A Topical Solution to Tropical Museum Pest Control

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Abstract

At the National Heritage Board of Singapore, an approach to pest control management in the museums' collections has developed along side the relocation of existing stored collections to a new purpose built storage building. This process of relocation provided an ideal opportunity to tackle the prevailing levels of insect activity within the museums' stored collections. The occupation of this new building has enabled staff at the Heritage Conservation Centre (HCC), to instigate an approach to Integrated Pest Management (IPM), which has proven to be effective in establishing and maintaining low levels of insect activity.

This has evolved into a two-tiered approach. The new storage collection building is managed within a rigorously applied IPM framework. This ensures maximum control where the greatest risk occur, whilst concurrently a more adaptive IPM policy is maintained in the Museum Buildings themselves. Here, the risks of pest activity have been balanced in response to the different uses of the buildings, changing curatorial use

of the collections and the level of available conservation resources. Therefore, pest control and the consequent risks to the collections have had to be balanced against other museological and commercial requirements. This report will review the IPM strategy for the storage facility in relation to that applied to the other museum buildings. It will discuss the need for pest control strategies to be appropriate to the developing needs of the Institution.

Key Words

environment, collections care, insects, integrated pest management (IPM), storage, tropics.

Introduction

The National Heritage Board (NHB), formed in 1993, oversees Singapore's National Museums. These are the Singapore History Museum, the Singapore Art Museum, and the Asian Civilisations Museum. The collections include artefacts associated with social history, archaeology, ethnography, and fine, modern and applied art.

NHB has a stated mission to explore and present the heritage and nationhood of the people of Singapore in the context of their ancestral cultures, their links with Southeast Asia, and the world.

This is significant in terms of the care of the collections, as both indigenous and imported collections of material culture are housed in the same display and storage

environments. This has necessitated a compromise when setting environmental conditions between those prevailing in the tropics and those of higher latitudes.

The NHB museums are housed in nineteenth century buildings that have undergone a large degree of refurbishment in the last fifteen years.

Between 1997 and 2000, NHB was engaged in transferring the majority of its stored artefact collections to a purpose-built central repository, the Heritage Conservation Centre (HCC). This has provided the opportunity to confront the problem of insect infestation in the collections on a major scale for the first time. The incorporation of insect eradication and IPM strategies into the relocation project was an attempt to ensure that the new repository remains un-contaminated and the collections are not exposed to the damaging effects of insect activity.

Previous Storage Conditions

Prior to1997, the majority of the stored collections were held within the historic Raffles Museum building, where some rooms had been dedicated to storage of collections continuously since 1906 (Liu 1987). The major proportion of collections has been traditionally stored in non-air-conditioned rooms, ventilated by circulation fans and open windows.

Figure 1. Photograph of previous stores, showing open windows

Environment

Annual external climate conditions in Singapore range between 23-36 °C and 65-95% RH (mean of 84% RH). Non air-conditioned interiors typically range 24-26 °C and 72-78% RH. These conditions would be expected to result in accelerated rates of deterioration in a range of materials types from organic to metal artefacts (Kwa 1989), but this is not found to be the case in NHB collections.

One advantage of the environment of the humid tropics, which works in the favour of the preservation of the collections, is the lack of significant annual variation. Nothing equivalent to the cyclical seasonal change experienced in temperate regions is evident

in Singapore. The relative climatic stability, at high levels of relative humidity, has been thought to be a factor in the unexpectedly good levels of preservation for some of the collections (Loo-Lim 1991).

At the high RH levels experienced by the stored collections, mould growth could also be expected to be a problem. However, this has not been a significant risk factor, probably due to air movement and ventilation in the stores, maintained by ceiling fans. Air movement affects mould growth indirectly by dissipating local microclimates that would otherwise develop around substrate surfaces (Scott 1996). The increased ventilation used in the control of mould increases the risks of exposure to polluted air, and also perhaps most importantly, pest activity. The relative effects of these differing threats need to be considered when evaluating a strategy for collections care in the tropics.

Previous Pest Activity

Insect infestation is considered one of the most significant risks to museum collections housed in the humid tropics (Engelhart 1990). According to NHB staff and information from past surveys, insect infestation has been endemic and has resulted in extensive damage to some areas of the collections.

A sample survey of the whole collection in 1995 put the level of infestation in the organic object collections at over 17%. Some collections, such as the woven fibre collection was estimated to be 50% infested, whilst the textiles collection was estimated to be 25% infested (Koestler 1995).

The species of insects identified in NHB collections appear to be largely similar to those found in temperate museums, indeed many household /museum pests are considered to be of tropical origin (Florian 1997). In the tropics, due to the favourable conditions for insect growth, the life cycle tend to be rapid.

The use of insect-resistant tropical hardwoods in artefacts and storage furniture, such as teak, is thought to have restricted the proliferation of wood boring beetles in some areas of the collection. However, the effects of pests can be seen quite dramatically in the condition of the fibre and basketry collections, where an infestation of cigarette beetle, *Lasioderma serricorne,* had become well established. The NHB collections, like many other South East Asian collections, consist predominantly of cellulose rich artefacts e.g. textiles, basketry, and woodcarving. This provides a large potential food source for the resident insect populations (Lim 1990).

The insects that have been identified as a threat to the collections are listed in Appendix 1. This list is continuously updated. In addition to these pest insects, over 26 species of non-pest insects have so far been identified. Their presence indicates levels of access to the storage areas. They also provide a potential source of nutrition for pest species, such as carpet beetle and moth.

Previous Pest control

Documented cases of residual insecticide treatments for tackling pest infestations in the collections are known. For example, Lindane (gamma HCH) and Mystox

(pentachlorophenyl laurate) have been applied to the surfaces of infested objects in the past. Other methods of prevention such as the use of mothballs (Naphthalene), formaldehyde, chloroform, and more recently Xylamon (Lindane) have been used as a vapour inside storage cabinets.

Between 1995 and 1998, a system of anoxic treatment using argon was in operation. In this system individual or small groups of objects are bagged and sealed in an argon-enriched atmosphere, maintained by the use of oxygen scavengers below an oxygen concentration of 700 ppm for 28 days. The use of argon was recommended, in preference to nitrogen-based anoxic treatments, due to its comparatively shorter length of treatment time. In addition, nitrogen was thought to have the ability to support anaerobic growth at the high humidity situations found in the tropics, whereas argon does not (Koestler 1995). With the adoption of this method, the eradication of active infestations in individual artefacts was tackled. However, the lack of space in the store meant that treatments had to be carried out *in situ*. Subsequent proximity to other infested artefacts meant that general levels of infestation continued. The relocation of collections to a new building provided the opportunity for a larger scale solution.

Figure 2. The Heritage Conservation Centre

Pest Eradication during the Relocation of the Collections

As part of the IPM strategy for HCC, an insect eradication programme was carried out to treat all vulnerable artefacts before entering the new building. Rentokil Singapore Ltd. was engaged to provide large-scale pest eradication treatment for the relocation

project. After considering the particular needs of our collections and the resources available for the project, both controlled atmosphere technology (anoxia) pest treatment and methyl bromide fumigation were chosen for use. An estimated capacity of 1600 m^3 was required to treat the selected materials.

The use of inert gas anoxic environments has been well established as a safe method for pest eradication in museum artefacts (Gilberg 1989, Maekawa and Elert 1996). Rentokil has developed large-scale controlled atmosphere technology (CAT) treatments using nitrogen in anoxic enclosures in Europe and the USA (Smith 1995). The treatment of the collections during the relocation project represented the first use of this new technology in South East Asia. It was also the largest scale nitrogen anoxia treatment undertaken at that time. Over 40,000 objects were treated in a total volume of 500 m^3 (Smith 1998).

Large areas available prior to occupation in the empty storage building provided enough space to set up these large-scale CAT bubbles. Each bubble was on average 35 m^3 in volume. Oxygen levels inside the bubbles were targeted to below 0.2 % (0.4% oxygen being the upper level considered acceptable during treatment) for a cycle of 35 days, with a temperature of 23 °C and RH of 65% inside the bubbles.

Figure 3. Large scale eradication treatment showing two 35m³ CAT bubbles

Integrated Pest Management at HCC

The first phase of IPM implementation has been established at HCC since 1997. It is currently being adapted to the requirements of the NHB museum buildings (Singapore History Museum, Singapore Art Museum, and Asian Civilisation Museum Wings 1 and 2). IPM at HCC consists of a Buildings Pest Control Maintenance Contract and an IPM strategy for pest control for the collections of NHB.

Pest control through IPM aims to provide practical, safe and cost effective methods that prevent collections and buildings from becoming damaged by pest infestation. The IPM

strategy at HCC is based on minimising potential pest infestation by managing the following factors:

Access

Prevent the introduction of pest infestation into the collections.

All artefacts, materials and supplies that enter HCC are checked for signs of potential insect infestation before passing beyond the designated quarantine areas (see appendix 2. Flow diagram of movement of artefacts into the storage areas at HCC)**.** This includes artefacts, which are not themselves susceptible to infestation, but may also provide harbourage for pests. As part of this initial check, dust or debris, especially any material from past insect infestations, is removed before artefacts are moved into the permanent stores. All incoming artefacts that cannot be readily examined, or are suspected of being infested, are isolated and monitored prior to a potential eradication treatment.

Building precautions include well-sealed external envelopes with seals on exterior and internal doors. The building is designed without windows in all stores. Therefore, pheromone traps can provide a valuable way to identify insect populations within the storage environment.

Housekeeping

Maintain an environment that does not encourage pest infestation.

The routine cleaning and removal of rubbish (e.g. from corridors, stairwells, outside areas) forms part of the building cleaning contract and are regularly monitored by the estate management team.

Food is allowed only in designated areas away from artefact holding areas and these areas are routinely cleaned.

No artefacts are stored permanently on the floor or against walls, as space around artefacts is needed in order to carry out routine inspection.

Flooring in the storage areas consists of white epoxy paint and light coloured vinyl flooring. The use of carpets has been restricted to office areas only.

The environment inside the storage areas at HCC is set at a temperature of 23 °C with the RH at either 55% or 65%. When compared to the more favourable warm moist conditions outside, there is a considerable disincentive for insects to enter the building. This is unlike temperate museum buildings, where interior environments are generally more attractive to insect activity than outside environments.

The maintenance of relatively low internal temperatures (23°C) reduces the ability for insects to fly and therefore restricts their tendency to spread. This has an implication for the positioning of pheromone traps, (they need to be near floor level), and for checking for insect presence. Routine checking inside storage cabinets and boxes is required in order to identify *in situ* insect activity that might not be evident in the trapping survey.

Common corridors and outside perimeter zones are generally clean and free of dirt and debris. There is a good perimeter barrier of concrete and paving and this is only breached by a small plant bed at the front of the building. This has been identified as an

area that must be kept in check in order to prevent a source of insect problems developing (Pinniger 1999).

Monitoring

Assessing the extent of pest infestation and the degree of risk to the collections.

Regular routine checks of the storage areas are conducted by HCC staff and potential problems are recorded.
Collections most at risk, e.g. textiles and garments, organics, furniture, mixed media and paper objects are especially targeted. Vulnerable artefacts benefit from being identified and marked to ensure that they can be more frequently inspected. Boxes and cupboards containing high-risk artefacts are regularly opened and examined.

Survey

As part of the monitoring process, a programme of insect trap pest surveys and sighting records is used to identify the level of insect pest activity within the collections. The extent of this survey is governed by the availability of staff time and resources.
Specific pheromone traps are used to target known pest species in vulnerable stores. Checking of the traps is carried out on a three-monthly basis, and this is continuing to be reviewed in line with the perceived level of risk to the collections.

In addition, a survey of insect populations outside the building has been initiated to determine the level of pressure on the building. It can also be used to investigate the

relationship between the outside and inside populations. For the outdoor survey, standard and pheromone sticky traps are used.

One limitation of the trapping system is that recording, documentation, and surveying can become routinely focused on the outcome of trapping incidence. This means that the regular examination of dead areas, enclosed object storage environments, window ledges, light fittings, can become less frequently carried out when extensive trapping surveys already demand a significant investment of staff time and resources. Therefore, a more targeted location of traps in relation to the risk of the collections and a greater focus on regular general checking of the storage/ display areas would perhaps provide a better level of monitoring.

How extensive the trapping survey needs to be, has to be balanced between risk to collections and available staff resources, and how this can be integrated into general collections care activities. If general housekeeping and monitoring is carried out, this information can be recorded with other relevant information in the pest control incident log. If general checks are carried out for leaks, dirt, security etc., then the scope of the check should include observations relating to pest control.

Identification and Assessment

All insects found in the stores are retained for identification. This is critical in assessing the level of risk to the collections. It also enables the trapping survey to be adapted to the type and extent of insect activity found.

Currently, insect identification forms part of the buildings pest control maintenance contract and the identification service is provided on a three-monthly basis.

A spreadsheet of all insect trap catches is completed after each survey by conservation staff. If an infestation is suspected, then additional traps and more frequent monitoring may be required to locate the problem.

An annual report is produced of the surveys, incident logs, and any other findings during the year.

Due to high standards of routine maintenance, cleaning, and general housekeeping, there are low levels of identified insect activity and currently no significant infestation problems. There are occasional invaders of non-pest insects and geckos, which show that there are breaches in the external building envelope that need to be identified and rectified. Monitoring, in order to identify the need for action, is the key to checking the success of this. Current high standards can only be maintained if potential future trouble spots identified during the surveys are eliminated swiftly and if adequate resources are provided for monitoring, maintenance, and cleaning. The present commitment by staff seen during the IPM course is a very positive factor (Pinniger 1999).

Results of the trapping survey

Since the occupation of the new building in 1997, the initial resident populations of psocids, geckos, silverfishes, and cockroaches have gradually reduced in occurrence. The perennial presence of insectivores (geckos and spiders) does suggest the presence

of an insect population sufficient to sustain them. These animals also tend to compete for insects with the trapping survey. Geckos are frequent visitors to the sticky traps and therefore are likely lead to a reduction in the insects recorded in the trapping survey.

The presence of *Lasioderma* s*erricorne* in the collections has been used in the relocation project as an indicator insect to determine the efficiency of the eradication process. The presence of this insect has decreased in the collections and the number of locations where it is present has decreased significantly. Two areas (non-storage areas) of persisting activity have been associated with inadequate external sealing of the building (roller shutters, ventilation ducting and fire exits,) and also the presence of pheromone traps, which have attracted insects to enter from outside (Fig 4). Traps outside the building caught forty-eight *Lasioderma* in June 2000 showing there were more pests immediately outside the building than inside.

The information from the trapping survey has been used to assess the effectiveness of current IPM strategies and to review the scope of the pest building management contract. This has lead to increased sealing of internal and external access points. The survey results have reassured NHB that the resources allocated to the relocation and eradication project were well used, and have resulted in significant benefit to the condition of the collections.

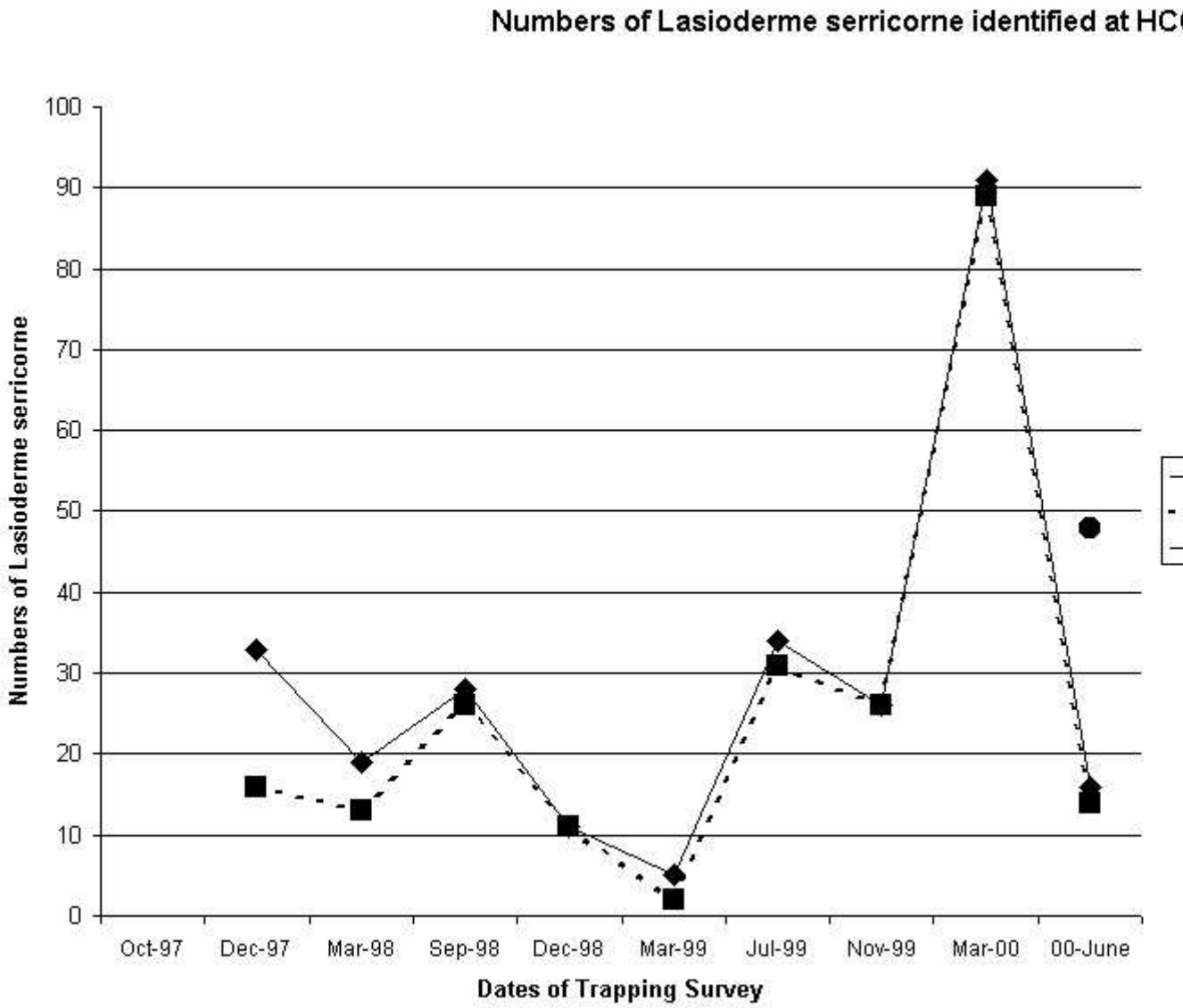

Figure 4. The presence of *Lasioderma serricorne* at HCC.

Eradication

Artefacts currently suspected of having pest infestation are sealed in polythene bags/sheeting, and monitored. If insect activity is identified, then the surrounding areas of the store are checked and cleaned to identify the source or cause of the infestation. In the majority of cases, the routine eradication treatment for infested artefacts is by freezing or nitrogen anoxic bagging treatment.

Freezing

Infested objects, with absorbent materials and a thermocouple, are enclosed in close-fitting, well-sealed polythene bags and placed inside the freezer. This is exposed to low temperatures at -25°C for 7 days (-30°C for 72 hours). This is intended as a treatment that ensures no survival of infesting insects. Once the use of this treatment has become more routine, the procedure can be reviewed, possible reducing treatment times, and increasing temperature, e.g. -20 °C for 72 hours. Lethal cold temperature for most tropical species is suggested to be around –15 °C for 48 hours (Florian 1997).

The use of reduced temperature treatments for insect eradication in tropical environments has not been fully evaluated in a museum context. The raised moisture content of artefact materials and the fact that indigenous artefacts have not been conditioned or designed to tolerate reduced temperatures, need to be considered. The danger of ice crystal formation, when reducing the temperatures of materials with high moisture contents and the inability of tropical insects to become cold hardened, suggests investigating the viability of increased treatment temperatures for eradication.

Chen *et al*. (1990) looking at temperate and tropical flies, identified that the tropical flies were unable to produce polyols during lowering temperatures and therefore could not become cold-hardened (Florian 1997).

Nitrogen Anoxic Treatment

During nitrogen anoxic treatment, the infested object and oxygen absorbers, are placed inside an oxygen-impermeable bag. The oxygen-rich air inside the bag is removed by vacuum and replaced with nitrogen gas from a cylinder. A repeated process of sucking out air and flushing with humidified nitrogen gas continues until the oxygen level inside the bag falls below 700 parts per million (ppm).

The object is left for 30 days once the required oxygen level has been reached. The oxygen level in the bag is monitored throughout the process to ensure that the level stays preferably below 700 ppm and does not rise above a threshold level of 2000 ppm. Once the treatment has been successfully completed, the treated object is removed from the bag, examined for insect activity, and cleaned using vacuum cleaners with High Efficiency Particulate Accumulation (HEPA) filters, before returning to the store. Once cleaning has been done, the treatment information is recorded on an attached artefact label. This information is then transferred to a conservation treatment record card when the object next requires interventive conservation treatment.

Our anoxic system has many built-in safeguards and can be considered as overkill. However, we hope to develop the system, adapting the timing and levels of target

oxygen in relation to the type of insects undergoing treatment. The rigorous standards enforced during the introduction of a treatment process, can be gradually amended once the system has proved to be effective and operating staff are comfortable with the tolerances of the system.

Training

To maintain an effective pest control system, it is critical to raise the awareness of museum staff to the dangers of pest infestation and ensure that key staff are trained to perform the required functions of IPM

As part of this process, an IPM course was conducted in November1999 at HCC by David Pinniger and was attended by all collections care staff and key staff from other areas of the museum.

In addition to the training function, the aim of engaging a pest control specialist was to review the pest control requirements of NHB museums and storage facilities. He was also able to comment on the pest control strategy developed for NHB.

IPM at the Heritage Conservation Centre

It has been possible to implement a rigorous IPM framework at HCC due to a number of favourable factors. These included the provision of a new, clean, and purpose-built storage facility and the chance to start “afresh”. This raised the priority of pest control within collection care and enabled the allocation of sufficient resources to resolve the perceived problems. However, the situation in the three pre-existing National Museum

buildings has been somewhat different, and policies have had to be applied to the varying needs of the individual buildings. Thus a more limited range of IPM measures are in practice for the museum buildings, focused on protecting exhibition and storage areas. This is largely because the same level of access control at HCC is not currently possible at the NHB museum buildings.

General IPM Approach in the Museum Buildings

A buildings pest control maintenance contract is employed at each museum building. A pest control firm is also engaged to prevent pest activity in the museum grounds. The museum precincts are fogged once every month to prevent mosquitoes breeding. Routine inspection, baiting and spraying is conducted to control termites, flies, rodents, mice, cockroaches, geckos, birds, and ants.

Pest control in the museum buildings storage areas are organised in a similar way to the stores at HCC. This involves checking of artefacts before access and maintaining a quarterly trapping survey. Within the galleries, the use of trapping surveys is currently being developed to build up a picture of background insect populations. Until recently, only galleries presenting increased risk of insect activity, during specific exhibitions, have been monitored.

IPM Guidelines for the museums buildings have been developed as the basis for initial approach to managing pest control projects. The details tend to be negotiated on a case-by-case basis. The features include:

- All artefacts and exhibition materials are inspected for potential insect infestation before entrance into the museum. This requires prior notice to enable checking to be carried out.

- Artefacts will only be treated if suspected or identified as being infested.

- All organic material intended for use as props or exhibition material should be checked and may be required to be treated before entering the museum.

- Vulnerable artefact material held in museum stores for medium or long-term periods should be identified to enable regular checking.

- During the construction of displays, contractors should be discouraged from using materials that encourage insect infestation, especially termites. The use of old, salvaged, or badly stored materials should be discouraged.

- The introduction of wooden materials into the building, during installation or construction work, should be monitored

- Insect access to the museum building should be restricted, windows and doors should not be left open, poorly sealed areas should be sealed. Badly fitted or louvered/perforated windows/doors should be screened or sealed.

- Food should not be displayed, prepared, nor consumed in the galleries.

Events where food is served should be limited to foyer and outside areas. All materials should be removed after the event and the area cleaned.

- Potted plants, fresh or dried flowers should not be housed in the museum buildings.

Asian Civilisations Museum (ACM)

This museum, opened in 1997, is the most recently established of the three national museums. It is housed in an historic school building built in the late nineteenth century and displays material culture from Asia.

The galleries are all air-conditioned, but only a proportion of the galleries have 24-hour climate control. Basement storerooms are conditioned with a target of 22°C and 55% RH. The relative humidity of the stores and some climate-controlled galleries in ACM range between approximately 50% and 60% RH and temperature between 21 and 23 °C. Stored objects are of mixed materials and are kept on open shelves.

This is a small and relatively well-sealed building, which helps to restrict the potential problems of pest entry. Another advantage of this museum is the level of awareness of pest control amongst museum staff. This has been emphasised in part, due to the large number of high profile loans which have been used for display and which have demanded a high level of collections care and awareness of pest issues. Thus, the entry and condition checking of all artefacts entering the museum has become a routine activity.

Museum staff have been keen to safeguard lenders' collections, often coming in from non-tropical environments, against the relatively high-risk insect populations of

Singapore. Thus the benefits of IPM in the Asian Civilisations Museum have been generally well received amongst museum staff.

Pest Problems

There has been a history of subterranean termite problems in this building, which had previously resulted in severe structural damage to a newly laid oak floor. This eventually had to be completely replaced with a more insect-resistant tropical hardwood. Roof timbers had also been affected during recent years.

The particular use of the museum has also led to certain compromises in the implementation of IPM. The museum is one of the first of its kind in the region and its profile has demanded that regular public functions take place on the premises. These functions generally include catering. These activities have tended to be restricted to the lobby areas, and strict hygiene and cleaning has been incorporated as part of the process of each function.

Exhibition Case Study

The Museum highlights various festivals celebrated by the different communities in Singapore. One of these is Deepavali, the Indian festival of light. During the festival, decorative floor designs are created using combinations of fresh flowers, spices, grains, pulses, etc., which last several weeks and thereby require a revised IPM approach. Normally, the entry and long-term presence of food materials in the museums is actively discouraged. Pest control guidelines recommended treatment of fresh

vegetable materials before entry. However, due to the lack of time available it was agreed that the artists would freeze the materials themselves before use. The delicate nature of the fresh flowers meant that freezing could not be used, therefore they were left untreated. In this case, since the colourful floor patterns are an integral part of the festival highlighted in the exhibition, it was decided to monitor the gallery space using insect trapping. The designs were installed on the gallery floors with the gaps in the floorboards sealed with a Melinex barrier to prevent ingress of food materials. The areas were thoroughly cleaned following the exhibition. No increase in insect activity was observed in the trapping survey during or following the exhibition.

Singapore Art Museum (SAM)

The Singapore Art Museum was opened in 1995 and highlights artists and their work from around the region as well as hosting international travelling exhibitions. Like the Asian Civilisations Museum, it is housed in an old historic building, which has been converted and adapted to the requirements of a museum.

All the galleries are air conditioned to 23°C, 60% RH. The relative humidity throughout stores and galleries range between 55% and 65% RH and temperature between 22 and 24^0C. Well-maintained exhibition and storage areas, with a high standard of housekeeping, help to make this museum relatively free of pest activity. IPM issues have been implemented to restrict of entry of artefacts and materials and the strict use of designated areas for public functions that often involve consumption of food and drinks. Like ACM, general museum staff awareness of pest issues has been

maintained since the museum was first opened. This has again been further encouraged by the high proportion of loaned artworks exhibited in the museum and the associated high standards of collections care.

Pest Problems

Many of the difficulties of the Museum in terms of the implementation of IPM strategies have been due to the unusual nature of many art installation works. These often involve the artist's use of ephemeral, organic materials. Examples of these, which have been exhibited in previous exhibitions, are re-cycled garbage, bread, rice, pastry, seeds and desiccated coconut, etc. Such materials make an excellent potential foodstuff for insects.

In order to deal with art works that are potential risks to infestation, a tailored IPM approach has been adopted to suit the needs of each exhibition. Trapping and monitoring is carried out in those galleries identified at risk. However, in order to be well prepared for any potentially problematic material incorporated in an art installation, a procedure of information gathering from the artist has been in place for the past two years. Where appropriate, each artist is required to submit a detailed description of his/her artwork including installation process, material components, and replaceable parts. This is required for loaned works as well as proposed acquisitions. Armed with such information, conservation concerns can then be negotiated whilst maintaining the artists' intent for the artwork. For example, in previous cases, the more ephemeral components of an artwork have been negotiated as replaceable, thus

avoiding the need for long-term storage of materials, which are extremely vulnerable to insect attack.

Exhibition Case Study

An international contemporary art exhibition of loaned material was planned to last for one month in February 2000. One installation art piece involved a heap of over 200 fresh red roses, information about which was not received until very late into the exhibition process. The potential problems of using fresh vegetable matter in this context is evident. Over the course of the exhibition period, one would expect the roses to decay and provide harbourage for insects. The presence of spider mites and mould growth on the roses was identified after only a few days of installation. Once conservation staff were alerted, a process of negotiation with the artist, curators and exhibition organisers began trying to avoid an escalation of insect activity. The solution was to replace the fresh roses by dried red roses that were first frozen by the Conservation Department before entering the galleries.

Although this had been suggested as the preferred approach prior to the original installation, it was perhaps more useful for museum staff to see the rapid increase in insect activity occurring as a consequence of introducing fresh flowers into the galleries. The actual effect of the infestation on the insect populations in the surrounding display areas appeared minimal. The spider mites suited to pollinating fresh roses are not well suited to finding alternative niches for survival within the museum building.

The main consequence was economic, in terms of staff resources dealing with the problem and the cost of replacement dried roses, which in the tropics tend to be valued as imported exotic flowers. The economic argument of lost resources can be a powerful factor in effecting change in procedures. It is equally justified therefore to critically review the costs involved in changing pest control procedures for the better. The consequence of a more rigid access policy, for example, is likely to have implications for planning public programmes, exhibition planning, and longer lead in times for exhibitions. This is especially significant when considering the costs of maintaining IPM programmes, which tend to be substantial in terms of staff resources.

Singapore History Museum (SHM)

This museum is the landmark museum of Singapore having been established by Sir Stamford Raffles over 100 years ago. Over the years, gallery spaces have been adapted and refurbished, but a full-scale re-development of the building is currently being planned as a future project.

SHM presents the history of Singapore through the exhibition of social historical material.

Most of the galleries are air conditioned to 22°C and 65% RH during public opening hours. However, the main entrance and atrium are not conditioned and frequently reach 28°C and 75% RH. On the exterior building walls, louvered window shutters are kept open during the day, which provide access points for insects.

Old storerooms at the rear of the building are not climate controlled, and are used for storage of props, equipment, showcases and sometimes artefacts that have yet to be processed into the museum's collections.

Pest Problems

The Singapore History Museum presents problems of access and lack of controlled environment associated with an old building in need of refurbishment. Of the three museums, it is perhaps the most challenging for implementation of best practice IPM. The entry of insects through open windows and doorways is difficult to control. In addition, the gallery spaces are only partially sealed and controlled, and therefore potentially vulnerable. The use of gallery spaces, often "leased" out to other organisations who install their own exhibitions, means that conservation concerns are sometimes more difficult to apply.

Exhibition Case Study

In 1998, an Exhibition to mark the 111th anniversary of the Museum was installed. The exhibition comprised of natural history specimens on loan from another institution. Problems associated with the material; bird, butterfly, mammal and fish specimens, not only included their susceptibility to insect attack, but also the stipulations of the loan. The preferred approach to exhibiting this material was to check the condition of objects prior to installation, monitor the gallery and case interiors with insect traps and construct well-sealed showcases to restrict insect access.

Common to many natural history collections, the materials had been stored in mothball (naphthalene) filled cabinets. It was stipulated by the loaning institution that the showcases should be designed to incorporate mothballs. Problems with the use of naphthalene in terms of health hazards and effectiveness as an insect repellent have been well recorded (Linnie 1997). However, it was important in this case to be sensitive to the lending organisation's requests.

The showcases, made by a local contractor, presented further problems. The construction specifications, were that they should be well-sealed, and the wood pest-free. To comply with this, the contractor treated the case materials with creosote. This was applied on the museum premises without the knowledge of museum staff. The strong lingering residues of creosote in the gallery areas were an unforeseen problem that had to be addressed with the use of air circulation and air filtering equipment. Trapping and monitoring of this particularly vulnerable exhibition was carried out for the duration of the exhibition. This revealed the presence of *Lasioderma serricorne* within the open display platforms. The presence of this insect in the building has long been established, and its isolated presence within the gallery was not thought to compromise the safety of the vulnerable materials inside the showcases. The source of the infestation was identified and the perimeters of the effected area were treated using a commercial permethrin spray. An increased number of Lasioderma *serricorne* pheromone traps were positioned, but no further insect activity was identified in the display areas.

IPM in the Museum Buildings

The intermittent use of insect traps to check for insect activity in vulnerable exhibitions has only recently been superseded with more systematic general insect trapping surveys in the museum buildings. The numbers and types of pests found in the areas so far monitored, correlate closely to the presence of environmental control. This tends to reduce insect access due to better sealing and creates a less attractive environment for insect activity to take place.

There are fewer insect pests found in the galleries and stores of the Singapore Art Museum and the Asian Civilisations Museum compared to the Singapore History Museum. The interiors of the first two Museums were specifically designed with curatorial and conservation in put, whereas the oldest museum, SHM, is awaiting refurbishment to bring it in line with current museum standards.

The focus of IPM in the museum buildings is largely on the factors of good housekeeping, monitoring and eradication. The control of insect access in an open public building is usually compromised, therefore concentrating on identifying insect activity and taking swift action when it occurs has been a reasonable approach. So far these have been satisfactory in managing incidents of insect activity.

An extension of monitoring pest activity in the museum buildings, will enable a clearer picture of the real consequences to be evaluated. Within the limitations of staff resources, activities need to be prioritised and a realistic appraisal of consequences needs to be in place.

Discussion

The two-tiered approach to the pest control of the museum buildings and the HCC storage building, represents an attempt to focus resources on areas of the collections at greatest risk.

The main focus of IPM activity has been in tackling the prevailing levels of infestation in the stored collections during the relocation program. This was followed by the initiation of new IPM procedures for the new storage building. Monitoring the effect of these procedures has been a more recent priority for IPM activities at HCC. A review of these procedures has suggested the success of this process.

The nature of the museum's displays, largely based on temporary exhibitions and storage areas housing loaned material or collections awaiting exhibition, are considered to be at less risk to long-term damage by insect activity.

The initial approach to dealing with pest control at the museum buildings has been more reactive, dealing with identified or potential problem areas. The emphasis of function of the museum buildings has been placed on public access, public activity, and facilitation of a rapidly changing temporary exhibition schedule. Therefore, IPM strategies have been required to work around these often competing priorities.

The implementation of a clear policy at HCC has helped to justify the need for changes and facilitated the broader application of IPM procedures to the museum buildings.

There are significant resource implications when applying pest control procedures for temporary exhibitions. Therefore, this should be done with a clear idea of the level of benefit in terms of averting risk to the collections.

General hygiene levels are high in Singapore, with little debris present around buildings and public areas. Generally, building maintenance contracts with pest control

companies are efficiently managed by estate management staff. Along with high standards of building integrity, this limits the potential for pest insect damage in what would otherwise be very favourable conditions. However, there are endemic populations of pests such as *Lasioderma* living outdoors and so there is constant pest pressure on all museum buildings. The short-term consequences of displaying fresh foodstuffs, fresh flowers etc. have been minor in increasing general levels of insect activity. A realistic approach to the consequences of these activities therefore needs to be developed in relation to a realistic evaluation the risks to the collections.

Information from monitoring surveys is critical in providing justification for adapting working practices, especially where there are additional resource implications. Rapidly changing exhibition programmes, which involve the introduction of unpredictable materials that encourage pest activity, may require additional resources to resolve the problems caused. There is less risk of infestations developing and becoming damaging to the collections if the exhibition areas are isolated from reserve collection storage areas. This separation of function enables a differentiated approach to protection of different areas based on an assessment of the relative risks.

Maintaining museum buildings as multi-use public spaces demands a more flexible approach to museum pest control. The no food, no cut flowers rules are inappropriate when wedding receptions are routinely held in exhibition areas and where exhibitions contain materials themselves made of foodstuff. Lead-in times of a few weeks for temporary exhibitions, demanded by the public exhibition programme, do not allow time for necessary eradication treatments

A greater freedom in the use of the building means a greater input of resources in monitoring the potential problems. In HCC, trapping surveys take place every three months. In temporary exhibitions, containing vulnerable material, monthly and weekly survey checks take place. This is necessary to monitor initial problems with fresh material brought into the exhibition areas in the form of construction and exhibits. This enables swift action to take place to manage the problem if an increased risk is identified.

Conclusion

The museum situation in Singapore is not typical of the majority of Tropical South East Asia. The National Heritage Board is responsible for the care of both locally derived indigenous collections and a large number of significant imported collections that are housed there. The process of importing collections means that international standards of care during storage and display need to be provided (Loo-Lim 1991). Thus, the allocation of cultural heritage resources is shaped by factors such as, international competition for long-term loaned or donated collections, and the exhibition of temporary loans from institutions and individuals worldwide. This differs from an approach where human and financial resources are targeted at the challenges posed largely by indigenous collections (Pearson 1991).

There has been a recent expansion of investment in the National Museums in Singapore, which has been focused on providing high standards of exhibition, storage and related facilities. It is an important challenge to develop collections care strategies

to meet these raised expectations. The provision of modern storage and conservation facilities at the Heritage Conservation Centre has boosted the ability of NHB to maintain its material cultural heritage to a level comparable to international standards of collections care.

In dealing with the inherent insect infestation in our stored collections, the extensive programme of pest eradication has involved and continues to involve considerable investment of resources. One of the responsibilities of collection care strategies is to make best use of available resources. Our approach now is to continue to monitor and maintain the collections within an integrated approach to secure this unique advantage provided by centralising the collections of NHB within one storage building.

Acknowledgements

The authors thank David Pinniger consultant entomologist, Colin Smith and Kevin Peters of Rentokil, for their technical assistance. Thanks to National Heritage Board for encouragement to publish. Also to the staff of NHB for their assistance in the project and comments on the text.

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Materials

Argon Anoxic System

Artcare International Inc

103 Greenbush Rd

Bellans Park

Orangeburg, NY, 10962

USA

Insect Monitoring Traps

New Serrico Trap (Lasioderma serricorne).

Fuji Flavor Co., Ltd.

3-5-8 Midorigaoka,

Hamura-sha,

Tokyo, 205-8503,

Japan

Controlled Atmosphere Technology (CAT)

Rentokil Singapore Ltd

488 Tanglin Halt Road

Singapore 148808

List of Captions

Figure 1. Photograph of previous stores, showing open windows

Figure 2. Photograph of The Heritage Conservation Centre