

STUDY ON THE MORPHOLOGY, FEEDING CAPACITY AND PREY PREFERENCE OF *Neoscona crucifera* AND *N. adianta* (Orb-Weaving Spiders)

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ABSTRACT

Laboratory studies were carried out to investigate morphology, prey preference and feeding capacity of *Neoscona crucifera* and *N. adianta* (orb weaver spiders) collected from rice crop fields, bushes and houses of Azamgarh district in Uttar Pradesh (India). It was observed that these make webs between paddy plants, twigs of bushes, corners of porticos of houses mostly at night, occasionally during day time and feed on small locusts, aphids, moths, mosquitoes, house flies and other soft bodied insects entangled in the web. Coleopterans were the least preferred prey for both of the orb weavers. A single individual of *N. crucifera* can prey on about 12.10 ± 1.52 insects/24h where as *N. adianta* has ability to prey on about 18.30 ± 3.02 insects/24h.

KEYWORDS: *Neoscona crucifera*, *N. adianta*, morphology, feeding capacity

Spiders are among the most diverse groups on earth, which received the seventh ranking in global diversity after the six highest insect orders. Among various arthropods, the spiders are known for their complete dependence on predation of small insects and arachnids. A number of entomologists have acknowledged the importance of spiders as one of the major predators in regulating the pest of different crops. Spiders have different size and colours, and can be located easily in different habitats. They may be found everywhere, on dry leaves, on forest floor, tall grasses, underground caves, under bark, stones, logs, near water source, mountainous areas and inside human habitations. All spiders possess spinnerets and produce silk, which is mainly composed of protein called fibroin. Spiders use the silk for various purposes. A web spider uses its silk to trap the prey. Poison glands are found in all spiders except members of two small families. Spiders use their venom to kill the prey and as means of defense. Generally it is believed that spiders are highly poisonous and harmful. Indeed all spiders have poison glands but few of them are dangerous to man (Gajbe, 2004).

Spiders are the abundant natural enemies in any agro-ecosystem and are found in most terrestrial habitats and often present in high numbers. All spiders are predaceous and insects constitute their main prey. They are generalist predators, can kill a large number of insects per unit time and hence of great importance in reducing and

even in preventing outbreaks of insect pests in agriculture. Spiders feed on a variety of prey. But even then, spiders mostly preferred soft bodied, immature stages with more internal body fluid, especially the homopterans. The presence of spiders in biotic environment of insect pests greatly influence their population dynamics (Sandidaque, 2005; Rajeshwaram et al., 2005; Bastawade and Khandal, 2006; Haunt et al., 2005; Singh and Sihag, 2007).

Up until 1970, most of the research on spiders concentrated on identification. From the early 1970s, researchers began to study the basic ecological and biological characteristics of spiders as biological control agents. Spiders in rice fields have been studied more than spiders on other crops. However, most of these studies were limited to the identification of spiders, and to investigating the dominant spider species, their regional distribution, seasonal fluctuations and the effect of insecticides. There were few studies on the spatial distribution of spiders, how this is related to their ecological role, and how many insect pests they consume in rice fields. Studies on Indian Spider fauna have been carried out by different workers (Biswas and Biswas, 2003, 2004; Patel, 2002; Gajbe, 2004; Majumder (2005 and 2007) in different regions of the country and documented 1,035 species belonging to 240 genera under 46 families from Indian Subcontinent.

From the review of literature, it is evident that role

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of spiders as bio-control agents in agriculture, poultry as well as in controlling house-hold insects is being studied in various parts of the world, but unfortunately, proper investigation, regarding role of these efficient bio-control agents in India is scanty. As of today, major part of spider diversity remains undiscovered and un-described. There is no documentation of spider faunal diversity or their habitat or general ecology in U.P. (India). Thus the present study has been undertaken to study morphology, feeding capacity and prey preference of a Orb-weaving spiders *Neoscona crucifera* and *Neoscona adianta* (Orb weaving spiders) collected from various agricultural areas of Azamgarh district of U.P. (India).

MATERIALS AND METHODS

Collection of Spiders

Individuals of *Neoscona crucifera* and *N. adianta* were collected from paddy crops fields, houses, orchards, ornamental and wild plants in some habitats of Azamgarh district of U.P. (India) by following methods:

1. Direct Hand Picking

Collection of most web building spiders was made by direct hand picking with the help of test tubes.

2. Inverted Umbrella

In this method an inverted umbrella was placed below flowering shoots and bushes and when the tree or branch was thoroughly shaken, spiders along with insects fallen to the inverted umbrella. After removing leaves, spiders were transferred into collecting tubes.

Preservation

Before the spiders were permanently preserved for morphological study, they were arranged properly. For this, collected specimens were transferred into petridish containing Isopropyl alcohol. It was kept covered undisturbed for about 2 or 3 hours in order to allow the relaxation of body muscles. The body parts like legs, abdomen, and palps were then arranged in a life like manner with the help of forceps and brush. Spiders were then kept in alcohol in a closed pair of petridish overnight before transferring to tubes for permanent preservation. The glass vial containing preserved specimens were stoppered by a rubber cork to prevent evaporation of alcohol. Alternatively,

glass vials were plugged by cotton and group of these tubes were then placed in large bottle containing alcohol. This was the method used for preserving most specimens. Each collecting tube enclosed a label indicating the collection data. Collection data includes the name of the collector, place of collection, date of collection and habitat of collection.

Photography

Live photographs of all spiders were taken with the help of Web Cam of 12 mega pixel connected to computer. For taking alive photographs, the spiders were anesthetized with mild doses of chloroform in specimen tubes. Generally, major diagnostic features such as dorsal view, ventral view, ocular area and side view were taken for the study. Attempts were also made to take natural photographs of spiders while they were feeding on insects.

Identification

It was done on the basis of morphometric characters of various body parts. The help was mainly taken from the keys and catalogues provided by Biswas and Biswas (2003, 2004); Nentwig et al., (2003) and Plantik (2004), information and photographs available on internet and other relevant literature.

Study of Prey Choice

To study the prey choice of the collected spiders, adults of Orthopterans, Homopterans, Coleopterans, Lepidopterans and Dipterans were supplied to spiders which were kept under rearing chambers. Each rearing chamber (9.5 cm height, 6.0 cm length and width) was consisted of transparent plastic containers. The lid of each container was provided with small holes for aeration. Since, spiders are highly cannibalistic, individual spiders were kept in separate chambers.

To study prey choice, spiders were kept starved for 24 h, then each spider was supplied with Orthopterans, Homopterans, Coleopterans, Lepidopterans and Dipterans (ten individuals of each kind of prey in each rearing chamber) separately. After 12h number of fed and live prey individuals were counted to find out preference of their prey. Attempts were also made to take live photographs while spiders were preying.

Corcyra cephalonica and house flies were reared in the laboratory according to the method of (Chaubey and

Bhatt, 1988) respectively. Mosquitoes, moths and small insect pests were collected from houses, paddy crop fields and surroundings.

Statistical Analyses

Each experiment was repeated six times and student's t-test was applied for comparison between two sample means.

Study Area

Spiders were collected from crop fields/ bushes and houses of various places in the Azamgarh district of U.P.

RESULTS AND DISCUSSION

Neoscona crucifera

Classification

Phylum: Arthropoda, Class: Arachnida, Order: Araneae, Family: Araneidae, Genus: *Neoscona*, Species: *crucifera*.

Habit and Habitat

Prepare smaller snares along with rolling of small to medium size leaves centric or eccentric place of the web and hide in rolling of leaves. Web may be of considerable height from the ground level. It becomes difficult to notice and to collect the spider from such type of nests from the field. Preyed on smaller insects entangled by the nest. Many times they are found with other species of *Neoscona*.

Diagnostic Characters

Cephalothorax brownish yellow, longer than wide, narrowing in front and at the base of the cephalothorax provided with V-shaped brown marks, thoracic region provided with longitudinal deep groove. Both rows of eyes re-curved, anterior median eyes slightly larger than the posterior median. Chelicerae moderately strong, legs long and strong. Abdomen nearly oval (Fig. 1 and 2). During morphological studies there were found three pits on each dorso-lateral side of abdomen (Fig. 1 and 2). Lateral lobes of epigyne not horn like.

Distribution

These spiders have a wide geographic range. *N. crucifera* is found from Lake Okeechobee in southern Florida north to New England, west to Minnesota, and southwest to Arizona and central Mexico. In the more northern states, males may mature as early as late June and females in July but in Florida, adults usually are not apparent until late August. India: West Bengal: Sunderban area (Hingalgunj, Sandeshkhali, Dist. North 24 Parganas) Darjeeling, Pakistan (Majumder, 2007).

Remark

This spider species resembles *Neoscona pavida* (Simon) described by Majumder (2007). It is being reported here for the time from Chandeshwar and Sidhari places in Azamgarh district of U.P. (India). Presence of three

Table1: Prey preference and feeding capacity (Prey consumed/ 24h) of *Neoscona crucifera* (Orb weaving spider)

| S.N. | Type/Number of prey consumed/24h | | | | | Total |
|-------------|----------------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|
| | Orthoptera | Homoptera | Coleoptera | Lepidoptera | Diptera | |
| 1 | 2 | 3 | 0 | 4 | 5 | 14 |
| 2 | 1 | 2 | 1 | 6 | 3 | 13 |
| 3 | 0 | 3 | 0 | 5 | 3 | 11 |
| 4 | 0 | 3 | 1 | 4 | 4 | 12 |
| 5 | 1 | 2 | 0 | 5 | 5 | 13 |
| 6 | 2 | 2 | 1 | 3 | 3 | 11 |
| 7 | 0 | 4 | 1 | 4 | 3 | 12 |
| 8 | 0 | 3 | 0 | 5 | 4 | 12 |
| 9 | 2 | 3 | 1 | 4 | 4 | 14 |
| 10 | 1 | 2 | 0 | 3 | 3 | 9 |
| Mean ± S.D. | 0.90±0.87 | 2.70±0.67 ^b | 0.50±0.53 ^a | 4.30±0.95 ^a | 3.70±0.82 ^c | 12.10±1.52 ^a |

Significance level ^a0.001, ^b0.01 and ^c0.1 when compared with adjacent means

Table2: Prey preference and feeding capacity (Prey consumed/24h) of *Neoscona adianta* (Orb weaving spider)

| S.N. | Type/Number of prey consumed/24h | | | | | Total |
|-------------|----------------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|
| | Orthoptera | Homoptera | Coleoptera | Lepidoptera | Diptera | |
| 1 | 1 | 5 | 1 | 7 | 5 | 19 |
| 2 | 0 | 5 | 1 | 6 | 6 | 18 |
| 3 | 3 | 7 | 0 | 8 | 7 | 25 |
| 4 | 0 | 4 | 1 | 5 | 7 | 17 |
| 5 | 1 | 5 | 0 | 6 | 5 | 17 |
| 6 | 2 | 5 | 1 | 4 | 4 | 16 |
| 7 | 2 | 6 | 1 | 6 | 6 | 21 |
| 8 | 0 | 3 | 0 | 6 | 5 | 14 |
| 9 | 2 | 5 | 1 | 7 | 4 | 19 |
| 10 | 1 | 6 | 0 | 5 | 5 | 17 |
| Mean ± S.D. | 1.20±1.03 | 5.10±1.10 ^a | 0.60±0.52 ^a | 6.00±1.15 ^a | 5.40±1.07 [*] | 18.30±3.02 ^a |

Significance level ^a0.001 and * not significant when compared with adjacent means

pits on each dorso-lateral side of abdomen is described here for the first time.

Economic importance

As is clear from table1 that it preys on Orthopterans, Homopterans, Coleopterans, Lepidopterans and Dipterans entangled in its web. On average a single spider can prey on about 12.10±1.52 insects/24h. Acts as a predator of insect pest in the garden and rice fields. Other researches have also shown that spiders in rice fields can play an important role as predators in reducing the densities of plant hoppers and leafhoppers.

Neoscona adianta

Classification:

Phylum: Arthropoda, Class: Arachnida, Order: Araneae Family: Aranidae, Genus: *Neoscona*, Species: *adianta*

Habit and Habitat

They are found to prepare web with the support of 2 to 3 adjacent thin twigs. They prepare smaller snares along with the rolling of the smaller to medium sized leaf at centric or eccentric place of the web. Web may be of considerable height above the ground. It becomes difficult to notice and to collect the spiders from such type of nets in the collection fields. Prey on smaller sized insects entangled in webs (Fig. 5).

Diagnostic Characters

Cephalothorax longer than wide, narrowing in front, provided with a pair of lateral and a median longitudinal dark brown bands. Thoracic region provided with a distinct longitudinal median groove. Ocular quad longer than wide, wider in front than behind. Both the rows of eyes slightly re-curved; anterior median eyes larger than the posterior medians. Chelicerae strong and stout with prominent boss. Legs long and strong. Abdomen sub-oval, longer than wide with a conspicuous mid-dorsal chalk white bar having four pairs of lateral patches (Fig. 3 and 4). Epigyne with prominent black rim with a constriction at the middle and a pair of lateral lobes.

Economic Importance

As is evident from table 2, it preys mostly upon orthopterans, homopterans, coleopterans, lepidopterans (Fig. 5) and dipterans entangled in its web. Coleopterans were the least preferred prey. On average a single spider can prey on 18.30±3.02 insects/24h. It is also clear from feeding tables (Table 1 and Table 2) that both of the spider species prefer soft bodied insects as their prey. Some workers also suggested that spiders are the most important biological control agents regulating insect populations in rice fields, including insect pests. During present study, it was seen feeding on adult moths (Plate 01), house flies,

Plate-1



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5

Neoscona crucifera: Fig. 1: Dorsal view of young individual, Fig. 2: Dorsal view of old individual.

Neoscona adianta: Fig. 3: Dorsal view of spider collected from paddy crop field,
Fig. 4: Dorsal view of older individual collected from house,
Fig.5: Feeding on an adult of rice moth, *Corcyra cephalonica*.

mosquitoes and other smaller insects, entangled in its web. Thus it can be used as a bio-control agent for controlling insect pests in paddy fields, gardens and other crop fields like those of *P. subpiraticus*, *P. clercki* and *G. dentatum*.

Remark

It is being reported here for the first time from bushes and paddy crop fields in Nai Bsti Katghar, Sidhari, Chandeshwar and other places of Azamgarh district U.P. (India). This spider species resembles the *Neoscona* theis (Walekenaer) which has been reported from West Bengal: Sunderban area (Dist. North and South 24 Parganas), Hugly, Nadia, Maldah, Bankura; Gujarat; Maharashtra; Orissa by Majumder (2007).

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