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Spatial mapping of spiders (Araneae) in the Gomarda Wildlife Sanctuary, Chhattisgarh, India

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ABSTRACT

The current study looks at spider diversity and composition in diverse habitats in the Gomarda wildlife sanctuary, which was created by the state government of Chhattisgarh in India in 1972. The GWS is 277.82 square kilometres in size. The spiders were sampled by using six different collection techniques as they utilize extensive variety of niches. Each habitat supported distinct/discrete spider assemblages that reflect major differences in structural complexity of vegetation. Collected Specimen were Identified, belonging to 16 families, 49 genera and 105 species, 15 spiders were identified till genera. Overall the most abundant families were Araneidae (18.41%) followed by Oxyopidae (14.45%), Lycosidae (14.63%) and Thomisidae (13.89%). The highest species richness was found in Forest (120 species), while the lowest species richness was in cropland sites (38 species). Simpson's index differ significantly among the three habitats types, however Margalef species richness and Shannons - Weiner index were significantly higher for Natural forest than other two habitats.

Keywords: Araneae, Diversity,Gomarda wildlife Sanctuary, India, Spatial Mapping

I. INTRODUCTION

Rapid declining of diversity and complexity of living organism, causing alarming threat to life supporting systems on earth [1]. Approximately 44% of the geographical area of state Chhattisgarh is covered with tropical forest has strong potential for carbon sequestration. However, increased anthropogenic activities, introduction of alien species have led to degradation of forests in last few decades. According to the report published by Forest Survey of India (FSI) on state forests of India, a net loss of 189 km^2 of forests occurred between year 2005 and 2011 in Chhattisgarh. During this period vast area (3.5 - 5%) of dense forests is converted into open and degraded forests.The pace of land use and land cover is very high in the dry tropical forest ecosystems of State Chhattisgarh,India. Sustainable land use techniques are critical for biodiversity conservation, carbon sequestration, increased production, and improved bio-geochemical cycles. Increased destruction of natural ecosystems emphasises the importance of analysing biodiversity patterns and their geographical and temporal fluctuations in order to support conservation and management choices. [2]

Spiders are often been mystified with insects but in reality they belong to the class Arachnida, order Araneae. Spiders are a group of megadiverse arthropods, including approximately 3935Genera and 44906 described species of spiders worldwide [3].catalogued 1685 species of spiders representing 438 genera under 60 families from India.Spiders inhabit extensive variety of both spatial and temporal niches [4]. They are eye catching and participate in trophic networks as predators although may consumed as prey by some species. They play crucial role in balancing the ecosystem by regulating the population of insects. Therefore spiders (Araneae) comprise an

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appropriate group for analyzing changes in diversity patterns with reference to alteration in habitats. As the diversity of spiders may alter in response to biotic and abiotic factors [5], it would be estimated that alteration of fundamental components in natural habitats would also influence the diversity of this group [6][7].

The present study was conducted to analyze the diversity of spiders in a dry and moist tropical forest ecosystem. The impact of natural and induced human surroundings on the quantity and composition of spiders in the Gomarda Wildlife Sanctuary in Chhattisgarh, India is investigated in this study.

II. MATERIAL AND METHODS

2.1 Study area

Chhattisgarh state extends between $17^o46'–24^o08'$N & $80^o15'–84^o24'$E in the central Indian landscape having a total area of 1,35,194km^2. More than 44% area of the state is covered by forests and a major part (35736.239km^2) is outside protected areas. Biogeographically, the state is in the Deccan Plateau and includes 6C-Eastern Highland, 6D-Chota Nagpur Plateau and 6E-Central Highland [8]. The state of Chhattisgarh is bordered on the north by the upper Gangetic Plains, on the south by the Godavari Valley, on the west by Madhya Pradesh, and on the east by Odisha and Jharkhand. The state boasts a richness of natural resources and biological diversity, but it is under threat from fast forest encroachment for agriculture and horticulture, as well as industrialization.

Present research was carried out in an area surrounding Gomarda wildlife sanctuary (GWS) established by government of State Chhattisgarh, India in 1972. The GWS covers an area of 277. 82 sq.km.,receives average rainfall of 1200-1350 mm. annually. The climate is dry, humid, tropical and consists three major seasons: rainy, winter, and summer. Annual temperature ranges between 29.5 - 49 °C during summer and 8 – 25 °C during winter. State is covered mostly by tropical dry deciduous forests.

Natural Forest: exhibit diversity of higher woody trees. Vegetation is dominated by *Shorea robusta,Terminalia tomentosa,Tektona grandis, Pterocarpus marsupium* and comprised most of the ground layer herbaceous plant.

Grassland: Most grassland is situated near forest peripheries, dominated by herbaceous vegetation. This habitat is severely disturbed than the natural forest; most of the patches were close to villages and on the periphery of protected areas therefore undergo grazing and other anthropogenic pressure.

Cropland: Agricultural plots of rice were selected as study sites, situated near forest.

2.2 Sampling design

The study was conducted monthly over three seasons for a period of one year starting fromApril 2013 to March 2014 using random sampling method.Spiders were sampled by six collection techniques i.e. Pitfall trapping, sweep netting, ground hand collection,aerial hand collection, vegetation beating,litter sampling[9].A total of 60 transects (20 m in length each) were sampled across three habitat types. Spiders were sampled along 20 m transect length of 20 transect per habitat. Pitfall traps were laid along a single transect line at interval of 5 m. Transects were selected randomly within the classified habitat types to ensure the independent sampling protocol and minimizing spatial autocorrelation. The survey was conducted from 07:00 to 10:00 hours during morning and 14:00 to 15:00 hours during evening. Collected specimens were then transferred to 70% alcohol for later identification. Specimenswere identified by using taxonomic keys, as provided in Indian spiders explained by Tikader [10][11], Sebastian and Peter [12] and published literatures. Voucher specimens are deposited in Zoological Survey of India, Kolkata, India.

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2.3 Statistical analysis

To evaluate value of alpha diversity for sampling plot of each habitat, the Margalef species richness was calculated, the two usually used diversity indices, the Simpson index, Shannon index and Evenness through PAST software[13].Simpson index is more sensitive to changes in the abundance of common species. Value of Simpson index denotes dominance. Chao1 provides an estimation of the completenumber of species in an assemblage based on the numeral of rare species (singletons and doubletons) in the sample. Chao1 estimate of species richness is suggested for inventory completeness values, completeness being the ratio between estimated and observed richness [14][15].Differences in species composition and diversity measures of different habitat types were tested by using one way Analysis of Variance (ANOVA) and post-hoc pairwise tests (Tukey's Honestly Significance Difference test).

The similarity across sites was depicted as Bray-Curtis similarities [16], using species composition. Non metric Multidimensional Scaling (nMDS)Plots wereconstructed based upon similarity values of species composition across vegetation types in SIMPER [17].Analysis of similarities (ANOSIM) was performed between each pair of habitat types to determine whether there is a significant difference between the spider assemblages in the three habitat types[18]. This approach provides a global R- statistic, which is a measure of group separation; these values were used to compare spider composition across habitat types. Using similarity percentages, researchers were able to determine the relevance of species in distinguishing between groups that differed greatly. The species with the greatest dissimilarity to standard deviation ratios were recognised as good discriminators for each comparison[19]. Cumulative and contribution percent were purged arbitrarily at 50%.

III. RESULTS

Almost 10% of the pitfall traps were lost, the majority of which were lost in grassland owing to animal disturbance. During the sample, a total of 7913 specimens were collected. 15 spiders were recognised until genera, with specimens belonging to 16 families, 49 genera, and 105 species. Overall the most abundant families were Araneidae (18.41%) followed by Oxyopidae (14.45%), Lycosidae (14.63%) and Thomisidae (13.89%). The highest species richness was found in Forest (120 species), while the lowest species richness was in cropland sites (38 species).

Traditionally used diversity indices; Shannon Weiner index, Simpson index, Margalef species richness and evenness were used in the present study to describe the diversity and community structure of spiders among different habitats [20]. The numerical values of diversity indices were given in Table 1 , Simpson's index differ significantly among the three habitats types, however Margalef species richness and Shannons - Weiner index were significantly higher for Natural forest than other two habitats (Table 1).

According to nMDSand ANOSIM, spider composition differed by habitat type (ANOSIM, p=0.0004), with spiders found in woods differing from those found in grassland (ANOSIM, p=0.0308) and agriculture (ANOSIM, p=0.0273). Comparing among sampling plots of different habitat types revealed that on average, species composition was much more similar within the same vegetation type than among different vegetation types (Figure 1). The most abundant families were Araneidae, Gnaphosidae and Thomisidae of all sampled specimens.

The families Araneidae, Thomisidae, and Gnaphosidae were found in abundance in the woodland site, but Oxyopidae and Lycosidae were found in abundance in the grassland and farmland sites. In the forest habitat, the

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Araneidae, Lycosidae, and Thomisidae families accounted for the most spider species, accounting for roughly of all species, but in the grassland habitat, a single family accounted for approximately of all spider species.

Spiders use a variety of tactics to catch their prey. Based on the strategy of capturing prey spiders can be categorized into six guilds [21]. These guilds are orb web weavers, sheet web weavers, stalkers, foliage runners, ambushers. Guild compositions of spiders in the three different habitats were compared with help of SIMPER (Table 2). It was presumed that behavior of hunting is harmonized according to a specific type of habitat. For example web weavers require appropriate substrate for attachment of webs and ambushers require an appropriate place for concealment (Figure 3).

Result of Bray Curtis cluster analysis (Figure 4) reveals that grassland and cropland had 70.34% similarity in species composition while forest forming a separate cluster group indicates different patterns of species composition.Present study endeavored to elucidate the relationship between hunting strategies and habitat type.

IV. DISCUSSION

The present studyis the first study on community of spider in this area. As there is no check list of spider species is available for GWS. In different habitat types, the community structure and diversity of spiders are not the same. Comparatively, natural forest exhibit highly diverse assemblages, possibly due to higher structural complexity. Relatively open secondary forest and cropland supported less diversity. The result reveals that habitat exhibiting high structural complexity, such as natural tropical dry forest chronicled the highest diversity. However, for an even sampling effortgreater species richness and number of individuals were trapped in higher vegetation complexity habitats, possibly reflecting availability of resources[22]. The heterogeneity of the vegetation arrangement in habitats may support extra potential niches for a functionally diverse fauna, and probablysupport a greater range of food webs than lesser complex habitats [23].

Natural forest have medium to higher trees but provide homogeneous niche for web dwellers to construct their webs, though more space are available for non-web dwellers at different stratification, resulting high abundance for dominant species. Grasslands are open areas where there are extreme risks of predation. Spatial heterogeneity, competition, predation, habitat type, environment stability, and productivity are several factors that affect the diversity of spider species [24].

All functional groups in the study area of Gomarda wildlife sanctuary follow the trend of an increase in species richness along with an increase in architectural complexity of vegetation. Several findings revealed the correlation between vegetation structure and abundance of spiders [25][26]. Kajak [27]observed that relative and prey densities were interrelated to the vegetation complexity of the habitat.

Result clearly proposes a low incidence of web weavers in the grassland followed by cropland, which could be probably due to exposure of habitats to anthropogenic pressure and grazing, leads to the suppression of vegetation. Some extensive research on the negative effect of grazing on ground dwelling spider communities [28].

Spiders may be influenced by vegetation structure through a number of biotic and abiotic variables, such as web structure, vegetation architecture, food availability, natural predators, heat, and humidity[29].

The structure of vegetation influence the diversity found in the habitats. There is clear evidence available that vegetation structure is one of the most essential factors that influence the diversity, distribution and abundance of the species of spiders in both natural and agricultural ecosystems [30][31][32]. High abundance for some

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dominant species was most probably related to their adaptation in favorable microclimate and adequate support of web for these spiders [33]. Furthermore, web dwellers tend to construct web at niche which provide more canopy cover to protect them from effect of adverse weather, predators but at the same time provide them with adequate sources of food[34]. Spiders tended to be more abundant and species rich in forest area than the other habitat types and composition strongly varied in different space habitats.One aim of this study was to explore the diversity of spider fauna, to conserve biodiversity. Spider diversity and richness are higher in undisturbed habitats with diverse flora.

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