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Research Article

DIVERSITY OF PREDATORY SPIDER AND THEIR SPECIES COMPOSITION IN RICE ECOSYSTEM IN KOLASIB DISTRICT OF MIZORAM

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ABSTRACT

Spider is one of the most abundant beneficial arthropods in rice ecosystem of Mizoram. Most of them are polyphagous predators in rice ecosystem, able to feed on various insect pests of rice ecosystem. In this context, ICAR Research Complex for NEH Region, Mizoram centre has taken an initiative to describe the diversity of spider communities in the rice growing area of Kolasib, Mizoram. About 8336 specimens were collected from different rice ecosystems of Mizoram and conserved for further characterization and evaluation. A total of 10 family, 20 genera and 31 species were collected from different rice productive areas of Kolasib, Mizoram. The most dominant species were *Lycosa pseudoannulata* (Boosenbery & Stard) followed by *Oxyopes Lineatipes* (C.L. Koch), *Oxyopes javanus* Thorell, *Tetragnathus maxillosa* Thorell, *Thomisus pugilis* and *Phidippus audax*. The collective contribution of these six species was 70.52%. Lycosidae was the most dominant family in the ground sample while Tetragnathidae was the most dominant in the foliage sample.

Introduction

Rice is the most important cereal food crop of India. It occupies about 23.3% of gross cropped area of the country. It plays vital role in the national food grain supply. Rice contributes 43% of the total food grain production and 46% of the total cereal production of the country. Rice is highest in worldwide production after maize. The staple food of the people of Mizoram is preliminary rice. Rice cultivation is concentrated in 5 districts of the state. In Mizoram average productivity (yield 1,000-1,500 kg/ha) and average production was 0.933 lakh tones of rice. The rice crop is prone to stress throughout the crop growth period due to onslaught from different pests such as insects, nematodes, diseases, weeds and rats. Among the biotic stresses insect pest s cause about 10-15% yield losses. Spiders have often been confused with insects, but in truth they belong to the class Arachnida, with major differences being that spiders have two body divisions and eight legs and insects have three body divisions and six legs. About 39000 species of spiders have been named so far (Platnick, 2005) representing what is believed to be only about one-fifth of the total spider species (Levi, 1981). Spiders are one of the more diverse arthropod taxa, ranking seventh in global diversity (Coddington, 1986), which makes them a fascinating group to study.

Biodiversity is not only an issue of curiosity but stands firm on the political agenda as a resource for humanity (Kamal *et al.*, 1992). Spiders are predaceous arthropods which largely feed on insects, their larvae and arthropod eggs (Barnes and Barnes, 1954; Riechert and Bishop, 1990; Mansour *et al.*, 1980; Bartos, 2005; Nyffeler *et al.*, 1987a). Being generalist predators spiders feed on a variety of small sized prey relative to their own size (Nyffeler and Benz, 1987). On account of these attributes spiders are rated as important biological agents for controlling insect pests in the rice and farmlands. Before attempting to assess the role of spiders in suppressing pest populations in a given agricultural situation, there must be available sufficient information on their taxonomic diversity and abundance habitat preferences in space and time, hunting strategy, body size of species, predators and prey items and the rate of their consumption, and reproduction. Information on these aspects is essential for the formulations of ecological concepts and conclusions (Hrowood *et al.*, 2001).

However, in North-East few studies have been conducted and most often limited to the identification and some basic ecological information about spider species. No information about the population dynamics and functional role of spider in agricultural fields of North-East is available. To fill this gap, the present study was planned. The main objective of this study was to characterize spider fauna occurring in the rice fields of North-East. Eight rice fields located in four different districts of North-East were compared to assess whether faunal differences occur between rice fields in terms of spider diversity, species composition and guild structure. Phenological patterns of the agrobiont species were also studied to determine their relationships with phenology of crop. This study will provide baseline data about the spider fauna of rice fields of North-East India. It will be helpful to establish and evaluate future management practices for rice fields in this area.

Materials and methods

Study areas

The study areas were located in the four districts in Mizoram: Kolasib (latitude $24^0$12’ 74” longitude $92^0$40’63” and altitude 622). Five sampling sites were selected in each study area. The sampling sites were selected at random in all the localities. The rice fields in these selected sites were similar in their physical structure. The rectangular shaped flooded fields were vegetated mainly by rice plants surrounded by bunds (grassy strips), which harbor weeds. Farming practices and natural phenomena such as monsoon rainfall frequently disturbed the rice fields.

Sampling

The study was carried out from May through November of 2014 in all rice fields. During sampling, information about environmental factors (temperature, humidity and rainfall) and agricultural practices (plowing, tilling, and spraying insecticides) were also noted daily. The following methods were used for sampling.

Ground collection

Ground-active spiders and other invertebrates were collected by pitfall traps. Wide mouthed glass jars (6 cm diameter x 12 cm deep) were used as pitfall traps. Floating pitfall traps were used during flooding in the fields (Sronu and Szinetar, 2002). During sampling, the jars were buried in the soil such that their rims were at level with the ground. At each site traps were set in 3 m x 3 m grid pattern at twelve localities (6 grids within 30 m of margin and 6 girds in the centre of the fields). Two hundred and fifty ml of 70 % alcohol and two drops of 5 % liquid detergent were added to each trap. A plastic rain cover (18 cm x 18 cm) supported by three nails (9 cm length) was placed over each trap to prevent inundation by rainwater. At each location, traps were operated consecutively for 72 hours (= trapping session) after every two weeks.

Foliage collection

Insect net was used to collect the spiders from the foliage of rice plants. Collection was done during early morning hours because it was observed that spider activity is maximal at that time of the day in the rice fields. 20 patches were identified according to visual observation and sweeping were done with the help of insect net. About 10-15 net sweepings were taken each time. The spiders collected from each site at each trapping date were brought to the laboratory, washed with alcohol, stored in a mixture of alcohol and glycerin with proper labeling of locality, date of collection, and other notes of importance. Spiders of all life stages were collected during sampling. The spiders were identified to the species level with the help of the keys and catalogues provided by Dyal (1935), Tikader and Malhotra (1980), Tikader (1987), Tikader and Biswas (1981), Proszynski and Zechowska (1981), Barrion and Litsinger (1995), Platnick (2007), Proszynski (2003) and other relevant literature. Immatures of some species could not be identified up to species level. Voucher specimens were deposited at the ICAR Research

Complex for NEH Region, Mizoram centre as well. Spider species were considered dominant, if they accounted for 1 % of the total abundance, while most dominant, if represented by more than 10% of the total catch (Schmidth and Tscharntke, 2005). The term agrobiont is used collectively for most dominant and dominant spiders. Spider species that represented less than 1 % of the total specimens, but still common in the fields, were called agrophile (Samu and Szinetar, 2002), whereas those species represented by 5 or fewer than five specimens were considered rare (Taher *et al.,* 2009)

Data analysis

For analysis, data from two years was pooled together. The diversity of the spiders in different localities was analyzed by using widely used indices: namely, Shannon- Wiener index, which is sensitive to changes in the abundance of rare species in the community and Simpson's index, which is sensitive to changes in the most abundant species in a community (Sebastian *et al.,* 2005). The Margalef index was used to calculate species richness. Species accumulation curve was prepared using RAREFRAC. BAS (Ludwig and Reynolds, 1988) to check the completeness of inventories. Evenness index was calculated using modified Hill's ratio (E5). It is the best and least ambiguous evenness index because it is the most easily interpreted and independent of the number of species in the sample. The Shannon-Wiener, Simpson, Margalef, and Evenness (E5) indices were computed using the statistical software, SPDIVERS. BAS of Ludwig and Reynolds (1988). Two-way ANOVA followed by Tukey's test was used to assess the differences in diversity, richness, evenness, and abundance of the spiders in different sampling areas in each trapping session.

To investigate the variation in community composition of different sites, abundance data for the agrobiont species of each sampling site was analyzed using Correspondences Analysis (CoA). For this analysis, agrophile and rare species were not included and the program SPSS (Version 13) was used. These sites were classified by a Cluster Analysis using group average strategy and chord distance. The Program used was Cluster. BAS (Ludwig and Reynolds, 1988). We also separated the data ink) ground and foliage spiders to assess the differences in distribution pattern of spiders residing on the ground and in the foliage of rice fields.

Identification of Spiders

The adult spiders were identified on species level and others on genus or family level using available literature (Tikader, 1987). Monthly data were prepared with detailed information on the occurrence of mature male, female and juvenile spiders. Voucher specimens were preserved in 75% alcohol and deposited in a reference collection housed with the ICAR Research Complex for NEH region, Mizoram centre, Kolasib, Mizoram.

Results

A total of 9 family, 21 genera and 31 species were collected from different rice productive area of Mizoram. Out of 31 species, most dominant species were *Lycosa pseudoannulata* (Boosenbery & Stard), *Oxyopes Lineatipes* (C.L. Koch), *Oxyopes javanus* Thorell, *Tetragnathus maxillosa* Thorell, *Thomisus pugilis* Stoliczka, 1869 and *Phidippus audax* C.L.Koch, 1846. The most dominant species of over data were *Lycosa pseudoannulata* (23.54%) followed by *Phidippus audax* (8.81%), *Oxyopes Lineatipes* (5.63%), *Tetragnathus maxillosa* (10.72%), *Thomisus pugilis* (3.66%) and *Oxyopes javanus* (7.09%). Collectively contribution of six species 68.18% out of 31 species of spider (Table1). However, differences in the abundances of these species were recorded in foliage and pitfall samples. Eight species *(Araeneus Nympha*, *Cyclosa confraga*, *Nesocona vigilans*, *Nesocona sp1*, *Atypena adelinae*, *Salticidae sp1*, *Salticidae sp2* and *Scytodes fusca)* were present in the foliage collection but not represented in the pitfall sample. However, six species *(Araeneus ellipticus*, *Araeneus. Insutus*, *Nesocona vigilans*, *Salticidae sp1*, *Salticidae sp*2 and *Scytodes fusca*) were present in the ground sample and were absent in the foliage sample of the total catch, 46% (3647) specimens were juveniles (immature), 29% (2524) adult males, and 25% (2127) adult females.

A total of 8336 spiders (63.59 % of the total sample) were collected from the ground using pitfall traps. Nine families, 21 genera, and 30 species were identified. Lycosidae was the only most dominant family and comprised 70 % of the total ground sample. It was represented by four genera and five species (*Lycosa pseudoannulata*, *Pardosa amkhasensis*, *Lycosa tista*, *Lycosa poonaensis* and *Hippasa sp*). All other families (Salticidae, Gnaphosidae, Oxyopidae, Thomisidae, Scytodidae, tetragnathidae, Linyphiidae and Araneidae) contributed only 30% to the ground sample. Numerically the most abundant species in ground samples were *Lycosa pseudoannulata* (38.72 %) and *Lycosa poonaensis* (24.12%), *Hippasa sp* (16.12%) and *Oxyopes javanus* (18.48 %). Only these two species

collectively contributed 95.80 % of the total number of ground catch.

A total of 4058 spiders (36.40% of the total sample) were collected from foliage. Nine families, 21 genera, and 31 species were identified. Among the families found, Tetragnathidae (43.7%) showed a clear-cut numerical superiority over the foliage spiders.

Table 1. Abundance of spiders collected from lowland rice fields (Eight sides) in Mizoram

Scientific name	Family	Abundance (%)	Total Abundance (%)
Araeneus ellipticus (Tikader and Bal, 1981)	Araneidae	0.16	0.93
Araeneus. insutus (Koch, 1871)		0.19	
Araeneus. nympha (Simon, 1889)		0.17	
Cyclosa confraga (Thorell, 1892)		0.24	
Nesocona vigilans (Blackwall, 1865)		0.10	
Nesocona sp1		0.08	
Atypena adelinae Barrion & Litsinger, 1995	Linyphiidae	0.51	0.80
Atypena sp.		0.29	
Gnaphosa sp.1	Gnaphosidae	0.61	0.99
Gnaphosa sp.2		0.38	
Tetragnatha javana	Tetragnathidae	0.42	16.68
Tetragnatha maxillosa Thorell		10.72	
Dyschiriognatha dentata Zhu & Wen, 1978		5.54	
Lycosa pseudoannulata Bosenberg & Strand, 1906	Lycosidae	23.54	52.98
Pardosa amkhasensis Tikader & Malhotra, 1976		6.72	
Lycosa tista Tikader, 1970		11.42	
Lycosa poonaensis Tikader & Malhotra, 1980		7.20	
Hippasa sp.		8.30	
Oxyopes javanus Thorell, 1887	Oxyopidae	7.09	12.72
Oxyopes lineatipes (C.L. Koch)		5.63	
Myrmarachne plataleoides (Cambridge, 1869)	Salticidae	0.83	13.87
Hasarius adansoni (Audouin, 1826)		2.19	
Rhene danieli Tikader, 1973		1.88	
Phidippus audax C.L.Koch, 1846		8.81	
Salticidae sp1		0.12	
Salticidae sp2		0.04	
Scytodes fusca Walckenaer, 1837	Scytodidae	0.06	0.06
Misumenops maygitgitus Barrion, 1995	Thomisidae	0.60	5.03
Oxytate virens (Thorell, 1891)		0.50	
Thomisus pugilis Stoliczka, 1869		3.66	
Ozyptila sp.		0.20	

It was represented by three species: *Tetragnatha javana*, *Tetragnatha maxillosa* and *Dyschiriognatha dentate*. The next most common families were Lycosidae (23.97%) and Salticidae (13.75 %). Family Lycosidae was represented by two species: *Lycosa pseudoannulata*, *Pardosa amkhasensis* and *Lycosa tista* while Salticidae was represented by six species: *Myrmarachne plataleoides, Hasarius adansoni*, *Rhene danieli*, *Phidippus audax*, *Salticidae sp1*and *Salticidae sp2*. All other families (Salticidae, Gnaphosidae, Thomisidae, Oxyopidae, Scytididae and Linyphiidae) collectively accounted for 22.98% of the total foliage sample. The most dominant foliage species were *Tetragnatha maxillosa* (42.58%), *Dyschiriognatha*

dentata (19.7%), and *Phidippus audax* (16.5%). The remaining species formed 15.22% of the total foliage sample.

The family composition of the spider fauna is given in Fig. l. Family Lycosidae and Tetragnathidae accounted for the largest population of the spiders' species, each representing approximately 53% and 16% of all the species respectively. Other families, which were well represented, included Oxyopidae (13%), Salticidae (10%), and Thomisidae (7%). The families Araneidae, Gnaphosidae, Linyphidae, and Scytodidae collectively contributed 5% of the total species composition.

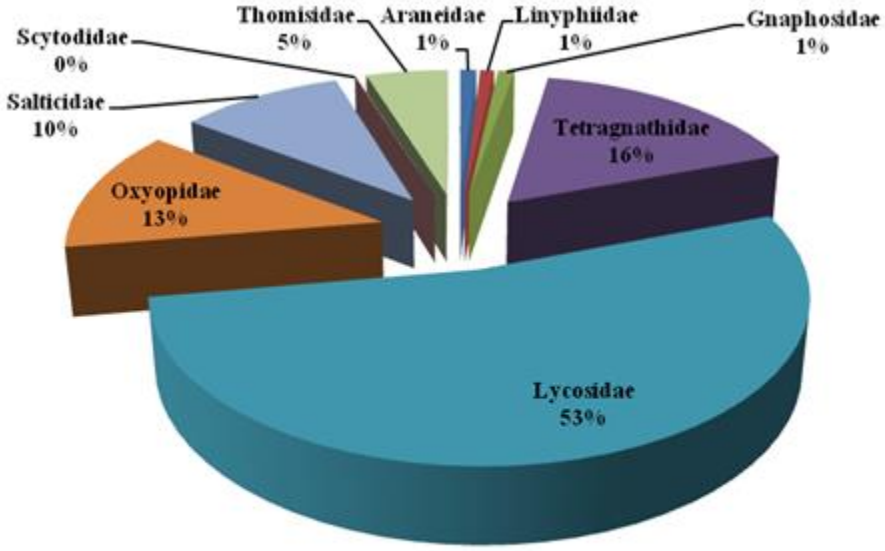

Fig. 1. Percentage composition of family in term of total number of species per family recorded from lowland rice ecosystem of Kolasib

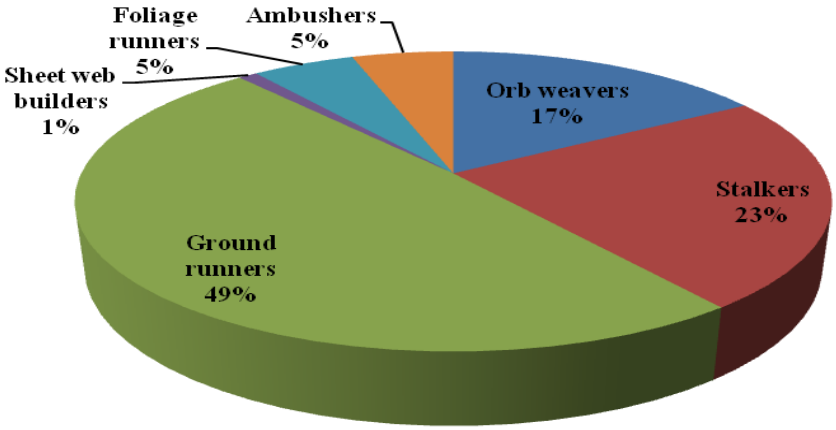

Fig. 2. Proportion of different guilds in rice ecosystem of Mizoram

Guilds in rice ecosystem of Kolasib, Mizoram

The collected spiders were divided into foraging guilds according to Uetz *et al*. (1999). These guilds were orb weavers (Araneidae and Tetragnathidae), stalkers (Oxyopidae and Salticidae), ground runners (Lycosidae and Gnaphosidae), sheet web builders (Linyphiidae), foliage runners (Clubionidae), and ambushers (Thomisidae). Ground runners (49%) founded the most dominant guild followed by the orb Stalker (23%) and orb weaver (17%). Ambushers foliage runners and sheet web builders were less common in the study areas while space web builders were not recorded from any

sampling site (Fig. 2).

Discussion

In this study, diversity was low in rice fields as compared to those studies conducted in outside north east. The crop phynology and irrigation method and patterns were similar at all collection sites. A fewer number of spider species in rice ecosystem than other crops such as wheat and maize (Rezac *et al.,* 2006) could be attributed to the practice of monoculture prevailing in the study areas and the flooded condition of the fields during most of the study (Sebastian *et al.,* 2005).

Lycosidae was the most dominant family in the ground sample while Tetragnathidae was the most dominant in the foliage sample. Similar results were reported in the studies of Settle *et al.* (1996) and Sebastian *et al.* (2005). The strong dominance of Lycosidae on the ground may partly be attributed to the extensive use of pitfalls as a sampling method. It has been found that pitfalls overestimate the relative abundance of this family, particularly in spring and summer (Lang, 2000). The dominance of tetragnathid spiders in the rice ecosystem might be expected as this wet habitat provides congenial conditions for this family (Sebastian *et al.,* 2005).

Family and species composition of the present study was different from the findings of Sebastian *et al.* (2005) and (Taher *et al.,* 2009). *Lycosa pseudoannulata* (Bosenberg and Strand, 1906) and *Pardosa amkhasensis* Tikader & Malhotra, 1976 were the most dominant lycosid species in the present data. Collectively these two species contributed 70.20% of the total ground sample. *Tetragnatha maxillosa Thorell* (Tetragnathidae) was the most dominant species recorded in foliage sample. This species found 48.58 % of the total foliage sample in the present study instead of 5.75 % in the study of (Sebastian *et al.,* 2005). The other two dominant foliage species. *Dyschiriognatha dentata* Zou *et al.,* 2005 (21.2%) and *Phidippus audax* C.L. Koch, 1846 (17.8%) were not reported by Taher *et al.* (2009) from the rice fields of Punjab. Pakistan and (Jeyaparvathi *et al.,* 2013) from the rice field of Tamilnadu, India. *Phidippus audax* C.L.Koch, 1846 first reporting in rice ecosystem of Mizoram. *Lycosa pseudoannulata* (Watanabe, I. & P.A. Roger, 1985) was the most dominant foliage species in their study.

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