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Insect Pest of Herbarium and Their Integrated Pest Management

Suboohi Nasrin
Research Scholar, Department of Museology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

Abstract:
Mostly 90% of deterioration into herbaria is caused by insects. Pests are the most hazardous to cellulosic objects. Insects like Silverfish (Lepisma saccharina), Booklice (Psocoptera), Termites (Isoptera), Bookworm (Annobium punctatum), Cockroaches and beetles' species can damage herbaria and paper materials. (Bhowmik;1968). Cockroaches destroys leather binding, paper and parchment and made holes. Due to their excretions severe stains may occur on the pages of herbarium. (Schofield & Crisafulli;1980). Herbarium is a national property it serves the society in many ways like provide materials for teaching, provide job opportunities for graduate and undergraduate students, gives the identity of plants, serve as the repository of new collection, run educational courses for the people seeing a lots of uses of herbarium its conservation and preservation is very essential. In herbaria mostly the threat of deterioration is caused by insects where environmental condition also plays a vital role. Herbarium insects are cosmopolitan in nature and distributed all over the world especially in tropical countries. The aim of this paper is to point out different types of herbarium pests which destroys it and given a modern strategy plan on Integrated pest management.

Keywords: *Deterioration, herbaria, insects, integrated pest management, insects, conservation*

1. Introduction

Pests are the deteriorating agent in Herbaria, Archives and Libraries causes a severe damage to the cellulosic collection. For their preventive conservation a modern integrated pest management (IPM) is very important. To avoid pest infestation, it is very necessary to focus on prevention of the objects by using pesticides, but it is well known that directly application of pesticides on herbarium and paper materials may deteriorate it by producing undesirable residues (Zycherman and Schrock;1998, Dawson;1992). Integrated pest management is defined as monitoring and managing pest with different pest control methods to prevent deterioration in the collection. This concept was developed in 1950 in the food industry starting in 1980 it has also been applied in museums. (Story, 1986; Albert;1988) in U. S. A, Canada and Australia. Today it is applied to more and more museums including some smaller collection also Pest management strategy for museums were described by (Boylan, 2004;Strang, Kigawa, 2006). To prevent pest deterioration in herbaria, a systematic concept of prevention should be applied. This is completed by sealing the building against pest entry, provide microclimate into the herbaria, provide high hygienic standards (cleaning is an important part of Integrated pest management to reduce food sources for pests and education of staff or staff training is an important part of IPM. If an active infestation is found in herbaria non chemical method should be applicable like freezing, heating or anoxia treatment.

2. Objective of the Study

The aim of this paper is to focus on different types of pests in herbarium and make a strategy plan on Integrated pest management.

2.1. Insect Pests of Herbaria

2.1.1. Cigarette Beetle or Tobacco Beetle

Cigarette beetle belongs to the order coleoptera and is known as Lasioderma serricorne. It is known as herbarium beetle. Adult of this insect is reddish brown in colour with 2. 5-3. 0 mm long. Body is without marks and longitudinal furrows is present on the wing cases. Larva of this insect is 4 mm long yellowish white in colour and is C shaped hairs are present on the body of the insects. 30-100 eggs were laid by female and hatched in 6 to 10 days. They complete their lifecycle in 5 to 10 weeks.
Cigarette beetle is the chief pest of herbaria and mostly deterioration is caused by larva. (Story, 1985). If this species paper, herbarium specimens, book binder paste, leather binding etc. If there is a fine dust around the material it means presence of pest in the materials or objects.

2.1.2. Dermisted Beetle Especially Varied Carpet Beetle

Dermisted beetle known as *Anthrenus verbasci* belong to the order Coleoptera and family dermistidae. The Varied Carpet beetle is deteriorating pest in herbaria and is known as herbarium beetle. Adult of Varied Carpet beetle is 1. 8-3. 0 mm long. Body is ovate in

outline wings were yellowish white, brownish-orange and black forming an irregular pattern. The ventral surface is covered by fine, long, grayish yellow, scale like hairs. Larval body shows hairs and is 4 to 6 mm long with a tuft of long bristles at the tail. Eggs of varied carpet beetle is 0. 5 mm long and 0. 3 mm wide. Female lays 40 eggs in their whole life, larva hatch after 17-18 days and pupa takes 10-13 days.

The worst damage to plant specimen is caused by *Anthrenus verbasci*. Its larval stage is very damaging It may attacked leather book binding, makes holes on them and leaves dust and larval skin near the objects.

2.1.3. Cockroaches Especially German and American

Blatella germanica known as German Cockroach and *Periplaneta Americana* is known as American Cockroach which infest herbaria. The colour of adult cockroaches is dark in colour, its shape is dorsiventrally flattened. It has a cylindrical antenna, body is long and prominent wings are present. Adult of German Cockroach is 12 -15 mm long, its colour is pale grayish brown. Foreparts of the body shows two dark brown longitudinal streaks.

American Cockroach is 30-40 mm long, its colour is dark reddish brown to nearly black. 50 eggs were laid by female cockroaches. The nymph moult six to seven times until they reach adult size. Mostly cockroaches are preferred warm and moist climate. Both the varieties of cockroaches live inside the building. They are generally nocturnal in nature.

2.1.4. SILVERFISH (Lepisma saccharina)

Silverfish belong to the order Thysanura. It is cosmopolitan in distribution. Its body is fish like flattened or carrot shaped outline is present. Body is covered with scales and three tail like appendages were also present Silverfish are particularly fond of items containing starch and cellulose. Its colour is silvery grey or dull grey.

Eggs of silverfish are in a silvery white hue. Generally, eggs of silverfish hatch anywhere from 19-45 days. The young silverfish spend 3-4 months as nymphs. The average lifespan for the various silverfish species can be from 2-3 or 5 years. Fish moths were abundantly found in the places where Rh is high enough. Fishmoths or silverfish can absorb total water requirement from the atmosphere where Rh is high enough. Silverfishes are nocturnal in nature and have poor aleft undisturbed, behind the pictures and underneath loose wallpaper. They can move fast to one place to another in search of food. Silverfish feeds on starch, glue and other carbohydrates and damages binding labels of specimen, glossy paper prints photographs etc. They may have made holes and destroy the edges of paper.

2.1.5. Booklice

The best common name is psocids. Booklice is a common pests of herbaria. Adult of booklice are minute soft bodied, 1-2 mm long, dull brown or whitish in colour. Head has large, dark eyes, two thread like long antenna were also present. Neck is relatively narrow;wings were absent on their Body. 200 eggs were laid by Liposcelis bostrychophilus. Incubation period is 11 days at 25 C and Rh 75%. Nymphal period to maturity period takes 15 days and breeding is irregular. Psocids are herbarium pests live under warm and damp conditions. They are capable of absorbing water vapour through their integument. (Edney, 1957). Common psocids feeds on microscopic fungi, they destroy the glue and paste of book bindings and paper if the conditions are not favourable. These species are fond of dried herbarium plants Particularly Brassicaceae or Asteraceae.

2.2. Strategy Plan for Pest Control in Herbaria

Care and conservation of the collection is an important responsibility of herbarium and its users. A strategy plan of IPM is necessary for pest control. Cleaning programme and building management enhances the effectiveness of integrated pest management. The success of any integrated approach to pest management is to sure that staff, visitors and clients are educated about the importance of the collections. Our strategy plan covers all the aspects in IPM that i

Following principles are as follows for an effective and Modern IPM: -

2.2.1. Monitoring

Regular observation is the cornerstone of IPM.

Inspection and identification is the two steps in observation. Regular inspection, monitoring tools, insect traps are used to monitor pest levels. Collection staffs inspected the collection quarterly in storage rooms. Curators should use bright torch light during their inspection for pests. The presence of larval skin or feeding debris near the specimens is an indication of presence of pests. Exit holes, feeding holes and silken feeding tubes is also an indication of insects. If an infestation is suspected, curators should use hand lens to examine for eggs. Correct identification of the pest gives an appropriate understanding of breeding, whole biology and the implementation of the correct control methods.

2.2.2. Physical Control

The most useful and important method to minimize pest deterioration to the collection is to exclude pest. Mostly the insects entered via packaging materials. Trapping acts as physical control for pests.

Zappers or electronic insect killer emit UV light that attracts flies and moths. Insects catch into the traps and fall into the shelf, which is checked Periodically and insects were recorded. The traps must be checked weekly.

Other important trap is blunder traps which is large sticky traps and is helpful to catch crawling pests.

Pheromone traps are sticky traps with specific pheromone to attract certain pests. This trap attracted the pest in surrounding **area**.

2.2.3. Environmental Condition

Maintained temperature and relative humidity(Rh) discourage pests from breeding.Environmental condition of herbarium storage areas is maintained at 16◦C and45% Rh. Maintenance of environmental factors is the key responsibility of herbarium staff.

2.2.4. Cultural Practices

Mostly herbarium pests are active at nightso that the specimens were not left out on the tables or in open boxes. This shows greater risk of infestation.

2.2.5. Education

For a successful integrated pest management programme, staff should be educated and aware. Every staff should be informed and educated about the uniqueness and importance of the collection. Herbarium staff will receive regular training and be informed of IPM changes and u

2.2.6. Sanitation

In herbaria, pests are attracted to paper as well as herbarium specimens. Both provides nutrition to herbarium pests. Following sanitation principles are very necessary and should be applied into the herbaria.

i. Food and liquids must not be taken into the herbarium storage areas.
ii. Food residues must be cleaned up after eating and drinking.
iii. Food must be stored in a plastic or glass container.
iv. The kitchen in herbaria must be cleaned up.
v. Starch or synthetic packaging noodles must be disposed off and not recycled as packaging.

2.2.7. Cleaning

Keep the herbarium in a proper way is the key responsibility of all staff. Herbarium pests are abundantly found where there is an adequate food source. Offices and laboratories should be kept clean at all time. The collection managers organize a cleaning programme in herbaria in which herbarium is regularly assessed by the collection manager. This will aid in cleaning.

2.2.8. Chemical Methods

In the past where there are active infestation chemical methods were used like DDT, methyl bromide, hydrogen cyanide etc. Today after prohibition of the use of DDT, Methyl bromide and hydrogen cyanide few museums still regularly use pesticides against insect pests. Pyrethroid fumigation are not preferred because they don't kill all stages of insects. 100% success in killing at all stages can be achieved with toxic gases, but also these have their limitation to be achieved in herbaria. Phosphine cannot be used because its nature is corrosive with gold and silver. In museums sulfuryl fluoride is the only toxic gas which is used in museums. In herbaria Cyanide gas is used which is very hazardous, after treatment areas were sealed for upto 48 hrs. Due to their toxicity ethylene oxide, phosphine, ethylene dichloride etc. were used in herbaria. sometimes chemical biocide was applied and it is less harmful for objects. That's why the use of non chemical methods were used in place of chemical methods.

2.2.9. Non Chemical Methods

Insect pests can be killed with different non chemical methods which is preferred in herbaria. They don't damage the objects, kill all stages of insects and don't harm the environment or health of museum staff. Physical treatment like controlled heating (Strang, T. J. K, 1992; Pinniger, 2003), Freezing (Florian, 1990; Berzolla, 2011), microwave radiation (Unger, 2008) or Gamma radiation. For more delicate objects anoxia treatment is preferred (Gilberg, 1989; Berzolla, 2011) evena single method is not perfect. Application of best method to be selected depending on time, financial resources, availability and types of pests and material to treat.

3. Conclusion

Insects pest are responsible for substantial damage to museum objects and herbaria. Different species of herbarium causes huge damage to herbarium collection. Species identification and knowledge of their biology is an important part of Integrated pest management. Knowing the biology helps the search for infested objects.

Maintenance of the humidity is the only way to stop the activity of insects. Some scientists believed that normally pests are transported with infested objects into the collectionand there they fly into the buildings through open doors or windows.The most abundant pest species of herbaria are Cigarette beetle or Tobacco beetle, Dermisted beetle especially the varied carpet beetles, Cockroaches, Silverfish and booklice.Some non insect's pestlike rodents are also present. These pests highly destroy the herbarium collection. If a pest is detected into the collection firstly confirm the identification of the insects, then determine the course of action. After this freeze the infested materials at -18 C for 7 days. Then clean the materials. (Parker, 1986) reviewed both pests and integrated pest management or controls in libraries. He also stated that the spaces beneath the specimen's cabinets should be open to allow sweeping and the tops should be kept dust free. Silica aerogel is used as antipest measure. A modern Integrated pest management is very useful to minimize the risk the risk of damage into the collections without affecting the objects, staff and the environment.

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