FERN - INSECT INTERACTION

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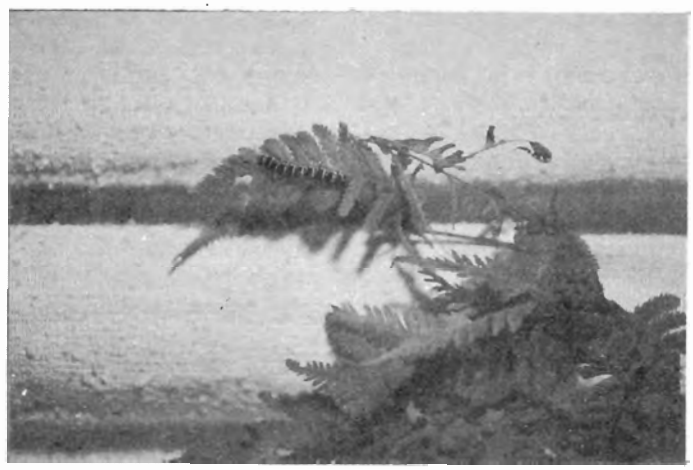
Introduction

Insects and plants are contemperaneously evolving organisms with roots from the Devonian times and are evolved in a nearly perfect symbiotic relationship acquiring diverse adaptive strategies in terms of food resources for survival, growth and reproduction (Ananthakrishnan 1992). The first well established vascular land plants, ferns and fern allies, faced competition with a number of predators and they have evolved some antiherbivore mechanisms. The knowledge about the interaction between the insects and the primitive vascular plants, ferns and fern allies will throw much useful informations about their coevolution. But such studies are only at an infant stage. The present report along with the previous reports will give some informations about the interaction between ferns and insects. The antiherbivore mechanisms of ferns are also discussed. The present communication is based on the field observation and previous published reports.

Observations and Discussion

Table 1 shows the species of ferns and fern allies, the associated insects and their mode and stage of association. It shows that insect association is seen from the primitive vascular plant *Selaginella* (Fern ally) to an advanced fern member *Polypodium*. In many cases the identification of the particular insect was not made since it is very difficult to rear the larvae under controlled condition. The association of the 'Blue Tiger' moth with *Pteris argyraea* T.Moore is the first report. The association of larvae of some unidentified insects on the ferns *Macrothelypteris torressiana* (Gaudich) Ching and *Pteris confusa* T.G. Walker is also the first report. In *Diplazium polypodioides* B1. and *Stegnogramma pozoi* (Lagasca) K.Iwats. the larvae feed on the tender sori only, while in *Macrothelypteris torressiana* (Gaudich) Ching the larvae feed on fertile or sterile leaves. It was confirmed by observing the faecal pellets under microscope. The stomata in the crushed leaf bits and the presence of undigested hairs in the faecal pellets resemble the same on the food plant. The larvae which feed on *Macrothelypteris torressiana* are about 2 cm long, black with yellow ridges and without hairs. The larvae which feed on the tender sori of *Diplazium polypodioides* B1. and *Stegnogramma pozoi* are about 1 cm long, yellow and without hairs. These larvae resemble the sori, which they feed, in shape and colour as camflage. The pupa associated with *Pteris argyraea* was the Blue Tiger moth. The pupa was hanging on the costa of the pinna. The pupa was oval shape with pointed ends, light green in colour with minute black and white spots. The larvae associated with *Pteris confusa* was observed inside the cacoon made by leaf rolling.

The observations shows some evolutionary pathways of ferns and related insects. Thus Bera and Gharai (1995) have suggested that the polypodiaceous ferns were initial host of aphid pest *Toxoptera aurantii* and related groups possibly during the Jurassic and continued till Upper Cretaceous when the aphids (*T. aurantii*) switched over to the members of Theaceae, Perhaps for more stable ecosystem with identical survival value. The interaction between *Acrostichum aureum* L. and a lepidopteron moth interaction is quite interesting so far as the co-evolution of the member of such association is concerned (Bera & Ghorai 1995). The knowledge on the association of insects and the specificity of the food plant may also give some idea on the taxonomical relationships of the plants. It is interested to note that a new species of fern was described based on the observation of the insect and fern relationship. A team of biologists searched for a natural enemy (insect) which destroy the Kariba weed, *Salvinia* sp. After finding an insect from a country they made a trial test against the weed. But it was of great failure. After making a through analysis they came to the conclusion that the natural host of that insect and the tested host are different ones. Then they differentiated and described a new species *Salvinia molesta* Mitch.



A larva feeding on the leaves of the fern *Macrothelypteris torressiana*

Defence Mechanism in Ferns

Generally ferns do not need the help of insects as pollinator. All the fern spores are dispersed by wind. So, ferns do not have any adaptation in colour or smell to attract insects. They have developed chemical defence mechanism by having higher concentration of phenols. 'Phloroglucinols' an important group of polyphenol have been reported in several ferns particularly in Dryopteroid ferns (Widen *et al* 1983, 1991).

Phytoecdysones which play an important role in defence mechanism, occur mainly in two groups of relatively primitive plants, the ferns and Gymnosperns which they still appear to be somewhat relatively free of insect predation (Hendrix 1980). The application of minor amounts of phytoecdysones to the larval stages of insects leads to precocious metamorphosis, resulting in extremely abnormal growth and development, cuticle shedding and in many cases death (Horn 1971).

Conclusion

It is very clear that the study of ferns - insect interaction is very much helpful to understand the co-evolution of both ferns and insects. The presence of the chemical defence mechanism (i.e presence of higher concentration of phenols and phytoecdysones) in ferns will be helpful to utilize them directly as biopesticides as in the case of *Acrostichum aureum* L. or by biotechnological methods by which the mechanism can be transferred to the crop plants to produce pest resistant strain. In the meantime the availability of enormous amount of Phytoecdysteroids can be utilised to rear useful insects by applying optimum doses at the required stage of the life cycle of the insects. Recently Chandrakala *et al* (1998) explained the scope of the application of phytoecdysteroids in

Table 1. List of ferns and associated insects

Ferns/fern-allies	Insect-stage associated with the ferns and fern-allies	Remarks
1. *Pteris argyraea* T.Moore	'Blue Tiger' moth; pupa attached on the costa of the pinna.	Whether the larval stage depend upon the same fern or not was not known. (Present report)
2. *P. confusa* T.G. Walker	.....About 2 cm long black colour larve sheltered inside the cacoon formed by rolling of leaves	There was an indication of feeding of leaves by the larvae (Present report)
3. *Macrothelypteris torresiana* (Gaudich.) Ching	.....Larva of about 2 cm long, black with yellow ridges.	Larvae feed on the fertile or sterile leaves. (Present report)
4. *Diplazium polypodioides* B1.	.....Larva of about 5 mm long	Larvae feed on the tender sori of the fern. Yellow in colour (Irudayaraj 1998)
5. *Stegnogramma pozoi* (Lagasca) K. Iwats.	.....Larve of about 5 mm long Yellow in colour	Larvae feed on the tender sori of the fern (Irudayaraj 1998)
6. *Acrostichum aureum* L.	Lepidopteron moth	Moth feeding/damaging the plant (Bera & Ghorai 1995) Spore dust used as biopesticide to control termites. (Present report)
7. *Polypodium argutum*	*Toxoptera aurantii* (Aphididae) (Tea pest)	Damage to the fern similar to the damage on tea plant by this aphid (Bera & Ghorai 1995).
8. *Selaginella monospora* Spring	Cynipid larva, pupa & adult	Gall formation (De & Bera 1995; Bern *et.al.* 1994).
9. *Pyrrosia adnascens* Sw.	Moth larva	Larvae feeding on the fern Pant *et al.* 1991)
10. *Pronephrium nudatum* (Roxb.) Holttum	Dipteron Fly's maggots (=larvae)	Maggots feeding on sori (Pande & Pande 1991).
11. *Pyrrosia nuda* (Gies.) Ching	*Julus* sp., millipede larvae (Diplopoda)	Infestation of younger of younger fronds by associating with rhizomatous region (Banerjee *et al.* 1995)

sericulture. Such an evolutionarily and biologically important group of plants, the ferns, should be conserved in nature to conserve the associated insects also.

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