UNIVESITY OF CALIFORNIA
AT BERKELEY

MUSEUM OF VERTEBRATE ZOOLOGY

INTEGRATED PEST MANAGEMENT (IPM) PROGRAM MANUAL

2008/2009

Approved By:

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UNIVERSITY OF CALIFORNIA AT BERKELEY
MUSEUM OF VERTEBRATE ZOOLOGY

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CHAPTER 1: INTRODUCTION

1.1. The Museum of Vertebrate Zoology Collections

The Museum of Vertebrate Zoology (MVZ) at Berkeley houses over 100 years of biological history. The collections represent an irreplaceable physical record of the natural history of California and numerous other localities around the world.

The collections are composed of organic materials such as bone, skin, fur, feathers, and paper. If the proper precautionary measures are not taken, all are subject to irreparable damage and destruction by a variety of museum pests.

Due to the central role that the collections play in every type of research that is done at the Museum, preserving them is of paramount importance. This is best achieved by instituting an Integrated Pest Management (IPM) program that provides a structure in which to make responsible decisions about appropriate prevention and treatment of pest outbreaks.

1.2. The Museum of Vertebrate Zoology Facility

The MVZ is located in the Valley Life Sciences Building (VLSB) on campus. The building houses four large natural history museums and one expansive library, yet remains relatively unprotected and completely unmonitored for harmful pests. There are current active infestations of mice, cockroaches, odd-beetles, red-legged ham beetles, and a few different species of dermestid beetles within the building[1].

Insect infestation is the main threat to the collections, as certain insects are attracted to the organic materials for food and shelter. It is expected that there will be occasional local insect outbreaks inside the MVZ due to the limitations of the building, the MVZ's restricted resources, and the Museum's open floor plan, which places staff offices next to the main collections area. Rodent infestations are a lesser threat because of the MVZ's location within VLSB.

1.3. What is an Integrated Pest Management (IPM) Program?

An Integrated Pest Management (IPM) program is a decision-making process that helps determine if, when, and where pest suppression is needed. It provides a variety of techniques to prevent and solve pest problems, with pesticides used only as a last resort. An IPM Program utilizes knowledge of ecology, the life history of pests, and the environment in which pests thrive and survive. Museum IPM has two goals:

1. *Protect the Museum and it's collections from pests.*

2. *Reduce the amounts of pesticides used in the collections.*

An IPM program is cyclical in nature and each component is ongoing. To carry out an effective IPM program, the MVZ must:

- ***Build consensus*** by working with all staff that are responsible for caring for the collections. To be effective, IPM requires coordinated strategies.

- ***Familiarize*** all persons working in the collections with the pests that can cause damage and the signs of their presence.

- ***Establish priorities*** to focus on tasks in an organized fashion. For example, identify areas of the collections that are most prone to pest outbreaks and monitor those areas more frequently.

- ***Establish action thresholds***. How many insects in the collections are too many?

- ***Monitor*** pests and environmental factors.

- ***Implement non-chemical management***. Prevent outbreaks by employing timely maintenance of the Museum, performing stringent housekeeping and using non-chemical treatments, such as freezing.

- ***Evaluate*** results to be sure the strategies are effective.

- ***Document*** monitoring and treatment actions.

1.4. An IPM Program for the MVZ

A successful IPM program calls for active involvement from all three collections managers in the organization, implementation, and ongoing management of the program.

The MVZ IPM program can be broken into four primary components:

- ***Prevention***. Includes identifying possible points of entry, blocking entry points to the fullest extent possible, reducing the prevalence of attractants left out in the open within the museum, educating the MVZ community in proper pest avoidance practices on an ongoing basis and regular housekeeping.

CHAPTER 1: INTRODUCTION

- ***Monitoring/Record Keeping***. Employs a variety of observation methods to systematically monitor the collections and adjacent work areas on a regular basis.

- ***Detection/Response***. Quickly, effectively, and appropriately take action to prevent the spread of an infestation when it is discovered.

- ***Recovery***. After an infestation has been addressed and actions have been taken to eliminate it, the area needs to be watched closely until it is evident that the response techniques were successful. Once this has been established, the area can be routinely monitored with the rest of the collections.

Although the presence of pests in the VLSB building is chronic, following the procedures outlined in this document will result in infestations within the Museum becoming low in incidence and severity. Infestations will most likely be found in gallery spaces, general use areas, and offices, rather than in the specimen cases. Awareness among all community members and vigilance from the curatorial staff is required for best results.

These recommendations are based on a year's experience monitoring and eradicating infestations in the MVZ, many consultations with pest management experts, and library and web research on museum pest management.

CHAPTER 2: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM OVERVIEW

2.1. INTRODUCTION

1. What information is contained in this chapter?

This chapter contains information on:

- the rational for each component of the MVZ Integrated Pest Management (IPM) program.
- necessary considerations for the implementation of the program.

2. Is there any information on specific protocols for the MVZ IPM program?

No. This chapter provides justification for the protocols that are presented in Chapter 3.

3. Why can't the MVZ continue to use pesticides as the primary method of insect control?

In the past, pesticides were the primary method of pest control in museum collections. They were effective, economical, and easy to apply.

Over the years we've learned that exposure to pesticides can cause a variety of health problems in humans[2], which includes but are not limited to:

- nausea
- vomiting
- difficulty in breathing
- seizures
- skin and eye irritation
- adverse changes in memory and mood
- cancer
- physiological defects

Pesticides can also damage collections by:

- deteriorating proteins such as fur, feathers, and wool
- altering the color of pigments
- causing metal corrosion in iron, brass, and other light colored metals[3]

"Chemical treatments are part of the program, but are generally considered only when all other methods of pest elimination have been exhausted. The application of smaller amounts of toxic chemicals benefits the safety and protection of the staff, public and the longevity of the collection items themselves."— Pat Kelley, Insects Limited, personal correspondence.

CHAPTER 2: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM OVERVIEW

2.2. PREVENTION

1. What is the purpose of prevention?

The purpose of prevention is:

- to reduce attractants that increase pest numbers or lead to infestation
- to create barriers which block access to the museum environment and specimens

2. How do pests enter the MVZ?

Pests can enter the MVZ via a number of routes:

- boring holes or using existing openings
- carried in by people on personal objects or field equipment
- found on loan specimens and/or in packing materials
- can be present in food/food containers that are brought into the MVZ

3. To what are pests attracted?

Pests are attracted to:

- specimens
- paper/packing materials
- plants
- carpets
- artwork
- literature
- wood furniture
- food stored in the MVZ

4. What actions can be taken to lessen the chance of infestation?

Prevention techniques can be grouped into 2 categories:

1. **Cultural Controls:** policies and procedures that can be implemented.

2. **Mechanical Controls:** techniques to limit pest habitats and close off areas where pests enter the Museums.

CHAPTER 2: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM OVERVIEW

2.2.1. Cultural Controls

1. *INSPECT* for pests

ALL material needs to be inspected before it comes into the collections areas. This includes:

- new acquisitions
- loan materials
- packing materials
- field equipment
- books/literature
- plants
- furniture

2. Where are inspections conducted?

All inspections should be done in the 1st floor prep lab where materials can be frozen and quarantined before being brought to the main collections areas.

Inspections should **NEVER** be conducted in the main collections or adjoining areas.

3. What are ways to make the Museum less attractive to pests?

Housekeeping and interior maintenance of collections and common-use areas eliminates shelter and food for pests.

- Clutter and trash should not be allowed to accumulate.
- Storage and packing materials shouldn't be allowed to accumulate if they aren't being put to use. Packing peanuts made of cellulose should be discarded immediately.
- Collections areas should be cleaned regularly so organic material does not build-up on surfaces, especially floors.
- In addition to routine cleaning of dirt, dust, hair, and foodstuffs, a thorough cleaning of the entire facilities must be done once a year.

Proper storage of specimens and other materials protects collections by keeping pests out and inhibiting the spread of pests inside infested cases.

Environment of collections areas: Fluctuations in temperature and relative humidity (RH) can cause damage to the collections and promote pest activity[4]. A climate-controlled environment with positive airflow is optimal for deterring pests.

Monitor the collections areas on a regular basis to ensure that a constant low temperature/low RH environment is maintained.

4. *EDUCATION*

The key to a successful IPM program is to involve everyone who comes in contact with the collections by raising awareness and encouraging community participation.

Unless all persons who have access to the collections areas are made aware of the IPM policies and are given incentives to follow them, it will be impossible to successfully avoid pest infestations.

It is crucial that an effort is made to continually educate the MVZ community in proper pest avoidance practices.

It is also necessary to keep the entire community up-to-date on the current status of the IPM program.

2.2.2. Mechanical Controls

1. *SURVEY* the MVZ premises for routes pests can use to gain entrance to the Museum.

Entry points to the Museum are:

- ***Doorways.*** There are 6 doors and an elevator that open onto the 3rd floor collections. The Pelt Room (1143 VLSB) is accessed through 2 sets of double doors. Currently, none of the doors have door sweeps installed and airflow into the Museum is strong, especially at night.
- ***Windows.*** Rooms 3104 and 3192 in the MVZ have windows that open to the outside.
- ***Floor Drains.*** There is 1 floor drain in the Pelt Room and numerous others throughout the Museum
- ***Ventilation System.*** VLSB has a common ventilation system that could allow pests from other areas of the building to gain access to the MVZ.
- ***Holes***
- ***Cracks***
- ***Junctions between the walls and floors***

Areas for or near collections must be inspected for damage and repaired immediately if damage is found.

Inaccessible spaces, such as drop ceilings and ventilation ducts, can easily hide problems and are difficult to survey and monitor. While it is not feasible or possible to eliminate the drop ceilings or modify the ventilation system, be mindful that areas such as these exist and are possible sources of infestation.

2. Specimen Cases

Specimen cases protect specimens from pests, fluctuations in the environment, and light. They should be regularly monitored for faulty seals and maintenance problems, and repaired as needed.

2.3. MONITORING/ RECORD-KEEPING

1. What is the purpose of monitoring the collections areas?

There have been numerous cases in the literature[5] of great works and scientific materials being lost over the years to pest infestations.

The purpose of monitoring is:

- to quickly detect pest activity in the MVZ collections and associated workspaces before a small containable problem blossoms into a catastrophe.

For the most part, pests are silent and unseen, so without monitoring they can go unchecked for years.

"To respond to a situation, we must characterize the background situation before offering a helpful strategy. The answers are not mechanistic, clear-cut, or without risk of failure."[6]

2. Are there different types of monitoring?

Yes! It is important to monitor for pests and monitor the environment because they provide different kinds of information.

CHAPTER 2: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM OVERVIEW

Pest Monitoring tells you…	***Environmental Monitoring tells you…***
Baseline information on the insects present in the collections	Baseline information on MVZ environment
How pests enter the MVZ	If conditions will support pest activity
Where pests are in the MVZ	If your actions are changing the environment
How many pests there are in the MVZ	If IPM protocols are working
If the control strategies are working	
If there is an outbreak	
What are the target insect species	
What seasonal population fluctuations are occurring	

Taken together, these two types of monitoring can help determine strategies to eliminate future access and survival of pests in the collections. Monitoring can also assist in evaluating of effectiveness of any treatment action that is taken.

3. Where is it important to monitor?

Prioritize monitoring in areas that house specimens or are points of entry to the Museum.

Keep in mind that not all specimens are created equal. While it is necessary to monitor all areas where collections are housed, pests will be more attracted to a bird or mammal study skin than they will be to a sealed ethanol jar.

Also, the VLSB building houses four large natural history museums and a library, all of which have attractants to pests. As the building is relatively unprotected, it is possible for pests to travel throughout the building. It is important to remember that the MVZ is not a closed environment and how other collections in the building manage pest prevention may affect the presence of insects in the MVZ.

CHAPTER 2: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM OVERVIEW

4. How many insects in the collections are too many?

ESTABLISHING ***ACTION THRESHOLDS***

Creating **action thresholds** prior to beginning the monitoring program is absolutely necessary.

Action thresholds refer to the level of pest populations that must be reached before action is taken to avoid damage done by them. Thresholds help determine both the need for control actions and the proper timing of such actions.

Including a written action threshold in the IPM program presents a clear statement of intentions before an infestation event occurs. This guidance can prevent under or over-reactions to pest problems by those who respond to the situation.

Examples:

- ***High action threshold***. Finding one museum pest in a trap near an exit door does not indicate the collections are in immediate danger, but does warrant increased vigilance in that area. More frequent monitoring should continue, but no response is necessary unless more pests appear in the trap.

- ***Low action threshold.*** Finding insect frass and casings in a closed case warrants rapid response. If evidence of pest activity is found in the immediate vicinity of specimens, action is needed before pest damage appears. Removing specimens, freezing them and applying pesticide would be the proper action.

5. Who should monitor?

Members of the MVZ community who are invested in the collections should conduct monitoring. Use of outside vendors or free student labor without supervision may result in missed infestations.

Monitoring is part of collections maintenance and care and, therefore, should be a shared responsibility of the Staff Curators.

6. What is the purpose of keeping records of the monitoring process?

Maintaining accurate and up-to-date records of all monitoring and infestation activity allows for better assessment of the IPM program and enables future situations/problems to be solved more productively and efficiently.

Past efforts must be documented to evaluate if current IPM

strategies are working. Thorough record keeping will allow for easy modification of IPM program components.

2.4. DETECTION/ RESPONSE

1. What is the goal of detecting and responding to evidence of pest activity?

If an infestation is discovered, a quick, safe, effective response is required to prevent the spread of infestation.

There must be a balance between the availability of resources and the acceptable level of pest activity. When the pre-determined thresholds are reached, it is time to respond to evidence of pest presence.

2. What type of response options are available if an infestation is discovered?

The MVZ can utilize several techniques for the physical control of an infestation:

- ***Temperature Control.*** Objects are put into the walk-in freezer set to -27°C for one week. At this temperature, as long as the materials are properly packed, all museum pests that pose a threat to the MVZ should be killed[7].
- ***Chemical Control.*** Nyguard and Tempo may be used in the affected area once the specimens have been removed for freezing.
- ***Anoxic Treatments.*** Nitrogen, argon or carbon dioxide is used to alter the atmosphere that the specimen and the pest inhabit. This is a viable treatment for small electronics and specimens that would be damaged during the freezing process. Kits are available online.

2.5. RECOVERY

1. How do I know when it's okay to return to normal operating procedures?

After an infestation has been addressed and actions have been taken to eliminate it, the area needs to be watched closely until it is evident that the response techniques were successful. Once this has been established, the area can be routinely monitored with the rest of the collections.

"Once an area has been cleared of an existing infestation, the staff should be vigilant in keeping further pests from entering the area. This is done through isolation, inspection, and treatment of new or returning specimens. If this is done, the risk of future infestations in this area becomes very low. Pesticide applications should not be necessary unless new activity is spotted."— Pat Kelley,

Insects Limited, personal correspondence.

2.6. CONCLUSION

If the IPM program is working, all time should be spent on prevention and maintenance and next to none on dealing with live pests and infestations in the collections.

CHAPTER 3: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM PROTOCOL

3.1. INTRODUCTION

1. What information is contained in this chapter?

This chapter contains information on:

- specific protocol for each component of the MVZ IPM program.

3.2. PREVENTION

Cultural Controls

- INSPECT

INSPECT and **TREAT** **ALL** material before it comes into the collections areas.

All inspections must be conducted **ONLY IN THE 1ST FLOOR PREP LAB**. Inspections must not be done in any of the collections areas or adjoining work areas. It is extremely important that the freezer in the Prep Lab remains as the only way that materials come into the MVZ.

All incoming specimens to the collections absolutely MUST be tracked on the PEST CONTROL FREEZING RECORD Excel sheet so that we have a record of when they were last frozen, how long, and when they entered into the Museum collections.

If the PEST CONTROL FREEZING RECORD is not maintained, problem solving is severely limited once an infestation arises.

Materials that need to be inspected/treated include (but are not limited to):

- New acquisitions
- Loans from other institutions
- Loan returns
- Packing material
- Field equipment
- Books/Literature
- Supplies that will be brought into the collections areas
- Furniture
- Plants

CHAPTER 3: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM PROTOCOL

INSPECTION PROTOCOL

1) Open all boxes, cases, or bags and remove all objects to determine if evidence of infestation is present.

   (See Appendix 4.1.5. for a photo example of pest activity in a specimen case)

2) Freeze items that won't be damaged by the freezing process (see Appendix 4.1.2. for specific protol) in the walk-in freezer located in the Prep Lab. **ALL ITEMS COMPOSED OF ORGANIC MATERIAL,** with a few exceptions, **MUST BE TREATED IN THIS MANNER**.

   Exceptions are:
   - Items that are too sensitive to the effects of freezing.
   - Electronics sensitive to freezing.

   Items that cannot be frozen must be treated with *anoxia*. Kits are available online and can be purchased at the expense of the researcher/visitor.

3) Curatorial staff needs to be vigilant about ***packing materials*** received!! Even if specimens do not need freezing (i.e., fluid specimens), all packing material must be frozen or discarded. Biodegradable packing peanuts must ALWAYS be immediately discarded.

4) ***Plants in the MVZ***: Before bringing in a houseplant or flowers, they need to be inspected to make sure they do not have pests on them. Greenhouse cut flowers are best if it is absolutely necessary to have greenery in the MVZ.

   Local cut wild flowers are **NOT ALLOWED** inside the MVZ.

- HOUSE-KEEPING

HOUSEKEEPING PROTOCOL

1) ***Offices.*** Food, dirty dishes, field equipment or animal cages should never be stored in offices.

The Staff Curators should inspect offices **EVERY 3 MONTHS** to ensure housekeeping standards are being maintained.

2) ***Garbage/Unwanted Clutter.*** Items and materials not being used should be disposed of and not allowed to sit around for a long time. **EVERY 6 MONTHS** do a sweep of the collections and work areas to remove any items that are not being used.

Garbage should continue to be taken out on a **DAILY** basis—especially food garbage. If there is an event with food at a time when the custodial staff is not available (i.e., Friday night or weekends), individuals should take out the garbage themselves to the dumpsters at the loading dock instead of leaving it for the custodial staff.

3) ***Food in the MVZ.*** A policy that prohibits the long-term storage of food in ANY of the collections areas or adjoining workspaces must be instituted.

Staff, all curators and lab members (anyone with desk space) are responsible for keeping their offices clean and free of food and dirty dishes.

Food **CAN** be stored in the Herp Lounge or Front Office. Food stored in either a sealed glass, metal or Tupperware container is acceptable for a day or two in your personal workspace, but long-term food storage, even in one of these containers, is strongly discouraged. Refrigerate food whenever feasible.

Food should not be left out overnight in these areas:

- Collections areas/Work areas
- Grinnell-Miller Library (GML) (journals are stored here)
- Herp Lounge (literature is stored here)

Plastic bags, cardboard boxes, and dirty dishes must NEVER be left out.

(See Appendix 4.2.4. for sample sign to post in common areas)

4) ***Spring-Cleaning.*** Perform **ANNUAL** spring-cleaning of the MVZ after Cal Day. A major cleaning should include:

- Non-collections areas (stairways, elevator, landings, emergency routes, hallways)
- All collections areas

Spring-cleaning should include but not be limited to these tasks:

- Sweeping/Vacuuming/Dusting: The entire collections areas must be swept and vacuumed. All floors, beneath furniture and the top of cases should be vacuumed **EVERY 6 MONTHS**. Dust that has accumulated on the top of cases or bookshelves should be removed by vacuuming and then dusting. Special attention should be given to the following areas:
  - Grinnell-Miller Library
  - Pelt Room (1143 VLSB)
  - Floor and shelves in the storage hallway (***this hallway should be sorted and unusable packing material should be discarded on a SEMI-ANNUAL basis***)

- Spray Floors with Pesticide: Application of Nyguard and Tempo pesticide on linoleum floors (including Pelt Room) should be done **EVERY 6 MONTHS**. One of those applications should be done immediately after the annual spring-cleaning is complete. Contact U.C. Pest Management to schedule a spraying appointment.

  (See Appendix 4.3.5. for contact information)

The entire MVZ community must participate. Duties should be divided as follows:

- **Curators/Staff:** clean their office spaces
- **Students/Postdocs:** clean their lab/desk space and as a group clean their office
- **Curatorial Staff:** clean curatorial area and collections areas
- **Group work:** groups are assigned to clean hallways, the reprint room, the Herp Lounge, the GML, and the front office.

PROPER STORAGE

Protect the collections by keeping pests out and inhibiting the spread of pests if items contained inside cases are infested.

STORAGE PROTOCOL

1) Specimen cases should be inspected on an **ANNUAL** basis. Look for faulty gaskets, hardware, and any damage to the frame and walls of each

case.

2) Specimen cases should never be open for more than a few hours at a time.

3) Specimens should ALWAYS be placed in a case or sealed container at the end of the day—never left out, exposed to the air overnight.

4) All mounts in the gallery should be enclosed in Plexiglass display cases (the California Condor mount is an example of a standard Plexiglass case). A Plexiglass case costs approximately $150.00-$200.00. However, this is a long-term investment, as a case will last approximately 40 years.

5) Plastic containers with properly fitted lids or rolling specimen cases should be used for the temporary storage and transport of specimens.

ENVIRONMENT OF COLLECTIONS AREA

The MVZ must be monitored to ensure that a constant low temperature/relative humidity (RH) environment is maintained. The ultimate goal should be a climate-controlled environment with positive airflow in all collections areas.

ENVIRONMENT PROTOCOL

1) Set environmental parameters:

   - 65°F ± 5°F
     50% ± 5% RH
     } For collection spaces
   - Place data loggers throughout collections **EVERY 6 MONTHS** to determine status of environmental conditions. Collect data for a 48-hour period. If fluctuations are present, contact the building manager to determine if a remedy is possible.

2) Contemplate cleaning the ventilation ducts **EVERY YEAR** if there are considerate fluctuations in temperature and RH and/or there is evidence of pest activity in the vicinity.

CHAPTER 3: MVZ INTEGRATED PEST MANAGEMENT (IPM) PROGRAM PROTOCOL

‣ EDUCATION

A continuous effort must be made to keep the MVZ community educated in proper pest avoidance practices and up-to-date on the current IPM program protocols and policies.

EDUCATION PROTOCOL

1) **ONCE A YEAR** these meetings need to be scheduled:
   - IPM program update presented at curator meeting to Faculty Curators and curatorial staff (15 minutes max.)
   - IPM program workshop given to each lab group (15 minutes max.)
   - IPM program evaluation meeting with Staff Curators and the Prep Lab Manager to discuss current issues, latest findings, possible improvements, and updated goals for monitoring, recordkeeping, etc. (1-2 hours)

2) At the beginning of **EACH SEMESTER**, Staff Curators should hold a training session on pest management and identification for all curatorial assistants (approx. 1 hour).

3) Post IPM flyers, posters and maps in high traffic areas and around the gallery.

(See Appendices 4.1.4, 4.2.4 and 4.2.5 for examples)

4) **CREATE ACCOUNTABILITY.** At staff/student training sessions, create accountability by requiring that participants sign a MVZ IPM contract.

(See Appendix 4.2.3 for example of IPM contract)

Mechanical Controls

‣ BUILDING STRUCTURE

BUILDING STRUCTURE PROTOCOL

ONCE A YEAR the MVZ facilities must be surveyed for structural damage and any damage found must be repaired promptly.

1) Conduct a building survey to determine areas around the MVZ that need repair.

2) Repair walls, floors, and ceilings, if necessary.

3) Seal any holes or cracks that are discovered.

4) Seal floor

‣ DOORS, WINDOWS, AND FLOORS

DOOR PROTOCOL

The following doors need to be fitted with door sweeps:

- 4 Emergency Exits: Rooms 3014 (Sound Lab) and 3088 (Klitz/Dunaway office), hallways near Room 3193 (Rauri Bowie's office) and Amphibia Web station
- Main double door to 3rd floor gallery space
- Double doors to Quarantine room on 3rd floor
- Double doors to Room 1143 (Pelt Room) on 1st floor
- ***Optional:*** Door to Herp Lounge. Consider installing a door sweep and closing the door at the end of each day.

EVERY DAY: Doors that access the collections areas from other parts of VLSB should remain closed.

EVERY YEAR: Doors fitted with sweeps need to be inspected to ensure they are functioning and that no repairs are necessary.

WINDOWS PROTOCOL

Both Room 3104 and 3192 have windows that open. These windows and any others near the collections must remain closed at all times.

EVERY YEAR: Inspect all windows to verify that seals and hardware are functioning properly. Make repairs as necessary.

FLOOR PROTOCOL

Inspect floor drains during regular monitoring routine.

Consider installing self-sealing floor drains that allow

liquid to drain but block insects from entering.
Doors to specimen cases should remain closed at all times. The exception is when work is being done to specimens remaining in the cases. Specimens in offices and preparation areas should be kept in cases or in plastic boxes with a properly fitted lid when not in use.

- SPECIMEN CASES

SPECIMEN CASES PROTOCOL

Set standards for cabinet construction. Survey cases for current condition and record current condition status.

EVERY YEAR: Check all cases to ensure that all gaskets, hardware and frame/metal exterior are in working order. Replace worn parts as necessary and update records.

3.3. MONITORING/ RECORD-KEEPING

- MONITORING

The management of monitoring, data collection, and collation should be the responsibility of one Staff Curator (with additional support from the other Staff Curators).

This person will have to take additional time at the end of each year to prepare reports and summaries to inform other staff of the pest management results.

The monitoring, data collection and collation will most likely take the curatorial staff about 2 days every month of man-hours (which would be from the combined efforts of Staff Curators, Curatorial Assistants, URAPs, Work-Study Students, etc.).

Keep in mind that time spent monitoring, cleaning, and applying pesticide can be variable.

INSECT TRAPS PROTOCOL

STICKY TRAPS

1) Place sticky traps in the following locations:
   - 1 trap per specimen case
   - Door to Skull Room
   - Main doors to 3rd floor gallery
   - Inside doors to Pelt Room
   - Along shelving and under pelts in Pelt Room
   - Along window sills (GML, Herp Prep Lab, the curatorial area, all offices)
   - Door to GML

- Door to Room 3140 (Herp. Skels. & Research Storage Room)
- Near drain in Room 1143 and any other drain locations in the MVZ

2) Write date and trap location on each trap.

3) Monitor traps not in cases **ONCE A MONTH**
   - If an insect is found, use a Micron pen to dot a circle around it and then dot a line to the edge of the paper where you can write the date.
   - Record insect activity on monitoring sheet and transfer information into computer database.

4) Monitor traps in cases **ONCE A YEAR**. Follow steps above if insect is found.

5) Replace traps as they become un-sticky and/or full of debris. Make sure insect information written in trap is recorded before discarding.

LIGHT TRAPS

1) Place light traps in the following locations:
   - Room 1143 (Pelt Room)
   - Curatorial area
   - Herp Prep Lab
   - Herp Lounge
   - 3rd floor gallery, along walls where there are outlets, especially in areas where food items are stored (i.e., Ted's trough, outside Room 3189 [map room])
   - Entrance to GML
   - Hallways to office spaces (see Appendix 4.3.4. for map of current trap locations on 3rd floor)
   - Outside of Room 3144 (Skull Room), near elevator
   - Inside door to Room 3140 (Herp. Skels. & Research storage)
   - Inside Room 3104, both office and anteroom.

2) Monitor traps **ONCE A MONTH**
   - If an insect is found, use a Micron pen to dot a circle around it and then dot a line to the edge of the paper where you can write the date.
   - Record insect activity on monitoring sheet and transfer information into computer database.

3) Replace sticky sheets as needed. Make sure insect information is recorded before discarding.

DERMESTID LARVAE MONITORS

These monitors were used in Room 1143 (Pelt Room) to determine if insects were on the shelves. If the room needs monitoring again, it is recommended that new larvae monitors be purchased.

PHEROMONE TRAPS

Pheromone traps are not currently used in the MVZ, but they are a possibility. If sticky and light traps are not working satisfactorily, there are a number of online vendors that supply this kind of insect trap.

DRAIN PROTOCOL

1) **EVERY MONTH**: While monitoring sticky traps, inspect drains to ensure they are not an access point for pests.

3.4. DETECTION/ RESPONSE

DETECTION/RESPONSE PROTOCOL

Ideally, no evidence of pests will be found while conducting routine monitoring. Realistically, there will be times when evidence of pest activity is found.

When that happens, it is important to remember that the response should be appropriate to the threat.

Please refer to Appendix 4.1.3. for the protocol used to stop an infestation and prevent it from spreading.

3.5. RECOVERY

To ensure if the response measures were successful, a previously infested area must be watched more closely following an infestation event.

RECOVERY PROTOCOL

1) Monitor the specimens/area that was infested every 2-3 weeks. Follow the normal monitoring procedures. Continue with more frequent monitoring for approximately **6 MONTHS**.

2) During this period, document the infestation event in affected specimen catalog records and in IPM records. If event has already been documented, check records to ensure the information is accurate and up-to-date.

3) Repair any damage to objects, if possible or necessary.

3.6. CONCLUSION

This manual is based on museum pest management research and experience at both the MVZ and other institutions. By nature, IPM is a highly customized process that should always evolve to fit the specific current needs of the MVZ.

Museum pest control is by nature labor-intensive, time consuming and never ending. However, all the hard work is well worth the end result—a world-class natural history collection that is conserved for future generations.

CHAPTER 4: APPENDICES

4.1.1. FREEZING/QUARANTINE PROTOCOL

GETTING ITEMS READY TO FREEZE

☐ When you are ready to bring items into the collections area, take said items (and any associated packing material) directly to the Prep Lab on the 1st floor.

☐ Make an inventory of all items that you'd like to bring into the collections area.

1) For **ALL** specimens:
   - o Include total count of specimens per box
   - o Note catalog or collector numbers. If specimens do not have an Accn yet, a descriptor of the Accn (ex. GRP Taylor Meadow 2009) may be used.
   - o Note part types (i.e. skull, skin, skel., fluid, etc.)
   - o Give a brief physical description of non-specimen items.

2) For Loan items:
   - o Note Loan number
   - o Note pertinent information from 1above)
   - o Check the items against the invoice sheet

3) Examples of acceptable labels:
   - o Prep Lab Materials: "*Bird Skins: Accn 14456 (PLC 347, PLC 358*).
   - o Field Work Materials: "*GRP Taylor Meadow 2009, Mammal skull only-uncleaned (JLP 3000, 3002-3005), Mammal comp. skels.-uncleaned (JLP 3006-3050), Bird Skins (CC 2500-2580)*"
   - o Loan Materials: "*Loan 3558, 5 mammal skins & skulls, MVZ 226439-226443"*

☐ Get the sealable plastic containers/lids from the Prep Lab walk-in fridge. Make sure that they don't have any cracks or openings in them. For large intakes, you can use a rolling case from the quarantine room on the 3rd floor. Large or oddly shaped items can be wrapped in clean plastic bags for freezing as long as the bags are sealed.

☐ Clean out the interior of the container you choose (plastic or metal rolling case). It should be completely clear of any dirt or insect casings!! **If this step is not done, it will be impossible to tell if there is insect activity during the freezing/quarantine process.**

CHAPTER 4: APPENDICES

4.1.1. FREEZING/QUARANTINE PROTOCOL (cont.)

☐ Pack your items in the container neatly; make sure they will not get jumbled. If you have more specimens that will fit into the bottom of a box, either use a new box or carefully layer them. Separate them with a thin layer of batting or a cardboard tray.

- **DO NOT** pack materials tightly. This creates a lot if insulation, which is undesirable. There needs to be a lot of airflow between items in the box in order for the items to reach the critical temperature.

- **ATTENTION!** If the item(s) are coming from a location that is cold (i.e., snowy, or below 30°F), then specimens need to remain in the Prep Lab for 24 hours before being placed in the freezer. This will help acclimate any pests to the warmer environment and reduce the risk of their ability to super-cool once in the freezer.

☐ Once you have finished packing your items, get a freezer slip from the door of the walk-in fridge and fill it out with the appropriate information.

- Note: you don't have to put all of the information from the inventory/loan sheet on the freezer slip. Write down the loan numbers/accn numbers/MVZ numbers.

☐ Use your inventory sheet/loan sheet to fill out the PEST CONTROL FREEZING RECORD.

- The PEST CONTROL FREEZING RECORD is located on GROMIT. Follow this path: MVZ Groups→ Curatorial→ MVZ Documents→ Prep Lab→ Pest Control→ "Pest_Control_Freezing_Records.xls"
- Fill in the data fields as directed. PLEASE BE SPECIFIC!:
  - For Loans: note the loan number and quantity and types of specimens. For example: "Loan 666: 32 *Onychomys*, complete skels".
  - For Prep Lab/Field Materials: list accns (or accn description), types of specimens (study skin, skel, etc.) and catalog numbers. For example: "4 Bird study skins from Prep Lab: Accn 14444 (PLC 648, 649, 650); Accn 14445 (PLC 651)".
  - If the item(s) are coming from out of state (even if they are originally from this state), the previous location must be clearly noted—NO ABBREVIATIONS, PLEASE.
  - Mark the present date in **BLACK**; write the future dates in **RED** to make it clear that the specimen has not gone through those steps yet.
  - Put your name on the entry so there is a record of who packed what boxes.

CHAPTER 4: APPENDICES

4.1.1. FREEZING/QUARANTINE PROTOCOL (cont.)

☐ Place your inventory/loan sheet in the container with you items. Containers/Rolling cases must remain frozen for a minimum of **ONE WEEK**. Wooden boxes, paper products and packing materials must remain in the freezer for a minimum of **TWO WEEKS**. Items are taken out of the freezer EVERY THURSDAY and brought to QUARANTINE. They must remain in QUARANTINE for one week before they are brought into the collections areas.

- How to fill out a Freezer Slip:
  - ***Date In Freezer***: use the date you are putting it into freezer.
  - ***Date In Quarantine***: find the date of the next Thursday from the date you are putting it in the freezer. It will be ready for Quarantine one week after that date.
  - ***Date Out of Quarantine***: one week from the Thursday it was put in Quarantine.

☐ Put your containers into the freezer as far back as possible on the floor. The shelves are reserved for specimens that still need to be prepared.

MOVING SPECIMENS FROM THE FREEZER TO QUARANTINE
(One week later…)

☐ On the morning your container(s) are ready to come out of the freezer, move them from the freezer into the walk-in fridge. Let them remain in the walk-in fridge until the late afternoon. This allows the containers to slowly come up to room temperature and avoids damage from condensation.

☐ Bring the boxes up to the Quarantine Room on the 3rd floor.

☐ Update the status on the PEST CONTROL FREEZING RECORD by changing the color of the appropriate date (Make today's date black).

MOVING SPECIMENS OUT OF QUARANTINE INTO CURATORIAL
(One week later…)

☐ Transfer boxes with today's date (or earlier) from the Quarantine Room to the curatorial area—unless they are specifically marked otherwise (i.e., "For Monica's case).

☐ Open the box and immediately check for pest damage to the specimens and/or signs of pests (frass, dirt, insect casings) around the specimens or in the corners of the box. Be sure to look inside skull/skeleton boxes as well.

- If items are clean, put specimens away in the proper curatorial cases and put any other materials away in their proper place.

- If you find any signs of Pest Activity:
  - Quickly close the box back up and bring it back to the Prep Lab.
  - In the Prep Lab, remove specimens, clean out box/boxes containing skulls and skeletons, repack the specimens and freeze them again following the freezing protocol.

CHAPTER 4: APPENDICES

4.1.1. FREEZING/QUARANTINE PROTOCOL (cont.)

☐ Update the PEST CONTROL FREEZING RECORD. Change all the date fields to the color **BLACK** and transfer the freezing record to the "DONE" worksheet.

☐ For uncataloged materials and newly cataloged materials:
- o Update Arctos accn remarks field and the Google spreadsheet.
- o PLEASE BE AS SPECIFIC AS POSSIBLE—note what specimen part you have received (skull, incomplete or complete skeleton, study skin, fluid part) and the catalog numbers.

LASTLY… If you have any questions, please ask either your supervisor or Monica before you take action.

Mistakes are bound to happen during the curatorial process and these very specific protocols help us when dealing with mix-ups, lost specimens, and other dilemmas. Therefore, **PLEASE** adhere to them closely to make everyone's life easier.

CHAPTER 4: APPENDICES

4.1.2. MUSEUM PEST MONITORING SCHEDULE

DAILY…

- ☐ Garbage, especially food, is taken out of the MVZ. Individuals must remove garbage at the end of the day if no custodial staff is on duty.

- ☐ Doors that access the collections areas from other areas of VLSB should remain closed.

MONTHLY…

- ☐ Monitor:
  - o Sticky traps not in specimen cases
  - o Light traps

- ☐ EVERY **3 MONTHS** inspect offices to ensure housekeeping standards are being maintained.

- ☐ EVERY **2-3 WEEKS** monitor specimens/areas that were recently infested and treated to ensure treatment strategy was successful. If this monitoring schedule is in use, continue checking every 2-3 weeks for a period of approximately 6 months.

SEMI-ANNUALLY…

- ☐ Search the collections and work areas for any items that are not being used. Garbage and clutter attract pests and should not be allowed to sit around if they are not being used.
  ******* Pay particular attention to the floor and shelves of the storage hallway, items tend to accumulate there.

- ☐ Vacuum:
  - o Tops of specimen cases/bookshelves/misc. furniture
  - o All exposed surfaces of furniture
  - o All floors
    ******* Pay particular attention to GML, Pelt Room, floors & shelves in the storage hallway

- ☐ Dust:
  - o Tops of specimen cases and bookshelves
  - o All exposed surfaces of furniture

- ☐ Spray all linoleum floors with Tempo and Nyguard pesticide (one of these applications can be done after Spring Cleaning)

- ☐ Place data loggers throughout the collection to determine status of environmental conditions. Collect data for a 48-hour period.

CHAPTER 4: APPENDICES

4.1.2. MUSEUM PEST MONITORING SCHEDULE (cont.)

ANNUALLY…

- ☐ Perform Spring-Cleaning of the MVZ after Cal Day

- ☐ Hold the following meetings:
  - o IPM program update at Curator's meeting to Faculty Curators and curatorial staff (15 mins max.)
  - o IPM program workshop for each lab group (15 mins max.)
  - o IPM program evaluation meeting with Staff Curators and Prep Lab Manager to discuss current issues, latest findings, possible improvements, and updated goals, etc. (1-2 hours)

- ☐ Survey MVZ facilities for structural damage

- ☐ Inspect:
  - o Door sweeps
  - o Windows
  - o Case construction/hardware

- ☐ Monitor:
  - o Sticky traps in specimen cases

- ☐ *Optional*: Clean ventilation ducts if there are considerable fluctuations in temperature and RH and/or evidence of pest activity in the vicinity of a ventilation duct.

EVERY SEMESTER…

- ☐ Hold a training session at the beginning of the semester on IPM and pest identification for all curatorial assistants (approx. 1 hour).

CHAPTER 4: APPENDICES

4.1.3. DETECTION/RESPONSE PROTOCOL

Follow these steps to stop an infestation and prevent it from spreading:

- ☐ Don't be impetuous! Do not rush to kill the pests. Be thoughtful about each action you consider. Remove pests safely by following the pre-determined protocol to keep the infestation from spreading or reoccurring.

- ☐ If an infestation is found on objects, isolate them immediately. Put infested objects in a sealed plastic bag or Tupperware container. Don't carry infested materials through the collections without first isolating them. Eggs and/or larvae can drop off of infested materials and spread the infestation.

- ☐ Identify the pests and note their development stage. You may find that the insects are not museum pests. If you do not feel confident in your pest identification skills, refer to the appendix for a list of pest identification websites or qualified people to contact.

- ☐ Determine the extent of the infestation. Start at the site where the first infested object was found and inspect the collections/area in ever widening circles. Isolate infested materials as they are found and document the findings.

- ☐ Determine the source of the infestation.
  For example, if you discover that infested materials were brought into the collections, evaluate and modify the policies and procedures that allowed that to happen. In contrast, if you discover that the infestation was a result of poor building maintenance, collaborate with appropriate staff to make repairs to the building.

- ☐ Develop a treatment strategy based on the location and extent of the infestation. What is the most prudent solution given the circumstances of this specific infestation event? Are live insects present? What is the age of the insect signs—is it an old, inactive infestation that wasn't discovered until now?

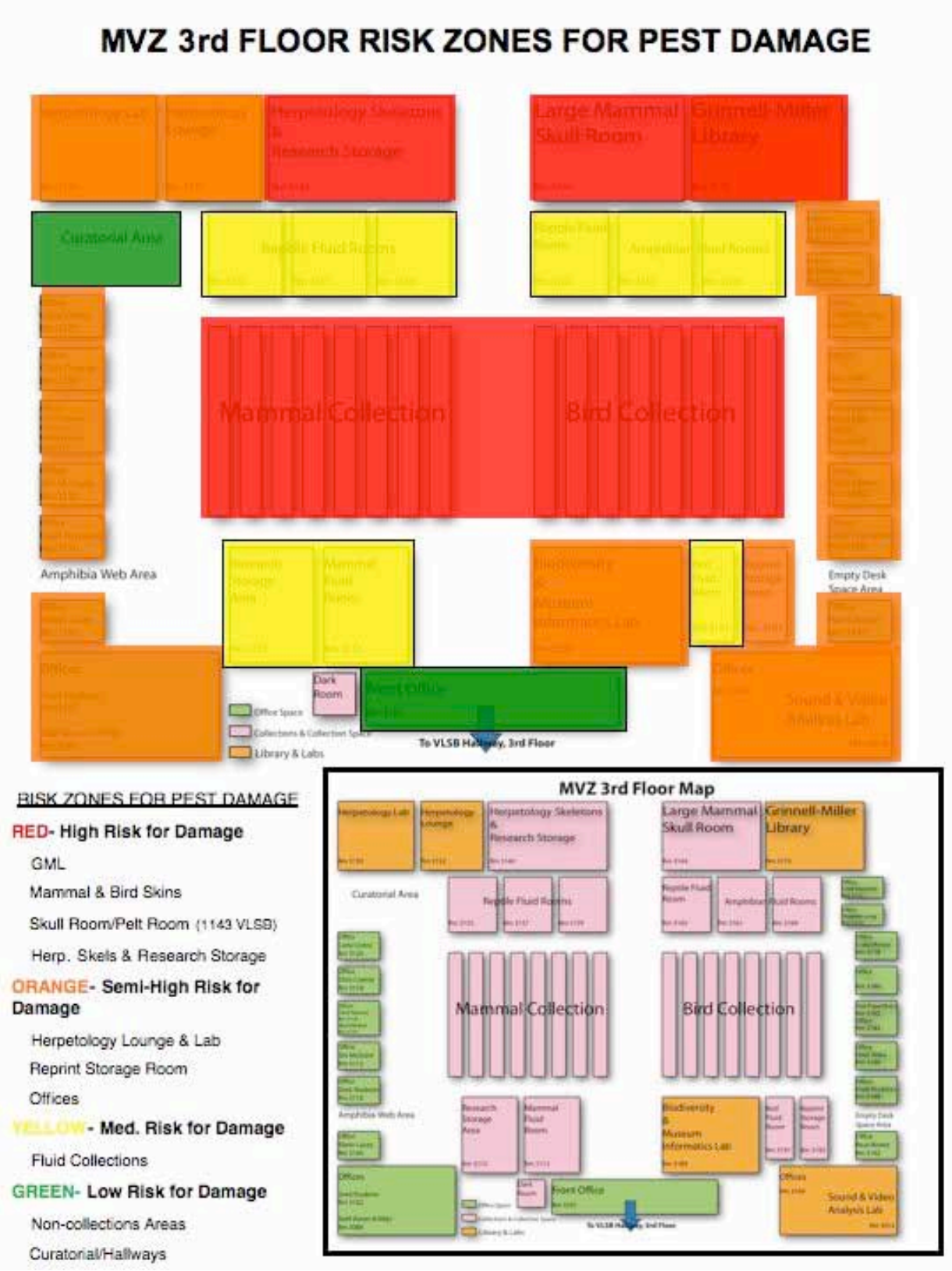
- ☐ Only after you've considered all options should you treat the infected object and/or area. There are a number of options for treatment:

  - *Temperature Control*: objects are put into the walk-in freezer to kill all life stages of pest.
  - *Chemical Control*: Nyguard and Tempo are applied to the affected area once the specimens have been removed for freezing.
  - *Anoxic Control:* Nitrogen, argon, or carbon dioxide is used to alter the atmosphere that the pest and the infected object inhabit.

- ☐ After treatment, clean the objects and storage area to remove dead pests and waste. Dead pests, larval casings, and nests can attract new pests and make it difficult to determine if the infestation has been eradicated.

CHAPTER 4: APPENDICES

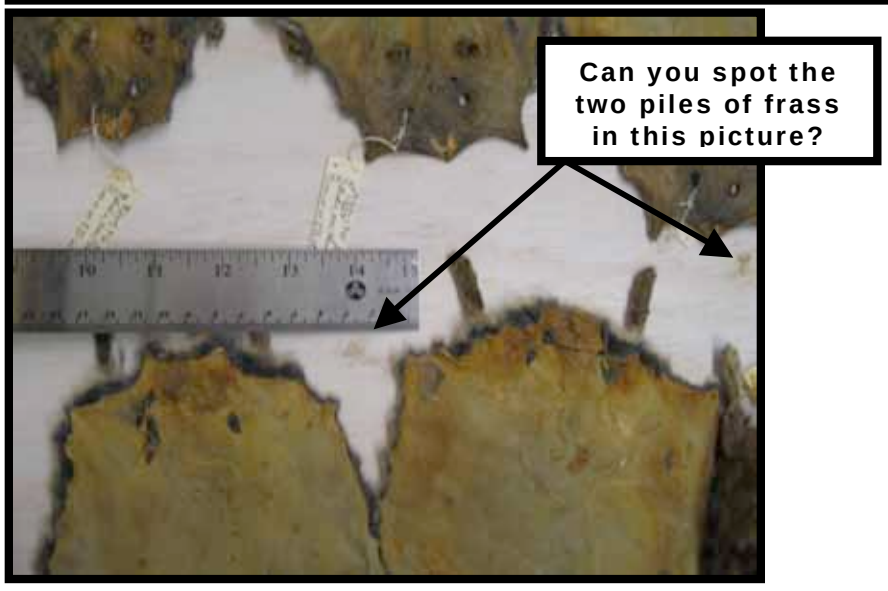
4.1.4. MVZ 3rd FLOOR RISK ZONES FOR PEST DAMAGE



CHAPTER 4: APPENDICES

4.1.5. EXAMPLE OF PEST ACTIVITY IN SPECIMEN CASE

The following pictures illustrate what typical evidence of an infestation in a case looks like. In this instance, the specimens did not appear to be damaged. This evidence was found in one of the *Ochotona sp.* cases during the spring of 2009. The trays in this case, as well as the surrounding cases, were all inspected for evidence of pest activity. All specimens and trays in this case were frozen using a rolling case. The "home case" was sprayed with Tempo before the specimens were returned to their "home case".

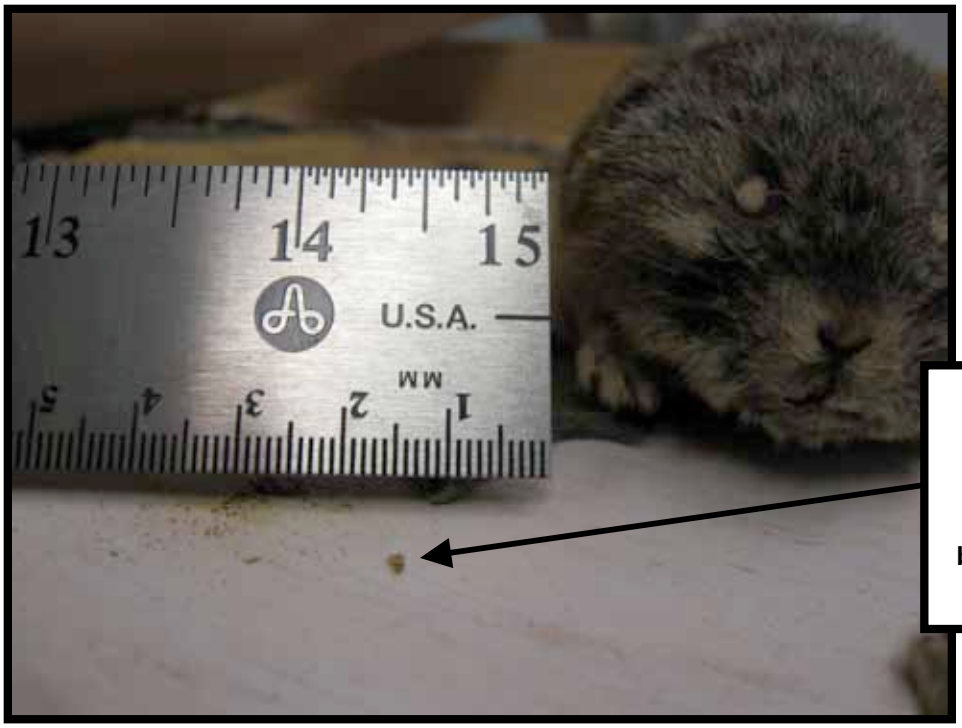


CHAPTER 4: APPENDICES

4.1.5. EXAMPLE OF PEST ACTIVITY IN SPECIMEN CASE (cont.)

A pile of frass is approximately 2mm by 2mm wide.

Individual pieces of frass are a fraction of a millimeter in size.

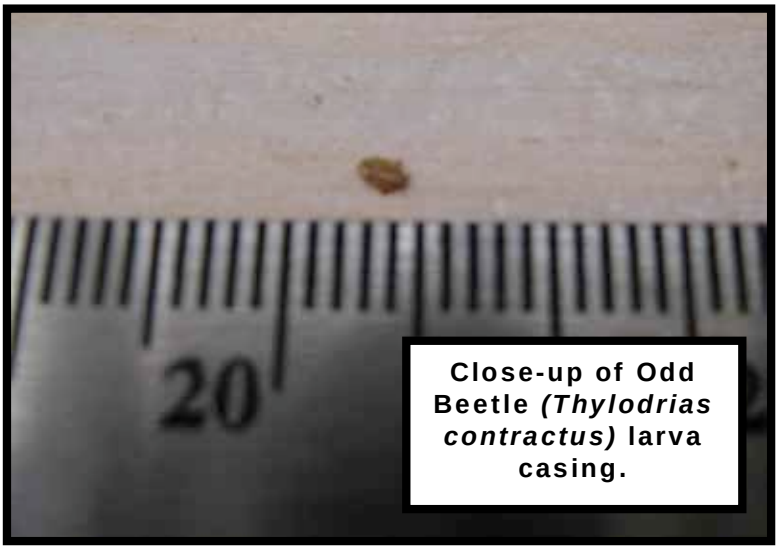


This is the casing of an Odd Beetle *(Thylodrias contractus)* larva next to the pile of frass.

The size of casings can vary, but are generally no larger than 3 mm long.

CHAPTER 4: APPENDICES

4.1.5. EXAMPLE OF PEST ACTIVITY IN SPECIMEN CASE (cont.)

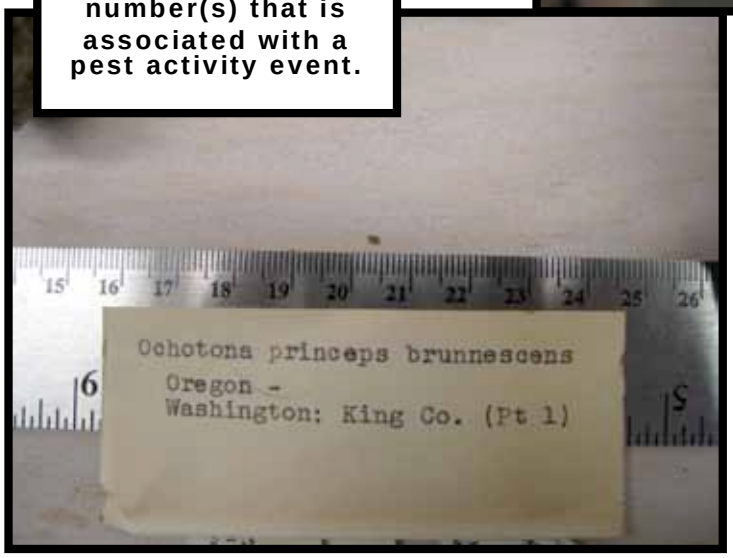


Close-up of Odd Beetle *(Thylodrias contractus)* larva casing.

This picture illustrates the relative size of an Odd Beetle casing and frass.

In hindsight, recording the MVZ #s for the specimens in this case would have been wise.

Specimens are often moved around in the collections, so it's a good idea to record the specific specimen number(s) that is associated with a pest activity event.



CHAPTER 4: APPENDICES

4.2.1. MVZ PEST MONITORING AREAS

CHAPTER 4: APPENDICES

4.2.2. MVZ PEST INSPECTION LOG

The following form is an example of an Inspection Log for the collections. It can be used to monitor specimen cases, rooms with literature/books, and offices.

Consider using the information on the next page to construct an Excel sheet with the same or similar information. To save paper, and skip a step, persons checking the collections can use a laptop computer to enter data directly to the Excel sheet while they inspect areas for pest activity.

Also consider listing the range of MVZ #s that are in the tray where you find pest activity. Specimens are often moved around so it is important to connect specific specimens to particular incidences of pest activity.

CHAPTER 4: APPENDICES

4.2.2. MVZ PEST INSPECTION LOG (cont.)

MUSEUM OF VERTEBRATE ZOOLOGY
PEST INSPECTION LOG

INSTRUCTIONS: **Any pests/pest evidence found must be saved. Put material in a small vial with a piece of paper that states the date and location (case, drawer #) where material was found.**

Case Taxa/Room# (w/ Description):_____

Order:_____Family:_____Genus:_____Case #:_____

Date:_____Surveyed By:_____

PEST EVIDENCE	YES	NO
	ACTIVE (DRAWER #, TYPE OF EVIDENCE)	INACTIVE (DRAWER #, TYPE OF EVIDENCE)
FUR/FEATHERS/HIDE PESTS		
DRUGSTORE BEETLE *(Stegobium paniceum)*		
CIGARETTE BEETLE *(Lasioderma serricorne)*		
ODD BEETLE *(Thylodrias contractus)*		
HIDE BEETLE *(Dermestes maculates)*		
BROWN HOUSE MOTH *(Hofmannophila pseudospretella)*		
SCAVENGERS/PAPER PESTS		
LARDER BEETLE *(Dermestes lardarius)*		
FIREBRAT *(Thermobia domestica)*		
SILVERFISH *(Lepisma saccharina)*		
BOOKLICE *(Liposcelis sp.)*		
CABINET BEETLE *(Trogoderma ornatum)*		
AMERICAN COCKROACH *(Periplaneta americana)*		
WOOD/FURNITURE PESTS		
FURNITURE BEETLE *(Anobium punctatum)*		
TRUE POWERPOST BEETLE *(Lyctus sp.)*		
FABRIC/TEXTILE PESTS		
BLACK CARPET BEETLE *(Attagenus unicolor)*		
WEBBING CLOTHES MOTH *(Tineola bisselliella)*		
FURNITURE CARPET BEETLE *(Anthrenus flavipes)*		
CASEMAKING CLOTHES MOTH *(Tinea pellionella)*		
VARIED CARPET BEETLE *(Anthrenus verbasci)*		
UNIDENTIFIED PEST(S)		

Storage Problems? NO_ YES___ Drawers_____

Specimen Damage? NO_ YES___ Drawers_____
If YES, WHAT NEEDS REPAIR (MVZ #)?_____

Treatment Recommended? NO_____YES_____Urgent?_____
Freeze Specimens: NO_____YES_____
Fumigate Case: NO____ YES___ Date Fumigated_____

Maintenance
Cases/Drawers Cleaned_____ Specimens Cleaned of Insects_____

Action Taken
Curator Notified_____Who?_____
Pest Sample(s) Identified?_____Identified By:_____
Unidentified Pest I.D. (drawer #)_____
_____

CHAPTER 4: APPENDICES

4.2.2. MVZ PEST INSPECTION LOG (cont.)

MUSEUM OF VERTEBRATE ZOOLOGY
PEST INSPECTION LOG

INSTRUCTIONS: Any pests/pest evidence found must be saved. Put material in a small vial with a piece of paper that states the date and location (case, drawer #) where material was found.

Case Taxa/Rooms (w/ Descriptions): MAMMALS (3rd floor balcony)

Order: RODENTIA Family: CRICETIDAE Genus: ONYCHOMYS Case #: 439 (furn map)

Date: 14 JULY 2008 Surveyed By: MARESSA TAKAHASHI

PEST EVIDENCE	YES X ACTIVE (DRAWER #, TYPE OF EVIDENCE)	NO INACTIVE (DRAWER #, TYPE OF EVIDENCE)
FUR/FEATHERS/HIDE PESTS		
DRUGSTORE BEETLE *(Stegobium paniceum)*		
CIGARETTE BEETLE *(Lasioderma serricorne)*		
OLD HOUSE BORER *(Hylotrupes bajulus)*		#4, CABINET + GRASS
HIDE BEETLE *(Dermestes maculatus)*		
BROWN HOUSE MOTH *(Hofmannophila pseudospretella)*		
SCAVENGERS/PAPER PESTS		
LARDER BEETLE *(Dermestes lardarius)*		
FIREBRAT *(Thermobia domestica)*		
SILVERFISH *(Lepisma saccharina)*		
BOOKLICE *(Liposcelis sp.)*		
CABINET BEETLE *(Trogoderma ornatum)*		
AMERICAN COCKROACH *(Periplaneta americana)*		
WOOD/FURNITURE PESTS		
FURNITURE BEETLE *(Anobium punctatum)*		
TRUE POWERPOST BEETLE *(Lyctus sp.)*		
FABRIC/TEXTILE PESTS		
BLACK CARPET BEETLE *(Attagenus unicolor)*		
WEBBING CLOTHES MOTH *(Tinaola bisselliella)*		
FURNITURE CARPET BEETLE *(Anthrenus flavipes)*		
CASEMAKING CLOTHES MOTH *(Tinea pellionella)*		
VARIED CARPET BEETLE *(Anthrenus verbasci)*		
UNIDENTIFIED PEST(S)		#8, DEAD BEETLE SP.

Storage Problems? NO ___ YES X Drawers #4, 5, 6 OVER CABINETS

Specimen Damage? NO X YES ___ Drawers ___
IF YES, WHAT NEEDS REPAIR (MVZ #)? ___

Treatment Recommended? NO ___ YES X Urgent? X
Freeze Specimens: NO ___ YES X
Fumigate Case: NO X YES ___ Date Fumigated ___

Maintenance
Cases/Drawers Cleaned X Specimens Cleaned of Insects ___

Action Taken
Curator Notified X Who? CRIS CONROY
Pest Sample Identified? X Identified By: CHERYL HAWLEY (MVZ MUSEUM)
Unidentified Pest I.D. (drawer #) 2 DRUGSTORE BEETLE (#6)

Last Modified: 9/22/09

CHAPTER 4: APPENDICES

4.2.3. MVZ IPM ACCOUNTABILITY CONTRACT

In order to ensure that everyone has been educated in and is encouraged to participate in the IPM program, some sort of accountability needs to be instituted. One solution is to create a contract that people sign when they participate in the IPM program education sessions.

SAMPLE CONTRACT:

MVZ INTEGRATED PEST MANAGEMENT (IPM) AGREEMENT

I have been made aware of the Museum of Vertebrate Zoology's (MVZ) Integrated Pest Management (IPM) policies and I agree to follow the written policies and procedures regarding pest management within the MVZ.

I have also been made aware of the consequences if I do not abide by the IPM policies.

Today's Date: _____

Printed Name	Signature	MVZ Position/Lab Group

CHAPTER 4: APPENDICES

4.2.4. FOOD POLICY POSTER

What Can I Do Daily To Help Prevent Infestations In Our Collections?

- Please keep any food that you have in a sealed Tupperware/glass/metal container. Do not leave food in your work area overnight.
- Use the available refrigerators whenever possible.
- Please do not leave behind partially eaten food.
- If you eat at your work area or in a meeting area after the cleaners have emptied the garbage pails, take your garbage with you when you leave. You can dispose of it in a garbage pail in the main part of VLSB or take it home with you.
- Do not let food sit out overnight.
- Keep coffee stations and eating areas spotless— wash your dishes, clean up your crumbs and wipe up spills. If you see a mess, clean it up.

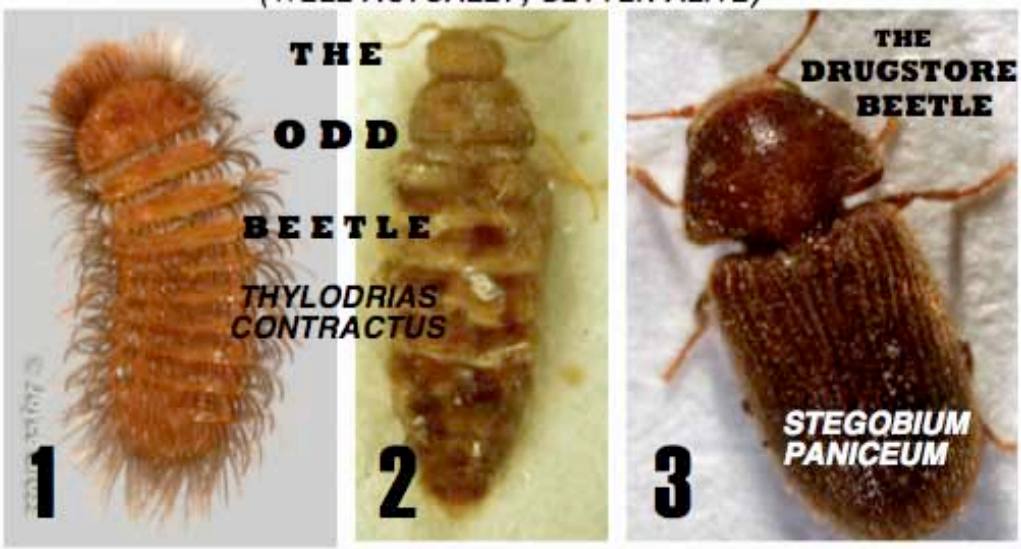
CHAPTER 4: APPENDICES

4.2.5. MUSEUM PEST I.D. POSTER

WANTED

DEAD OR ALIVE

(WELL ACTUALLY, BETTER ALIVE)



The "PESTY PESTS" BUNCH

THE "ODD BEETLE". *1)* LARVAE. *2)* ADULT FEMALE.
3) THE "DRUGSTORE BEETLE". ADULT.

WANTED FOR THE DESTRUCTION (NIBBLING) OF MVZ SPECIMENS

AREAS OF SPECIAL CONCERN:

WHAT TO DO:
- DO NOT KILL IT OR THROW IT AWAY
- ALERT A STAFF CURATOR AND MONICA ALBE
- ATTEMPT TO CONTAIN IT IN A VIAL & LABEL THE VIAL WITH LOCATION FOUND

AND ESPECIALLY … Please do not remove specimens from this area without contacting curatorial first – they may be infested!!!

CHAPTER 4: APPENDICES

4.3.1. TABLE: LIMITING AND FATAL FREEZING TEMPERATURES FOR COMMON MUSEUM INSECT PESTS

LIMITING AND FATAL FREEZING TEMPERATURES FOR COMMON MUSEUM INSECT PESTS

INSECT SPECIES	TEMPERATURES THAT LIMIT BREEDING & DEVELOPMENT (°C)	*LETHAL TEMPERATURES*	
		LOW TEMP (°C)	HIGH TEMP (°C)
FABRIC/TEXTILE INSECTS			
Black Carpet Beetle *(Attagenus unicolor)*	10	-24	> 41
Casemaking Clothes Moth *(Tinea pellionella)*	—	—	—
Furniture Carpet Beetle *(Anthrenus falvipes)*	—	-14	> 40
Varied Carpet Beetle *(Anthrenus verbasci)*	14	-20	> 40
Webbing Clothes Moth *(Tineola bisselliella)*	9	-18	49
SCAVENGERS/PAPER			
Booklice *(Liposcelis sp.)*	—	—	—
Cabinet Beetle *(Trogoderma ornatum)*	—	—	—
Cockroach, American *(Periplaneta americana)*	—	-15	45
Cockroach, Oriental *(Blatta orientalis)*	2	-8	46
Firebrat *(Thermobia domestica)*	22	0	55
Larder Beetle *(Dermestes lardarius)*	15	<-2	54
Silverfish *(Lepisma saccharina)*	4	—	37
FUR/FEATHERS/HIDE			
Brown House Moth *(Hofmannophila pseudospretella)*	—	—	—
Cigarette Beetle *(Lasioderma serricorne)*	16	-12	49
Drugstore Beetle *(Stegobium paniceum)*	17	-18	49
Hide Beetle *(Dermestes maculates)*	6	-23	60
Odd Beetle *(Thylodrias contractus)*	—	—	—
Redlegged Ham Beetle *(Necrobia rufipes)*	—	—	—
WOOD/FURNITURE			
Drywood Termite *(Incisitermes sp.* or *Kalotermes sp.)*	—	-20	51
Furniture Beetle *(Anobium punctatum)*			
True Powderpost Beetle *(Lyctus sp.)*	—	—	54-58

Data from: Strang, T.J.K.. 1992. A review of published temperatures for the control of pest insects in museums. Collections Forum 8(2): 41-47.

"—": Denotes no data available, yellow highlighting denotes active infestation of this insect species in MVZ within the past 3 years.

CHAPTER 4: APPENDICES

4.3.2. SUPPLEMENTAL INFORMATION ON FREEZING ITEMS TO EXTERMINATE PESTS

Information courtesy of Monica J. Albe, Sr. Museum Scientist/Prep Lab Manager
August 2009

FREEZING TEMPERATURES

Many insects have the ability to super-cool (over-winter), and may survive to temperatures around -20°C. The study of the lethal effects of cold on museum pests has only begun in earnest in the last 20 years. Due to the limitations in the available research, we cannot know the lethal temperature for all species of pests, at all life stages. For some species, eggs and adults are the most prone to death, whereas larvae and pupae are the most resistant. In other species, the opposite or some other combination is true. However, there are agreements in all the research—insects are sensitive to cold shock, and the more rapid the cooling, the greater the chance of mortality of the pest. The collective research also shows that there is agreement on a duration and low temperature where all insects have been found dead. To be effective, we must use this time and temperature in our cautious approach.

In studies on pest death in freezing, it has been found to be vitally important that air can circulate around the treated objects in the freezer. Plastic boxes placed in the freezer should not be packed tightly (with lots of packing materials inside that create heavy insulation). Plastic boxes placed in the freezer should not be packed onto shelves with lots of bags or other materials around them that will reduce airflow around them.

The destructive effects of exposure to extreme temperature regimes are time dependent and it is, therefore, not possible to quote a single lethal temperature for an insect without stating the exposure period. Based on much literature research, it has been found that with our freezer temperature (-27°C), objects MUST remain frozen for at least 36 hours (if you include time to cool down and freeze, it is best to leave them in the freezer for at least 4 days). Our freezer has multiple uses and it's frequently opened during the week so to further safeguard and to simplify the process, we have designed a protocol where items are placed in the freezer for at least one week, with time spanning over a weekend when the freezer will most likely be unopened for at least 48 hours.

For temperatures above -20°C (regular freezers set at -12°C or -8°C), the literature shows that you need at least 14 days of freezing, and for regular freezers you need to cycle the specimens through the freezing process twice (and this still may be ineffective). For this reason, freezing objects in our -27°C walk-in freezer is imperative and we cannot accept specimens from the outside that have been "frozen" at unknown temperatures before entering the museum.

Freezing items for 24 hours or less requires a temperature of -40°C or lower. If we would like to move to a faster freezing process, we may want to consider purchasing an ultra-cold freezer. At these temperatures though, we cannot guarantee the safety and long-term structural stability of the specimen itself.

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4.3.2. SUPPLEMENTAL INFORMATION ON FREEZING ITEMS TO EXTERMINATE PESTS (cont.)

“To prevent desiccation of materials, condensation, and the escape of live insects, it is vital that all items for freezing are packed and sealed within a combined vapour and insect barrier.”—Linnie 1999.

INSULATING AND COOLING ISSUES

Insects not only have the ability to super-cool, but some can also acclimate to the cooler temperature, given time. “Cold acclimation could occur if infested material is exposed to a cool environment before freezing or if the temperature lowers too slowly during the freezing process.” (Florian 1990). We need to make sure that the specimens being placed into the freezer have not just come from an environment that is cool (i.e. someone coming back from a collecting trip high in the Sierras during the spring). For specimens coming from a colder environment, they must be given at least 24 hours to acclimate to 70°F before being frozen.

The above quote stresses that insects have the ability to acclimate to colder temperatures over time, which means that specimens cannot be well insulated while freezing, because this will give them more time to super-cool/acclimate to the freezer temperature. The faster the freezing process occurs, the higher the insect mortality rate. Thus, we should be concerned with insulation of our materials that might impede the rapid cooling of the specimens. Specimens should not be wrapped in layers of cotton or paper products when they are frozen. To separate layers of specimens, trays or strips of cotton can be used, but they should not be tightly packed into a box. There should be airflow around each specimen.

Damage to specimens:
Damage comes from
-dehydration (during freezing process)
-condensation (during the thawing process)
-water expansion as it freezes inside wet materials (during the freezing process)

Florian (1990) reported that damage to museum specimens and materials following exposure of up to -20°C should not occur if they are adsorbent and free of moisture.
To avoid damage from the freezing process, specimens must be sealed in a non-porous container/bag (plastic or metal), cooled steadily to -27°C, and then thaws slowly, remaining unopened in their container until they are raised back to room temperature (usually takes 24 hours post-freezer). Do not remove specimens from their container if there is still condensation on the outside.

Exposure to sub-zero temperatures rather than raised temperatures appears to be favored by museums and recommendations exist for the treatment of material prior to and after treatment to reduce any possible damage.

Since the 1980s, several museums have switched to freezing as their principal method of eliminating pests from materials, and thus far no deleterious effects have been reported in the literature.

CHAPTER 4: APPENDICES

4.3.2. SUPPLEMENTAL INFORMATION ON FREEZING ITEMS TO EXTERMINATE PESTS (cont.)

Placing specimens and materials to be frozen in sealed containers:
Placing specimens into sealed containers has several advantages. First, it helps to contain any pests that may survive the freezing process. Second, the sealed environment may help kill the insects. And third, but no less important, the sealed environment will help protect the specimens from the freezing process.

Before placing specimens inside any container, the container should be checked for any dirt or insect remains. All dirt and insect remains should be cleared out of the container before placing anything inside it. Thus, if any insect materials are found in the box after the freezing process, they can be assumed to be from the specimens.

Placing objects in sealed plastic boxes limits the moisture content change in the box. This has two key effects:

1. Limiting the damaging effects of dehydration of the specimen or frost formation on the specimen during the freezer stay, as well as condensation of water on the specimen during the thaw process.
2. Limiting dehydration of the air the insect is exposed to while in the freezer – the higher the relative humidity is in the sealed box, the greater the possibility of ice crystals forming in the insects' bodies, hence killing them.

The use of sealed metal cases is also an option, as long as they are sealed so that no air exchange can occur while the specimens are frozen or while the case is acclimating to room temperature. Sealed plastic bags may also be used for larger objects that neither fit in plastic boxes or metal cases.

Packing specimens to be frozen in wooden boxes, cardboard boxes, or any other porous material is prohibited.

Specimens may not experience damage from being exposed to the open air in just one cycle of freezing, but repeated exposure can lead to splitting in study skins and mounts. Bones should not experience any damage unless they have moisture trapped inside before freezing.

Freezing wood products and paper products:
The best-case scenario would be that all of our wooden boxes are heat treated to eliminate the possibility of pests (as freezing is less effective). Do to our lack of heating facilities, all boxes and packaging materials must be frozen for **two weeks**, instead of one to further ensure pest death. To eliminate the risk of condensation damage, place these items in sealed plastic bags or plastic boxes before freezing.

Experiments on temperature and relative humidity in our -27°C walk-in freezer:
Data loggers were placed in our freezer both on a shelf and inside metal rolling specimen cases to record temperature and relative humidity (RH) changes over time. The results showed that our freezer has temperature cycles, where the temperature lowers to -27°C and then cycles up to about 0°C four times a day. These cycles help the killing process, but emphasize the need for all items to be properly placed into plastic boxes to reduce condensation and frost-forming damage on specimens.

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4.3.3. RESULTS FROM PAT KELLEY CONSULTATION, 21 APRIL 2008

MVZ Integrated Pest Management Program:

CS_2 does not work – do not use anymore! (Has gone bad or does not work against *Thylodrias contractus*, unclear which is right, but one definitely is)

Best Case Scenario:

1. We have someone that will work on getting us up to speed this summer, hopefully working at least half time. Can be an undergrad (?), but must be highly functioning and organized undergrad (or recently graduated?). After that, once the routine is set, work it into the curatorial functioning. We need the vigilance of staff curators and curatorial assistants who are actively working with the collection.
   - This person will need a hand lens, and access to a dissecting scope (little ID station with computer for data entry)
   - Training on pest ID, access to references and time to read up on the latest in pest management and control (use Museumpests.net website, SPNHC reading, and other publications)
   - When ID-ing pests, don't spend forever on all bugs
     a. Is it a museum pest? If suspected, ID bug
     b. Is there a lot of the particular bug? If so, then ID for problem solving
     c. If it's not a suspected museum pest, and not in large numbers, do not ID to species, just note general description ("small flying insect, non beetle")

2. Set up a building pest committee that includes representatives from each major institution in the building – UCMP, Herbaria, Library, Building Manager, IB, MCB, Essig, U.C. Pest Management – could just be a mailing list that alerts key members of pest issues.

3. All sticky and light traps get monitored on a monthly (or every 2-6 months depending on our staff resources – no longer than six months) basis – areas that are infested are monitored every two weeks.
   - Sticky trap placement – at least one in each case, no need for ones of floor or on top of cases in collection. Put out 18 sticky traps in designated areas (see notated map). Extra in cases of special concern. Also place sticky traps in food rooms and one in each area of student offices (NE, NW, SE, and SW part of the museum in rooms with the most food potential). Place several in GML. Place in corners of collection rooms (if high traffic area, get metal covers to protect sticky traps). Do not set sticky traps in areas that are difficult to check, or set too many – you don't want the program to be overwhelming or impossible to handle.
   - Keep track of light and sticky trap locations in a database
   - Properly identify species found in traps (use Essig Museum of Entomology for reference if difficult)
   - All data collected in the bug database for review and long term pattern monitoring purposes, reports made every six months for curators
   - Sticky traps replaced when they loose stickiness (every six months to a year), light trap bulbs get replaced every year

CHAPTER 4: APPENDICES

4.3.3. RESULTS FROM PAT KELLEY CONSULTATION, 21 APRIL 2008 (cont.)

- Every time a sticky trap (or sticky paper in a light trap) is set, the date gets written on it. Anytime a bug is found, it's circled so that we know it's already been noted. In cases of very high volumes of bugs on sticky traps, total # of certain species goes on back with date (instead of circling all of them).

4. Museum needs a general vacuuming of rooms every six months – focus on getting dust bunnies and hair off of floor and out of corners in collections areas. Don't worry about offices. Vacuum needs to be cleaned out after every vacuum. The main concern is to avoid hair accumulating on floors, because it's a major food source for bugs.

5. Bone Room – set up two traps, one on either side of the entrance on the floor. Monitor temperature and humidity more often.

6. Mounts in museum – check them for pest issues once a year (includes hanging mounts and mounts in library).

7. Areas of special concern
   - Signs are hung up in the areas of special concern – notification of what to do if someone sees a bug, and also info on food storage, etc. Notices for rooms that are infested "Please do not remove specimens from this room without contacting curatorial – may be infested. Alert STAFF CURATORS if you see a bug, do not kill it! Try to catch it and place in a vial."
   - Eileen's Office:
     a. Four light traps set in there (2 in main office, 2 in ante room) on 22 April 2008 (check every week for the first month, then monthly)
     b. Clean out drawers that had candy in them (there are some candy pieces that should be removed and there are two drawers with candy crumbs in them)
     c. Vacuum up the dead bugs (in office and ante room) and clean the windowsill
   - Fur Room:
     a. Vacuum floors with hepa-filter vac (empty out afterwards)
     b. Spray floors (under shelving and around all of the wrack supports with Cyfluthrin). Add an insect growth regulator into the mix ("Nyguard"), stops larvae from turning into adults (for long term problem solving – makes it so in 3-5 years we won't have the next generation).
     c. Monitor temperature and humidity more frequently (once a month).
     d. Fit doors with brush strips to reduce the in-flow of pests from the hallway
     e. Pour water down the floor drain and then mineral oil to seal it.

CHAPTER 4: APPENDICES

4.3.3. RESULTS FROM PAT KELLEY CONSULTATION, 21 APRIL 2008 (cont.)

f. Monitor situation carefully with Dermestid larval monitors and sticky traps (every two weeks) – buy more or move around if you're not finding any bugs. If you haven't gotten anything in the traps in a month, move the traps or purchase more. If you do get something, concentrate your focus on that area. Zero in and then isolate possible infested items with clear plastic bags to see if bugs then come out of them, freeze those particular items. Sticky traps should be moved to the walls (none in center of the room).
g. Put sticky traps for mice on either side of entrance door. (we don't want mice getting in there! Even just one mouse can cause a lot of damage.)
h. *Worst case scenario* (many many things infested) – rent a refrigeration truck and load all items in there and then fumigate truck offsite (use sulfuryl fluoride (1 day needed) or Phosphine (3 days needed, copper corrosive) – while items are out, spray room with Cyfluthrin all over the place, and thoroughly clean.
i. Long Term Monitoring – UV light trap (1 per room) and sticky traps (set up in a grid pattern) checked once a month. Vacuum room when needed (whenever hair begins to build up under pelts).

- Library – place sticky traps in field notebook cases and monitor them at least once a month.
- Teaching Collection: 2 sticky traps on floor, on in each case, light monitor in room (check once a month).
- Cases with extinct species or important research specimens – place additional traps in these and monitor them once a month.
- Nests – these specimens should be monitored on a monthly basis.
- Jim Patton's Area:
    a. Vacuum floors with hepa-filter vac (empty out afterwards)
    b. Add four sticky traps on floor next to walls or next to metal cases for monitoring
    c. Spray floors (along the front of cases, and around borders of cases with Cyfluthrin).
    d. Start a rolling freezing plan – freeze two cases of materials at a time, while freezing materials, spray the case interior with Cyfluthrin.
    e. Once all cases have been frozen and their interiors sprayed, the pest problem in that room should be solved.
    f. Containment – prevent the spread of bugs by not allowing specimens from that room to freely flow throughout museum (not be transported elsewhere).

8. Freezing Regime maintained –
    - Condensation, freeze-thaw cycles, dehydration, and swelling do not significantly affect collections items properly prepared in sealed plastic bags (make sure no items are wet or have high moisture content before freezing).
    - Temperature ok to fluctuate between -17 and -26 C as long as the freezing process is fast (going from room temp to freezing in a day), and there is adequate air circulation around the items (not too densely packed).

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4.3.3. RESULTS FROM PAT KELLEY CONSULTATION, 21 APRIL 2008 (cont.)

- Items need to remain frozen for 1 week. Pelts, and shipping materials, and items with a lot of insulation need to be frozen for 2 weeks.
- After freezing, items are then transferred into the walk-in fridge for 1 day to slowly warm, then to the Quarantine Room for one week (all while still in plastic bins/bags). Items should be checked for bugs when being removed from the Quarantine Room.
- Items should *never* be put in the walk-in fridge before freezing!! (this will give the bugs a chance to super-cool.)
- Improvement: acquire 2 carts for freezing with shelving and some kind of sealed system – load the cart up, seal, roll it in the freezer, leave in for a week, then roll into fridge, then quarantine room – minimizes handling of specimens, and the specimens can remain on trays the whole time.
- Improvement: when students are unpacking loans, as they inspect for damage, they also inspect for bugs and if there are any signs, show Monica, and then clean off before freezing.

9. Anoxia Treatment – "Oxygen Scavenger" Treatment (use fact sheet from the MuseumsPests.net website)
   - This is for smaller items that are so delicate you don't want to risk freezing damage
   - Takes longer – 1 month

10. Synthetic Pyrethroids purchased and used to contain infestations. (Make sure we have proper equipment for application. Margaret from pest management can help with this, but perhaps Monica will get proper equipment too.)
    - These are short lived (compared to old-time nasty chemicals – only last about 3 months) and are water or oil based sprays (you mix them with water).
    - They have low mammalian toxicity and once dry, only effect people if they touch it.
    - Can be used to spray floors, insides of empty cases, border of cases (around seals).
    - Will effectively create a barrier for bug travel.

11. Education materials posted – bug posters put up on Quarantine Room, in Curatorial Area (by bathroom on bulletin board?), and Somewhere else where people will see it (GML?).
    - Emails sent out when we have an infestation
    - Flyers put in mailboxes of staff and students (use the MuseumsPest.Net policy template and also look under resources/reference documents as models) when outbreaks happen or when major food or buggy issues arise.
    - Curator Meeting updates

CHAPTER 4: APPENDICES

4.3.3. RESULTS FROM PAT KELLEY CONSULTATION, 21 APRIL 2008 (cont.)

Items for the MVZ Pest Management Budget:

-Fit all doors leading from outside into the museum with door brushes (Pat Kelley knows of some vendors) [these will have to be replaced in about 10 years]

- side doors on north and south side of museum office areas (sound room, hallway near Bowie's office, Klitz office, and door in amphibiaweb station = 4 doors)
- door leading into the fur ante room from hallway, and door leading into the fur room (=2 doors)
- **Cost of getting brushes for 6 doors (Door Brush Sweeps -- Louisville Cooler Manufacturing $35.00 each, 1-800-456-1440)**

-Purchase a hepa-vac (get one that is easy to replace the bag or clean out) **($200-400)**

-Purchase a rechargeable flashlight for inspections ("Streamlight" is a good brand a lot of people use) **(cost??)**

-If Margaret doesn't have time to do the spraying, look into getting proper equipment (gloves – chemical resistant gloves, respirator for pesticides and organic vapors ($50, EH&S), and pump sprayer (get one from gardening store – won't have the amount of control that we'd prefer, or Margaret?) etc.) for Cy-kick or Tempo (active ingredient is Cyfluthrin), and then purchase it. Get Nyguard as well (growth hormone). **(cost? – Pat can help – Margaret has these and will spray (yay!))**

-Mouse/Rat bait stations for outside doors (one outside loading dock, 2 on south side, 1 on east side, 2 on west side) – 10 lb. bucket of bait costs $60 should last a year – change bait every month **(total cost of 6 bait stations ($25-30 each – "natural stone" preferred) plus food? Covered by Building? Margaret may have these are help with these – has some and bait stations)**

-Metal boxes with sticky trap inside and place 2 on either side of entry doors to building (just for two entry doors that lead to the fur room, and covering the prep lab/loading dock entrance) **(cost of metal boxes? Repeater with solid lid – insects limited has, case of 12 is $130.00, JT Eatons or Viktor manufacturer (Univar) – attach to floor and wall with Velcro attachments (strong adhesives) – Margaret interested in purchasing, maybe we can share costs?)**

-light traps (don't need to purchase more) – bulbs need to be replaced on a yearly basis, sticky sheets every six months **(annual cost of bulbs and sticky sheets?)**

-routine purchase of sticky traps **(cost ("Trapper Monitors" $50 for case of 100/300 at insects limited)? Covered by Pest Management?)**

-get trays that fit inside the plastic boxes for skins to go on, or set up some kind of zinc case system inside the freezer (with giant sealable bags? – Pat has a supplier for these, giant re-sealable bags)… OR – get two big rolling carts that are plastic and sealable, with tray inserts. **(cost of equipment?)**

-purchase large clear plastic bags for use in pest isolation **(cost?)**

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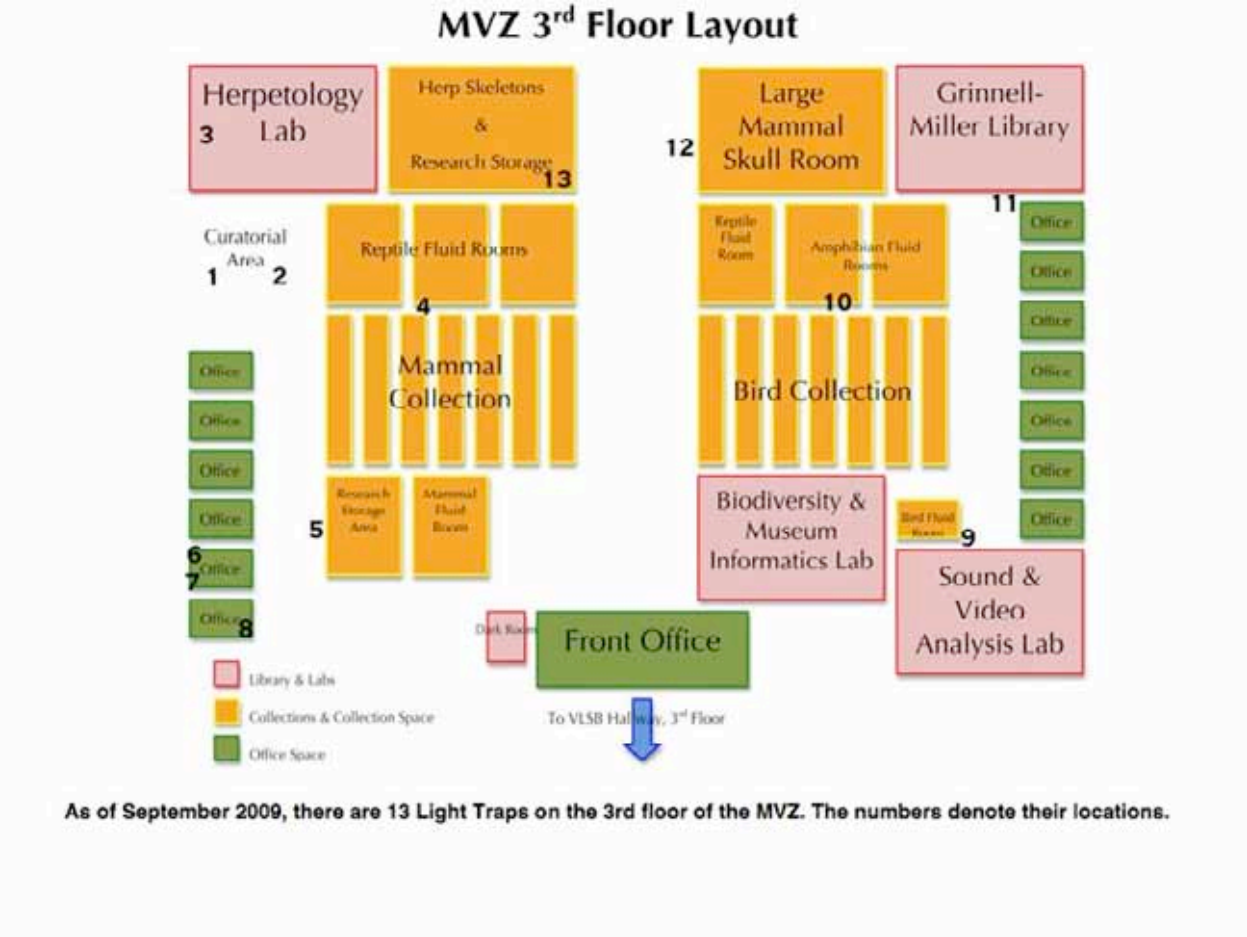
4.3.4. MVZ 3rd FLOOR LAYOUT WITH CURRENT LOCATIONS OF LIGHT TRAPS



As of September 2009, there are 13 Light Traps on the 3rd floor of the MVZ. The numbers denote their locations.

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4.3.5. GUIDES TO MUSEUM PEST IDENTIFICATION AND CONTACT INFO FOR MUSEUM PEST SPECIALISTS

There is ample published and online information to guide you in learning how to identify museum pests and signs of infestations.

Currently, there are also posters of common museum pests in North America posted throughout the 3rd floor Museum.

Also, we are fortunate enough to have a wonderful Entomology museum in the Valley Life Science Building. Both Monica Albe and I have consulted with the Collection Manager, Cheryl Barr, for pest identification and she has always been very friendly, helpful and informative.

Online:

- **Pest Management Working Group:** http://museumpests.net
- **Bug Guide:** http://bugguide.net
- **http://insectslimited.com**.
  During the spring of 2008, the General Manager of Insects Limited, Pat Kelley, was hired as a consultant to determine the best solution for an active infestation.
- **SPNHC:** Society for the Preservation of Natural History Collections
  http://140.247.98.87/?q=index.html
  Website has option to sign up for their listserve.

Published:

A Guide to Museum Pest Protocol by Lynda A. Zycherman and J. Richard Schrock. Pages 53-81.

On Campus:

- U.C. Berkeley Physical Plant- Campus Services (Pest Management)
  Margaret Hurlburt:
  Phone: 510-642-0878
  Email: hurlburt@berkeley.edu
- Essig Museum of Entomology
  1st Floor VLSB

  Rosemary Gillespie, Director
  Phone: 510-642-3445
  Email: gillespi@nature.berkeley.edu

  Cheryl Barr, Sr. Museum Scientist/Collection Manager
  Phone: 510-643-0804
  Email: cbarr@nature.berkeley.edu

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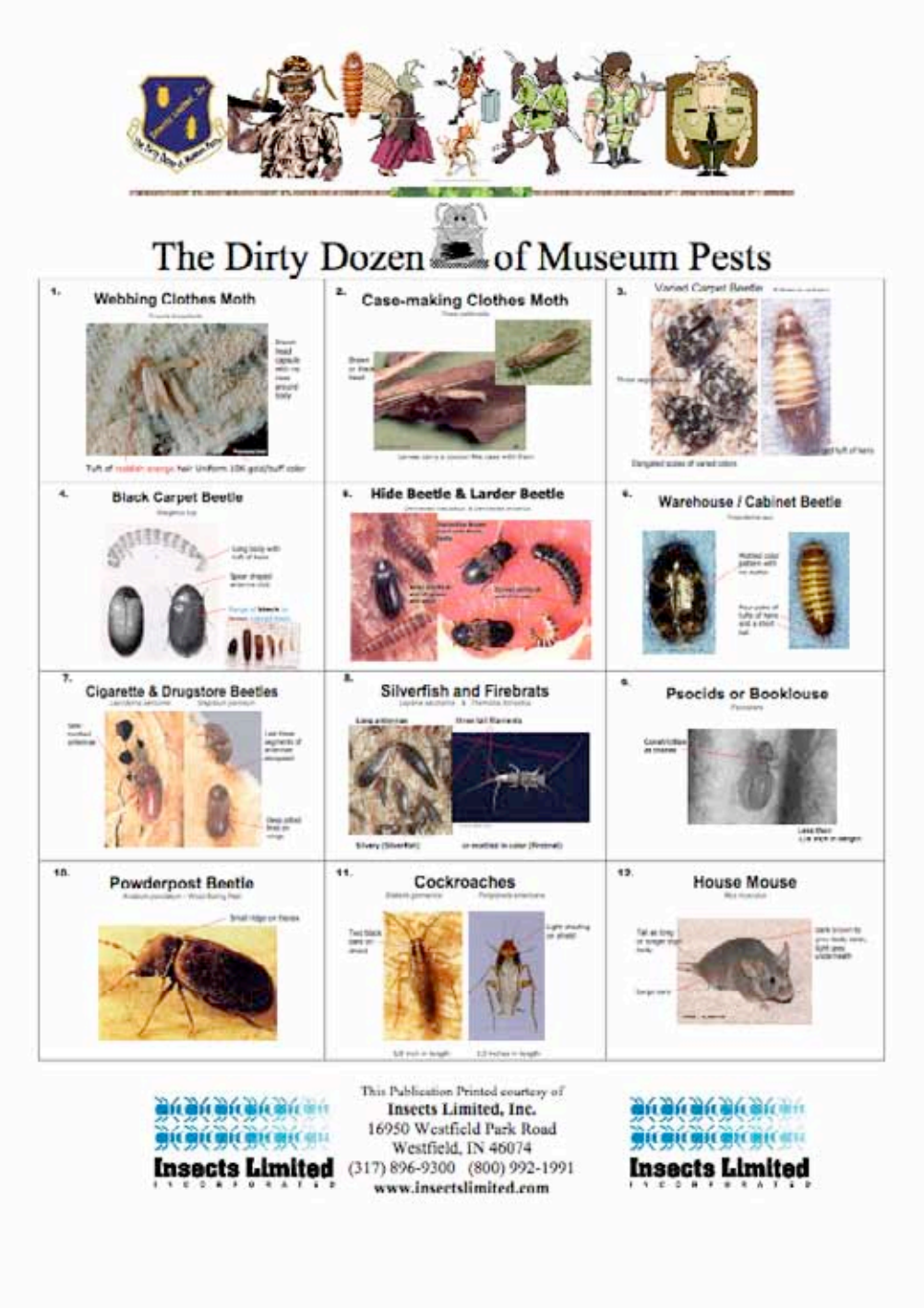
4.3.5. GUIDES TO MUSEUM PEST IDENTIFICATION AND CONTACT INFO FOR MUSEUM PEST SPECIALISTS (cont.)

Example of Information Found Online:



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4.3.6. MVZ IPM PROGRAM MANUAL REFERENCES

On Campus

[1] Pest infestation information provided by Margaret Hurlburt of U.C. Berkeley Pest Management Services as well as from staff members of the Bioscience and Natural Resources Library in VLSB, the Herbarium and the Museum of Paleontology.

Websites/Web Documents

Bug Guide: http://bugguide.net

Insects Limited (vendor/consulting/education): http://www.insectslimited.com

Museum Conservation Institute: http://www.si.edu/mci/

[2] MSDS sheets for pesticides that have been commonly used in museums (arsenic, mercuric chloride, thymol, DDT, ethylene oxide, dichlorvos [Vapona, DDVP], naphthalene, paradichlorobenzene [PDB]) were referenced. MSDS sheets are available online.

[3] National Park Service Museum Handbook, part 1, Museum Collections. Chapter 5: Biological Infestations (part D). Online version: http://www.nps.gov/history/museum/publications/MHI/mushbkl.html.

National Park Service Museum Handbook, part 1, Museum Collections. Chapter 4: Museum Collections Environment. Online version: http://www.nps.gov/history/museum/publications/MHI/mushbkl.html.

Pest Management Working Group: http://www.museumpests.net

Pest Products Vendor: http://www.pestproductsonline.com

Sticky Traps Vendor: http://www.catchmaster.com

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Rajendran, S. and Parveen, K.M.H.. 2005. Insect infestation in stored animal products. Journal of Stored Products Research 41: 1-30

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Strang, T.. 1995. The effect of thermal methods of pest control on museum collections. Preprints of the 3rd International Conference on Biodeterioration of Cultural Property: 199-212

[6] Strang, T. and Kigawa, R.. 2006. Levels of IPM control: Matching conditions to performance and effort. Collection Forum 21(1-2): 96

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4.3.6. MVZ IPM PROGRAM MANUAL REFERENCES (cont.)

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4.3.7. MVZ CASE STUDIES