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THE SPIDER FAUNA IN AND AROUND THE BANGLADESH RICE RESEARCH INSTITUTE FARM AND THEIR ROLE AS PREDATOR OF RICE INSECT PESTS[1]

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ABSTRACT

A survey was conducted to study the abundance, diversity and foodweb of spiders in and around the Bangladesh Rice Research Institute farm. Twelve species belonging to 10 genera under 8 families were recorded. The common species in three rice environments were *Oxyopes javanus* and *Tetragnatha javana*. Irrigated rice fields have richer and more diverse spider fauna. About 6% egg parasitism was observed on three spider species. Predation capacity of three spider species was determined. A variety of insects comprised the food of spiders.

Key words: Spiders, predators, rice insect pests, *Tetragnatha javana, Oxyopes javanus, Lycosa pseudoannulata*

INTRODUCTION

The advent of modern rice technology including the introduction of high yielding varieties, irrigation system to foster continuous cropping, high nitrogenous fertilizer usage and the frequent use of insecticides, appear to have increased the abundance of many rice pests, viz., planthoppers and leafhoppers. Natural insect control exerted by natural enemies -- parasitoids, predators and pathogens has been disturbed in Bangladesh. Among predators, spiders are highly abundant in rice fields preying on a wide array of rice insect pests (Barrion1990).They can be conserved or augmented to regulate many phytophagous pests.

Spiders are obligate carnivores, making up a considerable portion of animal life in agroecosystems. They are the only class of arthropods that are entirely predatory in nature. Their importance in suppressing insect pest populations of agricultural importance has been recognized. (Okuma, 1968, Kiritani, 1972; Gavarra, 1974; Hsieh and Dyck, 1975; Chandra, 1978; Kenmore, 1979; Barrion, 1980; Kamal, 1981; 1983), Spiders have higher host finding ability and capacity to consume greater number of prey than other paddy field inhabiting predators (Sasaba, et al. 1970; Kamal 1981 & 1983). Despite this claimed importance, the role of spiders in the regulation of pest populations has only been lately recognized by researchers. In Bangladesh, their potential as biological control agents of rice insect pests is not well documented except for a few cases (Kamal, 1983; Odud, 1984). Likewise,

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limited systematic information is available to ecologists and biological control specialists except for the taxonomic work by Chowdhury and Nagori (1981). It is therefore, essential to determine the importance and evaluate the efficacy of spiders.

The study included: a) a survey of spiders at the Bangladesh Rice Research Institute farm: b) an estimation of spider abundance in terms of dominant species in rice agroecosystems; and c) determination of the food web of spiders.

MATERIALS AND METHODS

Survey of spiders at Bangladesh Rice Research Institute farm Joydebpur

The spider fauna was surveyed twice a week in irrigated rice fields, seedbeds and weedy fallow in the Boro, Aus and T. Aman seasons of 1983. Spiders were collected by hand and sweep net. In each sampling occasion, 100 successive double-stroke sweeps were taken from each situation. All collected specimens were transported back to the laboratory for sorting, counting, preservation and identification. Spiders and spiderlings were preserved in Oudeman's fluid (85 parts of 70% ethyl alcohol, 5 parts glycerine and 5 parts glacial acetic acid). Care was taken not to place too many specimens in a vial or bottle, and in placing large specimens. Preservative was changed after 2 or 3 days as it became diluted by the body fluids of specimens.

Spiders were identified using available literature and references.

Quantitative Estimates of Spider Abundance

Quantitative estimation of species and individuals in different environments was made using the data derived from surveys. Species diversity(H′) was computed based on the Shannon-Wiemer formula;

$$H' = - \quad pi \log 10^{pi}$$

where, pi = Ni/N; Ni = total number of individuals per species. N = total number of individuals.

Evenness (J′) was also calculated to estimate the equitability component of diversity using the formula (Margalef, 1958; Pielou, 1966);

$$J' = H'/\log 10^{S}$$

where, S = species richness.

Richness ($\sqrt{ma}$) was computed using the formula (Pielou, 1966);

$$\sqrt{ma} = \frac{S - 1}{\log^{10} N}$$

where, S = total species collected.

Food Web of Spiders

To study the food web of spiders the following experiments were conducted:

a) Egg parasitization. Eggs of *O. javanus*, (Thorell). *Plexippus* sp. (probably *paykulli* Audouin), *Clubiona japonicola* (Boesenberg and Strand), *Lycosa pseudoannulata* (Boes. and Str.) and *Argiope* sp. were collected twice a week from rice fields and associated weeds. These were reared separately in test tubes containing small amount of water and covered with cotton wad. Hatched spiderlings and emerged parasitoids were counted and identified. The egg masses were then dissected to count unhatched eggs and unemerged parasitoids.

Per cent parasitization was computed as follows:

$$\% \text{ parasitization} = \frac{\text{No. of parasitoids emerged} + \text{No. of unhatched parasitoids}}{\text{Total number of eggs}} \times 100$$

b) Predation capacity of spiders. To measure the predation capacity of three spider species, *L. pseudoannulata* (Boes. and Str.). *T. javana* (Thorell) and *O. javanus* Thorell, adults were collected from the rice field and brought to the greenhouse where each spider was caged separately with second and third instar nymphs and adults of the green leafhopper, (GLH) *Nephotettix virescens* (Distant) and the brown planthopper (BPH) *Nilaparvata lugens* (Stal) on BR3 rice plants. The prey preference of the spiders was noted. One female adult of *L. pseudoannulata, T. javana,* and *O. javanus* were caged separately with BPH and GLH adults and nymphs. Each day for 5 days, the predators and preys were counted. Dead individuals were replaced. The normal survival of BPH and GLH nymphs and adults provided with and without spiders and caged under the same conditions were compared. The experiments were replicated overtime and space. The cumulative percentage mortality over 5 days was calculated, and the mortalities in the treatments compared statistically.

c) Prey determination. This was done by visually observing spiders confined in the test tubes and small cages and given a variety of insects to feed on.

RESULTS AND DISCUSSION

Survey of spiders at BRRI farm

The survey yielded 12 species belonging to 10 genera under 8 families (Table 1).

The more prevalent species of spiders in each situation were as follows:

Seedbed: *O. javanus Thorell, T. javana* (Thorell), *Thomisus cherapunjeus* Tikader and *Plexippus* sp. (probably *paykulli* Audouin).

Irrigated rice field: *T. javana, O. javanus, Plexippus* sp. (probably *paykulli* Audouin) and *L. pseudoannulata.* (Boes & Str.).

Weedy fallow: *O. javanus, T. javana, T. cherapunjeus* Tikader, *Runcinia roonwali* Tikader, *Plexippus* sp. (probably *paykulli* Audouin) and *L. pseudoannulata.*

L. pseudoannulata, O. javanus, T. javana and *Plexippus* sp. probably *paykulli* were more abundant than the other species in all the three situations.

Table 1. Spiders and their observed preys collected from rice fields in BRRI farm, January - December, 1983.

Scientific name	Family	Prey[a]	Identified by
Argiope sp.	Araneidae	BPH, GLH, WBPH. WM	A.T. Barrion, IRRI.
T. javana	Tetragnathidae	BPH, GLH	"
Tetragnatha sp.	"		"
Oxyopes sp.	Oxyopidae	-	"
O. javanus Thorell	"	GLH, BPH, WRLH WM, RLF, Caseworm	"
C. japonicola Boes. & Str.	Clubionidae	BPH, GLH, WBPH, WM, ZLH, Caseworm.	"
T. cherapunjeus Tikader	Thomisidae	BPH, GLH, WBPH ZLH.	"
Misumenoides sp.	"	GLH, BPH	
R. roonwali Tikader	"	GLH,WBPH.	P.D. Hillyard,. CIE, London
Plexippus sp. *paykulli* (Audouin)	Probably Salticidae	BPH, WBPH, GLH, WRLH, ZLH, Notiphila.	
L. pseudoannulata (Boes. & Str.)	Lycosidae	BPH, GLH, WPBH, WRLH, SWRLH, caseworm, OHLH, RLF, ZLH, WM, Chironomids, SB.	A. T. Barrion, IRRI
C. formosena Oi	Linyphidae	Nymphs of BPH, WPBH and GLH	

[a]WBPH = *S. furcifera*, BPH = *N. lugens*,
GLH = *N. virescens*, WRLH = *Cofana spectra*,
ZLH = *Recilia dorsalis*, SWRLH = *C. yasumatsui*,
OHLH = *Thai oryzivora*, WM = Whorl maggot,
RLF = *Cnaphalocrocis medinalis*, SB = *Scirpophaga incertulas*

The abundance and diversity of spider species are probably related to the growth stage of rice. During the vegetative stage of the crop the jumping, hunting and other active species such as *L. pseudoannulata, O. javanus, Tetragnatha* sp. and *Plexippus* sp. were predominant in the field. The orb weavers and other sedentary species such as *Argiope* sp. were present during the reproductive stage of the crop. But *Callitrichia formosana* Oi was present during all stages of rice growth.

Quantitative estimates of spider abundance and diversity (Table 2.).

Spider abundance and diversity in rice fields, seedbeds and weedy fallow were estimated by using the Shanon Wiener formula. The species richness value (ma) of spiders in rice fields was 3.6 as compared to 3.0 in seedbed and weedy fallow.

Table 2. Comparison of spider diversity in rice fields, weedy fallow and seedbed at BRRI farm (Joydebpur), January - December, 1983.

Environment	N	S	H′	J′	$\sqrt{ma}$
Rice field	1124	12	0.975	0.973	3.605
Weedy fallow	2685	11	0.858	0.824	2.916
Seedbed	1944	11	0.824	0.791	3.040

The species diversity (H′) and species evenness (J′) of spiders in rice field are 1.0 and 0.9, respectively. The overall results indicated that the rice fields have richer and more diverse spider fauna among the situations observed (Table 1). But in terms of total number of individuals, the weedy fallow was the richest.

Food web of spiders

This study included egg parasitism and predation capacity of spiders.

a) Egg of 3 spider species, *C. japonicola, O. javanus* and *Plexippus* sp. probably *paykulli* were parasitized by four species of dipteran parasitoids (unidentified) and 3 species of *Idris* (Hymenoptera: Scelionidae).

Percent parasitization of the egg masses was high in weedy fallow adjacent to rice fields compared with rice fields (7.6% vs 4.6%). The overall average egg parasitization was only 6.4% (range, 0.13%) (Table 3).

b) Predation capacity of the spiders *L. pseudoannulata, T. javana* and *O. javanus* on brown planthopper and green leafhopper.

Compared with *Tetragnatha* and *Oxyopes*, *Lycosa* was the most efficient predator. The spiders killed 2- 3 preys per day (Table 4).

Between the two preys, green leafhopper was the preferred prey of all the

Table 3. Percent parasitization of egg masses of spider collected from rice fields and weedy fallow (April-November, 1983).

SPIDER SPECIES	No. of egg masses reared		Parasitization (%)	
	Rice field	Weedy fallow	Rice field	Weedy fallow
O. javanus	89	179	4.5	9.5
Plexippus sp probably *paykulli*	40	65	7.5	4.6
C. japonicola	22	38	4.5	13.1
L. pseudoannulata	7	19	0.0	0.0
Argiope sp.	15	27	0.0	0.0
Average	-	-	4.6	7.6

test spider species. But no preference was observed between the nymphs and adults of green leafhopper.

c) Prey determination. The spiders were observed to feed on a good number and variety of insects mostly belonging to orders Hemiptera, Lepidoptera and Diptera. These consisted of seven species of 'hoppers' under Cicadellidae and Delphacidae, adults of six species of Lepidoptera and two species of flies (Table 1).

Table 4. Predation capacity of spider predators collected from rice field attacking green leafhopper (GLH), *Nephotettix virescens* in cages, BRRI greenhouse, 1983. [a]

Predators	GLH prey stages	Predation capacity (No. of prey killed/ predator/day).
L. pseudoannulata	Nymph	2.7
	Adult	3.0
O. javanus	Nymph	2.4
	Adult	2.4
T. javana	Nymph	2.0
	Adult	1.9

[a] Data are averages of 5 trials each having 4 replications.

Table 5. Prey preference of predators collected from rice fields attacking green leafhopper (GLH) and brown planthopper (BPH) in cage BRRI greenhouse, 1983. [a]

Predator species	Prey mortality/predator/day	
	GLH	BPH
L. pseudoannulata	1.4	0.6
O. javanus	1.2	0.3
T. javana	1.1	0.3

[a] Data average of 5 trials, each having 4 replications.

CONCLUSION AND RECOMMENDATIONS

The rice fields in BRRI Farm are rich in spider species. As a group, spiders are highly resilient in rice ecosystems. They are long-lived and can readily seek out new fields after harvest. They are mobile and are predatory both in the immature and adult stages. But their behavior to feed only on moving insects perhaps saves

them from greater population depredations due to insecticides usage. Identification of selective insecticides should be carried out to overcome the situation. Habitat manipulation appears to be a fruitfull area of research to augment spider numbers. Harvest methods and management of straw are other possible investigations. More host preference studies are needed in order to determine their potential to suppress rice pests.

In the face of high price of insecticides and associated biological and ecological problems, the identification, determination of suppressive role of spiders and use of these effective biological control agents in our country will help in the formulation of effective pest management system.

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