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**Research Article**

# IMPACT OF URBANIZATION ON POPULATION DYNAMICS OF SPIDER SPECIES IN BANGALORE

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## ABSTRACT

Spiders are the largest order of Arachnids and rank seventh in total species diversity among all other orders of Arthropods. The present study was conducted to determine the impact of urbanization and climatic change on the spider population in the ever changing Bangalore's landscapes. Spiders were sampled from August 2013 to March 2014, approximately 25 random samples were collected, identified, and analysed with meteorological variables. Significant relationships were observed in the distribution of spider species between habitats with respect to urbanized and semi-urbanized landscapes. A significant decline in the number of spider species correlated with loss habitat due to increase in temperature. We conclude that urbanization and climatic changes affects not only the survival of particular spider species but also the habitat to which they are associated.

**Keywords:** Spiders, Climate change, Temperature, Biodiversity.

## INTRODUCTION

Biodiversity refers to the number of taxa (an animal or plant taxonomic group) in an area. It is also used as a measure of variety of taxa in a community, considering the relative abundance of each taxon. The order Araneae is an extremely diversified group distributed all over the world. Spiders can be found in all continents, with the exception of Antarctica. They have conquered almost all terrestrial environments and some aquatic too. Spiders are considered the seventh largest arthropod group, surpassed in number of species only by the order Acari and five orders of insects. The main differences between spiders and the other arachnids are the pedicel between the cephalothorax and the abdomen and the presence of spinnerets. The great success of these animals is probably due to their innovation in the use of silk, which results in a big capability of adaptation, culminating in a high diversity in this group.

Urbanization is now considered a major driving force of biodiversity loss and biological homogenization not only in developed countries, but increasingly in less developed countries (Savard *et al.*, 2000; Gupta, 2002; McKinney, 2002). However, urbanization appears to be having different effects on the biota of developed and developing countries (Lambin, 2001). In developed countries, urbanization is primarily fragmenting large areas, extending its influence over the entire landscape. In contrast, in developing countries, growth is still concentrated around urban cores, replacing adjacent land uses such as agricultural and more natural vegetation but at a slower rate than developed countries (McGranahan and Satterthwaite, 2003). Even though the effects of urban sprawl on biota have received considerable attention from the Scientific community, nearly all studies, and the derived conceptual frameworks, have focused on developed countries. The effects of urbanization on native and introduced biota in developing

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countries are poorly known and the scarce evidence that exists tends to focus on the effects with regard to specific taxa in particular situations (Estades, 2002; Fontes and Milano, 2002; Whitmore *et al.*, 2002).

The abiotic parameters are known to have direct impact on spider population dynamics through modulation of developmental rates, survival, fecundity and dispersal. Among the climatic factors, temperature is an important factor. Warmer conditions are likely to increase the importance of some existing spiders and also encourage other insect species, which may themselves become strange wide of insects (Cammell and Knight, 1992). The response of insect herbivores to elevated levels of atmospheric carbon dioxide will depend on their feeding strategy and how their host plant responds (Bezemer and Jones, 1998). Leaf chewing insects reared on plants grown in elevated carbon dioxide typically show an increase in foliage consumption (Williams *et al.*, 1994; Lindroth, 1996; Stiling *et al.*, 1999) reduced weight (Lindroth, 1996) and slower development rate (Johnson and Lincoln, 1991).

The present study was to investigate the effects of urbanization and climatic change on the spider population in the ever changing Bangalore's landscapes, random samples were collected, identified, and analysed with meteorological variables.

## MATERIALS AND METHODS

### Description of the area

Bangalore lies in the southeast of the South Indian State of Karnataka. It is at an average elevation of 920 m (3,020 ft). It is positioned at 12.97°N 77.56°E and covers an area of 1741 km² (673 mi²). The majority of the city of Bangalore lies in the Bangalore Urban district of Karnataka and the surrounding rural areas are a part of the Bangalore Rural district. Due to its elevation, Bangalore enjoys a pleasant and equable climate throughout the year. The highest temperature recorded was 38.9° C (102.0° F) on 22 May 1935 and the lowest was 7.8° C in 1884. Winter temperatures rarely drop below 11°C (52° F) and summer temperatures seldom exceed 36° C (97° F). A meteorological measurement of temperature for Bangalore shows a steady warming trend in both the minimum and maximum.

Four sites of the Bangalore were selected for sampling based on the following criteria: Accessibility, diversity of vegetation and soil characteristics, degree of exposure to human activities, and geographical position on the land. To draw inferences on the relationship between the diversity of communities and anthropogenic activities, the sampling covered virtually all types of habitat on the land (Figure 1). Human impact on collecting sites was categorized as low, intermediate, or high, based on the frequency of area usage, access and presence of buildings, economic activities, and number of tourists. The following are the four sites. (A) Semi Urban Region, (SUR) (B) Bangalore Rural, (BR) (C) Bangalore Urban (BU) and (D) Rajaji nagar Industrial Area (RIA). Spiders were sampled from August 2013 to March 2014, covering the rainy and winter seasons.


**Figure 1.** Distribution of collection points in Bangalore.

**Collection and identification of spiders**

The majority of spiders were found on trees, their foliage and flowers, under the caves of rocks, in the cervices of Building walls, grass and on the ground. A number of methods were applied for collection of spiders according a wide variety of habitats, such as hand collection, sweep netting, beating method and pitfall trap (Saini *et al.*, 2013).

**Ground hand collection:** One of the best methods to collect spiders was hand picking from ground to knee level for the spiders visible on (but not hiding in) the leaf litter and on the ground, low buttresses and the lowest plants. This method permits the specimens to be carefully picked by hand.

**Aerial hand collection:** This method was used to collect the spiders from knee level to as high as one can reach, accessing web building and/or free living spiders on the foliage and stem of living or dead shrubs, high herbs, tree trunks etc. Collection of several species was made by this method.

**Beating method:** The beating method was found suitable for spiders living in the shrubs, high herb plants, bushes and small trees and branches. In this method, spiders were collected by beating the plants with heavy stick while holding a collecting tray.

**Collection by sweep net:** This was observed as one of the simplest ways to collect spiders found in the habitat abundant with grass and flowers. Spider species were collected mainly using sweep net. A sweep net is made of a circular metallic ring and relatively large sized fabric sac. Sweep net was used by dragging the net back and forth across a small group of weeds and brush a number of times with a quick and steady motion.

**The pitfall trap:** Collection by a pitfall trap is an ideal method used for collecting the ground dwelling spiders. A pitfall trap consisted of a plastic jar dug and immersed up to the with soil surface, with a small plastic cup placed inside the large jar to remove the specimens conveniently without having to displace the entire tip. At the bottom, the jar contains a small quantity of preserving fluid such as ethylene glycol solution with a few drops of liquid soap to reduce the surface tension. A lid is placed 2-3 cm above the trap so that the crawling spiders can get by, but small vertebrates, rain water, dust etc. are kept out of the trap.

All the species collected by various collection methods were pooled for quantitative analysis and diversity was measured and were identified with help of expertise scientists and used for further analysis.

**Data analysis**

Species accumulation curves were plotted against sampling efforts for passive (pitfall traps) and active (beating sheet, active search) collecting methods, as well as for the data representing a combination of both methods. To verify the species richness of spiders among four sites, nested analyses of variance were performed using data from individual traps. Based on the literature, the most adapted forest specialist species for living on the forest floor of the undisturbed sites were regarded as habitat specialist species (Hurka, 1996; Schmalfuss, 2003; Buchar and Ruzicka, 2002).

**RESULTS AND DISCUSSIONS**

A total of 2351 individuals were collected from four different places (A) Semi Urban Regions, (SUR) recorded 524 spiders (B) Bangalore Rural, (BR) recorded 1355 spiders (C) Bangalore Urban (BU) recorded 197 spiders and (D) Rajaji Nagar Industrial Area (RIA) recorded 275 spiders. Highest spider density was recorded in September (Richness 162, Adult 312), and lowest in March (Richness 87, adults 23) (Table 1). Sex ratio varied from 1:1.2 (F: M) in September, to 1:1 in October, and to 1:0.2 in March (Table 1).

**Table 1.** Month wise collection of spiders in different locations.

| Month | Number of Spiders | | | Sex | Spider Density in Regions | | | |
|---|---|---|---|---|---|---|---|---|
| | Richness | Adult | Total | F:M | SUR | BR | BU | RIA |
| August 2013 | 162 | 312 | 474 | 1:0.5 | 136 | 214 | 70 | 54 |
| September 2013 | 191 | 292 | 483 | 1:1.2 | 98 | 312 | 25 | 48 |
| October 2013 | 180 | 112 | 292 | 1:1 | 44 | 196 | 33 | 19 |
| November 2013 | 224 | 186 | 410 | 1:0.8 | 98 | 223 | 15 | 74 |
| December 2013 | 146 | 96 | 242 | 1:0.4 | 41 | 150 | 19 | 32 |
| January 2014 | 111 | 27 | 138 | 1:0.8 | 29 | 86 | 7 | 16 |
| February 2014 | 140 | 62 | 202 | 1:0.6 | 52 | 106 | 23 | 21 |
| March 2014 | 87 | 23 | 110 | 1:0.2 | 26 | 68 | 5 | 11 |

The 2351 spiders were collected. They included 30 species belonging to 14 Families (Table 2). They were collected by ground hand collection method (Savard *et al.*, 2000) (*Cyrtophora moluccensis*, *Neoscona nautica*, *Hersilia savignyi*, *O. Shwetha*); Aerial hand collection method (Gupta, 2002) (*Argiope aemula, Nephila kuhlii, Perenethis venusta, Leucauge decorate, Scytodes fusca*), beating method method (McKinney, 2002) (*Myrmarachne orientales, Parawixia dehaanii, Gasteracantha dalyi, Tibellus elongates*) Sweep net method (Lambin, 2001), (*Thomisus lobosus, A. Anasuja, Oxyopes birmanicus, Rhene danieli, Heteropoda nilgirina*) and pitfall trap method method (Mc Granahan, and Satterthwaite, 2003) (*Stegodyphus sarasinorum, Lycosa tista, Scytodes fusca, Olios millet* and *Carrhotus viduus*).

**Table 2.** List of spiders collected from different locations during August 2013 to March 2014.

| Family | Species | Locations | | | |
|---|---|---|---|---|---|
| | | SUR | BR | BU | RIA |
| Araneidae | *Argiope aemula*(Walcknaer 1842) | + | - | - | + |
| | *A. anasuja* (Thorell 1887) | + | + | + | + |
| | *A. pulchella* (Thorell 1881) | + | + | + | + |
| | *Cyrtophora moluccensis* (Doleschall 1857) | - | - | + | - |
| | *Gasteracantha dalyi* (Pocock 1900) | + | + | - | - |
| | *G. Kuhli* (CL Koch 1837) | + | - | + | + |
| | *Neoscona nautica* (Koch 1875) | - | + | + | - |
| | *Parawixia dehaanii* (Doleschall 1859) | + | + | - | - |
| Eresidae | *Stegodyphus sarasinorum* (Karsch 1891) | + | + | + | + |
| Hersiliidae | *Hersilia savignyi* (Lucas 1836) | + | + | + | + |
| Lycosidae | *Hippasa agelnoides* (Simon 1884) | + | + | + | + |
| | *Lycosa tista* (Tikader 1970) | - | - | - | + |
| Nephilidae | *Nephila kuhlii* (Doleschall 1895) | + | + | + | + |
| Oxyopidae | *Oxyopes birmanicus* (Thorell 1887) | - | - | + | - |
| | *O. shwetha* (Tikader) | - | + | - | - |
| | *Peucetia viridana* (Stoliczka 1869) | - | + | + | - |
| Phyilodromidae | *Tibellus elongates* (Tikader 1960) | + | + | - | - |
| Pholcidae | *Crossopriza lyoni* (Blackwall 1867) | + | + | - | + |

| | | | | | |
|---|---|---|---|---|---|
| Pisauridae | *Perenethis venusta* (Koch 1878) | + | + | - | - |
| Salticidae | *Carrhotus viduus* (Koch 1846) | + | - | - | - |
| | *Epeus indicus* (Proszyn ski 1992) | - | + | - | - |
| | *Myrmarachne orientales* (Tikader 1973) | + | + | - | - |
| | *Rhene danieli* (Tikader 1973) | - | + | - | + |
| | *Telamonia dimidiate* (Simon 1899) | + | + | - | - |
| Scytodidae | *Scytodes fusca* (Walckenaer 1837) | - | + | - | + |
| Sparassidae | *Heteropoda nilgirina* (Pocock 1901) | - | + | - | - |
| | *Olios millete* (Pocock 1901) | - | + | + | - |
| Tetragnathidae | *Leucauge decorate* (Blackwall 1864) | + | + | + | + |
| | *L. tessellata* (Thorell 1887) | + | + | - | - |
| Thomisidae | *Thomisus lobosus* (Tikader 1965) | - | + | + | - |
| | *T. pugilis* (Stoliczka 1869) | + | + | - | - |

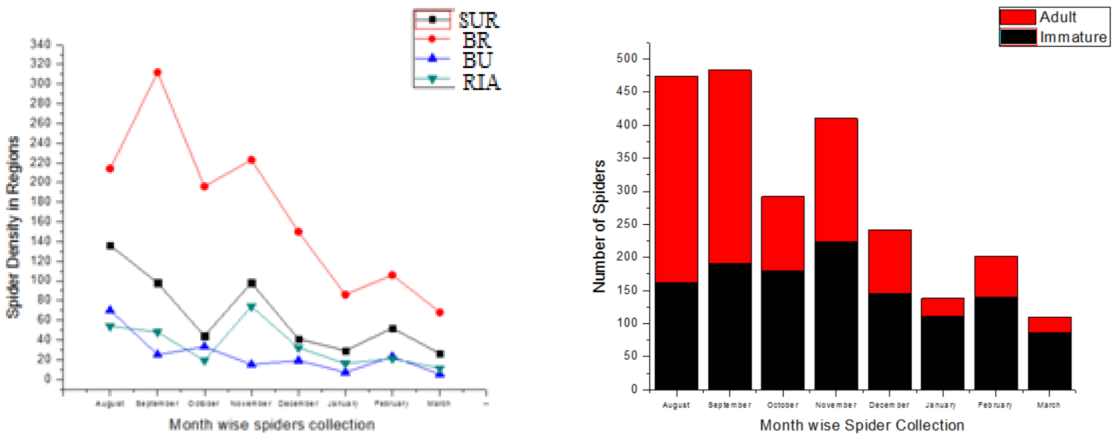


**Figure 2:** Graphical representation of spider density in different regions (Adult-Richness).

Collection of various spider species in different location is shown graphically in figure 2 recorded. The present survey shows that the species gradually reduces with the rise in temperature during the month of March, where the sex ratio also inclined with 1:0.2, female and male respectively. In the early periods SUR were found to support 136 species, which showed decline in late March to 68 species. Similarly BR which recorded highest with 312 in month of September also showed least 68 species in March. BU and RIA which recorded 70 and 54 species in month of August and were declined to 5 in month of March in BU and total 11 species were recorded in March at RIA.

## CONCLUSION

Urbanization and climatic changes affects not only the survival of particular spider species but also the habitat to which they are associated. Over all considerable decline of spider's species correlated with loss of habitat and increase in temperature and urbanization.

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