DIVERSITY OF SPIDERS IN KUTTANAD RICE AGRO-ECOSYSTEM, KERALA[1]

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The seasonal fluctuation in population of some important families of spiders in a rice agro-ecosystem of Kuttanad was studied during 1999 to 2001 by standard sweeping and handpicking method. The data was analyzed for species diversity, evenness and richness. Out of the four sampling sites, site-2 in upper Kuttanad exhibited maximum species diversity. A total of 22 species of 14 genera, from 8 families, were reported during the study period.

Key words: Kuttanad, rice, spider, diversity, evenness, richness

INTRODUCTION

Spiders are very important biological control agents in a rice agro-ecosystem and play a major role as defenders by suppressing the pest population to a safe level. This supports the concept of Integrated Pest Management (IPM) in modern agriculture. Presently there is a need to reduce pesticide usage on the world's crops and optimize natural biological control, for which full investigation of the means by which spiders control pest abundance is long overdue. More than 600 arthropod pest species regularly destroy more than 10% of our agricultural production (Samways 1997). Total reliance on synthetic pesticides entails severe and costly health, environmental and even pest management side effects (Newsome 1970). Spiders, despite their ubiquity and high densities, have not received due recognition as pest control agents, although their treatment in several recent compendia is encouraging (Toft and Riedel 1995). Over the last 35 years, field experiments have demonstrated that spiders can reduce insect populations and crop damage (Ito *et al.* 1962).

Study of spider community and species diversity is a pre-requisite to assess the role of spiders as biological control agents in any ecosystem. Spiders are known to play an important role in suppressing populations of Green Leaf Hopper (GLH), Brown Plant Hopper (BPH), White-backed Plant Hopper (WPH), and also certain dipterans, lepidopterans, coleopterans and orthopterans on paddy (Barrion 1980). Very little information is available on the spider population of the rice ecosystem in Kuttanad, except from the work of Sebastian and Chacko (1994), and Sudhikumar and Sebastian (2001). This work was carried out to study the population fluctuations and to estimate diversity and richness of spider species in Kuttanad rice agro-ecosystem.

STUDY AREA

Kuttanad is rightly called the "rice bowl" of Kerala, contributing nearly 20% of the total rice production of the State. The region extends from 9° 17' N to 9° 40' N and 76° 19' E to 76° 33' E. It is separated from the Arabian Sea by a narrow strip of land. Kuttanad is a deltaic formation of four river systems, namely Meenachil, Pamba, Manimala, and Achencovil, together with the low-lying areas in and around Vembanad lake. Most of the vast expanse of this region lies below mean sea level, is water logged almost throughout the year, submerged during the monsoon, with saline water ingression during the summer. It consists of 53,639 hectares distributed among 1086 units where rice is cultivated. It is a warm, humid region with fairly uniform temperature throughout the year, ranging from 21 °C to 36 °C. Humidity is generally very high throughout the year. The average annual rainfall is *c.* 300 cm, of which about 83% is received during the monsoon. The study was undertaken during the kharif (additional crop) and rabi (puncha) seasons (November to March and June to September respectively) of 1999, 2000 and 2001. Spiders were collected from four sampling sites of Kuttanad: Site-1 (Krishnapuram) and Site-2 (Pallikoottuma) from upper Kuttanad and Site-3 (Nedumudy) and Site-4 (Vellisrakka) from lower Kuttanad.

MATERIAL AND METHODS

Survey of Spiders

Spiders were collected fortnightly from four sampling sites during June, 1999 to March, 2001. Collections were made by the standard sweeping and handpicking methods. The collected specimens were killed in chloroform and preserved temporarily in 70% alcohol. These were sorted out by placing them in a petri dish containing 70% alcohol under a Stereo Zoom microscope (Leica MS 5); adult males and females were identified up to species level with the help of available literature (Tikader and Malhotra 1980; Tikader and Bal 1981; Tikader and Biswas 1981). Immature spiders were identified up to generic levels.

Quantitative estimation of species and individuals of spiders in different stages of crop growth was made, using the data derived from field surveys. Species diversity (H) was computed based on Shannon-Wiener formula (Kamal *et al.* 1992). Evenness (J) and richness (ma) were computed according to Pielou (1975).

RESULTS AND DISCUSSION

The present work, based on a critical study of different spider families, revealed that different groups were active at different times of the season, showing their prey preference at different stages of crop growth.

A total of 2708 spiders under 8 families, 14 genera and 22 species were collected during the study period. Of these, 24.03% of the spiders belonged to Family Tetragnathidae, representing genera *Dyschiriognatha* and *Tetragnatha*. *Tetragnatha listeri* was the most abundant species from this family. Family Araneidae contributed 23.52% and was represented by the genus *Araneus, Neoscona*, and *Cyclosa*. *Neoscona pavida* was the most abundant species of this family. Family Theridiidae contributed 21.27% and was represented by the genera *Phycosoma* and *Theridion*. Family Lycosidae contributed 18.57% and was represented by the genera *Evippa*, *Hippasa* and *Pardosa*. Others belonged to families Linyphiidae, Oxyopidae and Sparassidae.

The entire study was conducted during four different crop seasons. These include two rabi seasons (June-September) and two kharif (November-March) seasons. The first was from June 1999 to September 1999. Seven families were reported during this collection. The majority belonged to Family Araneidae (26.40%); other major families reported were Tetragnathidae (21.80%), Theridiidae (20.91%), Lycosidae (17.98%) and Salticidae (9.69%). The second season was from November 1999 to February 2000. A total of 588 spiders were collected during this period. The family composition reported was: Theridiidae 22.95%, Araneidae 22.44%, Lycosidae 21.42%, Tetragnathidae 18.53% and Salticidae 10.03%. The third season was from June 2000 to September 2000. A total of 663 spiders were collected during this period. The family composition reported was: Tetragnathidae 30.92%, Lycosidae 19.91%, Araneidae 18.85%, Theridiidae 18.70% and Salticidae 9.35%. The fourth season was from December 2000 to March 2001. A total of 673 spiders were collected during this period. The family composition reported was: Araneidae 25.70%, Tetragnathidae 24.66%, Theridiidae 22.73%, Lycosidae 15.45% and Salticidae 10.10%.

Analysis of Evenness, Species Diversity and Richness

Evenness, diversity and richness of spider species in four sampling sites are given in Table 1. The diversity index was highest (0.979) at Site-2 and lowest (0.488) at Site-3. Diversity was calculated with the help of two factors, species richness and evenness. Considerable discussion is going on about the measurement of diversity, which is directly correlated with the stability of the ecosystems, being higher in biologically controlled systems, and lower in polluted ecosystems (Rosenberg 1976).

Table 1: Total number of individuals in all species (N), number of species (S), evenness index (J), diversity index (H) and species richness index (ma) of four sampling sites during the study period

Sampling Sites	N	S	J	H	ma
Site-1	490	19	1.042	0.858	6.69
Site-2	460	21	1.113	0.979	7.51
Site-3	508	11	0.861	0.488	3.69
Site-4	303	12	1.063	0.689	4.43

The evenness index of Site-2 was highest (1.113) and that of Site-3 lowest (0.861) (Table 1). As evenness and species diversity are directly proportional, they showed the same pattern of expression in the study (Pearson 1977).

In case of species richness, site-2 had the highest index value and site-3 the lowest value (Table 1). A total of 950 spiders of 21 species were collected from upper Kuttanad. The values of J (1.113), H (0.979) and ma (7.51) from upper Kuttanad were slightly higher than lower Kuttanad. According to Boecklen and Simberloff (1986), habitat heterogeneity, in addition to area, is an important determinant of species richness.

According to Usher (1986), diversity is the most frequently adopted criterion for evaluation of conservation schemes. Diversity indices are directly correlated with the stability of the ecosystem and will be high in biologically controlled systems. All diversity indices have limitations because they attempt to combine a number of variables that characterise community structure.

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REFERENCES

BARRION, A.T. (1980): Taxonomy and Bionomics of spiders in Philippine Rice Agroecosystem: Foundation for future biological control efforts. *Proc. of the Nat. Conf. Pest Control Council of Philippines 11*: 1-39.

BOECKLEN, W.J. & D. SIMBERLOFF (EDS.) (1986): Area based extinction models. Conservation in dynamics of extinction. John Wiley and Sons, New York. 280 pp.

ITO, Y., K. MIYASHITHA & K. SEKIGUCHI (1962): Studies on the predators of the rice crop insect pest using the insecticidal check method. *Jap. J. Ecol. 12*: 1-11.

KAMAL, N.Q., A. BEGUM & V. BISWAS (1992): Studies on the abundance of spiders in rice ecosystem. *J. Ins. Sci. 5*: 30-32.

NEWSOME, L.D. (1970): The end of an era and future prospects for insect control. *Proc. Tall Timbers Conf. 3*: 117-136.

PEARSON, D. (1977): A pantropical comparison of bird community: Structure of six low land rain forest sites. *Condor 79*: 232-244.

PIELOU, E.C. (EDS.) (1975): Ecological Diversity. John Wiley and Sons, New York. 165 pp.

ROSENBERG, R. (1976): Benthic faunal dynamics during succession following pollution abatement in a Swedish estuary. *Oikos. 27*: 414-427.

SAMWAYS, M.J. (1997): Classical biological control and biodiversity conservation: What risks are we prepared to accept? *Biodiversity Conserv. 6*: 1309-1316.

SEBASTIAN, P.A. & ELIZABETH CHACKO (1994): Studies on the predatory spiders of paddy fields from Kuttanad. *Proc. 6th Kerala Sc. Congress. 6*: 377-378.

SUDHIKUMAR, A.V. & P.A. SEBASTIAN (2001): Studies on the spider fauna in rice field of Kuttanad, Kerala. *Proc. Biocontrol Pest Management for Quality Crop Protection in the Current Millennium. 1*: 31-32.

TIKADER, B.K. & A. BAL (1981): Studies on some orb weaving spiders of the genera *Neoscona* and *Araneus* of the family Araneidae (Argiopidae) from India. *Rec. zool. Surv. India. 24*: 1-60.

TIKADER, B.K. & B. BISWAS (1981): Spider fauna of Calcutta and vicinity. *Rec. zool. Surv. India. 30*: 1-149.

TIKADER, B.K. & M.S. MALHOTRA (1980): Fauna of India: Araneae. Zoological Survey of India, Calcutta. 443 pp.

TOFT, S. & W. RIEDEL (EDS.) (1995): Arthropod natural enemies in arable land. I, Density, spatial heterogeneity and dispersal. Aarhus. Univ. Press, Denmark. 314 pp.

USHER, M.B. (1986): Wildlife conservation and evaluation: Attributes, criteria and values in wildlife conservation and evaluation. Chapman and Hall, London. 394 pp.

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