

Collections Procedure

Pest management

Version: 2.0

1 Procedure statement

The purpose of this procedure is to ensure that staff, research associates, volunteers and visitors of the Collections are aware of the processes they must follow to prevent, or reduce the likelihood of, the introduction of pests. The procedure also covers pest monitoring and pest management practices to minimise damage to specimens as a result of potential pest infestation in the collections.

2 Background and context

The Plant Pathology Herbarium and Insect Collection hold authoritatively identified specimens that represent virtually all of the known plant pathogens and insect pests that occur in Queensland. The collections include irreplaceable specimens that are essential for diagnostics and identification, taxonomic and phylogenetic research, continued market access for agricultural products, State legislation (*Biosecurity Act 2014*), plant health management and education.

3 Scope

This procedure applies to DAF staff working in the Plant Pathology Herbarium and Insect Collection, as well as research associates, volunteers and visitors of the collections.

4 Abbreviations, acronyms and definitions

The **Building Management System (BMS)** is a computer-based automation system (Metasys® by Johnson Controls) which allows Facility Managers to monitor and control the building's mechanical and electrical systems (e.g. lighting, air conditioning).

The **Collection Management System** is the database used to manage and report information about specimens held in the collections. Specimen records are managed by the KE EMu® database.

The **Collections** encompasses the Plant Pathology Herbarium and Insect Collection. Both collections are co-located at the Ecosciences Precinct, Dutton Park, Brisbane, and are managed by Biosecurity Queensland.

An **Insect Pest** in this procedure document refers to living arthropods that are potentially damaging to natural history specimens (e.g. psocids, cigarette beetles), as opposed to the specimens of dead pinned or slide mounted insect pests collected from agricultural and horticultural commodities.

Integrated Pest Management (IPM) is the selection and implementation of a range of pest management techniques that prevent or reduce the development of pest populations with minimal chemical intervention to minimise risks to human health and the environment.

A **Pest Infestation** is deemed to have occurred following the detection of a significant number of insect pests in a section of the collection or insect frass/damaged specimens indicating the presence of insect pests.

A **Specimen** is an individual insect (or group of insects), diseased plant part, living culture, or genomic DNA extracted from an organism.

A **Trap** is a device or enclosure designed to lure, catch and retain insect pests, typically by allowing entry but not exit.

5 Key principles

The Collections use a number of Integrated Pest Management (IPM) techniques aimed at preventing the introduction of insect pests. Environmental controls and hygiene practices are employed to reduce the likelihood of development of damaging insect pest populations without the need for chemicals, which present a workplace health and safety risk.

The International Agency for Research on Cancer classifies naphthalene as a possible carcinogen to humans and animals (IARC 2002). Therefore, prior to the relocation of the collections to the Ecosciences Precinct in 2010, all naphthalene was removed from specimen drawers.

Furthermore, the use of chemicals for pest control at the Ecosciences Precinct is generally discouraged by Facility Managers as this may have adverse effects on live insect colonies maintained on site by different research groups (e.g. stored products team, fruit fly team).

5.1 Preventing access to pests

Preventing pests from entering the Collections Laboratory (2.C.405) is the best way to protect and preserve the collections. A number of preventative control measures have been implemented to exclude pests. All collection staff, research associates, and visitors must follow these procedures to prevent pest entry.

5.1.1 Hygiene practices

The Collections Laboratory (2.C.405) is a 'clean area'

- No paper, boxes or untreated specimens are to be taken into the Collections Laboratory. These can be left on the bench outside the laboratory before entry.
- Specimens from field collections, which have not been treated as per the freezing protocol outlined in Section 5.1.4 are to be worked on within the General Microbiology Laboratory (2.C.408) or other co-located laboratories only. Unprocessed specimens are not to be taken into the Collections Laboratory.
- The Collections Laboratory is to be kept clean by collection staff, research associates, and visitors. Collection staff will routinely sanitise benches with ethanol as the need arises. Visitors are not to leave any material in the laboratory.
- Specimens removed from collections that are taken into the Collections Laboratory, worked on, and returned to the collections within the same day do not need to be treated.
- Drawers or specimens removed from collections and taken outside the Collections Laboratory to the General Microbiology Laboratory (2.C.408) or other co-located laboratories must be frozen before being returned to the collections. Please see Section 5.1.4 for more information on the freezing protocol.
- As outlined in the DAF Ecosciences Precinct Laboratory Procedures Information Booklet, staff should not handle, store or consume food or drink in any laboratory. Food scraps or drinks containers are not to be disposed of in bins in the Collections Laboratory.

Cleaning

The Ecosciences Precinct is cleaned each weeknight by cleaning contractors. The specification for cleaning services developed by the building owner and manager (Department of Housing and Public Works) stipulates that waste is removed and hard floors are mopped each service. Hand washing basins are included in the service, but stainless steel sinks are not. Laboratory furniture, fixtures and fittings are excluded from cleaning.

The cleaners have access to the Collections Laboratory (2.C.405), but not the Herbarium (2.C.403), Entomology Collection (2.C.404) or Alcohol Collection (2.C.406), these three storage rooms must be maintained by collections staff.

Vacuuming or mopping the collection storage rooms will be performed by collections staff at least once per month, or more regularly if the collection has been accessed more often. Collections staff are also responsible for maintaining the cleanliness of laboratory benches, shelving and furniture.

Sticky mats

Sticky mats (600 mm x 900 mm) are placed inside the entrance of the Herbarium (2.C.403), Entomology Collection (2.C.404) and Alcohol Collection (2.C.406). The purpose of these mats is to reduce the likelihood of insect pest entry via footwear and trolley wheels.

Sticky mats are sourced from Clean Com Pty Ltd. They are comprised of 60 sheets of 45-50 µm low density polyethylene coated with an adhesive material. One sheet is removed (along with any contaminants) at least monthly, or more regularly as required, depending on the level of foot traffic in the collection storage areas.

5.1.2 Temperature and humidity control

Collection storage areas should be kept as cool and dry as practicable (Pinniger and Harmon, 1999), this will discourage mould and pest insect activity.

The Herbarium (2.C.403), Entomology Collection (2.C.404) and Alcohol Collection (2.C.406) are continuously air conditioned (24 hours per day, 7 days per week) with a temperature set point of 22°C and a relative humidity set point of 49%.

The Collections Laboratory (2.C.405) is also continuously air conditioned, although the temperature set point is 24°C and the relative humidity set point is 55%, making this laboratory more comfortable for staff working in this space for lengthy periods.

Temperature and humidity monitoring

Temperature and relative humidity within the Collections Laboratory and adjoin storage rooms is monitored by Johnson Controls and DAF Facility Managers using the Building Management System (BMS) (Figure 1). Furthermore, three Tinytag data loggers are located in each of the three collection storage rooms. Data from these loggers is routinely checked by collection staff to identify any gross deviations from temperature and relative humidity set points.

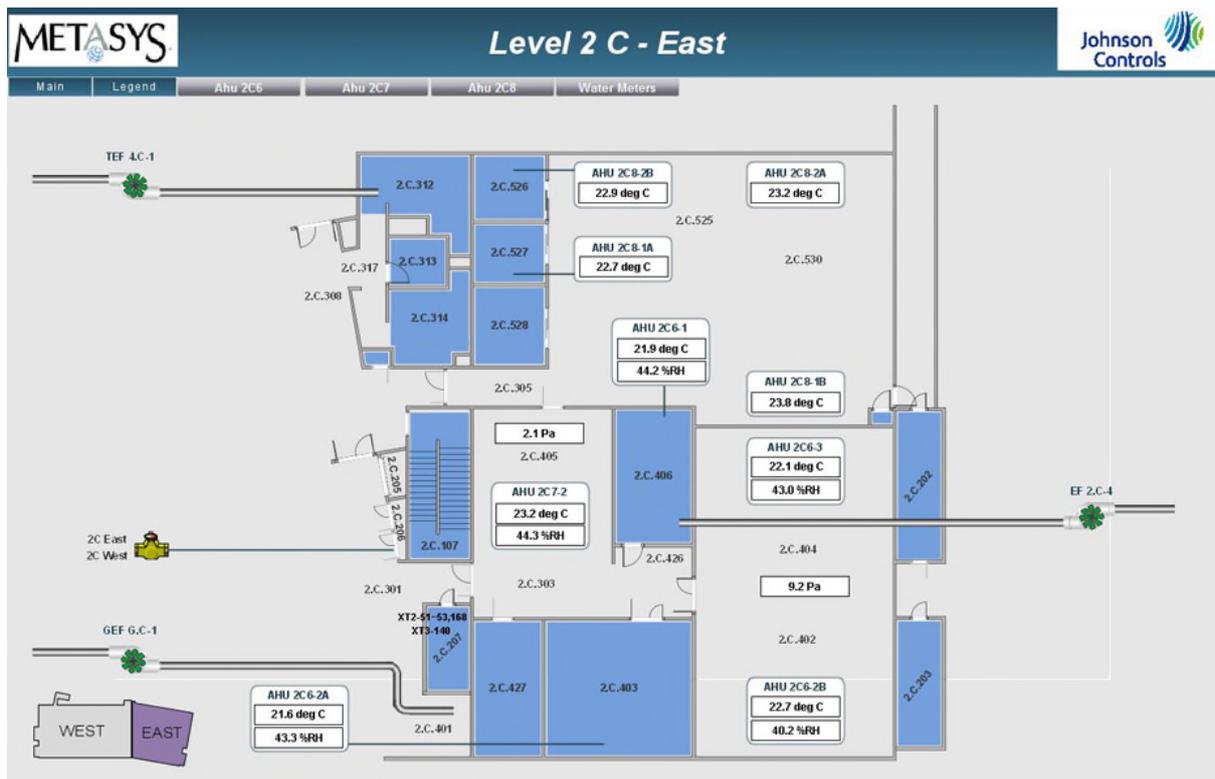


Figure 1. Screen capture of the BMS displaying the temperature, relative humidity and pressure for each of the three collection storage rooms.

5.1.3 Positive air pressure

The air handling unit, AHU 2C6, for the Herbarium (2.C.403), Entomology Collection (2.C.404) and Alcohol Collection has an inlet fan speed higher than that of the exhaust, resulting in net positive pressure in the collection rooms of approximately 10 Pa. The Collections Laboratory (2.C.405), which is serviced by air handling unit AHU 2C7, has a net positive pressure of 2 Pa.

Positive air pressure reduces dust accumulation in the Collections Laboratory and the collection rooms, and also helps to exclude insect pests.

5.1.4 Freezing protocol for specimens

All specimens, dried plant material, paper and cardboard (including packaged laboratory consumables) entering the Collections Laboratory must be treated by freezing at minimum of -20°C.

- Two upright freezers are located within the Collections Laboratory for freezing specimens and two large chest freezers are located in the adjacent Fridge/Freezer Storage Area (2.C.407).
- Drawers and storage containers are to be heat sealed inside plastic bags (to prevent condensation on specimens) and labelled with the name of the responsible staff member along with the commencement date for freezing.
- Specimens are frozen for one week (7 days), thawed for 3 days then refrozen for another week. Plastic bags should remain sealed for 24 hours until the specimens reach room temperature. After thawing, specimens are returned to the collections immediately. Generally the relevant Collection Managers will undertake this process.

- Note: Drawers or containers removed from collection storage areas that are taken into the Collection Laboratory for diagnostic, research or curatorial processes and returned to the collection within the same day do not need to be refrozen.

5.1.5 Heat treatment protocol for slides

While freezing provides a pest control method for most specimens and literature, some associated materials should not be frozen, this includes glass slides for microscopy. All slides entering the Collections Laboratory must be treated by heating.

- A large drying oven is located in the General Microbiology Laboratory (2.C.408).
- Slides are heated in the oven to 40°C for at least 2 weeks (14 days).

5.2 Pest monitoring

Insect activity in the Herbarium and Insect Collection must be monitored and, if detected, dealt with immediately to prevent damage to specimens. Insect activity in collections can be difficult to observe as damage may be hidden within drawers or specimen containers. To reduce the likelihood of specimen deterioration, the following monitoring methods have been implemented to detect insect activity as early as possible.

5.2.1 Sticky traps

Two yellow sticky traps are located within the Herbarium (2.C.403) and Entomology Collection (2.C.404) near each entrance. These traps are to be checked weekly for any signs of insect activity. Traps should be replaced every six months, or earlier if required. Trap type and location, and trapped insects are recorded in the Collection Management System.

If any sticky traps are found with insects, this will trigger a routine pest check to search for evidence of insect activity within specimen drawers or containers in the collections.

5.2.2 Routine pest checks

Pest checks are carried out every 6 months on 10% of the dried specimens held in the Herbarium (2.C.403) and the Entomology Collection (2.C.404). Drawers or specimen containers to be checked can be selected at random, but preference should be given to those not checked during the past 2 years. Estimates of drawers or specimen containers to be checked are as follows:

- Herbarium – Dried specimens in herbarium packets - 76 of 760 plastic containers.
- Herbarium – Dried specimens in metal filing cabinets – 8 of 88 drawers.
- Herbarium – Dried boxed specimens - 200 of 2000 plastic containers.
- Entomology Collection – Timber drawers in automated compactus – 450 of 4500 drawers.
- Entomology Collection - Metal drawers in metal cabinets -115 of 1150 drawers.

Checked drawers or specimen containers are marked with a dated sticker, with different coloured stickers being used each year. Collection staff are to check the bottom of unit trays or specimen containers for evidence of frass. In the Herbarium, collection staff should also check label stickers, as the adhesive glue can trap booklice (see Section 5.3.2, Figure 4). If any frass or live insects are found, collection staff are to follow the treatment procedure outlined in Section 5.4.

5.2.3 Ad-hoc monitoring

During daily curatorial tasks, collections staff, research associates and visitors are to be observant and report any indications of insect activity or damaged specimens to collection managers. If any live insects are seen, they should be captured and contained so they can be identified, and appropriate control strategies implemented.

5.3 Common pests of collections

The most commonly observed insect pests in the Plant Pathology Herbarium and Insect Collection have been booklice and museum beetle. However, other pests such as carpet beetles, pintail beetles, cigarette beetles and silverfish can cause specimen damage.

5.3.1 Varied carpet beetle (*Anthrenus verbasci*)

Varied carpet beetles (family Dermestidae) adults are ca. 3 mm long with elytra and pronotum irregularly patterned white, brown and yellow. Larvae are 4-5 mm long and densely covered in fine hairs, with the body patterned in light and dark brown stripes (Figure 2, 3). The larvae are serious pests of dried biological specimens.



Figure 2. *Anthrenus* adults, larval skin and pupa.



Figure 3. Frass beneath specimens is evidence of *Anthrenus* activity.

5.3.2 Booklice (*Liposcelis* spp.)

Booklice, also known as psocids (order Psocoptera), are 1-2 mm long, soft bodied, pale yellow to light brown insects (Figure 4) which feed mainly on fungi and algae, but may also feed on herbarium specimens, paper and glues (particularly those used in traditional book binding).

The frass caused by psocid feeding is generally finer (more dust-like) than that caused by *Anthrenus* so it is much less conspicuous beneath specimens. Psocid activity is often only detected by chance observation of a live individual walking around inside an insect drawer or stuck to adhesive labels on herbarium packets.

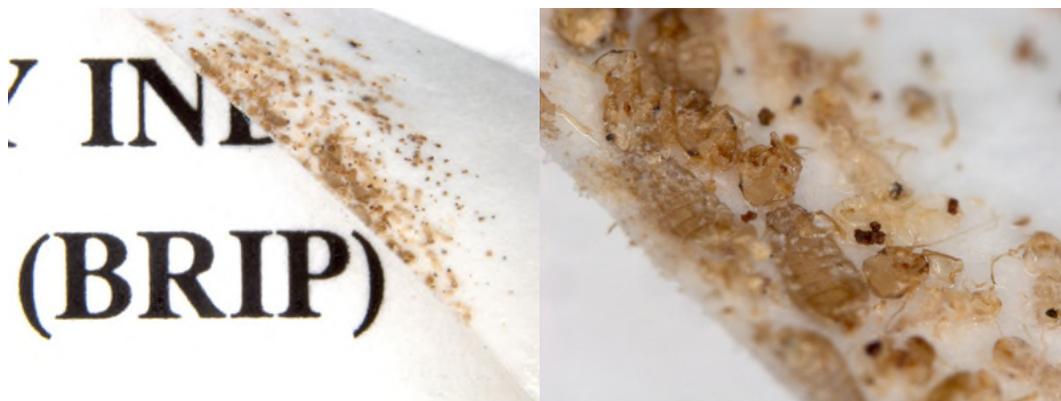


Figure 4. Psocids and frass stuck to the underside of adhesive labels on herbarium specimens.

5.3.3 Cigarette beetle (*Lasioderma serricorne*)

The cigarette beetle or tobacco beetle (family Anobiidae) is ca. 2-3 mm long and brown in colour. It is distinguished from the drugstore beetle by their serrated antennae and slightly smaller size. The larvae are a pest of dried and processed tobacco, but are also known to feed on a wide variety of stored products.

5.3.4 Drugstore or biscuit beetle (*Stegobium paniceum*)

The drugstore beetle or biscuit beetle (family Anobiidae) is ca. 2.5–3.5 mm long and brown in colour. It is distinguished from cigarette beetles by their club-shaped antennae segments. Elytra also have longitudinal grooves, whereas the elytra of cigarette beetles are smooth. Drugstore beetle feed on dried plant material, books and can bore into timber samples.

5.4 Treatment procedure for pest infestations

If a routine pest check or ad-hoc monitoring results in a pest detection, the following treatment procedure is to be followed:

1. Remove the infested drawer or container immediately from the Collections Laboratory.
2. Infested drawers or containers are to be sealed in plastic bags and placed in one of the large chest freezers located in the Fridge/Freezer Storage Area (2.C.407) for two weeks.
3. Next, remove drawers or containers that were adjacent to the site of infestation and process these as per step 2.
4. Check drawers or containers around those removed for evidence of pests. If further pest detections are made, then return to step 1 and repeat the process.
 - a. For 50 drawer cabinets in the Insect Collection, freeze five drawers above and below infested drawers, and also 5 drawers adjacent to infested drawers (Figure 5).
 - b. For 10 drawer cabinets in the Insect Collection, freeze all drawers in the cabinet with an infestation and check all drawers in adjacent cabinets (Figure 6).

- c. For the Herbarium compactus, freeze all containers adjacent to infested containers, and also all containers below infested containers. Check all other containers in adjacent columns within the compactus and freeze containers on the bottom shelf of these columns (Figure 7).
5. Check drawers or containers on the opposite side of aisle and also in the aisle adjacent to the infestation for evidence of pests. If pest detections are made, then return to step 1 and repeat the process.

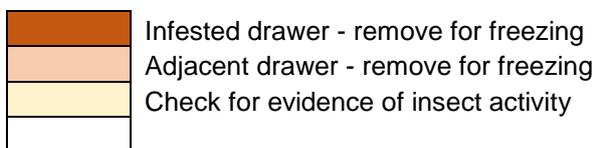
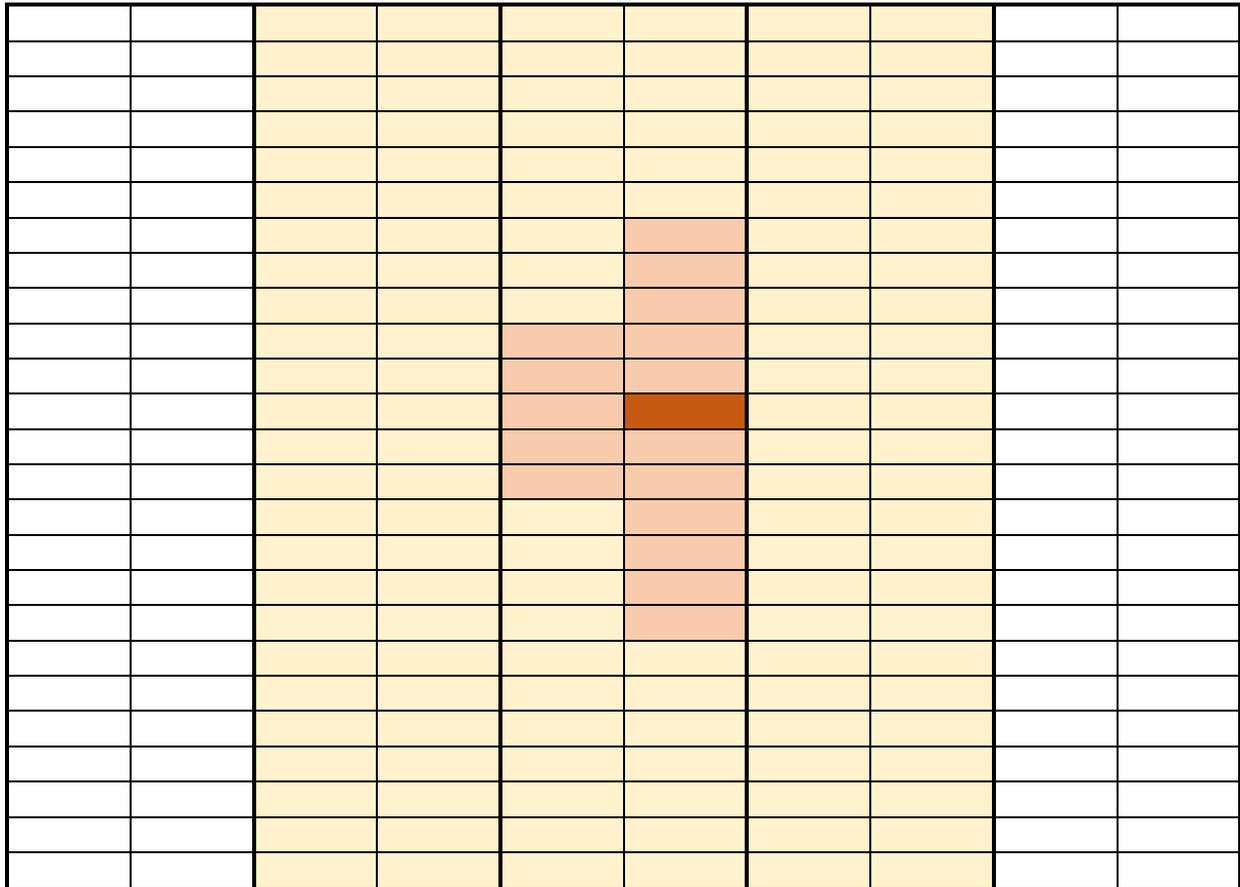


Figure 5. Pest infestation treatment methodology for 50 drawer entomology cabinets.

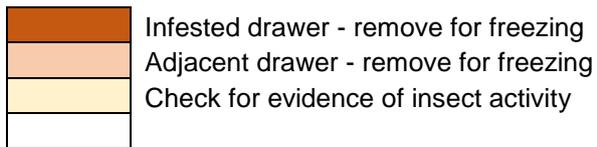
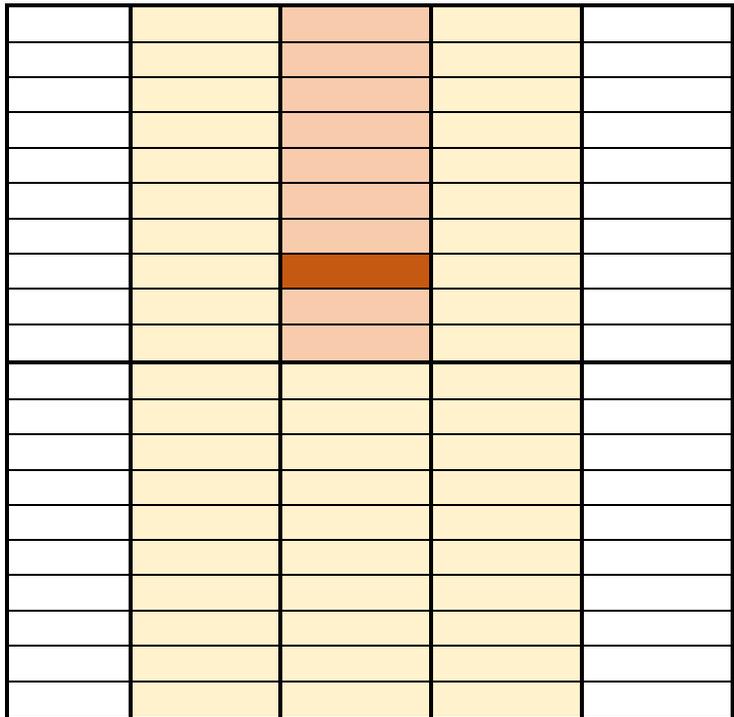


Figure 6. Pest infestation treatment methodology for 10 drawer entomology cabinets.

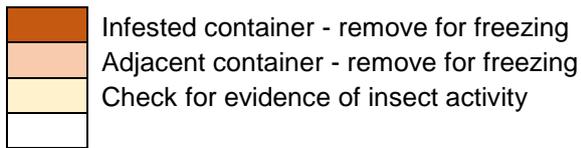
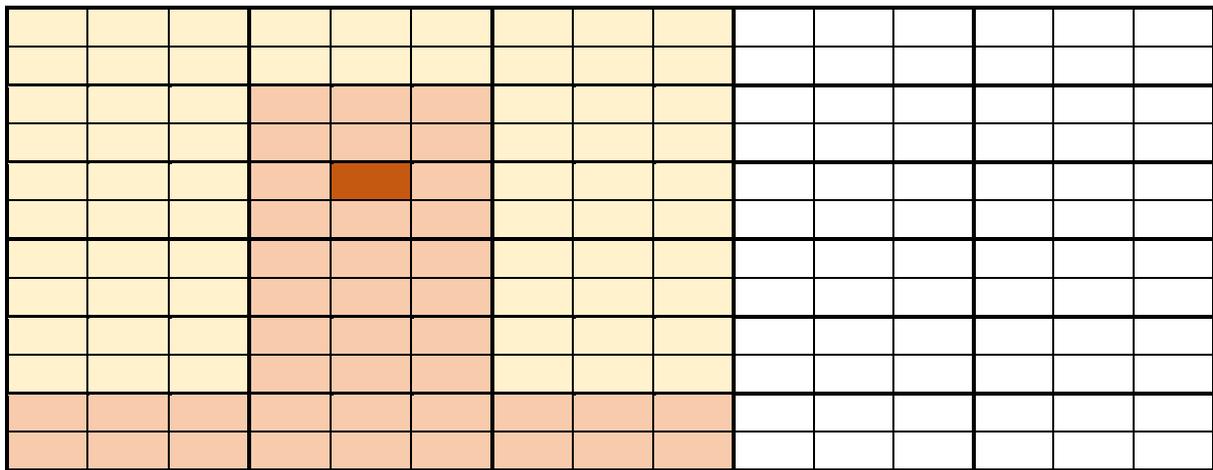


Figure 7. Pest infestation treatment methodology for storage containers in the herbarium compactus.

When drawers or containers are removed from the freezer after two weeks:

1. Stack on the wire racks adjacent to the chest freezer and leave to thaw for 24 hours before opening.
2. Visually check each drawer or container for the presence of dead insect pests and/or frass.
3. Remove dead insect pests and/or frass from unit trays or herbarium packets. Alternatively, replace the unit tray or herbarium packet with a new clean one.
4. If damaged specimens are found, record the accession numbers, so this information can be added to the Collection Management System.
5. Specimens that are badly damaged, should be passed to the relevant collection manager for assessment (and possible de-accessioning).
6. After 3 days at room temperature, refreeze the drawers or containers for another week before returning specimens to the collections, as per Section 5.1.4.

6 Responsibilities and accountabilities

Curator	Approve the pest management procedure. Assist with monitoring and treatment of pests if required.
Collection managers	Ensure pest prevention, monitoring and treatment procedures are implemented. Actively monitor for pests and initiate appropriate treatment procedures if a pest infestation is detected. Record any pest infestations in the pest register.
Collection staff	Ensure that visitors and volunteers are made aware of pest management procedures. Actively monitor for pests, and assist with pest infestation treatment procedures if required.
Research associates and visitors	Follow pest management procedures as directed by Collection managers and/or Collection staff. Report any pests to the Collection managers or the Curator.

7 Source documentation

Not applicable

8 Related and reference documents

Harmon JD (1993) Integrated Pest Management in Museum, Library and Archival Facilities: A Step by Step Approach for the Design, Development, Implementation and Maintenance of an Integrated Pest Management Program, Harmon Preservation Pest Management. Indianapolis

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Pinniger DB, Harmon JD (1999) Pest management, prevention and control. In: Carter D, Walker A (Eds). Chapter 8: Care and Conservation of Natural History Collections. Oxford: Butterworth Heinemann, pp. 152 - 176.

Author Name: Dean Beasley
Title: Senior Research Scientist

Contributing author/s Name: Justin Bartlett
Title: Technical Officer

Endorsed by Name:
Title:

Approved by Name:
Title:

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1.0	03/02/2017	Initial draft
2.0	23/02/2017	Revised procedure