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# Evaluating the Status of Storerooms in Some Egyptian Museums regarding insect pests' Management

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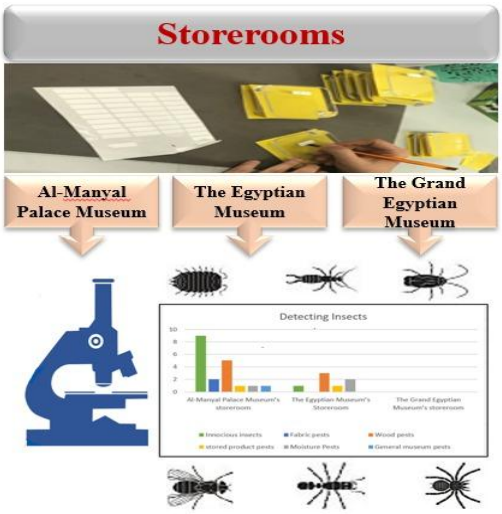
## HIGHLIGHTS

- Investigating the status of storerooms in some Egyptian museums regarding pest management.
- Selection of the storerooms in suitable museums for the present study.
- Placement and monitoring the sticky traps that were chosen and distributed inside some storerooms of the selected museums.
- Identifying the collected insects and insect pests that were caught by traps.
- Interpreting the results of catches' identification..

## GRAPHICAL ABSTRACT

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## ABSTRACT

In museums, pests can destroy highly precious and irreplaceable objects, causing serious and irreparable damage. Because organic objects are particularly prone to insect infestation, the goal of this study is to determine the value of implementing an Integrated Pest Management program (IPM) in Egyptian museums. It has long been usual to use control measures, when insect infestations are detected, but it has been proven that these are insufficient to keep insects away and protect the artefacts. Recently, researchers have been paying more attention to environmental sensitivity, developing more effective and environmentally friendly techniques and

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materials, and reducing the use of traditional pesticides such as Paradex, a para-dichlorobenzene. Furthermore, this study assesses the effectiveness of essential oils and pesticides that were used periodically every six months in protecting artefacts and preventing infestations inside museums, particularly after the appearance of insect pests in storerooms at both Mohamed Ali Palace in Al-Manyal and the Egyptian Museum in Tahrir square, which were treated with cinnamon oil and subsequently monitored with sticky traps. This process aids professionals in determining the best treatment plan for eradicating insects and protecting the area from re-infestation following treatment.

## 1. Introduction

The majority of Egyptian museums respond to insect pests by control measures, such as: fumigating, spraying objects with insecticides after an infestation has been found and confirmed, or spraying on a regular basis.

Since the seventeenth century, insecticides have been employed to treat museum pests [1]. Despite the dangers they pose to people, the environment, and artefacts, as well as the rise of insect resistance to them [2], some museums continue to use them due to their effectiveness. DDT, methyl bromide, para-dichlorobenzene, ethylene oxide, naphthalene, sulphur fluoride, carbon disulfide, and chlorpyrifos were the most widely used insecticides worldwide for decades [3], some of these insecticides, however, have been banned on a global scale [4]. While employing insecticides in a museum will not prevent many insect infestations, we have become accustomed to this method via tradition. Furthermore, spraying insecticides directly on artefacts might cause damage or leave behind undesired residues [3, 5]. Essential oils for insects' control are utilized in museums in today's society since they are eco-friendly and can be created utilizing nano technology. Although it is effective as insect repellents [6, 7], due to the volatile nature of the substance, it cannot provide protection for objects. This can be enhanced by adding other chemicals or natural products to the mixture [8, 9].

Through an understanding of insect biology and the museum environment, proactive responses to insect problems necessitate the employment of an Integrated Pest Management (IPM) program. IPM comprises the use of many forms of control and management measures to prevent insect invasion and discourage insects from becoming established [10]. This program has been used in the past in the agriculture industry, then museums developed it and utilized it in controlling museum infestations [11]**.** The goal of this program is to give a safe and effective technique to avoid pests by understanding the cause and conditions behind their appearance to protect collections and buildings from being destroyed by insects [12]**.** A good Integrated Pest Management program includes four key procedures [13]: first, avoiding the factors that attract insects to storage spaces and exhibition halls by controlling humidity, temperature, and paying more attention to museum cleanliness [12]. Second, preventing insects from accessing the museum or storage spaces [13]. Third, detection by establishing a monitoring system utilizing insect traps to provide us with early warning of the museum's insects problem [14]. Fourth, identifying insects once they have been captured. When it comes to insect control, proper identification is crucial [15].

Furthermore, detection entails identifying infested artefacts and isolating them, as well as discovering the source of the infestation and controlling it [13]. Finally, depending on the type of insect and the material of the infested artefacts, treatment is administered. There are different treatment approaches from which we can select the most appropriate one based on the case [13].

According to several field studies, the majority of Egyptian museums are treating and sterilizing their collections with pesticides and essential oils as the optimum answer to pest problems; yet, they are concerned about the recurrence of infestations in the same areas that have been treated and sterilized. This research will provide an answer to this question. To control insects, the project sector of the Center for Research and Conservation of Antiques employed essential oils and

pesticides in Al-Manyal Palace in winter 2020 and the Egyptian Museum in summer 2019. They employed cinnamon oil diluted in acetone at various concentrations, with high concentrations used to exterminate the live infestation and low concentrations used to preserve the Al-Manyal palace and Egyptian Museum's storerooms from re-infestation and keep insects at bay. They also utilized a pesticide called Paradex, a para-dichlorobenzene, that is used as an insect repellant at a concentration of 35 $g^3/m^2$. We began our investigation to detect the prevalence of insect pests in some treated storerooms after they finished their regular sterilization routine.

## 2. Materials and methods

The work is divided into four phases. **Phase 1** is concerned with selection of the storerooms in suitable museums for the present study. **Phase 2** is devoted to placement and monitoring the sticky traps that were chosen and distributed inside some storerooms of the selected museums, while **Phase 3** deals with identifying the collected insects that were caught by traps. **Phase 4** encompasses interpreting the results of catches' identification.

### *2.1. Description of the selected museums:*

#### 2.1.1. *Prince Mohamed Ali's Museum or Al Manial Palace*

The museum is located in Al Manial district on Rhoda Island on the Nile, Cairo. This district, which is located nearby the Faculty of Medicine and Dentistry of Cairo University is characterized by high traffic density, different human activities and parking areas. The museum is characterized by its Maghreb architectural style and surrounded by a permanent botanical garden ~34000 m, includes rare trees and plants. The museum consists of a number of Islamic arts, decoration and includes rare works of art. The museum includes reception hall, clock hall, mosque, hunting museum, throne hall, residence hall and golden hall. It's storeroom was chosen for the present study.

#### 2.1.2. *The Egyptian Museum*

It is located in Tahrir Square in Cairo's downtown area and is the Middle East's oldest museum, housing a significant collection of ancient artefacts. The Egyptian artefacts are displayed on three floors of the museum. The museum's primary storage rooms are located underneath the ground level and hold thousands of objects from various archaeological sites and periods, from which a storeroom was chosen for our study.

#### 2.1.3. *The Grand Egyptian Museum*

It is erected on the Giza plateau two kilometers west of the pyramids, near a motorway interchange. The traps were placed in a storeroom in the museum's basement, close to the museum's restoration laboratories.

### 2.2. Sticky traps

There are plenty of traps' types that can be used to detect insects' presence. The sticky traps utilized in this study were sheets from Kyzone Company that were 40x20 cm in size. These sheets were chosen for a variety of reasons, including their vivid hue, which attracts insects. Second, the adhesive used in the sheet is non-toxic, making it completely acceptable to use in museums. Third, the sheet was also double-sided sticky. Fourth, the sheet features two holes at the top and bottom, allowing it to be hung to catch flying insects. Finally, the sheet's large size is a benefit because it may be cut into multiple traps of various sizes to meet our demands.

### *2.3. Traps' setting out and inspection strategy*

The sheets were cut into small traps, about 9 X 9 cm, and then plans of the selected storerooms at the various museums were drawn up with the position of traps marked on them (Figs. 1- 4). The National Park Service criteria was followed when traps were placed in the chosen places [16, 17].

Beginning in January 2020, the traps were placed out and distributed for a period of ten months. The traps were monitored monthly for the first three months until being stopped

in March due to a decision by the Ministry of Tourism and Antiquities to close museums and archaeological sites across the Arab Republic of Egypt at the end of March in response to the Corona virus (Covid 19) epidemic, and they were gradually reopened at the beginning of July. Traps were monitored and inspected on a regular basis after these events, and the catch details were documented over time. In case the traps were squashed or coated in insects, fluff, or dirt, they were replaced.

### *2.4. Microscopic examination*

The insects found in the catches were examined with a Stereomicroscope Optika at magnifications ranging from 10x to 80x for identification. Photos were taken using a Canon Powershot G12 camera, and some were manually stacked in Photoshop Cs6. The specimens were identified using a variety of regional taxonomic keys, as well as a comparison to a specimen deposited in the Efflatoun Bey Collection. (Entomology Department, Faculty of Science, Cairo University) (EFC).

**Fig. 1: An example of labelling the sticky traps according to the date and place of setting them out.**

## 3. Results and discussion

The adoption of an Integrated Pest Management (IPM) program in the various museums has recently become important. As a result, the necessity of identifying the type of the collected insects and their life stage must be highlighted in order to understand the challenges that have been encountered and design an efficient and sustainable management strategy, so as to make right decisions to protect collections from insect pests.

The followings were identified as catches in the current study from various storerooms in the selected museums: The insects found in Al-Manyal Palace museum are shown in Table 1, while the species found in The Egyptian Museum are shown in Table 2. There were no catches at the Grand Egyptian Museum.

Fabric insects, wood insects, stored product insects, moisture insects, and general museum insects have all been detected and can damage museum collections, according to the results of the catches' identification [18].

In this respect, the presence of innocuous intruders such as: *Modicogryllus burdigalensis, Loxosceles rufescens, Matabelina treitliana, Cataglyphis savignyi, Aphaenogaster splendida, Parasarcophaga dux, Musca domestica***,** *and Mintho compressa* inside the storeroom of Al-Manyal Palace Museum indicates a poorly sealed building and can be related to the poor museum housekeeping plan [16]. Another interesting point to note is that these intruders were trapped near the doors because, unlike other selected museums, the museum is surrounded by a permanent botanical garden rich in garden insects. Furthermore, the existence of *Entomobrya* Rondani indicates

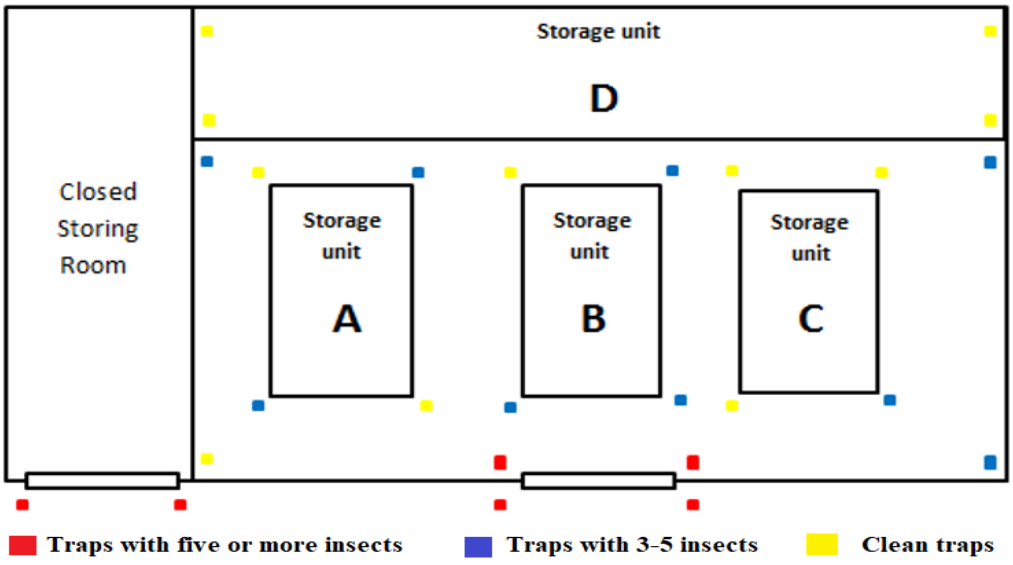


**Fig. 2: Floor plan of the selected storeroom of Al-Manyal Palace Museum with trap locations.**

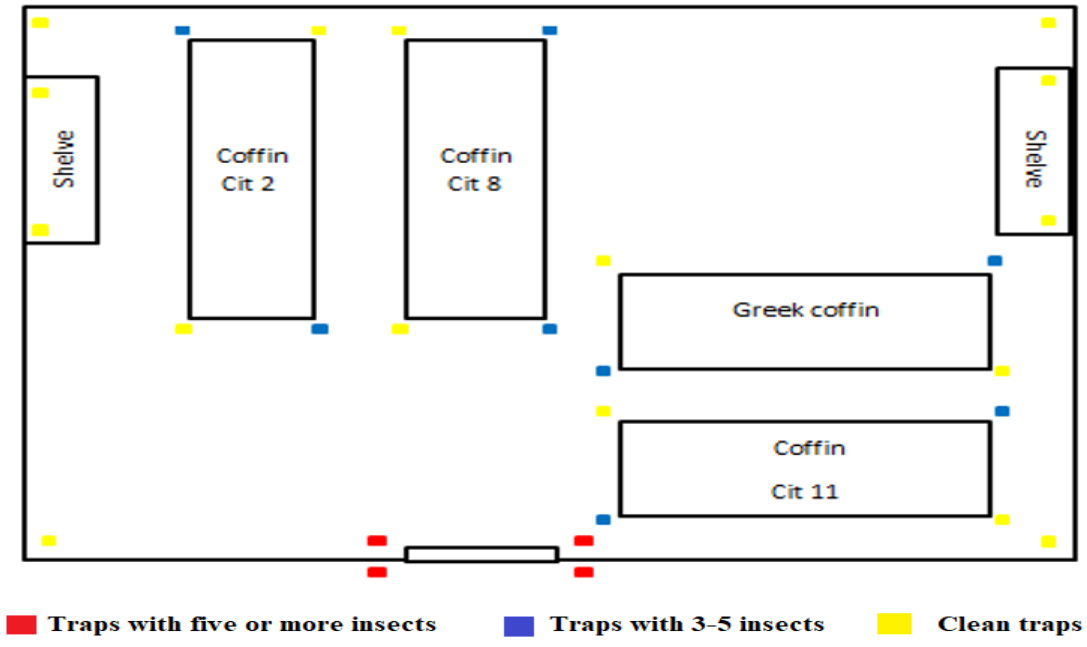


**Fig. 3: Floor plan of the selected storeroom of the Egyptian Museum with trap locations**

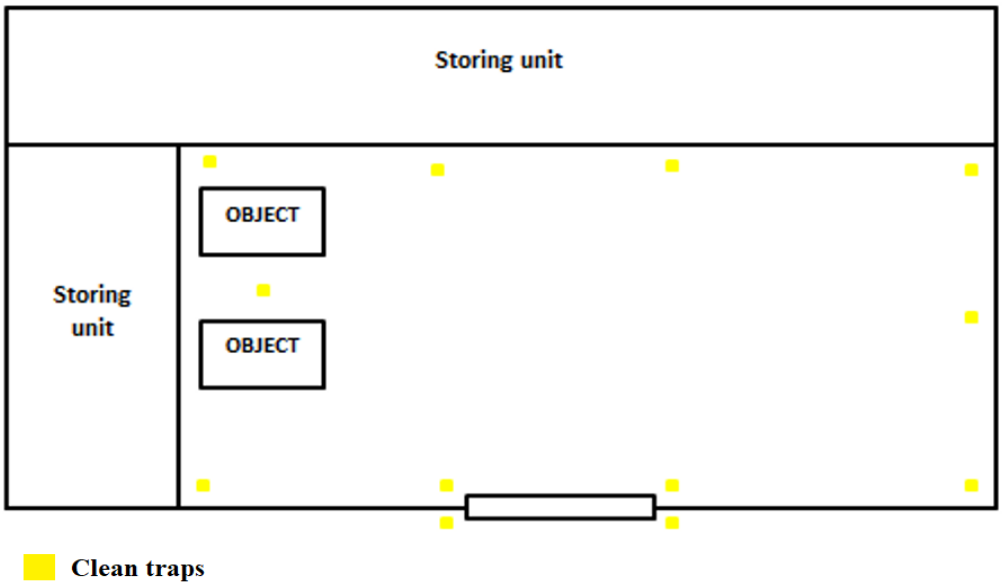


**Fig. 4: Floor plan of Tut storeroom of the Grand Egyptian Museum with trap locations**

high RH in the storeroom environment [17, 19], which attracts insect pests. However, other insects that can be exceedingly destructive were found, i.e., fabric pests; *Dermestes* nr. *Lardarius* and *Attagenus bifasciatus* [12, 20]. Besides, the study revealed the presence of adult and larval insects, indicating an active infestation [17]. *Anobium* Fabricius, *Porcellio* Latreille, *Camponotus maculatus*, *Philonthus turbidus*, and *Blaps polychresta* were among the wood-destroying insects found in the catches. Their numbers climbed dramatically from March to August, indicating an active infestation. Moreover, a spider beetle species, *Gibbium psylloids*, was identified among the stored products pests [17, 19, 20]. These catches include *Periplaneta americana*, a general insect that is also called a museum pest that feeds on museum collections [17]. This diversity of insect pests is mostly due to the variety of materials from which artefacts in this storeroom were made.

Wood insects such as *Porcellio* Latreille, *Camponotus maculatus*, and *Philonthus turbidus* were among the identified species found in the Egyptian Museum's storeroom, which could indicate the presence of an active infestation. Additionally, the presence of *Thermobia aegyptiaca* and *Lasius sp.* reveals a moisture problem [17], as these species are associated to damp environments [20].

Besides, G*ibbium psylloids*, the smooth spider beetle, was found among the catches from this storeroom that were identified and indicating to an active infestation. The numbers of *Loxosceles rufescens*, on the other hand, suggests inadequate museum housekeeping.

No catches were found in the storeroom of the Grand Egyptian Museum suggesting the success of the museum's IPM unit in reducing insect infestations and maintaining good museum housekeeping.

## 4. Conclusion

In this study, the status of some storerooms of selected museums was assessed in terms of insects control based on the presence of insect pests. Three separate Egyptian museums' storerooms were chosen. The Grand Egyptian Museum was found to be clear of insect infestation after the investigation. Unlike other storerooms in the chosen museums, different intruders were detected in the Al-Manyal Palace Museum's storeroom,

**Table I. The insect pests that were collected from the selected storeroom of Al-Manyal Palace Museum**

| Species name | Life stage | Jan. | Feb. | Mar.-Aug. | Sep. | Oct. |
|---|---|---|---|---|---|---|
| *Porcellio* Latreille, 1804 | Adult | 1 | 5 | 32 | 6 | 14 |
| *Camponotus maculatus* (Fabricius, 1782) | Adult | 2 | 3 | 121 | 24 | 9 |
| *Philonthus turbidus* Erichson, 1839 | Adult | 2 | 3 | 21 | 1 | 7 |
| *Modicogryllus burdigalensis* (Latreille, 1804) | Adult | 0 | 1 | 1 | 0 | 0 |
| *Loxosceles rufescens* (Dufour, 1820) | Adult | 1 | 2 | 11 | 1 | 5 |
| *Matabelina treitliana* (Werner, 1905) | Adult | 0 | 0 | 1 | 0 | 0 |
| *Dermestes* nr. *Lardarius* Linnaeus, 1758 | Adult<br>Larva | 0 | 0 | 1<br>3 | 0 | 0 |
| *Entomobrya* Rondani, 1861 | Adult | 1 | 0 | 0 | 0 | 1 |
| *Anobium* Fabricius, 1775 | Adult | 0 | 1 | 1 | 0 | 0 |
| *Periplaneta americana* (Linnaeus, 1758) | Adult | 0 | 0 | 1 | 0 | 0 |
| *Cataglyphis savignyi* (Dufour, 1862) | Adult | 1 | 0 | 0 | 0 | 0 |
| *Aphaenogaster splendida* (Roger, 1859) | Adult | 1 | 0 | 0 | 0 | 0 |
| *Gibbium psylloids* Pawel Czempiński, 1778 | Adult | 0 | 1 | 0 | 1 | 1 |
| *Attagenus bifasciatus* (Olivier, 1790) | Adult<br>Larva | 0 | 0 | 1<br>1 | 0 | 0 |
| (Forskl, 1775)*Blaps polychresta* | Adult | 0 | 0 | 0 | 1 | 0 |
| *Parasarcophaga dux* (Thomson, 1869) | Adult | 0 | 0 | 0 | 2 | 0 |
| *Musca domestica* (Linnaeus, 1758) | Adult | 0 | 0 | 0 | 3 | 0 |
| *Mintho compressa* (Fabricius, 1787) | Adult | 0 | 0 | 0 | 1 | 0 |

**Table 2. The insect pests that were collected from the selected storeroom of the Egyptian Museum**

| Species name | Life stage | Jan. | Feb. | Mar.-Aug. | Sep. | Oct. |
|---|---|---|---|---|---|---|
| *Gibbium psylloids* (Pawel Czempiński, 1778) | Adult | 1 | 3 | 3 | 5 | 3 |
| *Camponotus maculatus* (Fabricius, 1782) | Adult | 2 | 7 | 3 | 4 | 4 |
| *Philonthus turbidus* Erichson, 1839 | Adult | 2 | 1 | 2 | 3 | 2 |
| *Loxosceles rufescens* (Dufour, 1820) | Adult | 4 | 3 | 2 | 4 | 3 |
| *Porcellio* (Latreille, 1804) | Adult | 1 | 1 | 3 | 2 | 3 |
| *Thermobia aegyptiaca* | Adult | 1 | 2 | 3 | 2 | 2 |
| *Lasius* sp. | Adult | 0 | 2 | 2 | 1 | 2 |

highlighting the substantial disadvantage of the museum's proximity to a garden and indicating a poorly sealed building. Other insect pests were also identified, indicating a moisture issue and an active infestation. The results imply an active infestation, moisture problems, and poor museum housekeeping in the Egyptian Museum's storeroom, though the situation appeared to be less severe than that reported in the Al-Manyal Palace Museum. Finally, the study proved recurrence of insect infestation in the storerooms in Al-Manyal Palace museum and Egyptian museum after a short time from their sterilization using chemicals and essential oils. It is not possible to entirely eliminate the need for chemicals in our museums, but we can reduce their use as much as possible by monitoring pests and the museum environment. IPM strategies can then be developed to prevent pests from future access to the collection and evaluating their success.

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