Pak. J. Bot., 36(1): 127-131, 2004.

INSECT HERBIVORY IN POLLUTED MANGROVES OF THE INDUS DELTA

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Abstract

The study deals with estimation of insect herbivory on the attached leaves of the grey mangrove *Avicennia marina* (Forsk.) Vierh., in a highly polluted habitat of the Indus Delta. A greater proportion of the leaves was affected by herbivory in varying degrees of consumption by insects and mostly less than 20% of the leaf area was consumed. A vertical zonation of herbivory was observed with an increasing trend from upper to lower canopy. The overall estimate of herbivory in mangroves revealed that insects consumed as much as 22% of the foliage with an average value of 14.38 ± 4.37%.

Introduction

A large number of studies have been carried out on different aspects of mangrove ecosystem of the Indus Delta, but the important aspect of herbivory has so far been neglected. It is the consumption of attached leaf matter by insects which causes significant decrease in the total organic matter produced by the ecosystem, thereby affecting other herbivores and detrivores in the food chain. It has been established by several workers that leaves are eaten by insects while still attached to the plant (Odum, 1972; Johnstone, 198l; Robertson, 1987). According to Crossley (1966) a single larva of the beetle *Chrysomela knabi* consumes 7 to 16 mg dry wt of plant matter per day. Robertson (1987) reports that as much as one fifth of the attached leaf biomass of mangroves may be consumed by herbivory. The present study was carried out to study herbivory in the mangroves of Karachi, which forms the westernmost part of the Indus Delta and is highly polluted.

Materials and Methods

The study sites include Sandspit, which lies in the backwaters of Karachi Harbour, and Lat Basti (Korangi Creek) which have already been described in detail elsewhere (Saifullah & Elahi, 1992; Saifullah *et al*., 1994). Both of them are highly polluted with most of the city's domestic sewage and industrial wastes. According to Beg *et al*., (1975) the Lyari river discharges 130,000 tons of total dissolved solids, 16,000 tons of organic matter, 800 tons of nitrogenous compounds and 90 tons of phosphate compounds into the area annually. Only one species of mangroves *Avicennia marina* (Forssk.) Vierh., occurs in the area. Numerous leaves were picked randomly from different strata of the canopy i.e., upper, middle and lower canopy at the low water mark in 1995 and 1999. Normal and affected leaves were separated and assessed for the total and the affected areas by insect activity respectively. The area of the entire lamina was calculated by the formula:

$$\text{Total leaf area} = \text{Length} \times \text{Breadth} \times 62 / 100$$

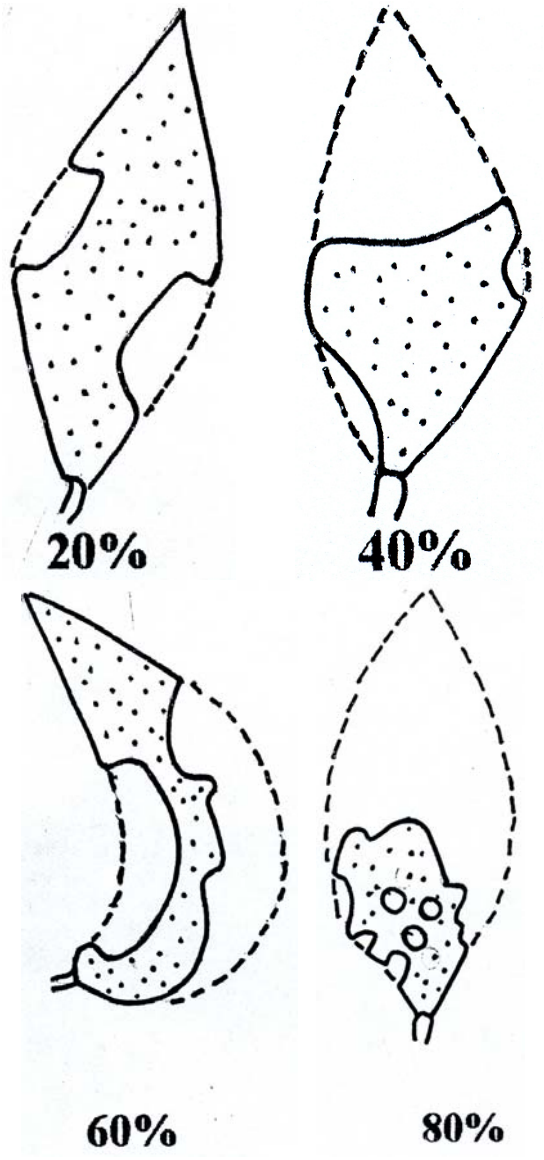

Fig. 1. Diagramatic representation of percentage leaf area consumed by insects (the dashed blank area)

The area consumed by the insects in a given leaf was measured by tracing the entire leaf along with the holes or the affected areas on a graph paper and calculating the ratio of the number of squares occupying the holes or spots to that of the total number of squares occupying the entire leaf area. It is given by the following formula:

% Herbivory in a given leaf = Affected area of the leaf x 100 / Total area of the leaf.

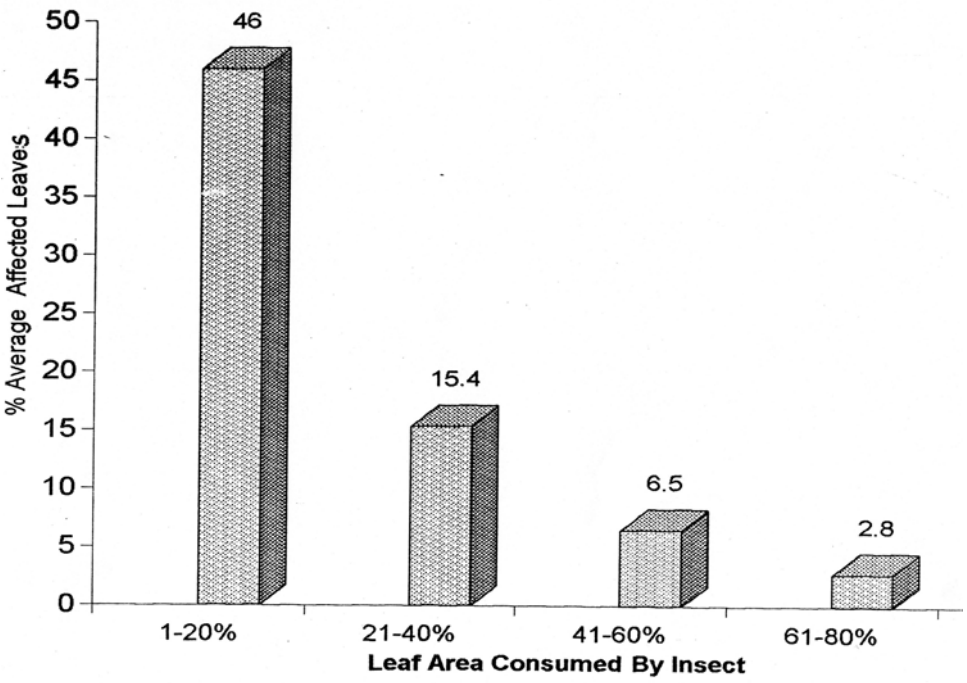

Fig. 2. Relative proportion of leaf matter consumed by insects.

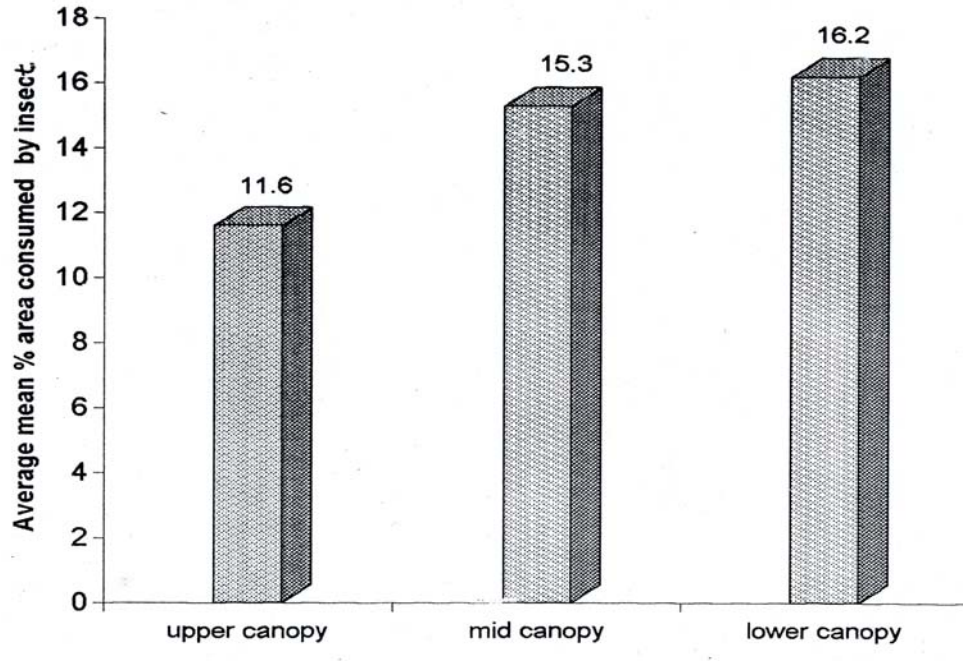

Fig.3. Variation in extent of herbivory with different levels of canopy.

Fig.1 shows different fractions of herbivory by insects in the leaves, as an example.

As the leaves were consumed in many different proportions, they were grouped into the following four categories for convenience, the group >81% being omitted because it was negligible.

1-20%, 21-40%, 41-60% and 61-80%

The total herbivory in a group of leaves including normal and affected leaves for a certain layer of canopy was calculated by the following formula:

$$\% \text{ Herbivory} = \Sigma fx / \Sigma f$$

where f is the frequency of both affected and unaffected leaves in different proportions and X = % area consumed by the leaves.

Results and Discussion

According to Johnstone (1981) there are three patterns of herbivory or leaf consumption by insects i.e., marginal, internal or a combination of both types. But in the present case it was mostly marginal i.e., the insects start eating from margin towards the mid rib (Fig. 1). The mode of eating was chewing and not skeletonizing or mining, which is the most common method in mangroves (Franklin, 1970; Johnstone, 1981).

In a given sample of leaves, the affected ones out numbered the unaffected ones. A majority of the leaves were less consumed, whereas a few leaves were consumed more. There appears to be a logarithmic rather than linear decrease in leaf consumption by insects. Thus, 46 % of the total leaves were consumed from 1 - 20%, 15.4% from 21-40%, 6.5% from 41-60% and 2.8% from 61-80% only by the insects (Fig. 2).

The extent of herbivory varied with different levels of canopy. It increased gradually from upper to lower canopy (Fig. 3). This may be due to the fact that the lower canopy is shaded and very humid or wet due to proximity to the level of tidal water which favours insect activity and growth, whereas the upper canopy is exposed to sun and relatively drier. Farnsworth & Ellison (1991) reported that leaves of shaded seedlings were more consumed by insects than the exposed ones.

The over all herbivory varied between 6.9 and 22% with an average value of 14.38% of the total leaf matter. In other words insects consumed about one seventh of the leaf biomass of mangroves, which is somewhat higher than those reported by Johnstone (1981) and Lacerda *et al*., (1986). This may be due to the fact that the present site is heavily polluted which encourage insect growth. Onuf *et al*., (1977) also reported values as high as 26% and correlated this to pollution in their area of study. They suggested that domestic sewage is rich in nutrients, therefore it increases the productivity of mangroves and hence herbivory as well. Our study is further strengthened by the fact that herbivory estimated in mangroves of a pristine area of Miani Hor, some 100km west of the area of study, was lower amounting to only 8.3%. Lacerda *et al*., (1986) and Johnstone (1981), however, documented that herbivory is not related to pollution.

Another possible reason for high value of herbivory in the area of study may be that the mangrove stand was monospecific. Watt (1973) observed that herbivory in monospecific stands is higher than mulitispecific stands, because the insects have no other alternate hosts to feed upon. Further studies carried out on larger scale including several different types of habitats and for extended period of time are needed for better estimation of the extent of herbivory in the mangroves of the Indus Delta.

Acknowledgements

The authors duly acknowledge the assistance provided by Miss Ratan K. Lal, Mr. F. Rasool and Miss Miss. Sadaf Gul in the field and also in laboratory.

References

Beg, M.A.A., S.N. Mahmood and A.H.K. Yousufzai. 1975. Industrial effluents their nature and disposal in Karachi. Part. I; Survey of the polluted Lyari river. *Proc. Pak. Acad. Sci*., 12: 125-131.

Crossley, D.A. 1966. Radioisotope measurement of food consumption by a leaf beatle species *Chrysomela Knabi* Brown. *Ecology*, 47: 1-8.

Farnsworth, E.J. and E.M. Ellison. 1991. Patterns of herbivory in Beilizeanmangrove swamps. *Biotropica*, 23(4b): 555-567.

Franklin, R.T. 1970. Insects influences on the forest canopy. In: *Evaluation of temperate forest ecosystems*. (Ed.): D.E. Reiche. pp.1-297. Springer Verlag., Germany

Johnstone, I.M. 1981. Consumption of leaves by herbivores in mixed mangrove stands. *Biotropica*, 13(4): 252-259.

Lacerda, L.D., D.V. Jose, C. E. Rzende, M.C.F. Francisco, J.C. Wasserman and J.C. Martins. 1986. Leaf chemical characterisitics affecting Herbivory in a new world mangrove forest. *Biotropica*, 18(4): 350-355.

Odum, W.E. and E.J. Heald. 1972. Trophic analysis of estuarine mangrove community. *Bull. Mar. Sci. Gulf Carrib.,* 22: 671-738.

Onuf, C.P., J.M. Teal and I. Valiela. 1977. Interactions of nutrients, plant growth and herbivory in a mangrove ecosystem. *Ecology*, 38: 514-526.

Roberetson, A.I. and N.C Duke. 1987. Insect herbivory on mangrove leaves in North Queensland. *Aust. Journal of Ecology*, 12: 1-7.

Saifullah, S.M and E. Ealhi. 1992. Pneumatophore density and size in mangroves of Karachi. *Pak. J. Bot*., 24(1): 5-10.

Saifullah, S.M., S.S. Shaukat and S. Shams. 1994. Population structure and dispersion pattern in mangroves of Karachi, Pakistan. *Aquatic Botany*, 47: 329-340.

Watt , K.E.F. 1973. *Principles of Envirnmental Science*. McGraw-Hill, N.Y.

(Received for publication 27 October 2003)