Exploring Micro Arthropod Faunal Diversity in Selected Forest Areas of Telangana State, India

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ABSTRACT

This study aimed to explore the micro arthropod faunal diversity in selected forest areas of Telangana state, India. During the 2-year study period from January 2019 to December 2020, a total of 31,440 insects belonging to 11 orders were encountered from all five plots of the study site. The seven most abundant insect orders were Coleoptera, Hemiptera, Hymenoptera, Orthoptera, Diptera, Lepidoptera, and Isoptera, while the four least abundant orders were grouped under miscellaneous order for further studies. The relative abundance of the insects varied with the months and taxonomic identity, with Lepidoptera being the most abundant insect order in the sanctuary. These findings highlight the importance of understanding the diversity and distribution of insects in forest ecosystems and provide valuable information for the conservation and management of these ecosystems. These findings provide important insights into the diversity and distribution of micro arthropods in forest ecosystems and can be used to develop effective conservation and management strategies for these ecosystems.

Keywords: Telangana, Isoptera, Orthoptera, Coleoptera, Hemiptera, Hymenoptera..

1. INTRODUCTION

Forests are one of the most biologically diverse ecosystems on the planet, providing habitat for a wide range of flora and fauna. In recent years, there has been growing concern over the loss of forest habitat and its impact on biodiversity. Micro arthropods, which include insects, spiders, and mites, are an important component of forest ecosystems, playing key roles in nutrient cycling, pollination, and pest control (Gupta et al, 2020). Despite their ecological importance, micro arthropod faunal diversity in many forest areas remains poorly understood, particularly in regions with high levels of anthropogenic disturbance.

Telangana state in India is home to a diverse array of forest ecosystems, ranging from tropical deciduous forests to dry thorn forests (Kulkarni et al, 2020). These forests are under threat from a variety of anthropogenic activities, including deforestation, habitat fragmentation, and climate change. Despite the ecological importance of micro arthropods in these forest ecosystems, there is a paucity of information on their diversity and distribution in Telangana state (Mohnaraj et al, 2021; Saha et al, 2021).

Recent studies have highlighted the need for more comprehensive surveys of micro arthropod diversity in forest ecosystems, particularly in regions with high levels of anthropogenic disturbance. For example, a study by Gavali et al. (2020) found that anthropogenic disturbance had a significant impact on the diversity and abundance of soil micro arthropods in a tropical deciduous forest in Maharashtra, India. Similarly, a study by Sridhar et al. (2021) and Sring et al (2021) found that forest fragmentation had a significant impact on the diversity and distribution of ground-dwelling arthropods in the Western Ghats region of India.

Given the importance of micro arthropods in forest ecosystems, and the threat to these ecosystems from anthropogenic activities, there is an urgent need to better understand the diversity and distribution of micro arthropods in Telangana state. This study aims to fill this knowledge gap by conducting a comprehensive survey of micro arthropod faunal diversity in selected forest areas of Telangana state. The findings of this study will have important implications for the conservation and management of forest ecosystems in the region.

2. MATERIALS AND METHODS

2.1 Study Sites

Kawal Wildlife Sanctuary (Latitude: 23°35'N, Longitude: 88°23'E and Altitude: 5 m above sea level) was situated under the Police Station jannaram in Adilabad District which was a part of moribund delta zone of lower gangetic plain of telangana, India. According to the classification of Champion and Seth (1968) this Sanctuary was classified as tropical moist deciduous type of forest. The extent of this sanctuary was 0.6686 km2 or 66.87 hectare or 165.15 acre.

Figure-1 Satellite Imagery of Kawal Wildlife Sanctuary

Five different forested sites in the sanctuary were selected on the basis of vegetation type for constant monitoring of insect and microarthropod diversity and seasonality throughout the study period.

Site I: Inside Salim Ali Nature Trail (Vegetations were dominated by Teak)
Site II: Bank of Pond No. 3 (Vegetations were dominated by Ficus sp.)
Site III: A temporary wet land Inside the Brandis nature Trail (Vegetations were dominated by Bamboo)Site IV: Behind the Forest Rest House (Vegetations were dominated by Sissoo)
Site V: Forested area adjacent to north-eastern boundary of sanctuary (Vegetations were dominated by Teak).

2.2 Period and Places of Work

Above ground insect diversity was studied from January, 2019 to December, 2020 and the soil microarthropods were studied from January, 2020 to December, 2021.

Extraction, sorting, preservation, setting and pinning etc. of insects and soil microarthropods were done mainly in Acarology section of Zoological Survey of India and identification of different insect orders were carried out in different entomology sections viz., Coleoptera Section, Hemiptera section, Hymenoptera Section, Lepidoptera section, Orthoptera section, Diptera Section, and Isoptera section and Central Entomological Laboratory of Zoological Survey of India, Kolkata.The neighbouring nursery was where the dirt was obtained. To remove anything that wasn't dirt, the soil was first allowed to dry in the open air before being placed through a 2mm sieve. Earthen pots about 20 cm in diameter and 25 cm tall were used to cultivate the plants. Three kilogrammes of air dried dirt were placed into each pot.

2.3 Collection Method

Quadrat method (Brower et al., 1998; Krebs 1999) was used for sampling of insects. Five randomly selected plots, each covering an area of 2500 m' (50 x 50 m2) were selected in forest on the basis of habitat differences. Three quadrates were marked randomly in each plot, each having a size of 5 x 5 m2. Therefore a total of 15 quadrates in 5 plots were selected in the forest. Samples were taken from all of the three quadrates of each plot in every month from January, 2019 to December, 2020.

Sweep netting, hand picking, pitfall trapping and fluorescent light trapping method were used to assess the seasonal changes in relative insect abundance from all the 15 quadrates. Three Pitfall traps were placed in the middle of each quadrate of each of the Rve plots and left throughout the day from 5 a.m. to 5 p.m. A light trap was arranged in the middle of each plot and left switched on for 10 hours, from 6 p.m. to 4 a.m. The four methods together, however, gave overall assessment of the seasonal changes in relative insect abundance as well as in diversity. According to Lowman (1982) the number of insects captured simply represents an index of temporal distribution; does not indicate the actual numbers within the entire community.

Therefore, one sampling units comprised of 10 samples collected by 1 light trap, 3 pitfall trap, 3 hand picking method and 3 samples collected by sweep net operation and consequently altogether 50 samples were collected from the five plots at each sampling operation. 24 sampling operations were carried out, one at each month from January, 2019 to December, 2020 and a total of 1200 samples were collected during the 2 years study period.

Various studies showed various mode of insect collection methods throughout the world, for instance, sweep net was employed in sampling insects in tropical forests (Janzen and Schoener, 1968; Janzen, 1975) and malaise trapping for lower Montane forests (Buskirk and Buskirk, 1971) of Costa Rica. Barberena-Arias and Aide (2002) used 4 different sampling methods like, litter sampling, malaise trap, interception trap, and pitfall trap baited with human feces for the collection of insects from a mature forest and 2 abandonedpastures of Puerto Rico. Kai and Corlett (2002) collected the insects from a secondary forest of Hong-Kong South China by applying 3 methods like hand picking, beating and malaise trapping. Deans et al. (2005) collected the insects from a Canadian boreal peatland forest by malaise trap method. In India Joshi et al. (2008) studied the insect fauna of Pindari forest of Western Himalaya and samples were collected by sweep net method. Recently, da Silva et al. (2019) collected the insect in the Cerrado of Brazil by fluorescent light trap method.

2.3.1 Sweep Netting

Sweep net sampling was carried out with a sweep net of 30 cm diameter, 90 cm depth and 1.5 mm mesh. Each sweep represented a horizontal swing with an arc between 135 to 180 degrees and encompassing an area from 0.5 to 2 m above the ground levels. Each sample consisted of 100 sweeps. After a series of three sweeps the contents of the net were emptied into a one liter killing jar which contains liquid benzene soaked cotton in it.

2.3.2 Hand Picking

Small, delicate insects like Diptera, Hemiptera, bark inhabiting Coleoptera, Hymenoptera, Isoptera etc. were collected either with the help of a fine camel hair brush moistened with alcohol (70%) or by forceps.

2.3.3 Pitfall Trapping

Pitfall trap was a circular container with 5cm diameter and 7 cm height buried in the soil with its rim at the surface level. These traps were baited with rotten fruits which attract insects like Hymenoptera, Diptera and Coleoptera.

2.4 Identification

2.4.1. Identification of Insect

Due to inadequacy of taxonomical information the identification of tropical forest insects was not so easy and thus many species left unidentified till now. Though there are 30 orders of insects (Girmaldi and Engel, 2005), the representatives of all the orders were not found from this sanctuary. Only 11 dominant insect orders were identified from this sanctuary. Insects were identified by following the standard identification keys.

2.4.2 Identification of Soil microarthropod

Most of the oribatid mites were opaque and darkly pigmented. These were macerated in 1:1

lactic acid and 95% alcohol. The tubes containing the solution were kept open allowing gradual evaporation of alcohol leaving only lactic acid to act upon the specimen later on. The process continued from 5 days to about 2 months depending on the size and pigmentation of specimens. Then all the sorted and processed specimens were preserved in 70% alcohol in tightly capped tubes and tubes again were kept in jars containing 70% alcohol to avoid drying of the specimens. Temporary slides of oribatid mites were prepared with lactic acid for identification. Regulated heating of the slide (depending upon the darkness and size of the specimen) on a hot plate in 40°C to 60°C worked well in removing the air bubbles and making specimens more transparent. Camera Lucida drawings of the specimens were made when necessary. Specimens after identification were again transferred to tubes with 70% alcohols which were then kept in jars with similar solution for long time preservation.

Mesostigmata and Prostigamata were temporarily mounted in lactic acid and after identification replaced in to 70% alcohol and labeled properly. Collembola were mounted permanently in Canada Balsam and after proper labeling permanent slides were preserved in slide box and identified under a phase contrast microscope at 400X magnification.

2.5 Data Recording and Analysis

For the protection of biodiversity there is a need of a system for recording the identity of each species and their habitat. The Zoological Survey of India have massive collections of biological specimens from all over the world. Insects and microarthropods were deposited in respective Sections of Zoological Survey of India, Kolkata. The analysis of data chiefly involves the estimation of density and relative abundance of oribatid species and the population as a whole, and the diversity indices of the oribatid community.

2.6. Analysis of Diversity

Diversity has remained a central theme of ecology and its measures provide tools for monitoring ecological conditions. This consists of two components, variety of species and their respective relative abundance. There is no unanimity regareding the use of a specific diversity index satisfying all aspect. A number of approaches are therefore necessary reach any conclusion (Magurran, 1988).

All the Diversity Analyses were carried out using Biodiversity Professional Software version Beta (McAleece, 1997) and Microsoft Office Excel version 2007.

Following indices were worked out to investigate the diversity features of above-ground insects and below-ground soil microarrthropod communities in kawal Wildlife Sanctuary, telangana, India-

2.7 Shannon index of diversity (Shannon and Wiener, 1963)

This is one of the most widely used ’information theory’ indices which was based on the concept that the diversity or ’information’ in nature could be estimated in the form of a code or message (Magurran, 1988).

3. RESULTS AND DISCUSSION

3.1 Assessment of the diversity of above-ground insect

3.1.1.Relative Abundance of insect population

A total of 31,440 insects from 11 orders were encountered in 24 samplings during the study period of 2 years, from January, 2019 to December, 2020, from all the 5 plots of the study site. It was quite impossible to study all insect orders during the present investigation, our study was concentrated only on eleven orders. The seven most abundant insect orders were Coleoptera, Hemiptera, Hymenoptera, Orthoptera, Diptera, Lepidoptera, Isoptera and rest four least abundant orders were Thysanoptera, Odonata, Blattaria and Mantodea which were grouped under miscellaneous order for further studies. In all instances the insects were associated with the above-ground vegetation and litter of the forest area.

Number of insect species under each insect order varied considerably with highest representatives of Coleoptera and least representatives of Blattaria and Mantodea. The relative abundance of the insects were varied with the months and taxonomic identity.

In the comparison on the basis of relative abundance at order level, Lepidoptera occupied 24.53% of the insect community and deserved the status of most abundant insect order of this sanctuary. Lepidoptera was followed by Coleoptera (19.47%), Hemiptera (17.060/0), Diptera (12.05%), Hymenoptera (10.85%), Isoptera (7.52%), miscellaneous group (5.13%).and Orthoptera (3.39%) (Figure 2).

3.1.2 Quantitative monthly and seasonal variation in insect population

The population abundance of Coleoptera, Orthoptera and Lepidoptera were maximum in August and minimum in December, April and May respectively. The population maxima of Hemiptera and Isoptera were observed during July. Hymenoptera population was reached at its peak during October and it was minimum during February. The population of Diptera was maximum during November (Figure 3).

Analysis of variance (ANOVA) and Tukey Test on the abundance of different insect orders:

Abundance Data of different insect orders of 24 months were taken together for one way ANOVA test and this test indicated the statistically significant variation among the abundance of different insect orders in the study area ($P<0.05$) (Table 3).

In order to comply with homogeneity of variances, the abundance of insect orders were subjected to Levene's test which revealed significant Leven statistics= 16.805, df= 7, 184, $P<0.05$. Thus the data was transformed as ln (x+1) and the same test was performed. Although Levene's statistics did not show any significant deviation (Levene statistic= 11.541, df= 7, 184, $P<0.05$), the ln (x+1) transformed data were used for analysis (ANOVA). The Welch's test for equality of means yield a value of 19.237, df= 7, 78.386, $P<0.001$, justifying suitability of ANOVA using ln (x+1) transformation and that the means among the insect orders were significantly different. The post hoc Tukey Test for multiple comparison revealed that the relative abundance of the orders Coleoptera, Hemiptera, Lepidoptera, Hymenoptera and Diptera did not differ significantly, while rest of the orders, like Isoptera, Orthoptera and miscellaneous group differed significantly with the above mentioned orders (Table 1).

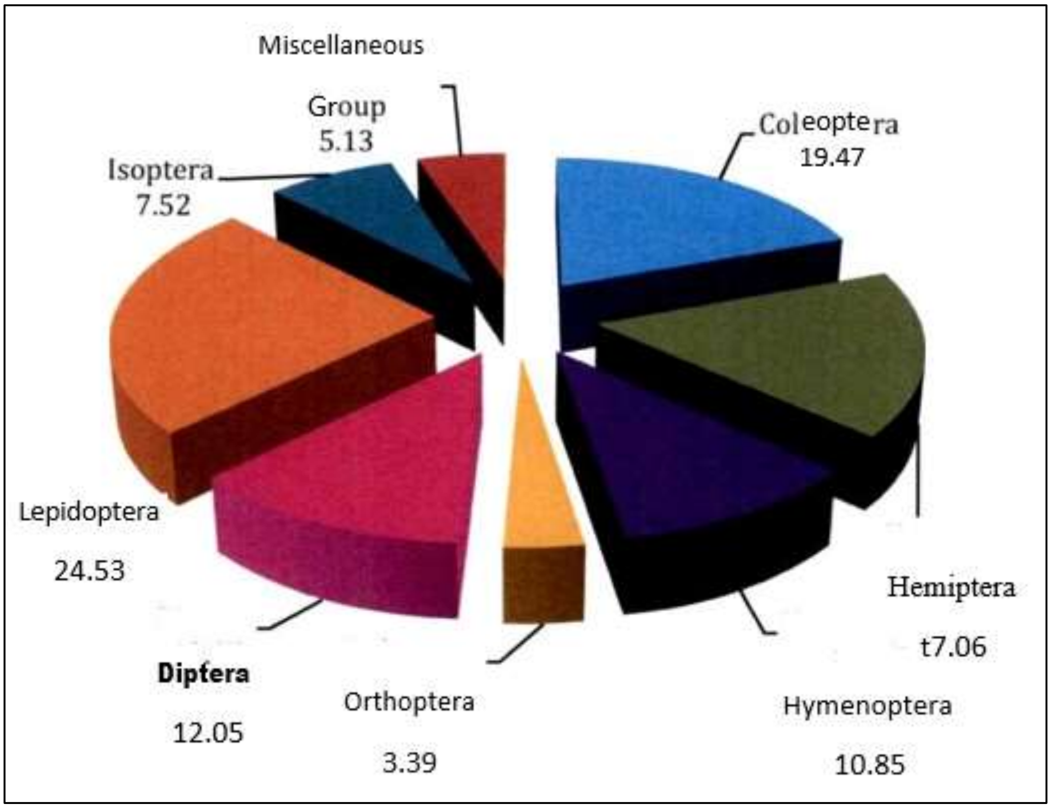

Figure 2: Relative Abundance (%) of different insect orders.

3.2 ANOVA on monthly abundance of insect population and Tukey Test

Insect abundance data of 24 months were taken together for one way ANOVA test and this test indicated statistically significant difference in insect abundance among the months (P<0.05) (Table 1). Tukey Test also expo.sed th\at mean abundance of" insects in ‹different months were statistically significant.

In order to comply with homogeneity of' vai'iances, the monthly data on insect abundance was subjected to Levene's test which revealed significant Levene's statistics =7.459, df =11, 180, P < 0.05. Th us the data was ti ansformed as ln (x+ 1) and the same test was performed. Levene's statistics showed significant deviation (Levene statistic= 1.402, df =11,180, P>0.05), the ln (x+1) transformed data were tised for analysis (AN OVA). The Welch's test for equality of liieans yield a value of 5.794, df= 11, 70.781, P<0.00 1, jii.stifying suitability of ANOVA using 1 n (x+1) transrormation such that the means among the months were significantly different.

The present study provides a comprehensive assessment of the insect diversity in a forested area of India. The results indicate that a total of 31,440 insects belonging to 11 orders were encountered during the 2-year study period. Among the insects encountered, seven orders were found to be the most abundant, with Coleoptera being the most diverse order, followed by Hemiptera, Hymenoptera, Orthoptera, Diptera, Lepidoptera, and Isoptera. The remaining four least abundant orders, Thysanoptera, Odonata, Blattaria, and Mantodea, were grouped under the miscellaneous order for further studies.

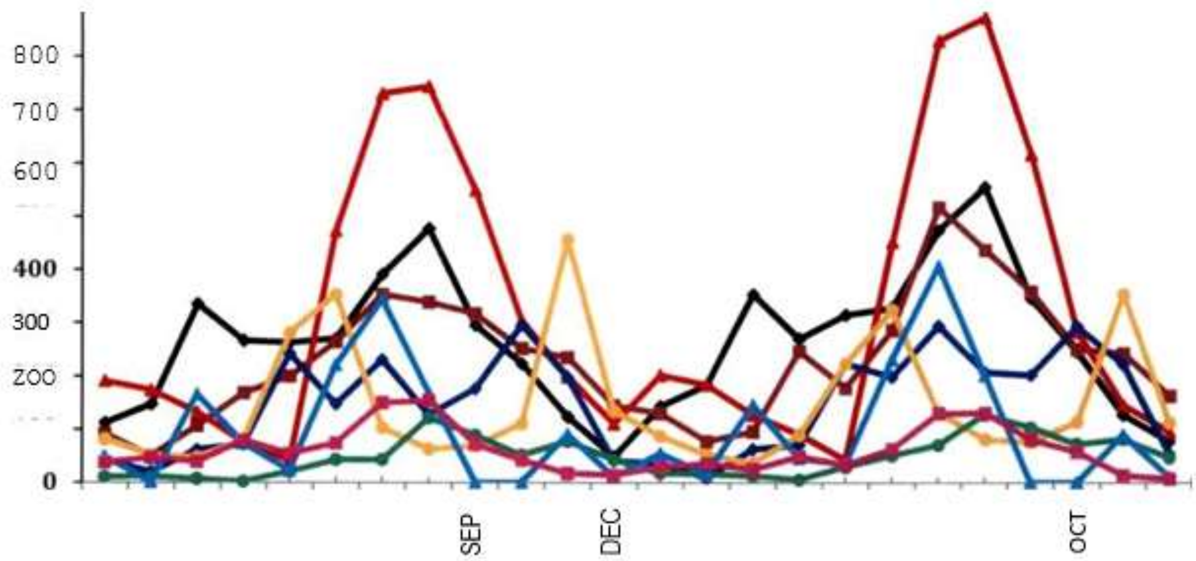

Figure 3: Variations in relative abundance of different insect orders during the study period, 2019 and 2020.

The present investigation revealed that the relative abundance of the insect orders varied with the months and taxonomic identity. The Lepidoptera was found to occupy the highest proportion of the insect community (24.53%), followed by Coleoptera (19.47%), Hemiptera (17.06%), Diptera (12.05%), Hymenoptera (10.85%), Isoptera (7.52%), and the miscellaneous group (5.13%). Orthoptera was the least abundant order, accounting for only 3.39% of the insect community.

These findings are consistent with previous studies that have reported high diversity and abundance of Lepidoptera in forest ecosystems. For example, a study by Jagdish et al. (2021) found that Lepidoptera was the most diverse insect order in a tropical forest in India. Similarly, a study by Singh et al. (2020) reported high diversity and abundance of Lepidoptera in a protected forest area in the Western Ghats region of India.

The present study highlights the importance of understanding the diversity and distribution of insect communities in forest ecosystems. The findings of this study provide valuable information for the conservation and management of forest ecosystems in the region. Further research is needed to understand the ecological roles of different insect orders and their interactions with other components of forest ecosystems.

Certainly! The study's finding of high diversity and abundance of insects in the forested area

Is significant, as insects play vital roles in maintaining the ecosystem's functioning. The insects encountered in the study are associated with the above-ground vegetation and litter of the forest area, indicating their important contributions to nutrient cycling and ecological processes.

Table 1. Results of One way AN0VA using nsect orders as variables.

Source of variations	Sum of Squares	df	Mean Square	F
Between Insect Orders	119.693	7	17 099	15.539*
Error	202.470	184	1.100	
Total	322.164	191		

** indicate significant at P<0.05 level*

The study's results also provide insights into the taxonomic composition of the insect community, which can aid in the identification of key insect groups that are important for ecosystem functioning and conservation. For example, the high abundance of Lepidoptera in the study area suggests that this group may play a crucial role in pollination and herbivory in the forest ecosystem.

Moreover, the study's focus on the relative abundance of insect orders across different months provides valuable information on the seasonal dynamics of insect communities, which can have important implications for the management and conservation of forest ecosystems. The results of this study can be used as a baseline for future studies on insect diversity and abundance in the region, allowing for the tracking of changes in insect communities over time.

Overall, the study's findings underscore the importance of understanding the diversity and distribution of insects in forest ecosystems and highlight the need for continued research on insect communities in the region. The information gained from such studies can aid in the development of effective conservation and management strategies to preserve the ecological integrity of these vital ecosystems.

4. CONCLUSION

In conclusion, this study provides a comprehensive assessment of the insect diversity in a forested area of India, highlighting the high abundance and diversity of insects in the Telangana State, India. The study's findings underscore the importance of understanding the taxonomic composition and seasonal dynamics of insect communities in forest ecosystems, which can aid in the identification of key insect groups important for ecosystem functioning and conservation. The results of this study can serve as a baseline for future studies on insect diversity and abundance in the region, allowing for the tracking of changes in insect communities over time and facilitating the development of effective conservation and management strategies to preserve the ecological integrity of these vital ecosystems.

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