin, etc.)	Clothes Moths, House Moths, Carpet Beetles, and Larder Beetles - at their larval stages
Cellulose based material (paper, cardboard, books) preferably in damp environments	Silverfish, Firebrats, Grey Silverfish, and Booklice
Wood (particularly plywood, oak and ash)	Furniture Beetles, Death Watch Beetles, Dry Wood Termites, and Woodlice
Dried plants, food, or seeds	Cigarette Beetles, Drugstore Beetles, Spider Beetles, and Indian Meal Moths
Mold and fungi	Booklice, Fungus Beetles and Plaster Beetles
Human food and waste	Cockroaches, Rodents, Ants, and Crickets

## WEB RESOURCES AND KEY READINGS

<https://museumpests.net/>

<https://www.insectslimited.com/museum>

<https://www.youtube.com/user/InsectsLimited/featured>

<http://www.pestodyssey.org/>



<https://www.canada.ca/en/conservation-institute/services/agents-deterioration/pests.html>

<https://www.english-heritage.org.uk/learn/conservation/collections-advice-and-guidance/>

BS EN 16790:2016. *Integrated Pest Management (IPM) for Protection of Cultural Heritage*. London: British Standards Institution.

Baars C., Henderson J., 2019. Novel Ways of communicating museums pest monitoring data: practical implementation.

Biebl S., 2019. *Practical Emergency Plans in Case of Pest Infestations in Museums*.

CCAHA, 2019. *Managing a Mold Infestation: Guidelines for Disaster Response*.

Crossman A., Pinniger D., 2013. *Museum Integrated Pest Management: a timeline*. In: P. Querner, D. Pinniger, A. Hammer (eds.), *IPM in Museums, Archives and Historic Houses – Proceedings of the International Conference in Vienna, Austria 2013*.

Deacy-Quinn C., 2020. *FUNDamentals of Museum IPM*. Spurlok Museum, College of Liberal Arts and Sciences, Illinois.

Handerson J., Baars C., Hopkins S., 2019. *Standardizing and Communicating IPM data*.  
Mallis, A. 1997. *Handbook of Pest Control*. Mallis Handbook and Technical Training Company.

Museumpests.net, 2019. *Dealing with an Active Infestation. Help! What do I do if I have an Active Infestation*.

Peter W., Pinniger D., Bacon L., Child B., Harris K., Lauder D, Phippard J., Xavier-Rowe A., 2011. *Integrated Pest Management for Collections Proceedings: A Pest Odyssey, 10 Years Later*. English Heritage.

Pinniger D., *Pest Management in Museums, Archives, and Historic Houses*, 2004. London: Archetype Publications Ltd.

Pinniger D., 2015. *Integrated Pest Management in Cultural Heritage*. London: Archetype Publications Ltd.

Portoni F., Doyle A., Phippard J., 2019. *Are we really integrating pest management? Reducing pest risk at a large national museum*.

Querner P., 2019. *Communicating and Teaching Integrated Pest Management*.

Simmons J. E., 2018. *Things Great and Small*. American Alliance of Museums.

Strang T., Canadian Conservation Institute CCI, 1996. *Preventing Infestations: Control Strategies and Detection Methods*.

Strang T., 2012, *Studies in Pest Control for Cultural Property*. Gothenburg: University of Gothenburg.

Strang T., Kigawa R., 2018. *Agent of Deterioration: Pests*. Canadian Conservation Institute.