ABSTRACT

Gastrallus indicus R. (Anobiidae: Coleoptera) is regarded as one of the most serious pests of paper materials. It is commonly known as 'Bookworm'. Several workers have reported severe damage caused by *G. indicus* to paper materials and palm-leaf manuscripts from different parts of the world. It had become evident from the study of the available literature that not much work had been done on the distribution, morphology, bionomics and control of *G. indicus*. Therefore, a detailed study on the subject was undertaken as a prerequisite for understanding the bionomics of the insect and designing effective control strategies with the hope that this would be useful to the custodians of the museum and library collections who would like to devise long lasting control operations and precautionary measures for protecting their precious collections.

The infestation of paper materials by *G. indicus* is commonly found in tropical humid regions. Several species of *Gastrallus* have been identified from different parts of the world. During the present study a cursory survey regarding the distribution of *G. indicus* was carried out by means of various methods like personal inspection of the collections in museums, archives and libraries. Besides this, information was also collected by personal enquiries from library personnel and by sending out questionnaires to the custodians of various institutions. The survey reveals that bookworm infestation is widely spread throughout India.
Based on the above mentioned information a cursory survey map of India has been prepared showing different regions from where information regarding bookworm infestation was received. However, in future, a detailed study is required to be done to ascertain the exact extent of distribution of the pest in different parts of the country.

During the study, egg clusters, larvae and adults of *G. indicus* were locally collected from the Moulana Azad Library at A.M.U., Aligarh. I took the help of the Entomology Section of the Department of Zoology and the International Institute of Entomology, London, to identify the species. Detailed morphological studies of the important structures of the insect were carried out by preparing permanent slides.

The biology of the insect was studied in our laboratory under controlled conditions of temperature and relative humidity. Observations were made daily on the developmental stages of the larva, pupa and adult along with the breeding and feeding behaviours.

Mostly the egg clusters were found attached to the inner surface of the bindings and inside the tunnels as well as on the margins of the peripheral pages of books. The average size of an egg cluster measured about 1-1.5 mm. in diameter and consists of approximately 30-40 eggs. Hatching took place within 2-3 weeks (at controlled temperature ranges of 28-30°C in most of the cases).
Five larval instars were recorded. The body of a mature larva was more or less elongated in shape, gradually narrowed towards the posterior end. The legs are short, without claws and terminate into globular pads which may be regarded as a peculiar characteristic of the genus Gastrallus (among Anobiids). The larva is a voracious eater and during its feeding process it causes severe damage to paper materials. The development of larval stages gets completed in about one year (under laboratory conditions).

The experiments conducted regarding the feeding response reveal that the larva shows a distinct liking for paper materials over other food materials if made available along with paper.

The pupal stage is considered harmless as pupae do not cause any damage to paper materials. This stage may be regarded as the most vulnerable period of the insect because maximum natural mortality has been recorded during this phase. The pupal period ranges from 8-12 days. Soon after, the pupa completes its developmental process and gets transformed into an adult.

Male beetles are comparatively smaller in size than female. The average size of a male beetle is 2-3 mm. whereas average female size is 3-4 mm. The copulation starts soon after the beetles attain sexual maturity. The breeding usually takes place during the months of June, July and August. After mating, the female fly away from males and disperse themselves in search of suitable sites for egg laying. The life span of adult is about 2-3 weeks.
Pesticides are still, our most powerful weapons in the arsenal of pest management, although popular opinion now a days is to minimising their use. During the experiment conducted for determining the toxic efficacy of four insecticides, it was also observed that out of the four insecticides viz fenitrothion, malathion, milphos and sevin, tested against the larvae, fenitrothion was found to be the most toxic to larva, whereas sevin was relatively less toxic (in low concentrations). The relative toxicity of these insecticides was deduced in the following decreasing order fenitrothion > malathion > milphos > sevin having respective values of 1.77 > 1.07 > 1 > 0.56.

Based on the above conclusions any one of the suitable intoxicant can be employed for impregnating the paper in required strengths of the solution and the same can be used for covering the surfaces where the infestation is to be controlled. It can also be used as a residual spray which can be sprayed in and around places where paper materials are stored for creating a long lasting chemical barrier against the insect attack.

Fumigation is regarded as one of the best methods for controlling insect pests of paper materials. Fumigation of infested books in a closed chamber using para-dichlorobenzene (PDB) 335 gm/m³ for a week was found enough to achieve cent percent larval mortality. However the above fumigant, kills larvae, pupae and adults but eggs laid in furrows may be unaffected. Hence there is a possibility of their hatching into larvae within 2-3 weeks. Therefore further dose of fumigation is required for the complete eradication of the insect after the said period.
Certain experiments on freezing technique show that freezing of infested books for either 24 hrs. at -5°C or for 48 hrs. at 0°C is quite effective in combating the infestation. Hence freezing the books after wrapping them in polythene bags can be recommended for the control of the insect in museums and libraries.

An efficient air-conditioning of the building may recommended for minimising the pest menace as temperature between 20-25°C and relative humidity between 40-60% round the clock inside the building can prevent insect activity to a very large extent.

As there is no single method, known to the science of pest management which could give an everlasting solution to the challenge posed by the insects, therefore it becomes imperative to design an integrated pest control programme for the prevention and control of the infestation. The use of pesticides is accepted as an important component of the integrated pest control programme in which different types of techniques are blended to control the harmful insects with minimal effect on human being and the environment. However, in institutions like museums and libraries, the control measures should aim at the complete eradication of the pest population, contrary to the approach adopted in the field of agriculture where the objective is to bring down the pest population to keep it below the threshold level. Therefore, in case of such institutions we should move beyond integrated pest management (IPM) to an approach which may be called integrated pest
eradication (IPE) programme. The integrated pest eradication programme should help not only in controlling the insect pests that have already entered and proliferated within a building, but also serves as a means of long term strategy for the prevention of fresh attacks. Such a programme should comprise of all types of curative and precautionary measures (including the use of different toxic and non toxic methods) aimed at the eradication and prevention of insect infestation. For the prevention and eradication of insect infestations in the library and museum buildings, the author would like to suggest the following (as an integrated programme).

1. Quarantine treatment to be given to the new materials before adding to the collections.

2. Thorough periodical checking of the collection for signs of pest infestation.

3. Immediate isolation of the material showing any signs of infestation and subjecting the same to the disinestation treatment.

4. Keeping the object as far as possible in hermatically sealed polythene bags charged with chemical repellents or fumigants.

5. Use air-tight Almirahs, drawers, etc. for storing purposes.

6. The librarians are suggested to keep the books in constant use.

7. Periodically the collection should be subjected to fumigation or spraying of appropriate insecticide in consultation with some experienced agency in the field of pest management.