Chapter 6

SUMMARY AND CONCLUSION

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Summary

Spiders are obligate carnivores and hold the unique position of being the only large class of arthropods which are entirely predatory in nature. To form a basis for research into the role of spiders to determine the economic importance of them in the rice agroecosystem of Kuttanad region (9° 17' N-9° 40' N & 76° 19' E-76° 33' E), a bio-ecological study was carried out for a period of 3 years from November 2001 to February 2004 in 8 selected sites both in Kharif and Rabi seasons. Collections were made twice in a month by hand picking and standard sweeping methods. The collected spiders were identified up to the species or genus level with the help of diagnostic keys. Different diversity indices of the spider community were calculated using the SPDIVERS.BAS programme. The findings of this study can be summarized as follows:

1. A total of 17717 individuals belonging to 99 species, 66 genera and 20 families were sampled from Kuttanad rice agroecosystem during the investigation. Out of the 99 species of spiders collected, 5 genera and 10 species were first reports from India.

2. Spider population in the monsoon (Rabi) and winter (Kharif) had a slight different species composition. In monsoon season, 70 species of 17 families were present whereas in the winter season, 94 species of 20 families were documented. Sixty eight species appeared during both winter and rainy seasons. Families Amaurobidae, Pisauridae and Pholcidae were present only during the winter season. Dyschirognatha dentata (Tetragnathidae), Pardosa pseudoannulata (Lycosidae), Erigone bifurca (Linyphiidae), Tetragnatha mandibulata (Tetragnathidae), Atypena adelinae (Linyphiidae), Phycosoma martinae (Theridiidae), Araeneus ellipticus (Araneidae) and T. cochinensis (Tetragnathidae) were some of the dominant spiders in the Kuttanad rice agroecosystem.

3. There was significant difference in Shannon (H'), Richness (R) and Evenness (E) indices between two seasons. However, Simpson index (λ) was not significantly different between two seasons.
4. The collected spiders were classified into 7 feeding guilds based on their ecological characteristics relating to foraging manner, nature of web, prey species, microhabitat use, site tenacity and daily activity. Among the 20 families of spiders collected, majority of spider families (28%) belonging to “stalkers” category. Spiders coming under this category actively jump over the prey for feeding. The second dominant guild was the “orb weavers” (26%). Spiders of this guild construct perfect orb webs for prey capture. Ground runners (13%) (feeding on the ground layer of the field and rarely coming to the foliage or canopy of the plant for prey capture), space web builders (11%) (constructing irregular space webs for prey capture), ambushers (10%) (showing a “sit-and-wait” type of behaviour for prey capture), foliage runners (7%) (hunting on foliage for phytophagous insect pests) and sheet web builders (5%) (constructing sheet like web for prey capture) were the other guilds.

5. Spiders collected from the field were classified into five vertical strata based on their distribution on the different strata. This stratification was based on the relative distance in the crop that exhibit limitations on spiders set by both physical conditions and biological factors.

6. Field population of spiders showed fluctuations in relation to the growth of rice plant. Population growth showed a gradual increase in the first 3 fortnights followed by a slight decrease in the 4th fortnight. Then it continued to grow up to 6th fortnight and attained the peak, which was then followed by a decline. The changes in the population density of web-builders and non-web builders differed between them. In hunting spiders, number of individuals increased at the final stage compared to a decrease in population of web builders. It was also observed that spider population increased in the field with prey (insect pests) abundance and vice versa.

7. Biological studies of 3 species of dominant spiders revealed that the number of instars varied among the species and sexes of the same species. The time taken to prepare the sperm web, its shape and size and the behavioural patterns associated with palpal charging were found to be different among different species observed in the laboratory. In all the 3 species studied, females had more life span than males. The longevity period of female (male) were $230.47\pm11.19$ ($187.05\pm10.98$), $236.27\pm13.91$ ($198.74\pm24.82$) and $319.72\pm15.23$ ($219.61\pm18.67$) days respectively in *T. mandibulata, A. ellipticus* and *P. pseudoannulata.*
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8. Laboratory experiments on feeding potential of the dominant spiders in major insect pests revealed that *P. pseudoannulata* was the most efficient predator (consumed an average of 6 brown plant hopper (*Nilaparvata lugens*) nymphs within 24 hours) compared to *T. mandibulata* (5) and *A. ellipticus* (4). This voracious feeder consumed an average of 5 individuals of green leaf hopper, *Nephotettix virescens* and 3 individuals of rice bug, (*Leptocorisa acuta*) over a 24-hour period. The test spiders were found preying on all insect pests actively. The rate of predation varied among different species of spiders and between sexes. Females of all spiders consumed more number of spiders where as their male counterparts consumed much less. Adult females consumed the maximum number and sub-adult males consumed the minimum number of insects.

9. Toxicity studies of 3 commonly used insecticides on spiders were conducted in the lab. Topical application (spraying) and dipping method were used for study. Of the three insecticides tested, Methyl parathion recorded the lowest lethal concentration values indicating its comparatively high toxicity in both methods. This is followed by Quinalphos and Monocrotophos. The exposure to Methyl parathion resulted in 80% mortality of experimental spiders compared to 65% and 40% of mortality with Quinalphos and Monocrotophos respectively. This is suggestive of the usefulness of Monocrotophos as a component of integrated pest management strategy for sustainable paddy cultivation. Of the three dominant species tested, *P. pseudoannulata* was the least susceptible to application of insecticides both by topical application method and the dipping method under laboratory conditions. *T. mandibulata* was the most susceptible to the insecticides tested under laboratory conditions. Among the two methods used, dipping method was found to be more fatal compared to topical application.
From this study, it can be concluded that the spider fauna of the Kuttanad rice agroecosystem is very rich in quality and quantity and can be used as an effective naturally occurring biological control agent to fight the insect pests. However, necessary steps should be taken to conserve these natural enemies by educating the farmers to use selective chemicals, which often affect the non-target organisms like beneficial arthropods, with optimum concentration and avoiding unnecessary repeated treatments. This will help to maintain the natural balance in the agroecosystem and also minimize environmental pollution.

The studies also revealed that the spider population increases with pest incidence and suppresses the pests to a level which cannot cause much loss in the crop yield. The potential of spiders as biological control agents should be assessed by studying the loss caused by the insect pests in the absence of spiders in the fields. Further studies in this line should be carried out by releasing these predators to the fields and even by introducing high potential predatory spiders found in similar habitats. For this, further studies are required to analyze the feeding potential of other dominant spiders both in the lab and in the field. The predatory efficiency can also be assessed by using radiolabelling techniques on the insect pests at their different developmental stages and evaluating the predation by spiders.

Finally, spiders are very important biological control agents in agroecosystems and play a major role as potential defenders by suppressing the pest population to a safe level which emphasizes the concept of Integrated Pest Management (IPM) in modern agriculture. Faced with the need to reduce pesticide usage on crops and optimize natural biological control, full investigation on the means by which spiders influence pest abundance is long overdue. Also in recent years, there has been a realization by ecologists that the components of agroecosystems are tractable to manipulate and that spiders are convenient model organisms. Consequently, there are a growing number of investigations in which spiders in agroecosystems are used as tools to gain insight into the role of generalist predators in community and ecosystem function. As part of implementation of IPM, further steps are needed to extend this lab investigation in the field conditions of Kuttanad rice agroecosystem.