M O N O G R A P H

Spiders: A Proficient Candidate in Practising IPM for Darjeeling Tea

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ABSTRACT

Effect of pesticides in the crop fields is now well known. Tea is no exception to this. Idea behind the present study is to appreciate the biological potential of spiders against tea pests. The study area included 6 tea estates viz. Badamtam T.E., Ging T.E., Salim Hill T.E. (organic), Castleton T.E., Namring T.E., and Thurbo T.E. (conventional). Altogether 85 species under 52 genera distributed over 18 families could be recorded. These can broadly be categorized into 7 trophic groups. The decreasing order of the groups are Orb weavers (48.24%) > Ambushers (22.35%) > Ground dwellers (11.76%) ≥ Stalkers (11.76%) > Foliage hunters (9.41%) > Sheet web weavers (2.35%) > Space web builders (1.18%). Out of the total species encountered 4 species are new from the country, 2 from the state and 36 species from the study area. Based on the species richness, the decreasing order of the tea estates are BTE (61.18%) > NTE (54.12%) > GTE (51.76%) > STE (42.35%) > CTE (28.24%) > TTE (25.88%). This leads to infer ‘organic tea system’ exhibits higher spider heterogeneity. Araneids and salticids are the dominant groups. Other than the Oriental representatives, Australian and Palaearctic are the next major groups. Nearly 32.94% of the species are found to be endemic.

Keywords: Spider fauna; diversity; tea system; Darjeeling; West Bengal; India
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1. INTRODUCTION

Spiders constitute an important component of the fauna distributed in tropical and subtropical areas of the world. Being nature’s master spinners of silken webs, they are the highly potential predators, certainly putting a check to the insect pests. Of late Entomologists/Plant Protection Specialists are laying emphasis on this tiny group as a proficient candidate of biological control. In depth knowledge on the biodiversity of spider communities of crop fields is important both in terms of enhancing pest control and understanding the driving forces influencing conservation strategies (Mansour et al., 1983; Maloney et al., 2003; Jayakumar and Sankari, 2010; Sharma, 2014)

Tea, unlike other perennials, is unique because only of its vegetative parts ‘two leaves and bud’ that are commercially exploited. Cultivation practice of tea has made the monoculture ecosystem distinctive, accommodating 1031 species of arthropods and 82 species of nematodes globally (Chen and Chen, 1989; Hazarika et al., 2009); it is 230 in Asia (Muraleedharan, 1992) while 173 arthropods and 16 nematodes are known to be pests in North-East India (Hazarika et al., 1994).

Their attack is supposed to cause yield loss to about 10-15%. India is the world’s 4th largest exporter of tea. Over the last few decades, India’s share in world tea export declined consistently for several reasons. One of the most important reasons is residual effect of pesticides in made tea. On the contrary, recent agricultural practices like organic farming towards reduced pesticide use and ecological sustainability have lead to increased interests in spiders as potential tools (Hazarika et al. 1994).

The spider fauna of several crop ecosystem have been well documented in some parts of the world (Sengupta et al., 2014). In India the araneofauna of tea ecosystem are well documented by Raychaudhuri and Saha (2012), Roy (2014) and Saha and Raychaudhuri (2015). Nestling in the foothills of snow-covered Himalayan range, Darjeeling, ‘the Queen of Hills’ grows one of the world’s most exclusive teas at altitudes ranging from 300 to 2000 meters. Currently there are 87 operational tea gardens in Darjeeling district (Coordinates: 27°3’ N 88°16’ E) covering an aggregated area of about 19,000 hectares. In recent times growing appreciation and demand for the organic products has driven some tea gardens of Darjeeling to produce ‘organic tea’. But unfortunately attempt to document diversity of the spider fauna of Darjeeling tea gardens is still wanting under the changed scenario.

Above prompted to study the spider species assemblage in tea ecosystem of Darjeeling, West Bengal.

2. STRATEGIES ADOPTED

In order to probe the state of the art, continuous monitoring on spiders was made through uninterrupted visit to the study sites during the period August, 2011 to March, 2013 in different sections of the referred tea estates. Sampling was done by visual search, hand picking, inverted umbrella, bush beating, foliage, trunk and branch scanning, pitfall and leaf litter extraction. Collected samples were preserved following Tikader (1987) and Barrion and Litsinger (1995).

The collected samples were studied under Stereo Zoom Binocular Microscopes model Zeiss SV-6 & 11 and Olympus SZX7. Status of the taxa were determined with the help of Tikader (1970, 1980, 1982 & 1987), Tikader and Malhotra (1980), Majumder and Tikader (1991), Barrion and Litsinger (1995), Sebastian and Peter (2009), Keswani et al. (2012), Metzner (2015) and WSN (2015). Later they were confirmed by comparing with the type specimens deposited in Zoological Survey of India.

Spider samples thus encountered are now in the deposition of Department of Agricultural Biotechnology, Ramakrishna Mission Vivekananda University.
3. KEY TO SYMBOLS

A. New Information

New to Science

New to India
New to West Bengal

New to Darjeeling
Endemic to India

B. Guild Structure

Orb weaver

Sheet web builders
Ground dwellers

Stalkers

Foliage hunters
Ambusher

Space web builder

C. Time of Activity

Diurnal
Nocturnal

D. Abbreviations of study sites

BTE – Badamtam Tea Estate
CTE – Castleton Tea Estate
GTE – Ging Tea Estate
NTE – Namring Tea Estate
STE – Salim Hill Tea Estate
TTE – Thurbo Tea Estate

E. World map showing zoogeographical regions

F. Time of occurrence
4. SPIDERS

A. Funnel web spiders: Agelenidae

*Agelena baruna* Tikader ♀

B. Typical orb weavers: Araneidae

*Arachnura angura* Tikader ♀
Araneus mitificus (Simon) ♂

Araneus nympha Simon ♂
Chorizopes bengalensis
Tikader ♀

Cyclosa bifida (Doleshall) ♀
Cyclosa mulmeinensis
(Thorell) ♂

Cyclosa neilensis Tikader ♀
**Cyclosa quinqueguttata**
(Thorell) ♀

**Cyclosa simoni** Tikader ♂
Cyclosa spirifera Simon ♀

Cyclosa kusaha Barrion & Litsinger ♂
Cyrtophora exanthematica
(Doleschall) ♀

Eriovixia excelsa (Simon) ♀
Gasteracantha unguifera
Simon ♀

Gea zaragosa Barrion & Litsinger ♀

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Neoscona mukerjei Tikader ♀

Neoscona nautica (L. Koch) ♀
**Neoscona theisi**
(Walckenaer) ♀

**Neoscona vigilans**
(Blackwall) ♀
Neoscona yptinica Barrion & Litsinger ♀

Parawixia dehaani (Doleschall) ♀
C. Sac spiders: Clubionidae

*Clubiona drassodes*

O. P. Cambridge ♀

*Clubiona rama* Dankittipakul

and Singtripop ♂
D. Wandering spiders: Ctenidae

*Ctenus sikkimensis* Gravely ♀

E. Dark sac spiders: Eutichuridae

*Cheiracanthium himalayense* Gravely ♀
F. Mouse spiders: Gnaphosidae
G. Two tailed spiders: Hersiliidae

Hersilia savignyi Lucas ♀

H. Sheet web spiders: Linyphiidae

Leptophantes rudrai
Tikader ♀
I. Wolf spiders: Lycosidae

_Hippasa agelenoides_
(Simon) ♂

_Hippasa greenalliae_
(Blackwall) ♀
Hippasa himalayensis
Gravely ♀

Lycosa phipsoni Tikader ♀
**Pardosa heteropthalma**
(Simon) ♀

**Pardosa songosa** Tikader & Malhota ♀
J. Long legged orb weavers: Nephilidae

*Herennia multipuncta* (Doleschall) ♀

*Nephila clavata* L. Koch ♀
K. Lynx spiders: Oxyopidae

*Oxyopes kamalae* Gajbe ♂
Oxyopes nalinae Gajbe ♀

Oxyopes shweta Tikader ♀
L. Nursery web spiders: Pisauridae

*Dendrolycosa robusta* (Thorell) ♀
M. Jumping spiders: Salticidae

*Dendryphax gitaee* (Tikader) ♀

*Carrhotus viduus* (C. L. Koch) ♂
*Epocilla aurantiaca*

(Simon) ♀

*Hyllus semicupreus*

(Simon) ♀
Menemerus brevibulbis
(Thorell) ♀

Myrmarachne bengalensis
Tikader ♀
Myrmarchne caliraya
Barrion & Litsinger ♂

Phintella vittata
(C.L. Koch) ♀
Plexippus paykullii
(Audouin) ♀

Plexippus pseudopaykullii
Sen, Dhali, Saha & Raychaudhuri ♀
*Portia fimbriata*
(Doleschall) ♀

*Rhene danieli* Tikader ♀
Rhene indica Tikader ♀

Rhene rubrigera
(Thorell) ♀
Thiania bhomoensis
Thorell ♀

N. Giant crab spiders: Sparassidae

Bhutaniella sikkimensis
(Gravely) ♀
Heteropoda andamanensis
Tikader ♀

Olios obesus (Pocock) ♀
O. Long jawed orb weavers: Tetragnathidae

Leucauge decorata
(Blackwall) ♀

Leucauge tessellata (Thorell) ♀
P. Cobweb spiders: Theridiidae

Chrysso urbasa (Tikader) ♀

Theridion indicum Tikader ♀
Q. Crab spiders: Thomisidae

*Camaricus formosus*
Thorell ♀

*Ozyptila khasi* Tikader ♀
R. Hackled web spiders: Uloboridae

Thomisus andamanensis
Tikader ♀

Miagrammopes nr. kirkeensis
Tikader ♀
SUMMARY

The present study unfolds the spider diversity of six tea estates of Darjeeling. A total of 2072 individuals belonging to 85 morphospecies under 52 genera and 18 families are recognized. Araneids and salticids are the dominant groups. Out of 85 species four are recorded first time from the country, two from the state and thirty six species from the district Darjeeling. Twenty seven species are reported as native to India exhibiting high endemicity (32.94%). Of these, most of the species are recorded from the family Araneidae (9). The generated data represents 5.04%, 11.87% and 30.0% of the Indian species, genera and family respectively. Even though species richness is little higher during premonsoon, always there remains a state of equilibrium throughout seasons. Six species viz. Araneus mitificus (Simon), Agriope pulchella Thorell, Neoscona bengalensis Tikader & Bal, Dendrolycosa gitae (Tikader), Thiana bhamoensis Thorell and Leucauge decorata (Blackwall) are the dominant members and encountered in most of the months of the year. Analysis of the zoogeographical distribution reveals that the fauna apart from Oriental, includes Australian (12.94%), Palaearctic (12.94%), Ethiopian (7.05%), Nearctic (2.35%) and Neotropical (1.18%) elements. Number of recorded spider taxa from the study areas shows that species diversity is maximum in Badamtam T.E. (possesses 52 morphospecies) and minimum in Thurbo T.E. (no. of species 22). Based on species diversity, the decreasing order of the tea estates are BTE (61.18%) > NTE (54.12%) > GTE (51.76%) > STE (42.35%) > CTE (28.24%) > TTE (25.88%). This leads to infer ‘organic tea system’ exhibits higher spider heterogeneity (exception in NTE). There may be two way explanation to such a fact. One may be that...
Namring T.E. being close to Teesta Valley experiences a tropical situation promoting heterogeneity or the in house species are tolerant to insecticides or both. Spiders such as wolf spider *Pardosa* are highly tolerant to botanicals such as neem-based chemicals (Theiling and Croft, 1988; Markandeya and Divakar, 1999). They are also generally more tolerant of organophosphates and carbamates than of pyrethroids, organochlorines and various acaricides. Tolerance may due to genetic resistance bred over a period of continuous exposure (Theiling and Croft, 1988; Wisniewska and Prokopy, 1997; Yardim and Edwards, 1998; Marc et al., 1999; Tanaka et al., 2000). For example, *Pardosa*, *Tetragnatha* are highly sensitive to the inorganic chemicals, but not to botanical pesticides (Tanaka et al., 2000). Species homogeneity is more common in conventional gardens. Both diversity and density of spiders are more in organic gardens as compared to conventional ones. At any point of time diversity and density of predators are more in organic gardens. Succession of species is more in organic gardens while conventional gardens are with dominant species in more numbers. All these gardens are dominated by the members of the family Araneidae. The dominant guild is constituted by the Orb weavers (48.24%) followed by Ambushers (22.35%), Ground dwellers (11.76%) and Stalkers (11.76%), Foliage hunters (9.41%), Sheet web weavers (2.35%) and Space web builders (1.18%). The common explanation for the observed pattern of spider guilds are structural diversity, microenvironment or the level of disturbance of the habitat (Jiang and Li, 2006). Guild composition can provide insight into the effect of habitat alteration and disturbances on arthropod diversity (Stork, 1987). So, the most promising option for utilizing the predatory attributes of spiders for the biological control of pests is to increase their density and diversity within crops as physically close to pests as possible (Sunderland and Samu, 2000).

6. LITERATURE CITED


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**Clubionidae**

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Uloboridae
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BIOGRAPHY

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SUMANA SAHA, Associate Professor, Post Graduate Department of Zoology, Darjeeling Govt. College is equally a well known personality in the field Zoology, precisely Entomology. Her contributions is well acknowledged in the ambit of both academics and research. A dedicated researcher of the contemporary period, Saha is the author of 129 articles including books/monographs and popular articles. She has received few honours in these 25 years of research career.

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