Diversity of Spiders (Araneae) in the Flood Plains of the Taj Trapezium Zone of Agra

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Abstract A survey of Yamuna flood plain was conducted to unravel spider diversity in the Taj Trapezium Zone of Agra. In spite of their vast numbers and the important role in bio-controlling applications in agriculture, the focus on the spider research has been limited. The current ongoing study focuses on the species richness and biodiversity in the vast open areas falling under agro-ecosystem and riparian habitat along the banks of the river Yamuna in Agra. A total of 44 species of Araneae belonging to 29 genera of 11 families including, Salticidae, Oxyopidae, Araneidae, Thomisidae, Tetragnathidae, Hersilidae, Lycosidae, Pholsidae, Gnaphosidae, Sparassidae and Corinnidae were recorded in abundance. The paper also discusses the role of these species in maintenance of the ecology of the Taj Mahal.

Keywords: Yamuna, flood plains, Araneae, spider species diversity

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1. Introduction

Biodiversity in any ecosystem indicates that the individuals have their inherent adaptability to evolve as per the adaptive requirement of the environmental conditions. Taj Trapezium Zone (TTZ) covers an area of 10,400 square km around the Taj Mahal and it appears like “trapezium” thus the name Taj Trapezium Zone. The TTZ comprises of 6 districts, Agra, Firozabad, Mathura, Hathras, Aligarh and Bharatpur in India [Figure 1]. The rationale of this defined area is to protect the heritage monuments like Taj Mahal, Agra fort, Fatehpur sikri and also the lesser known heritage monuments situated in this area from environmental pollution.

Figure 1. Taj Trapezium Zone
Spiders (Araneae) are natural bio-controller of agriculture pests and they can be found everywhere in the wild, near water bodies, tree trunk, on leaves, under leaf litters, dwelling on ground and because of their ubiquitous existence they serve as an interface between the sub soil detritus food chain and the above ground terrestrial food chain [8]. 48,462 species of spider have been reported from all over the world [14] of which 1686 species of spiders belonging to 438 genera of 61 families have been reported from India [12]. The earliest data on Spider species in the semi-arid habitat of Agra was reported by Anjali and Prakash [4,5,7]. The present study extends the earlier study by micro-focusing on specific habitat in the entire TTZ of Agra, in order to build a complete data base for spider conservation and management and also for its advanced applications in the pest management.

2. Ecology of Study Area

The Yamuna flood plains of Agra region falls under the semi-arid habitat (26°44' N and 77°25' S; 77°26' W and 78°32' E) in the south west part of state of Utter Pradesh. The Yamuna flood plains of Agra has semi-arid climate with temperature ranging from 2°- 48°C, relative humidity 25-95% and average rain fall is 650 mm per year. The soil of Yamuna flood plain is alluvial and sandy type which possesses gravels and completive soil.

3. Material Method

Three sites of the Yamuna flood plains of TTZ were explored for sampling. Collection methods varied for sampling namely pit fall, inverted umbrella, hand collection and visual searching depending on the specific ground conditions but majority of the collection was done by visual searching and hand collection methods. Identification was done by Platnick [14], Sebastian and peter [2], Tikader [3], Anjali and Prakash [4]. Figure 2 depicts the area of sampling site in the Yamuna flood plains. These are Site-1 Keetham, Site-2 Kailash Mandir river bank, Site-3 Ram Bagh garden. Diversity calculations involved the help of Shannon index, Simpson index and Marglef Richness index [1]. Each site was surveyed in all the three seasons in two years.
4. Results and Discussion

In current study a total of 3513 spiders of 44 species of 29 genera belonging to the 11 families have been reported from Yamuna flood plains, (Table 2) of which 697 individuals of 31 species and 25 genera belonging to 11 families were reported in monsoon season and 726 spiders of 42 species and 28 genera belonging to 11 families were observed in pre monsoon season from site 1 (Ketham). In the site 2 (Kailash mandir river bank) during post monsoon season 504 spiders of 37 species and 26 genera belonging to 11 families and during monsoon season 28 genera belonging to 10 families were recorded. Site-3 (Ram bagh) was surveyed during pre monsoon and post monsoon season. 574 spiders of 41 species belonging to 28 genera of 10 families and 546 spiders of 10 families including 35 species of 26 genera were observed respectively.

| Family           | Species name                               | Numbers of Spiders |
|------------------|--------------------------------------------|--------------------|
| **Araneidae**    | Neoscona thesi (Walckenaer, 1845)          | 103                |
|                  | Neoscona nautica (L Koch 1875)             | 68                 |
|                  | Neoscona sp-1 (Simon 1864)                 | 69                 |
|                  | Neoscona sp-2 (Simon 1864)                 | 17                 |
|                  | Cytrophora citricola (Forsskal, 1775)      | 148                |
|                  | Cyclosa sp-1 (Menge 1866)                  | 47                 |
|                  | Cyclosa sp-2 (Menge 1866)                  | 28                 |
|                  | *Araneus diadimantus* (Clerck, 1757)       | 78                 |
|                  | *Zygella indica* (Tikader)                 | 82                 |
|                  | *Argiope anasuja* (Thorell, 1887)          | 111                |
|                  | *Argiope pulchella* (Thorell, 1881)        | 171                |
| **Corinnidae**   | Castinaria zetes (Simon, 1897)             | 66                 |
| **Gnaphosidae**  | Happlodrassus sp (Chamberlin, 1922)         | 46                 |
|                  | Drassodus sp (Westring, 1851)              | 75                 |
| **Hersiliidae**  | Hersilia savagyi (Lucas, 1836)             | 42                 |
|                  | Hersilia sp (Audouin, 1826)                | 22                 |
| **Lycosidae**    | Pardosa pseudoannulata (Bosenberg and Strand, 1906) | 125               |
|                  | Pardosa birmanica (Simon, 1884)            | 121                |
|                  | Lycosa tista (Tikader, 1970)               | 164                |
|                  | Lycosa machinziei (Gravel, 1924)           | 134                |
|                  | Hippasa agelenoides (Simon, 1884)          | 6                  |
| **Oxyopidae**    | Oxyopes javanus (Thorell, 1887)            | 103                |
|                  | Oxyopes sp (Latreille, 1804)               | 69                 |
|                  | Oxyopes birmanicus (Thorell, 1887)         | 71                 |
|                  | Oxyopes sweta (Tikader, 1970)              | 73                 |
| **Pholcidae**    | Crassopriza lyoni (Blackwall, 1864)         | 230                |
|                  | Pholcus phalangiodes (Fuesslin, 1775)       | 34                 |
| **Salticidae**   | Plexipus paykuli (Audouin, 1826)           | 149                |
|                  | Plexipus petersi (Karsh, 1878)             | 35                 |
|                  | Hasarius andansonzi (Audouin, 1826)        | 83                 |
|                  | Menemerus semilimbatus (Hahn, 1829)        | 184                |
|                  | Menemerus bivittatus (Dufour, 1831)        | 61                 |
|                  | Mymarachne melanosep (Macheay, 1839)       | 11                 |
|                  | Epocilla sp (Thorell, 1887)                | 33                 |
|                  | Philipus pateli (Tikader, 1974)            | 63                 |
|                  | Thyne imparialis (Rossi, 1846)             | 37                 |
|                  | Hyllus semicurprinus (Simon, 1835)         | 58                 |
|                  | Salticus sp (Latreille, 1804)              | 212                |
| **Sparassidae**  | Hetropoda sp (Latreille, 1804)             | 36                 |
|                  | Olius sp (Walckenaer, 1837)                | 4                  |
| **Thomisidae**   | Thomisus sp (Walckenaer, 1837)             | 5                  |
|                  | Mymarachne melanosep (Macheay, 1839)       | 11                 |
| **Tetragnathidae**| *Leucase decorata* (Blackwall, 1864)      | 113                |
| **Total**        |                                            | 3513               |
The species richness indices of all three sites are 4.51, 5.77, 6.29, 4.38, 5.66 and 6.22 (Table 1). The Simpson indices are respectively 0.95, 0.96, 0.96, 0.94, 0.95 and 0.96 (Table 1) which are prominently exhibiting dominance of species and it is less susceptible to species richness, whereas Shannon index is the expression of heterogeneity which includes both richness and evenness component of diversity [1]. The values of Shannon index of above selected sites are respectively 3.21, 3.47, 3.46, 3.08, 3.33, 3.5 (Table 1). Indices values in the Yamuna flood plain area showing the rich diversity of spiders. The highest number of species of spiders found belonging to family Salticidae(18), Aranidae (15) and followed by Oxyopidae (8), Lycosidae (7), Pholsidae(3), Gnaphosidae (2), Hersilidae (2), Sparassidae (2), Thomisidae (2), Corinnidae (1), Tetragnathidae (1) [Figure 3]. The highest number of spiders found in the family Salticidae(n=995, 28%) and Aranidae (n=922, 26%) followed by Lycosidae (n=550, 16%), Pholsidae(n=264, 8%), Oxyopidae (n=316, 9%), Gnaphosidae (n=121, 3%), Tetragnathidae (n=113, 3%), Corinnidae (n=66, 2%), and least shown by Hersilidae (n=64, 2%), Thomisidae (n=62, 2%) and Sparassidae (n=40, 1%) [Figure 4].
In the Yamuna flood plains of Agra salticidae was the most predominant family followed by Araneidae, oxyopidae, and lycosidae. The humid condition, prey availability and presence of dense herbs and shrubs favours the development and survival of spider in flood plains area. Spider web help to spiders to capture prey as well as protect from predator and regulating body temperature of spiders [11]. Which favours the survival of spiders in extreme weather of Yamuna flood plains.

Presence of big trees like Neem, Eucalyptus, Ashok provide microhabitat for jumpers and hunters, Salticidae, oxyopidae, hersilidae and sparssidae [7]. It is observed that beneath the tree bark they protect themselves from their predator enemies as well from environmental stresses like temperature, rain and plant benefited by the elimination of insect pest. Different spider species develop different micro-habitat for survival and reduce competition, some are ground dwellers and some are web builders [7]. On the bases of microhabitat and the functional diversity of spiders, five guild structures were designed as per the model proposed by Anjali and Prakash [6]. During the survey, the jumpers and hunters (35%), the orb web weaver (30%), the Ground dwellers (22%), foliage runners (5%) and space web builders (8%) [Figure 5].

Plexippus paykuli was found on the ground, walls and on tree bark. Menemerus bivitatus spotted on tree bark of Neem, Mango and Eucalyptus. Menemerus semilimbatus reported from walls where mild sun light and humidity present. Phidippus, Thyne and Salticus species were found hidden behind the small shrubs and grasses in the morning between 8 am to 10 am and Neoscona species observed early in the morning and late evening hours. Neoscona species -2 were observed hidden on the leaves cover them self with silken retreat with the edges of leaf of Sheesham plant. Cytrophora species form dense colony of web in which 5 to 8 spiders were observed if the web was disturbed they moved to central portion of the dense web to keep themselves safe and made high speed vibration to the dense web to raise alert to other member of web and made confusion to predator. Their web is highly sticky and dense. Araneus diadimantus observed during late evening hours. Argiope species collected during morning hours and in the centre of the web with X - shaped stabilimentum. Oxyopidae are found on small shrubs and grasses and represents guild jumpers and hunters. Pholcidae were found in the corners of the walls. Gnaphosidae were collected in the morning found running to shelters and beneath some object seems like searching for dark, there posterior eye brilliant colour distinguish them for other spiders and support its nocturnal nature. Hersalia species collected from bark of Neem (Azadirecta indica) and Eucalyptus tree, Leucage decorata from shrubs and found in the centre of the web. Sparassidae collected during day time hidden beneath the bark of tree and beneath wooden debris. Thomisus species collected from the flowers. Zygilla species collected from shrub vegetation and grasses.

In the current study, highest number of spiders increased >1300 in pre-monsoon followed by Monsoon > 1163 and minimum found in post monsoon >1050. The fluctuation in the number of individuals of spiders responsible for inter specific and intra specific competition for food and microhabitat [13]. Complexity in vegetation pattern in habitat is also directly proportional to spider diversity [10]. It can be infer from the data the Yamuna flood plains of Agra and its climate favor the survival of different spider species and possesses enormously rich diversity of spiders. Higher vegetation and forest area provide space for microhabitat of spiders but Due to human intervention and the destruction of natural habitat, spider species needs conservation efforts.
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