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# Diversity Assessment of Major Insect Orders in Parvati Aranga Bird Sanctuary District Gonda, Uttar Pradesh, India

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**ABSTRACT**

**An assessment study was conducted on the abundance and diversity of insect species in Parvati Aranga Bird Sanctuary District Gonda, Uttar Pradesh. The present study was aimed to determine the species richness, dominance and evenness of insect fauna from study area. The assessment was carried out during the month of November 2020 to April 2021. A total number of 296 insects from 156 species, 31 families and 5 Order were recorded. This assessment shows that Coleoptera (33.97%) was most dominant order and followed by Lepidoptera (25.64%), Orthoptera (14.74%), Diptera (14.74%) and Hymenoptera (10.26%) according to total number of species. A number of statistical indices were used to determine the Dominance, Richness, Evenness and Diversity. The study supposed to the first report of insect diversity in study is and becomes useful information on those aspects to be documented for future references.**

***Keywords-*** Diversity Assessment, Insect Diversity, Parvati Aranga Bird Sanctuary.

## I. INTRODUCTION

Insect are the most abundant and diverse animal group on Earth which belong to largest class of Insecta in under the largest animal phylum Arthropoda. They characterized by three pair of legs, two pair of wings and body is divided into head, thorax and abdomen. Insects are further categorized into two sub classes, Apterygota (Primitively wingless insects) and Pterygota (Insects with wing) (Miller et al. 2000). They are performing several direct and indirect crucial roles to performing life process in ecosystem like pollination, agricultural pest and important bioindicators of environmental changes. Economically they provide different materials such as lac, silk, honey, wax etc. that have worldwide high value (Debdas et al. 2013, Khadijah et al. 2013). Taxonomically insects are divided into 29 orders in which Coleoptera, Diptera, Hymenoptera and Lepidoptera covers almost 81% insect species of total account of living insects (Foottit and Adler 2009). Insecta is the most populous animal class on earth with estimates of over 90% of life on earth falling it (Reuther 2012). The insects are considerably estimated to comprise more than 75% of the known speciesof the animals. In an ancient estimation from book "Indian Insect Life" reported 25700 species in India (Djamila et al. 2019) whereas, Nandani and Murali (2014) estimated insects from India have 619 families of 59353 species. Insects are not only diversified on terrestrial habitat but also inhabit diverse freshwater ecosystem about 45000 species of insects worldwide (Balram 2005, Rajnish & Nirupam 2012). About 751000 insect species known which are about three fourth of all recorded animals species on planet (Majumdar 2013, Bindulekha & Amalnath 2017, Roopam & Nita 2016, Ramar et al. 2018). Insects are also form more than half of the known global biodiversity. They inhabit all habitat types and play major roles in the function and stability of terrestrial and aquatic ecosystems (Okrikata & Yusuf 2019, Ramar et al. 2018). In insects has some specified group like Beetals (Coleoptera) is most diverse insect group of all animals with more than 350000 described species and about 15088 species were recorded from India (Pawara et al. 2014, Aland et al. 2012) whereas butterflies are most taxonomically studied group with worldwide more than 28000 species and about 1508 species were recorded from India (Aiswarya et al. 2014). Rasina et al. (2014) estimates of global insect species richness vary from less than 5 million to as many as 80 millions. The conservation of insect diversity is there for a topic of global importance. The insect diversity of Parwati Arga Bird Sanctuary is unknown till date. Therefore this study was conducted to evaluate and assess the insect population and diversity health (Ecological health) in study area with suppose of first report of Parvati Aranga Bird Sanctuary.

## II. METHODOLOGY

### *2.1 Study Area*

The present study was done in Parvati Aranga Bird Sanctuary in Gonda district of Uttar Pradesh (India) with an area covering 1084.47 Hectares (10 $Km^2$). It was

declared as Bird Sanctuary on 23rd May 1990 and their management undertaking by the Forest Department. Bird Sanctuary has vast area of vegetation with two large lakes in Hoof shaped (Cow's foot). Geographically study area located at a 26° 48'-27° N longitude and 81° 37'-82° E latitude. The Sanctuary harbours a rich floral and faunal diversity and is home for several rare and migratory faunas (Fig.1).

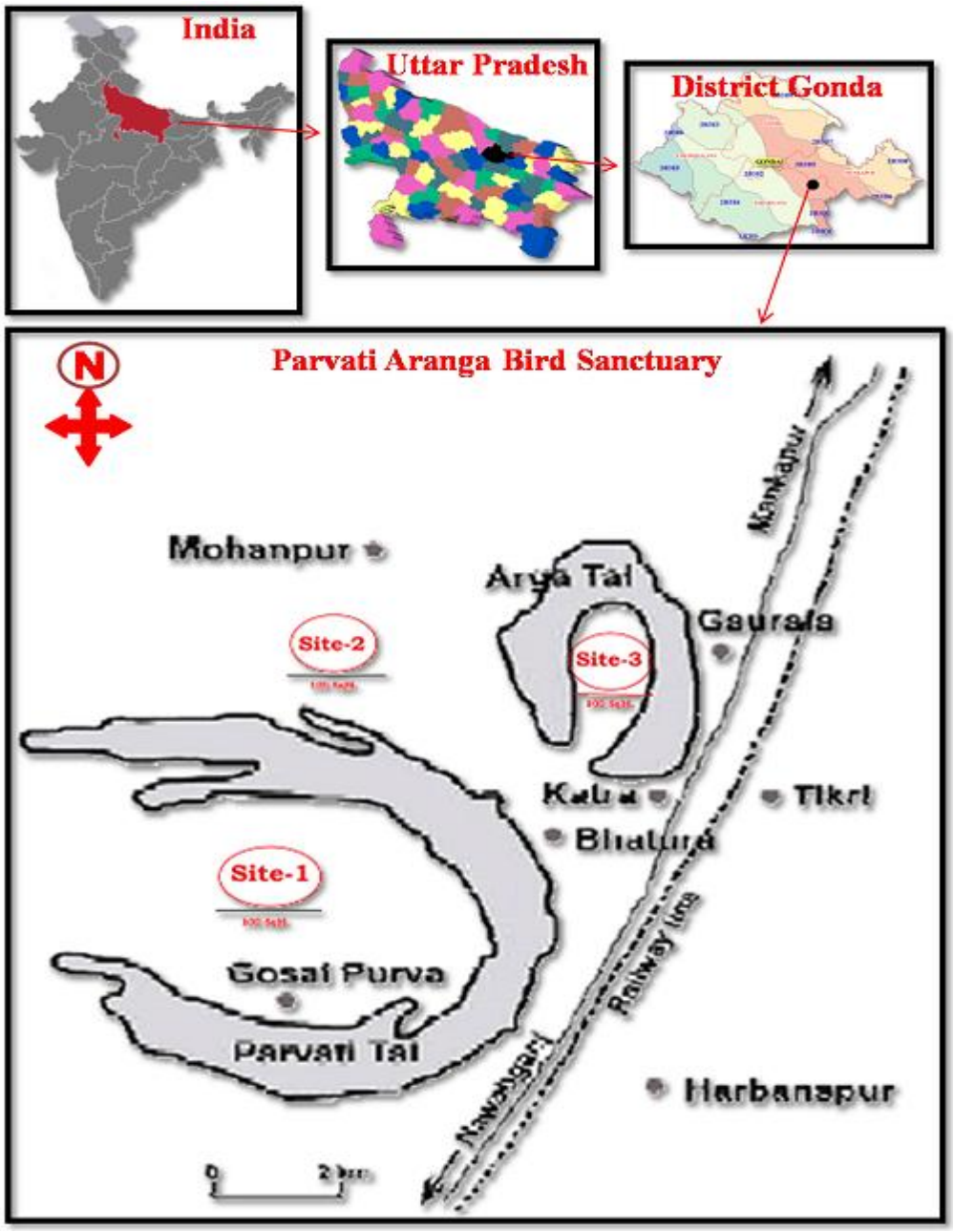


**Fig. 1: Map of Study Area (Parvati Aranga Bird Sanctuary)**

***2.2 Sampling and Data Collection***

Sampling of Insects was conducted between 09:00 to 12:00 (light period) and 05:00 to 08:00 (dark period) at 7 day intervals during November 2020 to April 2021. The insects were collected using the hand collection, light attractant and sweep sampling methods. To ensure that sampling was conducted in a consistent, systematic manner, a randomly selected 3 study sites each of 100 $m^2$ area. The collected insects were transferred into jars that contained cotton soaked in Chloroform (Trichloromethane) and then transported to the laboratory where the insects were mounted and pinned using insect pins. The samples were then preserved and after which they were set in wooden boxes in dry condition and labeled according to their taxonomic position. (Joshi et al. 2008, Nandani and Murali 2014).

***2.3 Species identification***

The collected insect specimen (species) were identified based on Filippini *et al.* 2016, Nair *et al.* 2012, Alford 1999, Balaram 2005, Chote 2003, Chote 2004, Foster and Obermeyer 2010, Goulet and Huber 1993, Gullan and Cranston 3rd Edition, Hutton 2011, Pescador et al. 2000, Merritt and Cummins 1988, Resh and Carde 2003 and also used some websites such as www.gbif.org, www.discoverlife.org, www.cabi.org, www.indiabiodiversity.org, www.antwiki.org, www.ifoundbutterflies.org, www.orthoptera.speciesfile.org, www.animaldiversity.org.

***2.4 Data Analysis***

The type of insect diversity used here is α-diversity, which is the diversity of species within a particular habitat. Statistical data analysis done by auto calculation through website www.alyoung.com and were explained different indices like Simpson's index, Simpson's Reciprocal Index, Dominance index, Shannon's index, Inverted Berger – Parker Dominance index, Margalef's Richness index and Equitability or Evenness index.(Table-2a, 2b, 3a & 3b)

## III. RESULT AND DISCUSSION

***3.1 Species Composition of Insects (Table-1, 2a & 2b)***

The Family and Order composition and number of insect species collected from study sites is shown in Table-1. A total number of 156 species belong to 31 families and 5 orders were collected and identified from three sites of Parvati Aranga Bird Sanctuary. The heist number of species belong to order Coleoptera (53), followed by Lepidoptera (41), Orthoptera (23), Diptera (23) and Hymenoptera (16) (Table-1). Were Species Dominance percentages in families of different orders shown in Graph (Fig. 2 to 6). Diversity indices, Abundance, Richness and Evenness for five different orders were calculated. Species Richness Index was higher in Coleoptera (2.267) with heist Dominance Index (0.835) while Lower Richness Index reported in Diptera (0.637) with lowest Dominance Index (0.664). Highest Simpson's Index of Diversity was reported Diptera (0.336) followed by Orthoptera (0.328) while lowest in Coleoptera (0.164) followed by Lepidoptera (0.261). In all five orders, Hymenoptera were observed with moderate Simpson's Index of Diversity (0.283). The Shannon's Index of Diversity varied from 1.054 to 1.955. The maximum Shannon's Index reported of Coleoptera (1.955) and the minimum of Diptera (1.054). Evenness Index of species also varied from 0.9592 to 0.7307. The highest Evenness Index reported of Diptera (0.9592) and lowest of Orthoptera (0.7307). Other than these, were Reciprocal Simpson's Index, Inverted Berger-Parker Dominance Index also reveled in all five orders (Table-2a & 2b).

***3.2 Species Composition and Abundance of Insect in Different Study Sites (Table 3a and 3b)***

A total number of 296 insects were collected which belongs to 156 species in under 5 orders and 31 families. For minimize of insect population harms, only one insect form a single species collected at a particular Site (Table-1 & Fig.7).

***3.2.1 Site-1:*** The maximum number of species reported from site-1 (106) with the maximum Dominance Index (0.783) and Evenness Index (0.9621) while Richness Index (0.857) minimum. Site-1 is surrounded by a huge evergreen water body named Parvati Lake with high vegetation frequency, which made it rich diversity site.

**Table 1: List of Insect fauna identified and collected from Sampling Sites**

| Family | S. N. | Species | Site-1 | Site-2 | Site-3 |
|---|---|---|---|---|---|
| **Order: Coleoptera** | | | | | |
| Scarabidae | 1 | Anomala dimidiate (Hope, 1831) | + | - | - |
| | 2 | Anomala lineatopennis (Linnaeus, 1758) | + | + | - |
| | 3 | Anomala binotata (Gyllenhaal, 1817) | - | - | + |
| | 4 | Anomala ruficapilla (Burmeister, 1855) | + | - | + |
| | 5 | Onthophagus agnus (Gillet, 1925) | + | - | - |
| | 6 | Onthophagus Taurus (Schreber, 1759) | - | + | - |
| | 7 | Onthophagus catta (Fabricius, 1787) | - | + | + |
| | 8 | Onthophagus dama (Fabricius, 1798) | + | + | - |
| | 9 | Onthophagus nasalis (Arrow, 1931) | - | - | + |
| | 10 | Chiloloba acuta (Wiedemann, 1823) | + | + | + |
| | 11 | Onitis philemon (Fabricius, 1801) | - | + | - |
| | 12 | Jumnos roylei (Hope, 1839) | - | - | + |
| | 13 | Protaetia sps. | + | - | - |
| | 14 | Canthon vigilans (Leconte, 1858) | + | + | + |
| | 15 | Pentodon idiota (Herbst, 1789) | + | + | - |

| | | | | | |
|---|---|---|---|---|---|
| | 16 | Deltochilum gibbosum (Fabricius, 1775) | - | + | + |
| | 17 | Holotrichia serrata (Hope, 1837) | - | + | - |
| Coccinelidae | 18 | Coccinella transversalis (Fabricius, 1781) | + | + | + |
| | 19 | Coccinella sexmaculata (Fabricius, 1781) | - | + | - |
| | 20 | Coccinella septempunctata (Linnaeus, 1758) | + | + | - |
| | 21 | Hippodamia variegate (Goeze, 1777) | + | + | - |
| | 22 | Hippodamia tredecimpunctata (Linnaeus, 1758) | + | - | + |
| | 23 | Harmonia axyridis (Pallos, 1773) | + | - | - |
| | 24 | Micraspis discolor (Fabricius, 1798) | + | + | + |
| | 25 | Zygogramma bicolorata (Pallister, 1953) | + | + | + |
| | 26 | Cheilomenses sexmaculata (Fabricius, 1781) | - | + | - |
| | 27 | Brachiacantha quadripunctata (Melsheimer, 1847) | + | - | - |
| Chrysomellidae | 28 | Altica himensis (Shukla, 2016) | + | + | + |
| | 29 | Altica cyanea (Weber, 1801) | + | - | - |
| | 30 | Sagra femorata (Drury, 177 3) | - | + | - |
| | 31 | Cryptocephalus aureoles (Suffrian, 1847) | - | + | + |
| | 32 | Meristata trifasciata (Hope, 1831) | - | + | - |
| | 33 | Aulacophora indica (Gmelin, 1790) | + | + | + |
| | 34 | Aulacophora faveicollis (Lucas, 1849) | - | + | + |
| Carabidae | 35 | Anthia sexguttata (Fabricius, 1775) | + | - | - |
| | 36 | Pheropsophus catoirei (Dejean, 1825) | - | - | + |
| | 37 | Pheropsophus bimaculatus (Linnaeus, 1771) | - | - | + |
| Meloidae | 38 | Mylabris cichorii (Linnaeus, 1767) | + | + | - |
| | 39 | Mylabris quadripunctata (Linnaeus, 1767) | - | + | - |
| | 40 | Mylabris pustulata (Thunberg, 1821) | + | + | + |
| | 41 | Meloe violaceus (Marsham, 1802) | + | + | + |
| | 42 | Zonitis sps. | - | + | - |
| | 43 | Epicauta pensylvanica (De Geer, 1775) | - | + | + |
| Cerambycidae | 44 | Aeolestes holocericea (Fabricius, 1787) | + | - | - |
| | 45 | Stibara sps. | + | + | + |
| | 46 | Kunbir telephoroides (Lameere, 1890) | - | + | - |
| Curculionidae | 47 | Rhynchophorus indostanus (Chevrolat, 1882) | + | - | - |
| | 48 | Mylloceruss viridanus (Fabricius, 1775) | - | + | + |
| Hybosoridae | 49 | Hybosorus orientalis (Westwood, 1845) | - | - | + |
| Elateridae | 50 | Elater fuscipes (Fabricius, 1775) | + | + | + |
| Tenebrionidae | 51 | Platynotus sps. | + | + | + |
| | 52 | Derosphaerus foveolatus (Marseul, 1876) | + | - | + |
| | 53 | Derosphaerus sinensis (Hope, 1842) | + | - | - |
| **Order:- Lepidoptera** | | | | | |
| Nymphalidae | 54 | Vanessa caschmirensis (Kollar, 1848) | + | + | + |
| | 55 | Vanessa indica (Herbst, 1794) | + | + | + |
| | 56 | Junonia iphita (Cramer, 1779) | + | + | - |
| | 57 | Junonia orithya (Linnaeus, 1758) | - | - | + |
| | 58 | Junonia attites (Linnaeus, 1763) | - | + | + |
| | 59 | Junonia lemonias (Linnaeus, 1758) | + | - | - |
| | 60 | Papilio phalantha (Drury, 1773) | + | - | - |
| | 61 | Papilio bolina (Linnaeus, 1758) | - | + | - |
| | 62 | Papilio genutia (Cramer, 1779) | + | - | + |
| | 63 | Papilio chrysippus (Linnaeus, 1758) | + | + | + |
| | 64 | Papilio almana (Linnaeus, 1758) | - | + | - |

| | | | | | |
|---|---|---|---|---|---|
| | 65 | Papilio limniace (Cramer, 1775) | - | + | - |
| | 66 | Papilio leda (Linnaeus, 1758) | - | + | - |
| | 67 | Neptis sappho (Pallos, 1771) | + | - | - |
| | 68 | Neptis yerburii (Fabricius, 1807) | + | - | + |
| | 69 | Pseudoergolis wedah (Kollar, 1848) | + | + | + |
| | 70 | Argynnis lathania (Linnaeus, 1758) | - | + | - |
| | 71 | Sephisa dichroa (Kollar, 1844) | - | + | - |
| | 72 | Ergolis meriane (Cramer, 1777) | + | + | + |
| Papilionidae | 73 | Papilio helenus (Linnaeus, 1758) | + | + | + |
| | 74 | Papilio polytes (Linnaeus, 1758) | + | + | + |
| | 75 | Papilio agamemnon (Linnaeus, 1758 | + | - | - |
| | 76 | Byasa polyeuctes (Doubleday, 1882) | - | + | - |
| Pieridae | 77 | Eurema hecabe (Linnaeus, 1758) | + | - | - |
| | 78 | Leptosia nina (Fabricius, 1793) | + | + | + |
| | 79 | Appios olferna (Swinhoe, 1890) | + | + | + |
| | 80 | Delias eucharis (Drury, 1773) | + | + | + |
| | 81 | Pieris canidia (Sparrman, 1768) | + | + | + |
| | 82 | Pieris brassicae (Linnaeus, 1758) | + | - | - |
| | 83 | Appias libythea (Fabricius, 1775) | + | - | + |
| | 84 | Catopsilia pyranthe (Linnaeus, 1758) | - | + | + |
| Lycaenidae | 85 | Lycaena rosimon (Fabricius, 1775) | - | + | - |
| | 86 | Spalgis epius (Westwood, 1851) | + | + | + |
| | 87 | Prosotas dubiosa (Semper, 1879) | + | - | - |
| | 88 | Catochrysops strabo (Fabricius, 1793) | + | - | + |
| Hesperiidae | 89 | Pelopidas mathias (Fabricius, 1798) | + | + | + |
| | 90 | Pelopidas conjuncta (Herrich-Schaffer, 1869) | + | + | + |
| Sphingidae | 91 | Macroglossum sps. | + | + | + |
| | 92 | Sphinx sps. | + | + | + |
| Noctuidae | 93 | Agrotis exclamationis (Linnaeus, 1758) | - | + | - |
| | 94 | Autographa sps. | - | - | + |
| **Order:- Orthoptera** | | | | | |
| Acrididae | 95 | Chrotogonus trachypterus (Blanchard, 1836) | - | + | - |
| | 96 | Acrida exaltata (Walker, 1859) | + | + | + |
| | 97 | Diabolocatontops innotabilis (Walker, 1870) | + | + | + |
| | 98 | Gesonula punctifrons (Stal, 1861) | + | + | - |
| | 99 | Leva indica (Boliver, 1902) | + | + | + |
| | 100 | Morphacris fasciata (Thunberg, 1815) | - | - | + |
| | 101 | Oedaleus abruptus (Thunberg, 1815) | + | + | + |
| | 102 | Oxya fuscovittata (Marschall, 1836) | + | - | - |
| | 103 | Oxya velox (Fabricius, 1787) | - | + | + |
| | 104 | Oxya hyla (Serville, 1831) | - | - | + |
| | 105 | Oxya nitidula (Walker, 1870) | + | + | + |
| | 106 | Phlaeoba infumata (Wattenwyl, 1893) | + | + | + |
| | 107 | Trilophidia annulata (Thunberg, 1815) | + | + | - |
| Gryllidae | 108 | Dianemobius fascipes (Walker, 1869) | + | + | + |
| | 109 | Teleogryllus occipitalis (Serville, 1838) | + | + | + |
| Pyrgomorphidae | 110 | Atractomorpha crenulata (Fabricius, 1793) | + | - | - |
| Gryllotalpidae | 111 | Gryllotalpa Africana (Beauvois, 1805) | + | - | + |
| Tetrigidae | 112 | Euparatettix histricus (Stall, 1861) | + | + | + |
| Trigonidiidae | 113 | Amusurgus fulvus (Wattenwyl, 1893) | + | + | + |

| | | | | | |
|---|---|---|---|---|---|
| | 114 | Trigonidium humbertianum (Saussure, 1878) | + | + | - |
| Tettigoniidae | 115 | Conocephalus longipennis (Haan, 1842) | - | + | - |
| | 116 | Conocephalus maculates (Le Guillou, 1841) | + | + | + |
| | 117 | Elimaea securigera (Wattenwyl, 1878) | + | + | - |
| **Order:- Diptera** | | | | | |
| Culicidae | 118 | Anopheles culicifacies (Giles, 1901) | + | + | + |
| | 119 | Anopheles subpictus (Grassi, 1899) | + | - | + |
| | 120 | Anopheles fluviatilis (James, 1902) | - | - | + |
| | 121 | Anopheles vagus (Donitz, 1902) | + | - | - |
| | 122 | Anopheles maculates (Theobald, 1901) | + | - | - |
| | 123 | Aedes aegypti (Linnaeus, 1762) | + | + | + |
| | 124 | Aedes albopictus (Skuse, 1894) | + | - | - |
| | 125 | Aedes walbus (Theobald, 1905) | - | - | + |
| | 126 | Aedes vittatus (Bigot, 1861) | + | - | + |
| | 127 | Culex vishnui (Theobald, 1901) | + | + | + |
| | 128 | Culex fatigans (Wiedemann, 1828) | + | + | + |
| Syrphidae | 129 | Sphegina macropoda (Bigot, 1883) | + | + | + |
| | 130 | Eristalis cerealis (Fabricius, 1805) | - | + | - |
| | 131 | Msembrius bengalensis (Wiedemann, 1819) | + | + | - |
| | 132 | Syritta indica (Wiedemann, 1824) | + | - | - |
| | 133 | Paragus serratus (Fabricius, 1805) | - | + | - |
| | 134 | Allograpta javana (Wiedemann, 1824) | + | + | + |
| Muscidae | 135 | Musca domestica (Linnaeus, 1758) | + | + | + |
| | 136 | Musca autumnalis (De Geer, 1776) | + | + | - |
| | 137 | Arthurella nudiseta (Aibuquerque, 1954) | - | - | + |
| | 138 | Atherigona reversura (Villeneuve, 1936) | + | - | - |
| | 139 | Pyrellia cyanicolor (Zetterstedt, 1845) | + | - | - |
| | 140 | Fannia canicularis (Linnaeus, 1761) | + | + | + |
| **Order:- Hymenoptera** | | | | | |
| Apidae | 141 | Apis florae (Fabricius, 1787) | + | + | + |
| | 142 | Apis dorsata (Fabricius, 1793) | - | - | + |
| | 143 | Nomada fulvicornis (Fabricius, 1793) | + | - | + |
| Vespidae | 144 | Vespa orientalis (Linnaeus, 1771) | + | + | + |
| | 145 | Polistes flavus (Cresson, 1868) | - | + | + |
| | 146 | Polistes watti (Cameron, 1900) | + | + | - |
| | 147 | Polistes indicus (Stolfa, 1934) | + | - | - |
| | 148 | Polistes stigma (Fabricius, 1793) | - | - | + |
| Xylocopidae | 149 | Xylocopa violacea (Linnaeus, 1758) | + | - | - |
| Formicidae | 150 | Camponotus sericeus (Fabricius, 1798) | + | + | + |
| | 151 | Camponotus compressus (Fabricius, 1787) | - | + | - |
| | 152 | Camponotus angusticollis (Jerdon, 1851) | + | + | + |
| | 153 | Camponotus vicinus (Mayr, 1870) | - | + | - |
| | 154 | Oecophylla smaragdina (Fabricius, 1755) | + | - | + |
| | 155 | Leptogenys diminuta (Smith, 1857) | + | - | - |
| | 156 | Solenopsis geminate (Fabricius, 1804) | + | + | + |

***3.2.2 Site-2:*** Site-2 is area that situated between Site-1 and Site-3 without any water body. This site has most of grassland with shrubs and nearby agricultural land, village also situated with too much human activity. In this Site, the minimum Dominance Index (0.763) and Evenness Index (0.9308) with moderate Richness Index (0.866) were reported. Were, a total number of 101 species collected.

***3.2.3 Site-3:*** The minimum number of species reported from Site-3 (89) with the moderate Dominance Index

(0.781), Evenness Index (0.9581) and maximum Richness Index (0.891). Site-3 is also surrounded by a water body named Aranga Lake that some time becomes dry during winter seasons. This Site also has much greenery with shrubby and tree vegetations.

Overall the maximum Insect Diversity reported in Site-1 with Simpson's Index of Diversity (0.216) and Shannon's Index of Diversity (1.548) while the minimum Insect Diversity calculated from Site-2 with Simpson's Index of Diversity (0.236) and Shannon's Index of Diversity (1.498). Site-3 has moderate number of Insect Diversity with Simpson's Index of Diversity (0.218) and Shannon's Index of Diversity (1.542) (Table 3a & 3b).

**Table 2a: Diversity indices for insect orders collected from different sites of Parvati Aranga Bird Sanctuary**

| Insect Orders | Total No. of Family | Total No. of Species | Dominance % | Average Population Size | Simpson's Index $\frac{\sum ni(ni-1)}{N(N-1)}$ | Reciprocal Simpson's Index $\frac{1}{\sum ni^2/N^2}$ |
|---|---|---|---|---|---|---|
| Coleoptera | 10 | 53 | 33.97% | 5.30 | 0.164 | 6.070 |
| Lepidoptera | 7 | 41 | 25.64% | 5.85 | 0.261 | 3.832 |
| Orthoptera | 7 | 23 | 14.74% | 3.28 | 0.328 | 3.048 |
| Diptera | 3 | 23 | 14.74% | 7.66 | 0.336 | 2.976 |
| Hymenoptera | 4 | 16 | 10.26% | 4.00 | 0.283 | 3.529 |
| Total | 31 | 156 | 100% | 31.20 | 0.233 | 4.281 |

**Table 2b: Diversity indices for insect orders collected from different sites of Parvati Aranga Bird Sanctuary**

| Insect Orders | Dominance Index $1-\frac{\sum ni(ni-1)}{N(N-1)}$ | Shannon's Index $-\sum\frac{ni}{N}\ln\left(\frac{ni}{N}\right)$ | Inverted Berger-Parker Dominance Index $\frac{N}{n_{max}}$ | Margalef's Richness Index $\frac{S-1}{ln.N}$ | Evenness Index $\frac{-\sum\frac{ni}{N}\ln\left(\frac{ni}{N}\right)}{ln.N}$ |
|---|---|---|---|---|---|
| Coleoptera | 0.835 | 1.955 | 3.118 | 2.267 | 0.8488 |
| Lepidoptera | 0.739 | 1.571 | 2.158 | 1.616 | 0.8075 |
| Orthoptera | 0.671 | 1.422 | 1.769 | 1.914 | 0.7307 |
| Diptera | 0.664 | 1.054 | 2.091 | 0.637 | 0.9592 |
| Hymenoptera | 0.716 | 1.212 | 2.286 | 1.082 | 0.8745 |
| Total | 0.766 | 1.516 | 2.943 | 0.792 | 0.9420 |

**Table-3a: Diversity indices for insect species collected from different sites of Parvati Aranga Bird Sanctuary**

| Study Sites | Total No. of Species | Average Population Size | Simpson's Index $\frac{\sum ni(ni-1)}{N(N-1)}$ | Reciprocal Simpson's Index $\frac{1}{\sum ni^2/N^2}$ | Dominance Index $1-\frac{\sum ni(ni-1)}{N(N-1)}$ |
|---|---|---|---|---|---|
| Site-1 | 106 | 21.2 | 0.216 | 4.622 | 0.783 |
| Site-2 | 101 | 20.2 | 0.236 | 4.229 | 0.763 |
| Site-3 | 89 | 17.8 | 0.218 | 4.580 | 0.781 |
| Total | 296 | 98.67 | 0.332 | 3.005 | 0.667 |

**Table-3b: Diversity indices for insect species collected from different sites of Parvati Aranga Bird Sanctuary**

| Study Sites | Shannon's Index $-\sum\frac{ni}{N}\ln\left(\frac{ni}{N}\right)$ | Inverted Berger-Parker Dominance Index $\frac{N}{n_{max}}$ | Margalef's Richness Index $\frac{S-1}{ln.N}$ | Evenness Index $\frac{-\sum\frac{ni}{N}\ln\left(\frac{ni}{N}\right)}{ln.N}$ |
|---|---|---|---|---|
| Site-1 | 1.548 | 3.419 | 0.857 | 0.9621 |
| Site-2 | 1.498 | 2.971 | 0.866 | 0.9308 |
| Site-3 | 1.542 | 3.296 | 0.891 | 0.9581 |
| Total | 1.096 | 2.792 | 0.351 | 0.9976 |

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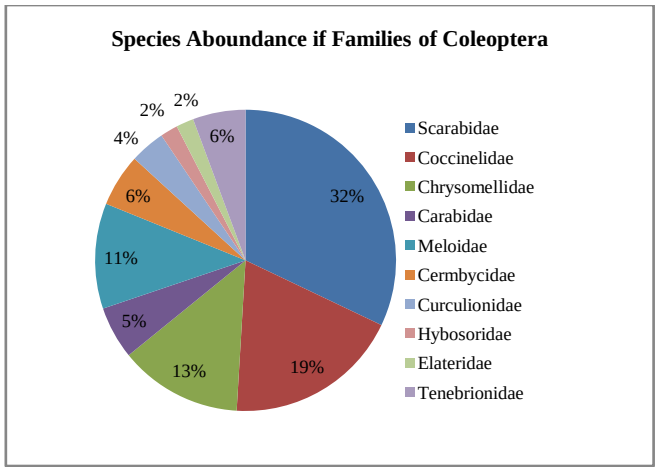


Fig.2: Species Aboundance in Families of Coleoptera

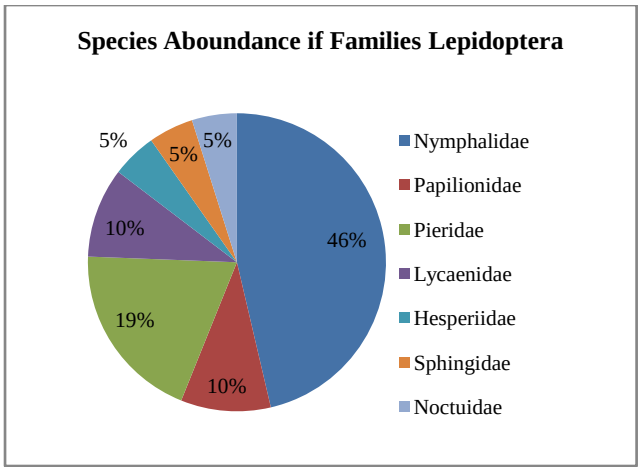


Fig.3: Species Aboundance in Families of Lepidoptera

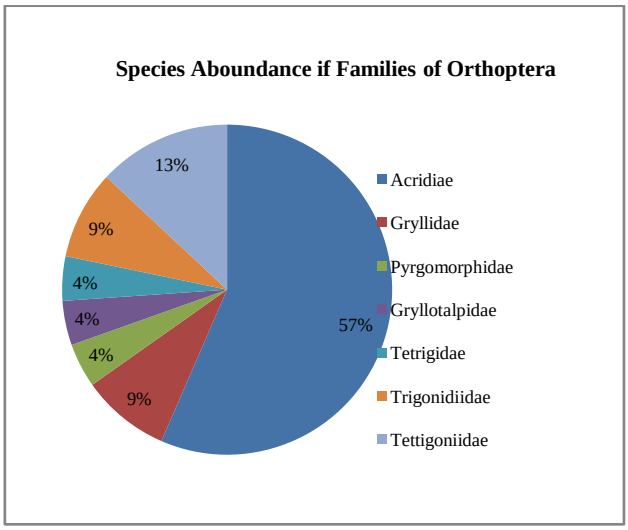


Fig.4: Species Aboundance in Families of Orthoptera

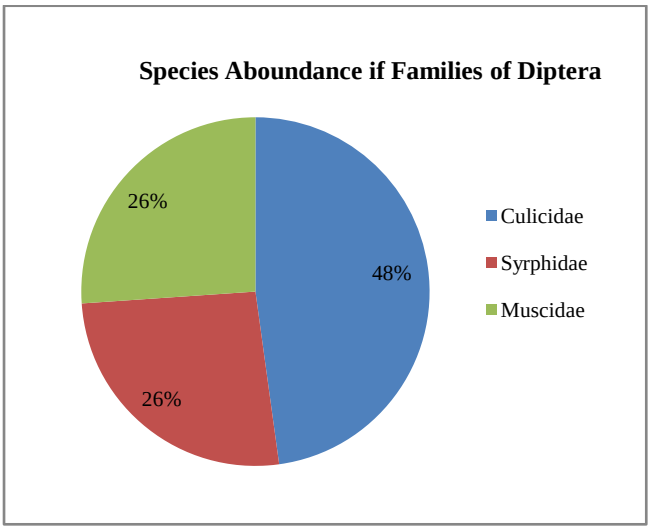


Fig.5: Species Aboundance in Families of Diptera

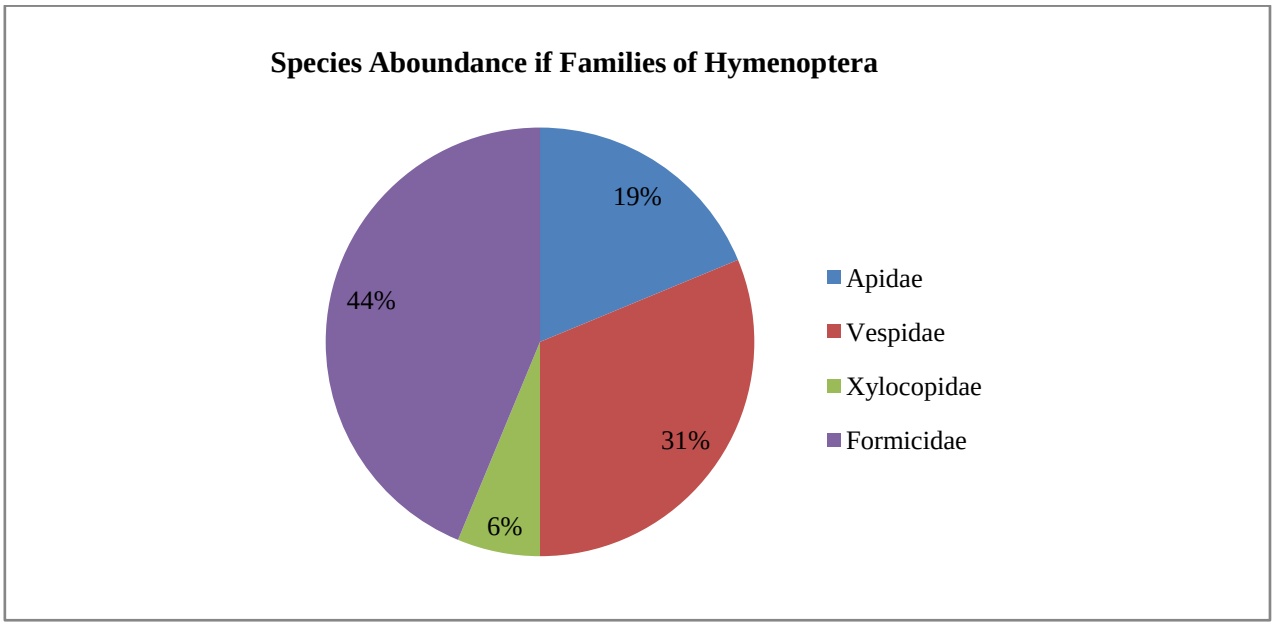


Fig.6: Species Aboundance in Families of Hymenoptera

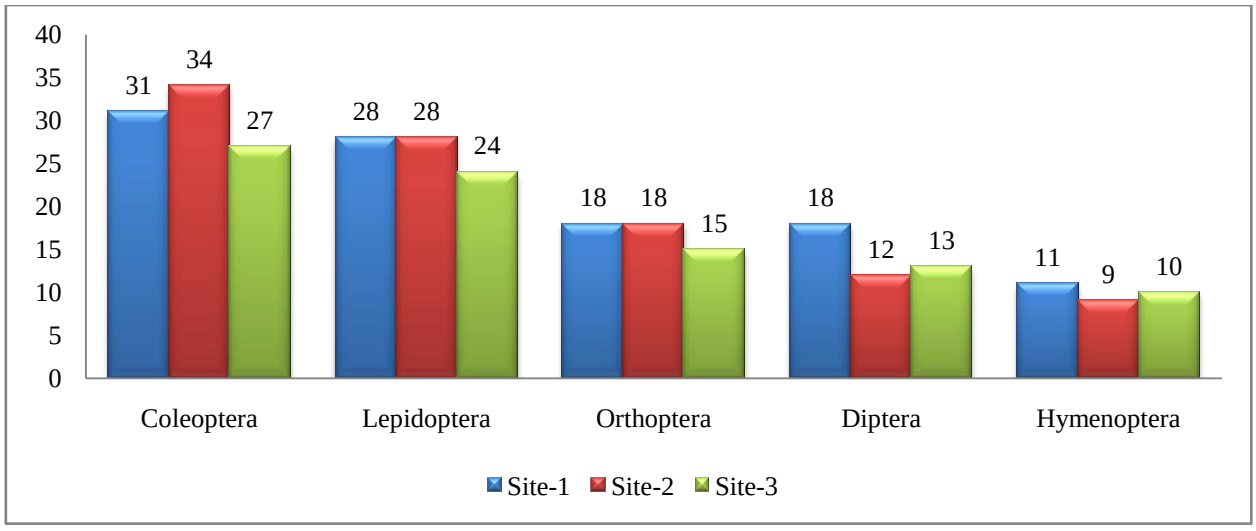


**Fig.7: No. of Species occurrence in Particular sites of Different Orders**

## IV. CONCLUSION

This assessment concludes that the study area has rich and vast diversity of insects, especially species level of major insect orders. This work also conclude that the Parvati Aranga Bird Sanctuary are dominated by insects and from these records it is obvious that the aquatic and terrestrial ecosystem together. It had diverse entomofauna with high level of insect distribution. This study evaluated that the selected site for assessment especially for water body and human activities. In taken study sites, Site-1 is situated by surroundings huge water body (Parvati Lake) that never become dry whereas Site-2 is situated away from any water body and has much interference with human activities. Other than both, Site-3 is also surrounded by water body (Aranga Lake) that some time becomes dry during winter seasons. The diversity of all these Sites is also effected by such factors and activities that expressed as Site-1 > Site-3 > Site-2. In all studied orders, Coleoptera has much species diversity than others that also be considered as the effect of water body occurrence.

Overall from this assessment, the Parvati Aranga Bird Sanctuary is still considered to have a diverse and vast entomofauna. However, the results which were being presented in this article might be the first comprehensive Insect Survey list of taken study area. Hopefully, there will be a further research study on the insect diversity and listed taxa in this area, in order to get better and useful information on those aspects to be documented for future references.

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