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NEW DEVELOPMENTS IN PEST MANAGEMENT FOR COLLECTIONS IN MUSEUMS AND HISTORIC HOUSES

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Abstract The concept of "Risk Zones" to evaluate and set priorities for preventing damage to collections across the whole museum has been used as a very useful tool by a number of major museums in London. Pest monitoring using sticky traps is well organised and documented, and many organisations in the UK use a system similar to, or based on, the one developed by English Heritage. Prevention is always better than cure, but there can still be a need for residual treatment with sprays or dusts. There has been pressure to move away from persistent and toxic insecticides for treatment of objects. The development of treatment techniques anoxia, freezing and heat, has given museums a number of very safe options which will kill all pests in objects if they are carried out correctly. Solar heating has promise for developing countries. IPM prevention together with treatment regimes based on anoxia and low and high temperatures should ensure that historic collections will be safely preserved for the future.
Key Words IPM, risk zones, pest monitoring, *Tineola bisselliella,* anoxia, temperature

INTRODUCTION

In the last ten years, Integrated Pest Management (IPM) has been adopted by many museums, archives and historic houses. In the past, there was widespread use of many toxic materials such as arsenic, DDT and mercuric chloride to prevent wood, textiles and natural history specimens from being destroyed by pests. In the last 20 years conservators and other museum staff have developed alternative strategies for preventing and controlling pests. (Rossol and Jessop, 1996; Florian, 1997; Pinniger, 2001; Strang and Kigawa, 2006). These IPM strategies based on detection and prevention of pests have been successful in many small and large museums, museum stores, historic houses, galleries, libraries and archives world-wide.

There are many parallels with IPM in the food industry; pest monitoring, environment and targeted treatment are all essential components. But in the heritage sector they have to be modified to take account of the special needs of the historic collections and the buildings they are housed in. This paper will not cover termites and other structural pests as these may need to be dealt with in different ways from collection pests. However, it is essential to recognise that many historic buildings are infested with their own resident populations of insect pests which will attack collections. For example, a building such as the Natural History Museum in London harbours populations of carpet beetles *Anthrenus* and *Attagenus* sp. They are living in organic debris (hair, skin and clothing fragments) in voids and dead spaces in the building but can easily move from these harbourages to infest and damage vulnerable collections. More recently, webbing clothes moth *Tineola bisselliella*, which is one of the most destructive pests of textiles, has been found living and breeding in large numbers in debris under the floorboards in the Victoria and Albert Museum. Recognition of this risk and assessment of the populations by use of monitoring traps have been key in preventing of damage to collections in these museums.

Risk Zones

Implementing an IPM programme in a large museum or collection can seem very daunting and may result in IPM not being accepted or adopted. A number of papers presented at the conference "2001- a pest odyssey" discussed ways of effectively implementing IPM in collections. (Kingsley et al, 2001). The concept of "Risk Zones" to evaluate and set priorities for preventing damage to collections across the whole museum evolved as a result of discussions at this meeting. The first museum to take the concept through to complete implementation was the Natural History Museum (NHM) in London. It was agreed that there are five key components of the system:

1. Museum buildings and historic houses have a resident population of pest insects.
2. Evaluate the vulnerability of the collections or objects to insect attack.
3. Assess the risk of collections being attacked by pests.
4. Assign each area in the museum to one of four risk zones: A. Very high; B. High; C. Low; D. Very low, or none.
5. Determine protocols for trap monitoring, inspection and cleaning for each zone.

The success of the project depended upon the appointment of an IPM co-ordinator with regular input from an IPM team representing the different departments. Floor plans were used by staff from collections management teams to walk through the museum identifying collection risk and colour coding each area. It was also noted where there had been past or current pest problems. Although the priority was to map the risk zones for insect pests, it became clear that a parallel system was needed for rodent infestation. An example of insect Risk Zones marked on a floor plan is shown in Figure 1. After the initial exercise, it was decided to test the risk zone system in a very high risk collections area, a detailed description of this is given in Doyle et al (2007). The pilot study showed that the risk zone concept was both effective and practical and therefore the museum undertook full scale implementation. A key factor in the success of implementation has been the training of staff in IPM and pest awareness. Risk zones have had to be continually revised to meet building changes over the last few years. Further developments include a standard trapping form and annual analysis of trapping data.

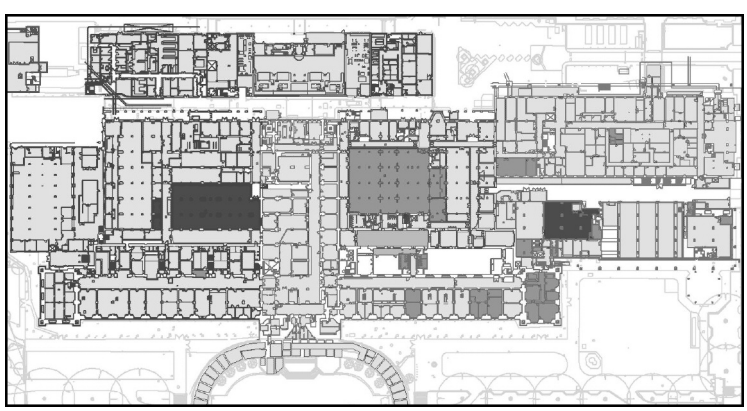

Figure 1. Insect Risk Zones in the Natural History Museum Basement, London

In parallel with the risk zone project at the NHM was the use of risk zones to implement IPM in the Imperial War Museum (IWM) main site in London. This was then extended to include such diverse sites as HMS Belfast, The Cabinet War Rooms, IWM North and Duxford Airfield. The adaptability of the concept to such diverse sites shows that the risk zone system has a potential value to all collections areas. The first priority at IWM was to devise an insect trapping programme to regularly collect data and then analyse it to show changes in pest incidence and abundance. The distribution of traps was determined by the A and B risk zones at each site and the programme resulted in effective early warning of pest problems and enabled prompt targeted action. An outbreak of moths in wool objects the "1940s House" exhibition led us to reassess the Risk Zones to include all open displays as a high Risk Zone A if they contained wool and other vulnerable items. Including only accessioned objects led to us missing the pest problem in props and exhibition material. Now the risk zones plans and trapping programme at all the IWM sites include areas which contain non-accessioned but vulnerable objects.

Staff at the Victoria and Albert museum recognised the value of the Risk Zone concept and incorporated it as a keystone for their IPM programme. The importance of recognising the risk to collections on open display from non-collections objects was demonstrated by an outbreak of webbing clothes moths in the reproduction fabrics in the Bed of Ware in the British Galleries.

A number of other museums, including the Museum of London, have now evaluated the risk zone concept and accepted that it is a very practical and cost effective way of implementing IPM. The application should be very straightforward and the system fits in very well with the current management concepts. Risks, priorities and cost-effectiveness are all topics which help a project to succeed. Our objective is to care for collections by preventing pest damage, and risk zones are a very direct way of achieving this.

The system of risk zones can also be used in a wider context. Strang and Kigawa (2006) have devised a system for ranking the risk to collections by building type and level of protection from pest attack. They propose a series of seven categories from "No resistance to pests" to "Comprehensive control". The combination of this system for the overall building, together with the use of Risk Zones for collection areas, would give a very comprehensive basis for effective IPM.

Trapping

Pest monitoring using sticky traps should be well organised and documented, and many UK organisations use a system similar to, or based on, the one developed by English Heritage for use in its historic properties (Pinniger, 2009). A simple Excel spread sheet and mapping system allows results to be analysed and population trends identified and pest epicentres pinpointed. Trapping programmes have identified new pest species to the UK, such as *Anthrenus sarnicus*, the Guernsey carpet beetle, and *Attagenus smirnovi*, the vodka beetle. In 2010, a population of *Anthrenocerus australis*, the Australian carpet beetle was found by means of traps, this is the first documented infestation of this species in a UK museum. Non-attractant sticky blunder traps are supplemented by very effective pheromone traps for webbing clothes moths *T. bisselliella*. These traps have been used to give early warning of moth presence and enabled prompt remedial action to be taken. Regular monitoring has also demonstrated the dramatic increase in clothes moth populations in many historic buildings in the UK over the last ten years (Figure 2). The use of moth pheromones as the basis of population control by male confusion has been adapted from the Exosex system used against *Ephestia* and *Plodia* in the food industry. Initial trials of Exosex CLM against *T. bisselliella* have shown promise in historic houses for limiting moth populations (Figure 3).

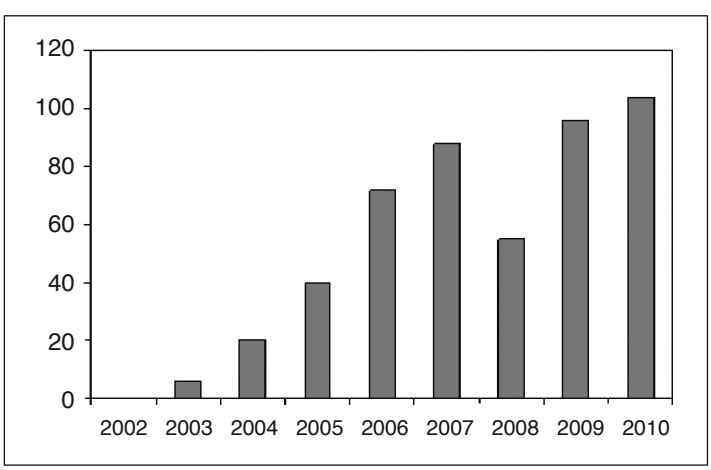

Figure 2. Increased catch of *T. bisselliella* on traps in a large historic house.

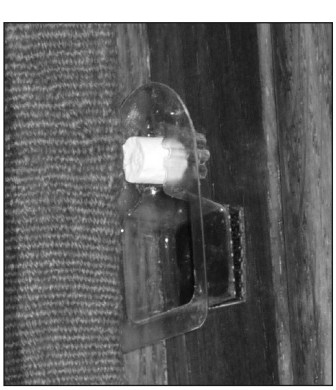

Figure 3. Exosex CLM clothes moth lure dispenser.

Figure 4. Mobile Thermo Lignum heat chamber.

OPTIONS FOR TREATMENT

Prevention is always better than cure, but there can be a need for residual treatment with sprays or dusts to control infestations in voids in buildings. Permethrin micro-emulsion sprays and desiccant dusts have been successfully used in combination with thorough cleaning to remove food sources (Child, 2001). Residual insecticides have been applied to structural wood or wooden objects to kill woodborers, but such treatments are unlikely to kill extensive and deep-seated infestations. Infestations must be active, as it is a complete waste of time and money to treat old damage and dead insects (Pinniger, 2001).

In the past, methyl bromide gas was very widely used for fumigation of objects in museums, but the use of this chemical as a fumigant has now been banned in many countries. The development of alternative treatment techniques based on physical means has given museums a number of safe options which will kill all pests in objects.

Anoxia

Nitrogen anoxia and carbon dioxide fumigation can be very effective in killing insects in objects. The technique is particularly useful for fragile and very vulnerable objects which might be damaged by low or high temperature treatments. However, enclosures must be gas-tight and exposures may have to be as long as 5 weeks to kill pests such as woodborers. The recent development of easier to use and cheaper oxygen scavengers such Zero2 (ColinSmithConservation, 2011) to produce anoxic environments may result in a more widespread adoption of anoxic control. The use of CO_2 as a fumigant gas is very effective and is used by a number of museums in North America (Warren, 2001), but in the EEC it can only be used for this purpose by approved contractors.

Low Temperature

Many insect species are tolerant of low temperatures, and to kill museum pests objects must be exposed to -30ϒC for 3 days or -18ϒC for at least 14 days. Objects must be wrapped in a buffering layer, such as acid-free tissue, and then sealed in bags. They should be placed carefully in a freezer and temperatures checked with a thermometer. Objects should be removed carefully and must not be unbagged until they have reached room temperature (Strang, 1996). A number of museums around the world have walk-in freezers or purpose-built freezer rooms for -30ϒC treatments. Low temperature treatments are used routinely by many museums treating for new objects and specimens coming into the museum to prevent pests being introduced on incoming collections. They can be also used for large scale programmes of disinfestation, particularly when moving collections from one building to another. The drawback of freezing treatments is the logistics of having enough staff and time for the lengthy process of bagging and unbagging objects.

Elevated Temperature

High temperatures of above 52ϒC will kill most museum pests in one hour. Objects can be treated without bagging in a special humidity-controlled chamber at 52ϒC, such as the Thermo Lignum process (Nicholson and Von Rottberg, 1996). There is also a portable Thermo Lignum system which can be taken to sites where objects need to be treated (Figure 4). Research has shown that some less sensitive objects can be treated in an oven at 52ϒC if they are bagged in the same way as for freezing (Strang 1996, 2001). Ackery et al (2002) have shown that insect specimens in entomological drawers can be safely and effectively treated by placing them in bin bags in a thermostatically controlled oven set at 52ϒC. Large objects can be treated in a simple hot box (Xavier-Rowe et al, 2000) or by using solar heating (Daniel, 2001; Brokerhof, 2002). There must be good air circulation to avoid problems with condensation due to temperature differentials (Strang, 2001).

Although many objects have been safely treated with freezing or heat, stressed or fragile objects should not be subjected to very low or high temperatures. If in doubt about the suitability of thermal treatments for an object, consult a conservator.

THE FUTURE

Because of the effects of some chemicals on staff, objects and the environment, there has been pressure to move away from persistent and toxic insecticides. The development of pheromone-based systems for population suppression is exciting, but success will depend upon the understanding of pest behaviour and the availability of economically priced lures. Low temperature treatments are now used for quarantine prevention and infestation control in many museums world-wide. The use of high temperatures is less common at the moment, but offers a rapid and safe alternative for many objects. The ability to use solar heating is of particular interest and value for

developing countries with limited access to expensive equipment and technology. The further development and adoption of treatment regimes based on anoxia and low and high temperatures should ensure that historic collections will be safely preserved for the future.

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