Journal of Tropical Biodiversity and Biotechnology

journal homepage: http://jtbb.or.id

Pest Management Challenge in Universiti Tun Hussein Onn Malaysia Natural History Repository

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ARTICLE INFO

Article history:
Received 15/03/2018
Received in revised form 09/12/2018
Accepted 18/12/2018

Keywords:
Pest management
Repository
Natural history

DOI: 10.22146/jtbb.33968

ABSTRACT

Under the Malaysian Universities Act 1971, Higher Learning Institutions are encouraged to set up museums that could support teaching and learning at the institution. With that provision, the Universiti Tun Hussein Onn Malaysia (UTHM) Natural History Repository was formed in 2014, to support the newly developed BSc Program called Biodiversity and Conservation. Under the Faculty of Applied Science and Technology, Centre of Research - Sustainable Uses of Natural Resources (CoR-SUNR), develops and organizes the repository. Currently the repository is sited at a shoplot building in Parit Raja Campus that had been modified as part of campus expansion plan. The process of converting this shoplot building into functional gallery/storage space introduced a new challenge in pest management. The goals were to ensure whatever pests already present are eradicated, determine ways to seal out future pests, stabilize the condition to decrease pest infestation, and establish a monitoring program. Baseline pest data were collected via trapping throughout the repository spaces before, during, and after retrofit construction. Data from trapping were used to assess pest problems, and actions to eliminate these pests were initiated. A year-long survey of pests was performed after staff and collections occupied the building. The results showed variation in pest diversity and populations. Having succeeded in controlling insects pest problems at UTHM Natural History Repository would lead to better teaching/learning experience for graduates as well as promoting public awareness and education especially among young public on biodiversity.

1. Introduction

There are many ways to define natural history collection. McGowan and Witmer (1991) wrote that natural history collection is any institution that houses specimens of wildlife, dead or alive, for the purposes of education or research. Several types of specimens are used in teaching and research. These includes specimens such as the study skins, skeletons, and wet specimens. Other type of specimens commonly kept include egg sets, nests, parasites and stomach contents.

Collections can be thought as reference materials for use in research and teaching, and one of the major uses of the collections is for identification. Uses of natural history ranging widely from provides basis for research on the relationships between species, answering ecological questions on population sizes, the distribution of species, the number of species in an area, habitat associations, and the attributes of individual specimens; to the extent of holding the potential for study evolutionary processes and documenting species declines (Holmes et al., 2016, McGowan and Witmer, 1991; Shaffer et al., 1998)

Malaysia is very committed to conserve its biological diversity, promote its sustainable use and ensure fair and equitable sharing of the benefits arising out of the utilization of biological resources. Although Malaysia lacks a Natural History Museum, the size of actual collections maintained by

different institutions is large. A survey done in 2007 pointed out that there are over 22 organizations in Malaysia supporting natural history units and collectively holding 3 million specimens. These include government agencies and also universities (Francis, 2008).

Under the Malaysian Universities Act 1971, Higher Learning Institutions are encouraged to set up museums that could support teaching and learning at the institution. With that provision, the Universiti Tun Hussein Onn Malaysia (UTHM) Natural History Repository was formed in 2014, to support the newly developed BSc Programme called Biodiversity and Conservation. In conjunction of that, Universiti Tun Hussein Onn, Malaysia see the need to help increasing the number of Natural History specimen collections in Malaysia. As a biodiversity students, it is compulsory for them to go to fieldwork, therefore contributing to the collections of flora and fauna specimens. With the increment number of specimens, and some earlier specimens shows damage, there is a need for a collection room or repository to ensure the welfare of the collections. The main role of this repository is to documenting Johor's Natural History by becoming reference centre for researchers.

Beginning at November 2014, a shoplot building in Parit Raja Campus that had been modified as part of campus expansion plan. Before becoming a repository room for natural history specimens, this room used to be a classroom. Because it had been left empty for quite a long time, the conditions of the room is quite bad. The process of converting this shoplot building into functional repository introduced a new challenge in pest management. Water leakage, age of building, as well as unregularly temperature are some of the reason that contribute to the existence of pest in the repository room. The goals are to ensure whatever pests already present are eradicated, determine ways to seal out future pests, stabilize the condition to decrease pest infestation, and establish a monitoring program. Even after the building was in use there were residual issues due to the building's age. Current activities of the museum require these systems to now run for 24 hours and their efficacy in maintaining required relative humidity and temperature conditions varies. By monitoring climate data, we were able to use seasonal corrections of air-handling set points to achieve consistency.

Museum collections are very susceptible to pest damage. The cumulative effects of this damage can ultimately destroy a museum object or collections. Museum pests are biological agents that can cause damage to museum collections. Pests are organisms that interfere with the management objective of the site. Pests come in a variety of forms: Insects, vertebrate (rodents, bats, and birds) and fungi.

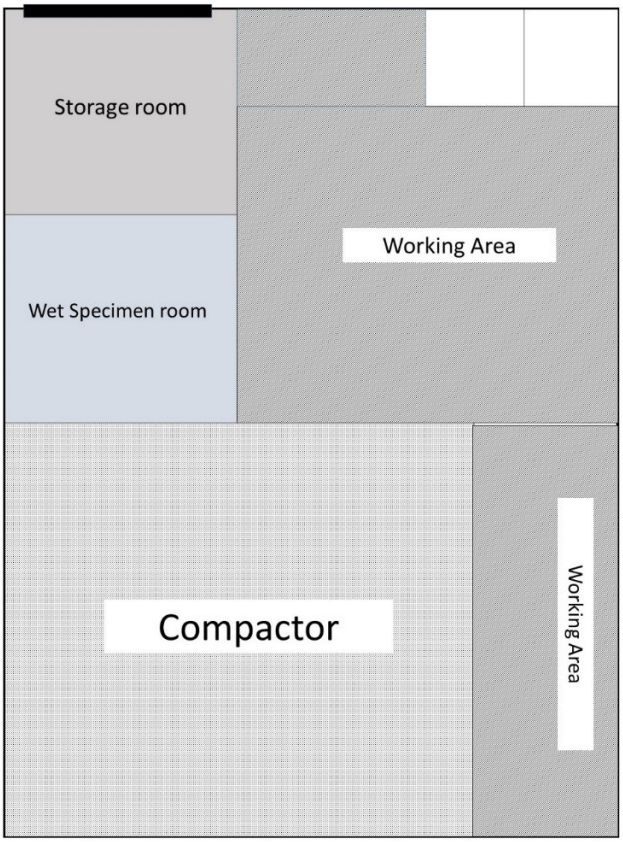

Figure 1. Layout of UTHM Natural History Repository

Attention to integrated pest management (IPM) concerns influenced each step of construction from planning to initiation. The three basic components of IPM in a museum setting are: prevention, monitoring, and treatment (Pinniger, 2001). Pest outbreaks can be prevented by excluding pests from the area where collections are stored and also by creating conditions that, while safe for the objects, are not optimal for the pests (Pinniger, 2001). The methods used for monitoring pests greatly depend on the resources available to the museum. The most frequently is monitoring with sticky traps, designed to capture insects and rodents. These traps need to be checked and changed at regular intervals or they can become attractants for pests (Alpert and Alpert, 1988). Also, objects within the collection periodically should be checked for any infestations. If there is an infestation observed within a collection, the focus turns to treatment options. Historically, pest treatment was in the form of pesticides; pesticides now generally are avoided but still are used in extreme cases. Many laws and human health issues, as well as safety of the collections themselves and the associated costs, have led IPM specialists away from chemical

treatments (Strang, 1992). Most museums now choose to treat infested objects through cleaning, freezing or anoxia treatments (Kelley, 2005). A successful integrated pest management program contains all of these practices and further relies on the use of staff. Collections staff need to be trained on IPM procedures that they can use in all planning and work related to the museum collections (Pinniger, 2001). It is essential that all persons involved with the collections and buildings in which they are housed, are aware of the issues related to the objects being stored. The Yale Peabody Museum used staff knowledge of IPM when retrofitting the West Campus building and in maintaining a collection-safe environment. The priority for collections staff was to monitor for pests in the building that might have been residual from previous tenants. Two trapping surveys were conducted to assess pest problems.

This paper intent to understand the type of pests exists that can damage specimen especially zoological specimens in a repository room. This will set a baseline data that can assists in future planning of integrated pest management program.

2. Materials and Methods

2.1. Pest Collection

Wire box-trap and sticky trap surveys were used to gain baseline data about pests and potential point of entry for the pest in the repository. One month before furnishing the room, a series of traps was placed throughout the repository spaces. Upon full-time occupancy, when the room had been furnished and the specimens started to fill up the room, a standardized monitoring program was initiated. Again traps were placed for an approximate 1-month period at predetermined locations throughout the repository spaces. After approximately 30 days, the traps were switched out with fresh ones.

To collect fungi pests, a petri dish containing Sabouraud Dextrose Agar were left exposed to environment for one night before incubated. Any damaged specimens shown fungi infection were swabbed by sterile cotton swab and cultured on Sabouraud Dextrose Agar. The petri dish were checked after one week, and three weeks after incubation for fungi growth. The used traps were then frozen to kill any live pests caught on the traps and examined as time allowed. Concurrently, the temperature and relative humidity of the room were recorded.

2.2. Pest Identification

Traps were examined under a stereo microscope when available. Macro morphology of the fungi were also checked under microscope and cross checked with experts. Data collected from each trap included the date and location of the trap, as well as the taxa and their abundance. Identification of pests was made to ordinal level and noted to family or below.

3. Results and Discussion

Sticky traps and wire-box trap were put randomly around UTHM Natural History Repository (Figure 1). Trap locations were chosen based on the highest potential for accidental non target pest entry points and target pest species hotspots

The initial results before the room was furnished to became repository shows that there are presence of insects such as cockroaches and ants. There were no rodents trapped. However, there was mould on the wall of the back room since there was a leakage from the air condition duct. The temperature ranging from 30^{o}C to 32^{o}C.

After occupancy in the repository room, results of the trapping shows that there are still presence of insects in the repository room. After the first month, there were signs wood boring beetles in the specimen boxes. There was also fungi infestation on the skin specimens in the compactor. Both presence of the pests before and after occupancy in the repository was shown in Table 1.

Trapping in almost every space in the repository areas yielded some type of insect activity, from non-target outside invaders to recognized museum pest species. Most outside non-target insects (species not known to be pests), represented in traps included ants (Hymenoptera: Formicidae), and ground beetles (Coleoptera: Carabidae). The

Table 1. The type of pest presence in the UTHM Natural History Repository before and after occupancy

Type of Pest	Order	Family	Genus	Pest Occurence in the repository[a]	
				Before occupancy	After occupancy
Insect	COLEOPTERA	Anobiidae	*Stegobium* sp.	1 account	0 account
	BLATTODEA	Ectobiidae	*Blatella* sp.	5 account	3 account
	HYMENOPTERA	Formicidae	*Dolichoderus* sp.	5 account	7 account
Mammalia	RODENTIA	Muridae	*Rattus* sp.	0 account	0 account
Fungi				3 account	9 account

[a] Pest occurrence were valued by the number of account found in the traps that were put around repository

Table 2. Pest occurrence on specimens in UTHM Natural History Repository

Type of pest	Order	Family	Genus	Number of Occurence		
				Skin specimen[a]	Pinned entomological specimen[b]	Insect box[c]
Insect	Hymenoptera	Formicidae	*Dolichoderus* sp.			7
	Acariformes	Pyroglyphidae	*Dermatophagoides* sp.			4
Fungi	Eurotiales	Trichocomaceae	*Aspergillus* sp.	2		
	Mucorales	Mucoraceae	*Mucor* sp.	3	4	
	Sordariales	Chaetomiaceae	*Chaetomium* sp.	2		

[a] Number of pest occurrence found on six damaged scientific skin
[b] Number of occurrence from infected pinned entomological specimens
[c] Number of occurrence from nine damaged insect box

infestation of wood boring beetles (Coleoptera: Anobiidae) in the insect collections box also became quite an issue.

Another pests that damaging specimens are fungi. In this repository, fungi infestation start even before the specimens been transferred into the repository. After the repository been fully occupied, fungi had been infesting some of the specimens. Most of the infestation happened on the dry skin specimens. However, even after occupancy, there was no damage done by rodents. Type of pests and specimens that been damaged were shown in Table 2.

Generally, fungi can grow under a very wide range of conditions. When the environment is suitable for germination,the spore swells and a germ tube extends outward. For most fungi,this action is triggered by a significant change in temperature or in the elevation of moisture. Fungi growth on artifacts has essentially the same appearance and smell (Baxter and Van der Linde, 1999). The fuzzy growth is often black or white, but can appear in other colours depending on the substrate it is growing on.

Florian divides the phyla *Dikaryomycota* into two subphyla: *Ascomycotina* and *Basidiomycotina*. Florian identifies that most fungi in heritage collections are found in the subphylum *Ascomycotina.* These include the orders *Sordariales* and *Eurotiales* that can be found in this study. Fungi that belong to these subphyla can be identified according to their narrow and septate hyphae – the diffuse, branched filamentous elements that form the body of the fungus. These subphyla live in a wide ecological range, meaning they can survive in a wide variety of environmental conditions. They are heterotrophic and if they have access to a nitrogen source, they can utilize their own amino acids to make proteins.

There are several ways to treat specimens that been damaged by pest. Nowadays, Integrated Pest Management (IPM) had been practiced all over the world. The reason is the concern for the safety of museum personnel when using chemical fumigants for the treatment of museum objects that had been damaged by insects and mould. It led to a greater emphasis on the development of nonchemical methods of pest control (Gilberg and Brekerhorf, 1991). Many laws and human health issues, as well as safety of the collections themselves and the associated costs, have led integrated Pest Management (IPM) specialists away from chemical treatments (Strang, 1992). Today, Integrated Pest Management (IPM) is the preferred method and many pests control firms are offering IPM services. The IPM approach relies primarily on non-chemical means (controlling climate, food sources and building entry points) to prevent and manage pest infestation. As IPM is an ecosystem approach to dealing with pest problems, it has always been site specific and thus adaptable to any application. It proves to have many benefits as a better pest control, safer and healthier workplace, lower costs and better public and occupant relations.

One of the method use is freezing. The whole box of infected specimens will be put in a -20^{o}C freezer for a minimum of five days. After five days, the specimens will be clean with alcohol before put into a 40^{o}C oven for another five days.

Beside freezing method, direct cleaning specimens with 99% alcohol is another method used to control infestation on the specimens. This method used especially for dry animal skin specimen that been infested with fungi. 99% alcohol were brushed onto the infested specimen before let dry in a 40^{o}C oven for two to five days.

The most effective strategy to prevent damage to artifacts and to prevent adverse health effects for humans is to ensure that the environment and other conditions inhibit mould growth. Ambient RH is often used to indicate mould growth potential. By keeping RH values below 60%, it is logical to assume that corresponding aw values in substrate materials would be limited to 0.6, which is the lowest aw level at which certain moulds can begin to grow (Guild and MacDonald, 2007).

4. Conclusions

It is encouraged that additional measures are taken to exclude insects and other pests from the entire repository. Door jambs, door and window seals, and door sweeps all should be re-examined for access points and fixed by mending framing and adding or repairing existing door sweeps. Regular check-ups of the specimens as well as monitoring any changes in temperature and humidity level should be done at least every three months. If there is any pest outbreaks happen, major housecleaning of the repository room need to be done, where the damaged specimens need to be quarantine and give treatment to ensure that the rest of the specimens maintain in pristine conditions.

Acknowledgments

The authors are very grateful to staffs, postgraduate students and volunteers for their help and efforts in developing UTHM Natural History Repository. This research was funded using UTHM contract grant U390. This paper was funded by UTHM contract grant U688 and was partly sponsored by the Centre for Graduate Students UTHM.

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