Chapter 6 Biological Infestations

A. INTRODUCTION

1. The Problem

a. Pests

Museum property is vulnerable to damage and deterioration caused by a variety of biological organisms. The damage can range from surface soiling and spotting to complete destruction of the object. Organic materials (e.g., silk, skin, wool, hair, hide, paper, and wood) are most vulnerable to damage by biological agents. The mechanism that causes damage to inorganic materials is complex, is rarely seen in museums, and is beyond the scope of this Handbook.

Pests that damage museum property can be divided into three categories:

- Microorganisms (e.g., molds and other fungi)
- Insects
- Vertebrates (e.g., birds and mammals, such as rats, mice, and bats).

The three categories can be interrelated. They can support each other's survival and can contribute to the damage caused by each other.

Unfortunately, the optimum conditions for the care, storage and exhibition of museum property are also good for the survival of pests. Improper storage and exhibition conditions such as high temperatures, high relative humidity levels, dust, overcrowding, and clutter enhance pest survival.

b. Traditional Control Measures

The traditional method for controlling pests in museums has been either the routine prophylactic treatment of collections with pesticides such as arsenic, thymol, mercury, DDT, ethylene oxide, Vapona (DDVP), naphthalene, and paradichlorobenzene (PDB),

or treatment with these chemicals once an infestation has been discovered. Recent studies have found that these chemicals can damage objects and pose health risks for staff. Furthermore, improper application of pesticides has increased insect tolerance to some of these chemicals. Chemical treatments may provide a false sense of security.

2. Integrated Pest Management

Integrated Pest Management (IPM) is an ecosystem approach to the control of pests. In contrast to the traditional control measures, IPM employs a variety of approaches to prevent and solve pest problems in the most efficient and ecologically sound manner without compromising the safety of the collections or staff. It is based on information about the pest, its habits and ecology, and the environment that supports it. IPM is site-specific and adaptable to any museum environment. IPM also provides a structure in which responsible decisions concerning the treatment of pest problems can be made.

The goal of IPM for museum property collections is two-fold:

a. To protect the museum property from pests that could damage the collections; and,

b. To reduce the amount of pesticides used. Pesticides can damage objects and cause health problems for staff and visitors.

In 1980 a Presidential memorandum directed all Federal agencies to adopt IPM into their management policies. A copy of the Presidential memorandum on IPM is included in Appendix A.

This Chapter provides detailed guidance on developing and implementing a comprehensive Integrated Pest Management Program for museum property collections. Each unit needs to review its existing IPM Program to determine what additional steps outlined in this Chapter need to be implemented to protect museum

property. The extent of the work involved in an IPM program depends on the material nature and size of a museum property collection and on the facility space housing museum property. The following examples are provided to illustrate this point.

1) Pest protection for two paintings on display in an administrative office space requires the following steps: ensure that the space and paintings are inspected for signs of pest activity on a quarterly basis; ensure that the person responsible for the quarterly inspection reports any pest activity to the person having pest management responsibilities (e.g., facility manager); and ensure that the pest management person knows who to call for technical assistance if either painting is infested.

2) Pest protection for 25 Native American baskets in a display case located in an administrative office space requires the steps outlined in the above example. However, in this instance, a sticky trap should be placed in the display case to facilitate monitoring for pest activity. On the other hand, except for periodic housekeeping tasks, an IPM program for rock and mineral specimens and metal instruments housed in a display case is not necessary.

3) Pest protection for a museum property collection of 750,000 archeological objects and records (including paper, textile, wood, leather, and plant fiber materials) housed in a large storage repository with adjacent offices and work spaces requires the development and implementation of a more comprehensive IPM Program.

B. IDENTIFYING MUSEUM PESTS

1. Microorganisms

Accurate identification of molds and other fungi requires

the services of a trained mycologist. Evidence of molds and other microorganisms indicates that the environment is suitable for their growth, and that it may be inappropriate for the preservation of museum property.

The spores of mold and fungi are omnipresent. They become active when the temperature and relative humidity (RH) are appropriate and when nutrients are available to support their growth. Mold has been found growing at temperatures between 32°F and 100°F, and when the RH exceeds 65%. Unfortunately, the materials in museum property (e.g., paper and sizing solutions in paper, animal glue, adhesives, and starch pastes) can provide nutrients for mold and fungi to flourish if environmental conditions permit the spores to germinate. All organic materials are prone to damage by mold. The damage can range from odor and staining to structural weakening and complete destruction of the object.

Mold and fungi present the greatest problems in tropical areas where ambient conditions (e.g., moisture and heat) are conducive to mold growth. In temperate climates, problems with mold and fungi can usually be solved by modifying the climatic conditions.

2. Insects

Not all insects cause damage to museum property. It is important, however, to identify every insect found in a facility housing museum property to determine if it is a threat to the collections.

Insect pests of museum property can be divided into categories based on the primary type of materials on which they live or feed. The categories are as follows:

- Mold Feeders
- Woodborers
- Cellulose Feeders
- Protein Feeders
- Starch Feeders

Some insects (e.g., cockroaches and crickets) are

omnivorous. Members of these groups can damage a wide variety of organic materials. Some insects do not feed on an object, but damage it by excreting, soiling, or burrowing to find a quiet place to develop into the next life stage. These category terms may have a different connotation outside of the museum field and should be used with care when talking with entomologists or pest control specialists not directly associated with managing museum property.

Structural pests (e.g., subterranean termites, carpenter bees, and carpenter ants) can also threaten museum collections. While beyond the scope of this Chapter, these pests should be identified and action should be taken to control them.

3. Vertebrates

Rodents, bats, and birds can cause both direct and indirect damage to museum property.

a. Rats and Mice

Rats and mice cause damage through chewing, nesting, excreting, and soiling collection objects with dirt and grease.

The presence of mice and other rodents in a museum structure should serve as a warning that insects may also be present. Rodent nests provide habitats for carpet beetles and other insects that feed on fur and animal excreta. Insects can easily move from the rodent nests to collection materials.

The traditional use of poisoned baits for rodent control can cause secondary problems. Although the poison bait will kill the rodent, it will not kill insects (certain carpet beetles and cellulose feeders) that may feed on it. When a rodent has consumed enough poison to kill it, it may die in an inaccessible location, becoming food for insects that

feed on the carcass, then move to museum collection materials.

b. Bats

Bats rarely have caused direct damage to museum collections and they are generally considered beneficial animals because they eat mosquitoes and other insects. Like rodents and birds, however, bat roosts and droppings can provide food for insects that can damage museum collections.

c. Birds

Birds can cause damage to museum objects through their droppings, which can stain objects and become acidic in the presence of moisture. These acids can degrade acid-sensitive materials. Bird nests also provide habitats for carpet beetles and other insects that feed on their droppings and cast feathers. These insects can move from the bird nests to museum collection objects.

C. ESTABLISHING AN INTEGRATED PEST MANAGEMENT PROGRAM FOR MUSEUM PROPERTY

1. Preventive Program

The damage caused to museum property by pests is almost always irreversible. Once an object becomes infested, the options for eliminating the infestation without further damaging or altering the object are limited. Many of the chemicals traditionally used to manage infestations have been found to damage or alter the material of which the object is made. This is contrary to one of the basic tenets of museum conservation--a treatment should be reversible and should not alter the materials of the object or specimen. Therefore, **it is**

preferable to prevent pests from gaining access to or becoming established in the collections. This can be accomplished by developing an IPM program. Through an effective IPM program, those elements essential to pest survival (e.g., food, moisture, and habitat) are minimized.

The basic components of any IPM program are monitoring and identification, inspection, habitat modification, good housekeeping, treatment action, evaluation, and education. These components are on-going and cyclical in nature. For a museum property IPM program, these components are used in five activities:

- **!** Determination of Biological Activity
- **!** Prevention of Pests from Gaining Access to and Surviving in Museum Spaces
- **!** Establishment of Thresholds for Pest Activity
- **!** Treatment Actions to Modify Conditions that Permit Pest Access and Survival
- **!** Action to Take When an Infestation is Discovered

2. IPM Program Activities

a. Determination of Biological Activity

Monitoring is the key to developing an effective IPM Program. Monitoring provides baseline information on the biological activity and climatic conditions in the spaces housing museum property: where the pests are, how they came into the museum, and why they are surviving. It can also help to determine strategies to take to eliminate future access and survival of pests in the collections. Finally, monitoring can help evaluate the effectiveness of any treatment action taken.

For museum property IPM there are two types of monitoring: monitoring for pests in the collections

and environmental monitoring. Environmental monitoring not only provides information critical to the protection of museum property against climatic damage, but also provides information about the interior climatic conditions of the building which might help to support an infestation.

Monitoring for pests is accomplished through the documentation of biological populations within the facility. Monitoring relies on the use of techniques such as direct observation, population sampling, routine inspections, and passive trapping. Techniques vary depending on the target pest. For example, the presence of wood boring pests can be detected by placing a sheet of white paper beneath holes created by insects. If sawdust accumulates beneath the holes, the infestation is active.

Since most insect pests in collections are small, avoid people, and are nocturnal, one of the easiest ways to document their populations in museums is to use traps placed throughout the area to be monitored. Passive traps are used to record the occurrence of pests when humans are not present. Traps are also useful because they can document the distribution of the insect population over time.

The most effective all-purpose insect trap currently available is a "sticky" trap. These come in two shapes (a box and a tent) and contain a food bait attractant. Both shapes consist of cardboard with an adhesive layer tacky enough to catch insects. For a wide variety of insects, the tent-shaped trap may be best.

1) **Steps for Establishing an Insect Trapping Program**
   a) Draw a floor plan of the area to be monitored. Indicate the location of all doors, windows, water and heat sources as well as floor drains. Furniture should also be illustrated. In addition, if the area being monitored is a collection storage or exhibition area, notations should be made as

to the type of collection material that is stored or exhibited.

b) Number and date the traps.

c) Place traps throughout the area to be monitored. Critical areas are perimeter walls, corners, near doors, under furniture, near water sources, near heat sources, and inside and outside exhibit and storage cabinets.

d) Indicate the location of the traps on the floor plan.

e) Inspect the traps on a regular schedule and record in a logbook or on a form the following information: trap number, location of the trap, date inspected, species of insects, and the number of individuals per species found in the trap. Also useful is a notation of the life stage of the species found, unusual conditions (e.g., leaky pipe or maintenance work), and the replacement date for a trap. Curatorial staff may devise their own survey form. Refer to Figure 6.1 for a sample Museum Integrated Pest Management Survey Form. During the initial phase of the monitoring period -- usually the first 3 to 6 months -- inspect the traps weekly.

f) As the trapping routine becomes more regular,

refinements in trap placement and inspection periods can be made depending upon the structure and the evidence found in the traps. An understanding of the biology of the pest will assist in the placement and scheduling for the maintenance of the traps. It is important, however, not to leave the traps uninspected for too long a time because the dead insects caught in the trap can

become attractive as food sources for other insects and rodents, which may feed on the dead insects in the trap without getting caught.

g) Traps should be replaced at least every 2 months, when they become full, or when the adhesive loses its tackiness, whichever comes first.

2) **Routine Inspections**

Another important activity in monitoring for insects is making routine, thorough inspections for insect evidence of all the interior spaces of the structure, including the collections themselves. Gain a familiarity with the structure(s) housing museum property. Window sills and door jambs should be checked for insects at least once a week.

Window Sills: Sills are a common resting place for insects that are attracted to light. This is especially important for determining if a carpet beetle problem exists, because the adults are attracted to light and attempt to go outside to feed on pollen and breed.

Door Jambs: Look for evidence of spider webs. If there are gaps around the doors, insects are likely to enter the building through these gaps. Spiders are likely to spin their webs so they can trap any insects entering the building through the gaps.

Inspect the museum collections at least every six months. Especially vulnerable materials, such as organic ethnographic materials and biological specimens should be inspected more often. Look for holes in textiles, and examine the bottoms of drawers and cabinets for cast larval skins of dermestid beetles, piles of woodborer frass

developing beneath wooden material, and frass and hairs cut off of animal skins.

Monitoring is not effective unless it is properly documented. Document what was found, where it was found, and when it was found. If possible, identify the species of the insect.

The identification of the insect and its life stage are critical to determining what is happening in the areas being monitored. To determine the species, refer to keys found in some of the references listed in this Chapter's selected bibliography. Assistance with identifying insects may be obtained from entomologists through the cooperative Extension Service, U.S. Forest Service, State Departments of Food and Agriculture, and museums of natural history. Curatorial staff may wish to establish an IPM pest reference collection to assist in identifying pests. If such a collection is established, store it properly to protect it from biological deterioration.

Monitoring for rodents uses a combination of techniques, including the use of traps. Sticky traps known as glue boards are available for rats and mice. These are usually shallow plastic trays filled with an adhesive onto which the rodent walks and gets stuck. Also effective for rodents are old-fashioned snap traps which can be baited with cotton batting (an attractive nesting

MUSEUM INTEGRATED PEST MANAGEMENT SURVEY FORM

Unit Name:_____________________________________Inclusive
Dates:__________________

Structure Housing Museum
Collection:____
Exhibit Space____ Storage Space____

Name and Title of
Inspector:____

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* Trap *   Location of Trap -   * Total Insects Count/Week**
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*Number *   Brief Description   *Week #1 *Week #2 *Week #3
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Figure 6.1. Example Museum Integrated Pest Management Survey Form

material, preferable for use in museums to a food bait, that can attract insects). A whole (unshelled) unroasted peanut is also an excellent bait that is unlikely to attract insects. **All traps should be monitored daily**. A dead mouse or rat constitutes a threat because it acts as an attractant to insects.

All curatorial staff should be trained in "pest awareness" and should immediately report any evidence of biological activity to their IPM coordinator. A logbook should be established, and any evidence of biological activity should be noted. Include the location and description of the evidence, the material on which the evidence was found, the time of day, and the name of the finder. If actual insects are found, they should be collected and identified and this information should be included in the logbook together with the time of day that the insect was found and whether it was found alive or dead.

Regular analysis of the data collected from monitoring programs can guide curatorial staff in developing strategies for minimizing or eliminating pests. Monitoring provides critical information concerning the extent and source of the infestation.

The strategies can range from improving sanitation and dust control to building modifications made to correct failures in the seal of the building that are not easily detected by humans, but permit insects or other pests to enter. Insects can come from a variety of places. For example, by placing a trap near an emergency exit door leading from the museum property storage or exhibition space directly outside, the tightness of the seal around the door can be determined. If the door is opened only in emergencies, and the trap shows that over a month's time many insects of different species are being caught, the seal around the edges of

the door should be checked to determine if it is tight. The seal should be checked periodically as part of the housekeeping program. Once the repair to the seal of the door has been made, subsequent monitoring will indicate whether or not the repair was effective.

b. Prevention of Pests from Gaining Access to and Surviving in Museum Spaces

1) **The structure as a physical barrier**

All pests require three things for survival: food, water, and shelter. Facilities housing museum property can provide all three. Restriction of pest access into the structure from the outside is therefore important. Adult mice, rats, and insects require only a small opening to enter a building. Insects are attracted into a structure at night and on cloudy days by light. Rodents are attracted by warmth during cool weather, and by dryness during damp weather. Some pests are attracted by the smell of food.

Consequently, all structural gaps should be closed to prevent access to the building. Actions that can be taken include installing weatherstripping around doors, caulking joints around windows and doors, installing screens on all operable windows, and installing screens on floor drains.

Minimize habitat for insects and rodents outside the structure. The larger the population of insects and rodents directly around the structure, the greater the potential for pest entry. Install a 3-foot wide, 4 inch deep gravel strip around the perimeter of the structure to prohibit vegetation from growing around the foot of the structure. While this may not be acceptable for historic structures, which require appropriate landscaping, it is useful for

non-historic buildings.

Similarly, if not prohibited by historic landscaping requirements, remove ivy and other plants growing on the structure. They provide support for bird nests that make attractive habitats for pests. Since branches can be used by rats as access points to the roof of the structure, trees should be routinely trimmed to prevent them from touching the building.

Other regular maintenance activities that help to reduce biological activity around the structure include periodic cleaning and repair of gutters, grading the soil around the foundation so that water drains away from the building, and removal of bird and wasp nests. Many of these recommendations prevent pests from gaining access to the structure and protect the structure itself from deterioration.

Establish a routine inspection program to maintain the exterior of the structure and surrounding vegetation. Inspections should be made routinely to document building changes, such as settling foundations, or evidence of biological activity around and on the structure.

2) **Barriers within the structure**

Inside the structure, enclosure of the collections in storage cabinets and exhibit cases is the first defense against pests. Cabinets and cases should be well sealed. Gaskets are useful for improving the seal around doors and drawers. Holes cut into cases for ventilation should be screened.

For exhibitions, enclose as much of the museum property as possible. Limit the use of open displays. In historic furnished structures, enclosing exhibits may not be possible. Therefore, additional care should be taken to

monitor all exposed objects in order to detect infestations before they become widespread.

Weatherstripping installed around interior doors helps to prevent pests from moving from one section of the building to another. It is especially important to separate public spaces (exhibit areas, information and sales areas, and

office areas) from the museum collection storage areas.

All areas inside the structure should be routinely inspected for structural changes or failures.

3) **Good housekeeping and sanitation**

Most pests require only small amounts of food and water to survive. Dust found in cracks may provide enough nourishment for survival. The dust is usually hygroscopic and may increase humidity enough to favor pest survival. Moisture from condensation on plumbing or water in sinks can also provide enough moisture for an insect to survive. Rodents are nibblers. They feed on almost anything available, including dead insects.

Establish a good housekeeping and interior maintenance program to minimize food and moisture sources. Shelter for pests comes in many forms, including cracks and crevices in walls and floors, voids in walls, and clutter. To minimize shelter and areas in which nutrients such as dust build up, make the interior spaces of the building as seamless as possible: caulk all cracks and crevices with silicone caulk and close gaps around plumbing fixtures and pipe penetrations through walls, floors and ceilings. The use of steel wool to fill such gaps in structures can provide additional protection against rodent entry.

Eliminate clutter. Clutter provides excellent hiding places for insects and rodents. It can also become food for some pests. Clutter gathers dust, which can become a microenvironment supporting mold, mold-feeding insects, and other insects. Dispose of all unnecessary materials and provide proper storage for equipment and supplies.

Minimize dust by building and cabinetry design and by proper sanitation. Cabinetry should be designed to permit easy access for cleaning the spaces beneath and behind.

Use vacuum cleaners to clean floors and structures. All spaces should be vacuumed according to an established housekeeping schedule. Refer to Chapter 7 for guidance on establishing a housekeeping program. A vacuum crack and crevice tool should be used to remove dust and debris from cracks and joints. The vacuum cleaner bag and its contents should be disposed of properly outside of the building to prevent redistribution of insects or eggs.

After documentation, all evidence of rodents and insects should be removed and disposed of properly. Dead insects and rodent droppings can provide food for rodents and other insects. Dead rodents, birds, and bats also are food for insects and rodents.

4) **Cultural controls**

Museum property can become infested despite good housekeeping, sanitation, and tight barriers. This often happens by incorporating infested material directly into the museum property collection. Uninfested materials can go on loan to another museum and become infested, new material can be accepted into the collections

without knowing that it is infested, scholars and visitors can bring materials from "home" for comparison with the museum's holdings and an infestation can be established.

Establish an area outside of the collection storage and exhibition area for the inspection of new objects and returned loans. Restrict the direct comparison of non-collection items against collection items. Do not incorporate any material into the collections until it has been judged to be pest-free.

Similarly, exhibit materials (e.g., props and new construction materials), equipment, and supplies may already be infested with insects when brought into spaces housing museum property. Set aside space near the museum's receiving area for thorough inspection of all material entering the building. If infested, do not bring this material into the building until it is pest-free. As plants and flowers can be nutrient sources for the adults of some carpet beetle species; they should not be brought into spaces housing museum property.

Restrict food and smoking in spaces housing museum property. Pests can enter the facility in smoking materials and food bags. If food and smoking is permitted in the building, designate special areas far away from the collections that can be thoroughly cleaned. Dispose of food and smoking wastes properly. Do not leave them accessible to insects and rodents. Take wastes outside of the museum and dispose of them in tight-fitting receptacles.

c. Establishment of Thresholds for Pest Activity

Thresholds are the points at which some action needs to be taken to correct the presence of a pest. With museum property, the threshold is site-specific in

establishing the level at which action should be taken. The intensity of the action is determined by the proximity of the pest to the collection. For instance, a pest caught near the entrance door to a storage or exhibit space may not warrant extensive treatment, but its discovery should trigger an increase in vigilance against pests.

d. Summary of Preventive Actions

Monitoring programs provide information about biological activity within the storage and exhibit spaces and the collections. Data from monitoring identifies what pests are in the museum, in what quantities, where they are located. Data also may reveal how they came into the museum, and whether or not they can survive.

Monitoring helps to evaluate the building structure: Does it provide enough of a barrier against pests from the outside? Are there structural failures? What can be done to improve the seal? Monitoring also helps to evaluate a unit's sanitation and housekeeping programs. From this information, improvements to the structure and modifications to the sanitation programs can be planned efficiently. Remember: Taking preventive actions to exclude pests from museum spaces and exercising constant vigilance through monitoring and inspections are the keys to effectively controlling pest problems.

D. ACTION TO TAKE WHEN AN INFESTATION IS DISCOVERED

1. Three Action Steps

If an infestation is discovered in a museum property storage or exhibit space, take immediate action. Actions should include steps to isolate and identify the infestation, develop a treatment strategy, and review the effectiveness of the existing IPM Program.

a. Isolating and Identifying the Problem

1) Isolate the infested material. Heavy polyethylene plastic (6 mil minimum) is useful. Small objects can be placed in resealable bags (e.g., Ziplock® bags). For larger objects, a polyethylene tent can be made using tape or heat sealing equipment. Make sure that the plastic is completely sealed.

2) Identify the pest.

3) Based on the habits of the pest, determine the extent of the infestation. Start at the site where the first infested object was found and inspect the museum property and the space(s) housing the property in ever widening circles. Isolate infested material as it is found and document the findings. Sweep away any old wood dust and frass and place a sheet of white acid-free paper beneath the object. Monitor for new wood dust and frass accumulation to determine if the infestation is still active.

4) Determine the source of the problem. If the problem is structural, make structural repairs to the building. If infested material was brought into the collection, evaluate and modify the policies and procedures that permitted this to occur.

b. Developing a Treatment Strategy

1) Identify developmental stages of the pests that are found on the materials.

2) Identify the media of the infested material (e.g., what is the material composition of the object or specimen?).

3) Based on an understanding of the biology of the pest, its life stage when found, and the material of the object, answer the following questions:

- **!** Can the infested material be disinfested by removing the pest?
- **!** Are eggs present?
- **!** What is the least damaging approach to treatment?

4) Treatment decisions should be based on evaluation of the identification of the pest, the infested materials, and the condition of the object. In consultation with the bureau's IPM Coordinator and a conservator, choose an effective treatment that will cause the least amount of damage to the object and to the environment. Treatment options range from simple cleaning to fumigation. If chemical options are selected, follow manufacturer and bureau safety procedures carefully. **NOTE:** Local laws and ordinances may be more restrictive than bureau safety procedures and often supersede them. A desirable alternative to use of chemicals is freezing. The success of this treatment, however, requires following very specific steps, including the careful bagging of objects and their exposure to repealed freeze-thaw cycles. Not all materials can be safely frozen. Freezing will stop pest activity, but may not kill all insects and eggs. Before using this treatment, consult a conservator.

5) Document any and all treatments made. After treatment, the objects should be cleaned, with all the removable evidence of the infestation documented and removed, and any pest damage documented and added to the museum records. File all treatment and/or damage documentation in the appropriate Accession File or Catalog Folder.

6) Evaluate the treatment to determine if it was effective. Following fumigation, the object should remain in isolation and should be monitored weekly or bimonthly for any signs of

continuing infestation. The object should be returned to the collection only when it is free of pests.

c. Reviewing IPM Program

1) Review the established museum IPM Program to determine how it can be modified to prevent a similar infestation from occurring in the future. Consult the bureau's IPM Coordinator.

2) As necessary, modify the IPM procedures. Document any modifications.

2. Fumigation

The word "fumigation" is commonly used to identify any chemical treatment of infested material. Although fumigants may exist in three physical states (e.g., solid, liquid, and gas), they need to be converted to a gaseous or vapor state in order to effectively kill pests. Solid fumigants (e.g., paradichlorobenzene [PDB], naphthalene, and thymol) convert to a vapor state with heat and time. Liquid fumigants (e.g., dichlorvos [Vapona®] and carbon disulfide) evaporate at room temperatures to a vapor state. Gaseous fumigants (e.g., ethylene oxide, methyl bromide, and sulfuryl fluoride [Vikane®]) are distributed in pressurized cylinders for specific use in fumigation chambers.

If it is determined that a chemical approach is necessary to control the pest infestation and is approved by the bureau's IPM procedures, the curatorial staff needs to adhere to the following guidance:

a. The Environmental Protection Agency (EPA) is required

by law to determine whether a pesticide can perform its intended function without causing "unreasonable adverse affects" on human health or the environment while taking into account the potential benefits of the proposed use. Each product's label contains the EPA Registration Number. The Federal Insecticide,

Fungicide, and Rodenticide Act (FIFRA) of 1972 (as amended) prohibits, with limited exceptions, the use of any pesticide product for any purpose or in any manner not specified on the label. Refer to Section 2(ee) of FIFRA for these exceptions. For example, the fumigant ethylene oxide (EtO) is not approved for use on books and archival materials. In addition, EtO only may be used as a fumigant in a chamber, and not as a contact pesticide or deterrent.

b. FIFRA classifies all pesticide products as either "general" or "restricted" use. General use pesticides are those that will not cause unreasonable adverse effects to the user or the environment when used in accordance with the label. These products are available to the public with no restrictions except those that are specified on the label. Museum pesticides and fumigants in this category include paradichlorobenzene (PDB), naphthalene, thymol, dichlorvos (e.g., Vapona®), and boric acid. Restricted use pesticides are those that cause adverse effects to the applicator or the environment and must be applied by persons who have received specific training in their use. Methyl bromide, hydrogen cyanide, and sulfuryl fluoride (e.g., Vikane®) are museum fumigants included in this category. EPA's list of restricted use pesticides is updated monthly. Check with the unit IPM Coordinator for a current list of the restricted use pesticides.

c. The law and DOI policy require that staff must be certified to handle and apply restricted use pesticides.

d. **The use of pesticides or fumigants (e.g., paradichlorobenzene, dichlorvos, naphthalene, and boric acid) are only approved in response to controlling a specific infestation. These materials are not approved for use as preventive repellents or deterrents.**

e. Fumigation, a complex process, should be carried out by a trained and experienced person. The specific

pest, the volume of space to be fumigated (e.g., chamber, room, or structure), and the type(s) of museum material(s) involved determine the type and amount of fumigant to be used and the length of exposure. During application, the proper and effective use of a fumigant requires the strict control of environmental conditions (e.g., temperature and relative humidity).

f. Units located in close proximity to a museum or other institution with a fumigation chamber should develop a working agreement with the institution to provide fumigation services when needed. Ensure, however, that the chamber is operated by certified persons. Portable fumigation equipment may be a practical approach to applying fumigants to infested objects in a unit's museum property collection. Although such equipment is expensive, it may be a cost effective alternative to constructing a fumigation chamber.

Remember: A chemical approach is used only when preventive measures have failed to control an infestation. The fumigant applied brings the infestation under control and reduces the threat of damage to collections. Once the fumigation procedure is completed, the curatorial IPM program should be evaluated to determine how a future reoccurrence can be prevented. Objects that have been fumigated should be continually monitored to evaluate the success of this control method.

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Chapter 6 Biological Infestations