

A REVIEW ON THE IPM STRATEGY FOR NATIONAL HERITAGE BOARD, SINGAPORE

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Introduction

NHB is the government statutory board that carries the mandate to preserve the nation's history through collecting and presenting its heritage and the arts in its four thematically distinct museums under its direction. These museums are Asian Civilisations Museum (ACM), National Museum of Singapore (NMS), Singapore Art Museum (SAM), and The Peranakan Museum (TPM). Alongside the museums is the Heritage Conservation Centre (HCC), a purpose built storage facility that houses all of the NHB permanent collections. The concept of IPM has existed in its building development plan to ensure that the building continues to provide a safe haven for the collections. One of HCC's main roles is to proactively preserve the Board's rapidly expanding tangible heritage assets and works of art. HCC is first of its kind in Southeast Asia with centralised storage together with conservation facilities housed under the same roof. The institution of an IPM program alongside the opening of the brand new centre has benefited the collections in storage. The full IPM program was described in Sully *et al.* (2001, p. 65-69), and it has been tested and proven that infestation can be effectively managed.

Background on the collections before the move to HCC

Before the inception of HCC, the majority of the collections were previously stored at one of the NHB museums. During that time, the storage area was not yet climate controlled. The space was mainly ventilated by ceiling fan and open windows. The storage was very susceptible to the influences of the external fluctuating weather and environment (figure 1). As for the remaining collections, they were also stored in similar climatic conditions at other off-site locations. Therefore, many of the organic materials that were vulnerable to insect attacks had suffered substantial pest damages (Koestler, 1995 cited in Loh, 1999, p.131).

HCC has a 24-hour controlled environment. It has four stories comprising mainly of stores, conservation laboratories, offices and a visual resource service. The 13,000m² building is fully air-conditioned with set points for temperature at about 23°C and relative humidity (RH) ranging from 55% to 65% (Loh, 1999, p.132). Each store is equipped with specific RH settings to suit the needs of the various collection requirements. As the new building is infestation free, it is vital to preserve the integrity of the facility. Therefore, all the collections composed of vulnerable materials from the museums and other off-site locations went through insect pest eradication treatments (Sully *et al.*, 2001) before they could be relocated to the new building (figure 2). After the completion of the insect pest eradication treatments, the collections were vacuumed and then moved to the designated stores for permanent storage.



Figure 1 – While old storage space was maximised, monitoring, detection and control of infestation were difficult.



Figure 2 – Vulnerable materials went through insect eradication treatment before they were relocated to the new storage facility at HCC.

Approaches of IPM at HCC

As HCC is designed to store the NHB permanent collections, it is necessary and vital to ascertain that any subsequent collections that enter the building must be free of risk from insect infestation. Thus the IPM program aims to provide achievable, practical and cost effective methods that prevent collections and the building from becoming damaged by pest infestation. The IPM strategy for NHB is based on preventing potential pest infestation by managing access of artefacts and related display materials; by following a deliberated work procedure; stringent housekeeping; monitoring the level of insect activity in areas where collections are present; eradicating potential infestation of the collections; and training of staff members who contribute to the safety of collections from pest infestation.

Table 1 shows the level of museum pests at HCC and their occurrence. Results obtained from the general insect sticky traps in the period from 2001 to 2007 generally provide a good indication on the level of harmful insect activity. Only

insects classified as museum pests have been listed. Hence insects that are more commonly identified as household or domestic pests such as geckos, cockroaches, ants, spiders, flies are not highlighted. We can draw inference from Table 1 to extrapolate the effectiveness and relevance of the IPM program that is currently in place at HCC.

Access

At HCC, in order to ensure that potential pest activity is not re-introduced back into the infestation-free storage areas, all new acquisitions, including accompanying crates, pallets and packing materials, make their first stop at the examination area on level 1 upon arrival to be inspected. After the new acquisitions are ascertained to be insect-free, they are cleaned to remove any loose surface dirt. When all the necessary registration procedures have been completed, the artefacts are then moved to their respective stores. For artefacts that returned from exhibition, condition checking is usually conducted in the gallery before they are moved back to HCC. If infestation is suspected, they would be bagged and quarantined, and added to the list of artefacts scheduled for the next round of eradication treatment.

All the doors of the building except those leading to the offices are installed with door brushes to prevent insects from crawling into the building. In addition, the doors are kept closed most of the time unless there are frequent movements of people or artefacts. The view glass on all of the emergency exits is also covered with a piece of black paper, and this has proven to be effective in cutting down light attracting insects from being drawn to the building at night.

Housekeeping

Vigilant housekeeping is one of the most effective and easily attained measures against the risk of major insect activity. Frequent cleaning such as mopping and sweeping of floors, emptying of trash baskets are part of the building's housekeeping. Food and drinks are confined to a pantry and offices. Only water is allowed in storage areas. Proper storage and restricted accumulation of recycled storage materials is also a practical preventive measure to avoid harbourage and growth of insects such as silverfish and psocids.

Monitoring

Monitoring includes the random inspection of the storage area and collections by the respective officer who manages the store. The officer also assesses the extent of pest activity and the degree of risk to the collections with the use of sticky traps. HCC engages the services of a commercial pest control company to undertake monitoring of domestic insects such as ants, mosquitoes, flies, rodents, termites and cockroaches. Hence the report that is produced by the company is geared towards the status of the domestic pests found in the building. Therefore, to better understand and manage the level of risk the organic collections are exposed to, the HCC IPM team also deploys general sticky traps to strategically monitor targeted museum pests.

From Table 1, besides silverfish and psocids, most of the listed museum pests merely occurred sporadically, and the number was as low as one or two. The subterranean termites, cigarette beetle, Indian meal moth, lesser mealworm beetle can be found in the open outside the building. Silverfish and psocids are commonly found in the tropics all year round and they are permanent residents at HCC, with efficient housekeeping measures keeping their numbers in check. Silverfish feed on

mould and glue on mainly paper substrates, while psocids feed on mould and fungal spores that grow on organic materials. Hence a higher level in RH usually contributes to an increased level of psocids.

It should be noted with caution that the figures derived from trapping only represent captured species and do not accurately convey the true extent of insect populations at HCC. Random visual checks of vulnerable collections inside storage enclosures such as boxes, dead spaces, underneath an oversize artefact on display, etc, are helpful in spotting and containing any suspicious insect activity and allow appropriate actions to be taken without unnecessary delay.

At the end of each year, the IPM team generates an annual report to provide an overview on the level of museum pest activity and addresses practical improvements to reduce any potential pest growth or activity.

Eradication

HCC has a fumigation room. There are broadly two types of eradication treatment that are conducted in-house – anoxic treatment using nitrogen and freezing. These two treatments have size limitations. If the number of artefacts is large, HCC outsource the anoxic treatment to Rentokil Pest Control Singapore. Rentokil provides a large scale nitrogen bubble service, known as the Controlled Atmosphere Technology (CAT). When required, the CAT nitrogen bubble is set up at HCC to conduct a large scale anoxic treatment, especially for organic artefacts that are newly acquired in bulk and artefacts on open display in the museum and have returned to HCC for storage.

Training

Training is a very important IPM component of collections care as it constantly raises the awareness of NHB staff members to the threat of insect infestation. In order to ensure that relevant staff members of NHB understand the importance of IPM in safeguarding the collections from the damaging effects of pest infestation, Dr. David Pinniger, an entomologist providing independent consultancy and training on pest management was invited to conduct a 3-day course at HCC in 1999 on the concept and application of IPM.

A refresher course is also conducted occasionally for any staff members who are already involved in certain IPM functions. The outcome of the refresher course brings about more consistency and accuracy in the pest survey. The level of insect identification is now more accurate and provides a clearer view of the current capture rates at HCC. Also, there is a greater awareness in ensuring that storage areas and galleries need to be kept clean, packing and storage materials are to be kept properly, the IPM team is to be alerted when an insect activity is detected or suspected, conducting quarterly pest survey and recording of pests in insect traps, etc.

Targeted pest monitoring conducted at the NHB museums

After implementing the IPM program at HCC and familiarising the procedure, the adapted program was incorporated in all of the NHB museums targeted to complement the existing pest control work contracted to the commercial pest control company engaged by the museums.

The conservation IPM team conducted a walkthrough in all of the museums and identified spaces that could provide representative information on what the types and level of population of insect that might be present, such as dark corners, behind showcases, entry points to the museums, space or gaps underneath permanent organic artefacts on open display, could readily favour insect activity.

For those insects that could not be easily identified, the conservator would then carry out the identification under the microscope. If the species still could not be identified, photographs would be taken and the specimens are stored in solution made up of ethanol and water. The vials are then sent to the contract pest control company for identification. A report would be generated and given to HCC for recording and investigation purposes (Figure 3).



Figure 3 – Report on insects that were identified by the pest control company.

The work arrangement has been very beneficial to the conservation IPM team in understanding and extrapolating the insects' behaviour in relation to the environment where they have been found, and whether the insects posed any harm to the collections or not. In addition, the more familiar the team is about the environment, the closer would be the assessment of the pest activity.

Table 2 shows the results from the pest monitoring program that was carried out in the museum galleries and storage areas by the IPM team from 2001 to 2007.

Generic pest control measures conducted by the pest control companies at the NHB museums and HCC

Building pest management is under the purview of the estates section. All the museums are well aware of the need for a suitable pest control strategy to be in place. So commercial pest control companies are contracted to conduct the agreed generic pest control measures based on the requirements of the museums to ensure insect activity in and around the museums are appropriately dealt with. From the brief survey and information collected from the estates personnel in relation to building pest management, the scope and types of treatment, inspection and monitoring are largely similar across the NHB museums, even though the plans are serviced by different companies.

On the outside of the building, thermal fogging is carried out to deter mosquitoes; soil is treated on a routine basis to prevent colonisation of termites; spikes and netting

are used on the building perimeter and roof to keep the birds away; termite baits that make use of soldier termites in carrying the poison back to its colony. On the interior, cockroach and rodent baits are deployed in non-storage areas such as office and pantry; UV lamp is installed close to the common entrance leading to stores; general sticky traps to monitor common household insect pests. These traps are inspected every month. In addition, ACM (EPB) engages Aardwolf Pestkare, the sole operator of TermiCam, which is a detection system that uses thermal imaging technology, to scan the building quarterly for termites that might potentially be concealed inside the fabric of the building hidden from the naked eye. This technology is proven to have efficiently detected termite activity at a very early stage. Other museums are considering including this service in their pest control contracts as well. Based on the feedback from the estates personnel, the pest control strategies have been effective in controlling insect activity within and outside the building.

In addition, the NHB museums also educate the Food & Beverage outlets within the museum compounds to pay close attention to hygiene and management of food. Trash bins must be covered; food waste must be properly disposed; only drinking water is allowed to be consumed in the auditorium, seminar rooms, theatre etc.

Changes and challenges

After conducting ten years of insect monitoring, the conservation IPM team reviewed the range of captured insect species and decided to prioritise their efforts on specific museum pests. This resulted in the cessation of monitoring and recording of household pests, which could be managed by the contract pest control company.

When IPM was first implemented, conservators were the only ones involved in the monitoring of targeted pests for HCC stores, laboratories, and museum galleries. In 2003, the registration personnel took up the responsibility of monitoring and surveying the pest traps for stores under their respective care. The transition promoted ownership and encouraged proactive involvement of the registration personnel, thus developing familiarity with insect activity in their stores and improving response time if any immediate attention was required.

As the team of staff members involved in IPM grew, the information that was captured on the pest survey record became less consistent. To ease the transition period, the IPM team continues to provide assistance and work together with the registration personnel to enable them to know the IPM process better and improve the identification of insects found in their stores. They are also taught how to use the microscope and resources to identify specific species. However, it is also not unusual that the IPM team occasionally runs into difficulty in identifying an unfamiliar insect. Fortunately, the IPM resources that HCC has collected over the years such as photographs, insect specimens, and reference guides have been of considerable assistance. Furthermore, the contract pest control company engaged by HCC provides a pest identification service upon request. Apart from the difficulty in insect identification, there are also occasions when the approximate numbers or the specific names of the insects are not properly recorded by staff members. Hence the information collated is not sufficient for the IPM team to learn about the environment. The other challenge that the IPM team faced is the late submissions of survey results. The collation process, assessment of information and report writing inevitably lengthens and more time is spent on administrative work.

Moving forward, the HCC IPM team aims to garner practical support from more museum staff members to play a more proactive role in IPM. This includes survey targeted at museum pests, adherence to good housekeeping, and random visual

inspection of artefacts on open display. However, shortage of human resources and other pressing priorities potentially pose challenges in gaining more support for IPM.

Continual training that highlights the principles and practices of IPM to NHB staff members will certainly strengthen the safety of collections, both on display and in storage. Familiarity with IPM will in the long run make it a natural part of the work routine.

As human resources are limited, it is worthwhile exploring the feasibility to engage commercial pest control companies in providing a more holistic pest control plan both for the museums and HCC based on the needs of the collections.

Conclusion

The pest eradication treatment that all of the organic collections underwent before the permanent migration to HCC for storage has proven to be a total success as there is no recurrence of new infestation on any of the previously infested artefacts and the commitment and adherence to the IPM program with continual training of new staff members bring about effective discouragement of active insect growth or habitation. Understanding the importance of IPM and taking up personal ownership in safeguarding the integrity of the collections not only raise the alertness of staff members who handle them, but it is also one of the most effective long term measures in managing insect activity at HCC and the NHB museums as the practice gradually and intuitively becomes part of work protocol.

Table 1: Results from pest monitoring at the HCC stores and laboratories conducted by the IPM conservation team from 2001 to 2007

Common name of insect	Scientific name of insect	Level 1	Level 2	Level 3	Level 4
* Silverfish	<i>Lepisma saccharina</i>	Rare	Rare	Common	Common
* Psocid	<i>Liposcelis sp.</i>	Very common	Common	Very common	Common
Cigarette beetle	<i>Lasioderma serricorne</i>	Rare	Rare	Rare	Rare
Subterranean termites	<i>Coptotermes sp.</i>	Incidental	-	-	-
Biscuit beetle	<i>Stegobium paniceum</i>	Rare	-	Rare	Rare
Lesser meal worm	<i>Alphitobius sp.</i>	Rare	Rare	Rare	Rare
Carpet beetle	<i>Anthrenus verbasci</i>	Rare	-	-	Rare
Flat grain beetle	<i>Cryptolestes sp.</i>	-	-	-	Rare
Confused flour beetle	<i>Tribolium sp.</i>	-	Rare	-	Rare
Foreign grain beetle	<i>Ahasverus advena</i>	Rare	Rare	-	-
Case making clothes moth	<i>Tinea sp.</i>	Rare	-	-	Rare
Webbing clothes moth	<i>Tineola sp.</i>	Rare	-	-	-
Indian meal moth	<i>Plodia interpunctella</i>	Rare	-	-	-

Legend:

* Silverfish and psocid are resident insects and they are present throughout the year.

Very common – could be found on majority of the deployed sticky traps, and low in number

Common – could be found on some of the deployed sticky traps, and very low in number

Rare - hardly found

Incidental - presence is incidental

Only insects classified as museum pests have been listed. Hence insects that are more commonly identified as household or domestic pests such as, geckos, cockroaches, ants, spiders, and flies are not highlighted.

Table 2: Results from pest monitoring at the NHB museum galleries and storage areas conducted by the IPM conservation team from 2001 to 2007

Common name of insect	Scientific name of insect	ACM (EPB) From Mar 2003 onwards	ACM (Armenian St) From 2001 to 2005	NMS From 2007 onwards	SAM From 2001 onwards
* Silverfish	<i>Lepisma saccharina</i>	Rare	Rare	Rare	Common
* Psocid	<i>Liposcelis sp.</i>	Rare	Common	Common	Rare
Cigarette beetle	<i>Lasioderma serricorne</i>	-	-	Rare	-
Subterranean termites	<i>Coptotermes sp.</i>	Incidental	-	-	Rare
Biscuit beetle	<i>Stegobium paniceum</i>	Rare	-	-	Rare
Carpet beetle	<i>Anthrenus verbasci</i>	Rare	-	-	-
Flat grain beetle	<i>Cryptolestes sp.</i>	-	Rare	-	Rare
Confused flour beetle	<i>Tribolium sp.</i>	-	-	-	Rare
Powder post beetle	<i>Lyctus sp.</i>	Incidental	-	-	-
Indian meal moth	<i>Plodia interpunctella</i>		-	-	Rare

List of services:

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26 Third Lok Yang Road

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References

Sully, D. Liu, M.-Y. & Lee, S.M., 2001. A topical solution to tropical museum pest control. In: A joint conference of English Heritage, the Science Museum and the National Preservation Office 1, *Integrated Pest Management for Collections - Proceedings of 2001: A Pest Odyssey*. London, UK, 1-3 October 2001. James & James (Science Publishers) Ltd: London.

Loh, H.N., 1999. A historical survey of approaches to pest management in the National Museum of Singapore. In: TNRICP (Tokyo National Research Institute of Cultural Properties), *23rd International Symposium on the Conservation and Restoration of Cultural Property – Integrated Pest Management in Asia for Meeting the Montreal Protocol*. Tokyo, Japan, 27-29 September 1999. TNRICP: Tokyo.

Lim, C.Q. Razak, M. & Ballard, M.W., 1990. Pest control for temperate vs. tropical museums: North America vs. Southeast Asia. In: ICOM-CC (ICOM Committee for Conservation), *9th Triennial Meeting*. Dresden, German Democratic Republic, 26-31 August 1990. ICOM-CC: Los Angeles.

National Environment Agency, 2002. *CONTROL OF OZONE DEPLETING SUBSTANCES*. [Online]

Available at: <http://app.nea.gov.sg/cms/htdocs/article.asp?pid=1526>

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