"IMPACT OF ANTHROPOGENIC ACTIVITIES ON

INSECT BIODIVERSITY OF

JHALAWAR DISTRICT OF RAJASTHAN"

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Thesis
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In the Faculty of Science (Zoology)
By

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2016

CERTIFICATE

This is to certify that the thesis entitled: **"IMPACT OF ANTHROPOGENIC ACTIVITIES ON INSECT BIODIVERSITY OF JHALAWAR DISTRICT OF RAJASTHAN."** submitted by Mrs. ROOPAM KULSHRESTHA to the University of Kota for partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in Zoology is a bonafide record of the work carried out by her, under my supervision and guidance. To the best of my knowledge and belief this is her original work.

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DECLARATION

I hereby declare that the work, which is being presented in the Thesis, entitled **"IMPACT OF ANTHROPOGENIC ACTIVITIES ON INSECT BIODIVERSITY OF JHALAWAR DISTRICT OF RAJASTHAN."** is my own work and that to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning except where due acknowledgement has been made in the text.

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(Mrs. Roopam Kulshrestha)

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CHAPTER 1

INTRODUCTION

Man has always been fascinated by the diversity of life. Biodiversity is the new international buzzword. Term ‘biodiversity’ was coined by Walter and Rosen (1985) which is formed by contraction of the term biological diversity. Biological diversity refers to the variety and variability among living oraganisms and ecological complexes in which they live. Biodiversity and natural resources forms the root of all living system. It forms the foundation for sustainable development, constitutes the basic for environmental health of our planet, and is a source of economic and ecological security for future generation.

The distribution of living species in the world in not uniform. Species richness increases from the poles to the equator. Fresh water insects, for example are three to six times more abundant in tropical areas than in temperate zone.

Global diversity: we believe that there may be 5-30 million species of organism exist on the earth. These include 3,00,000 species of green plants, 8,00,000 species of fungi, 40,00,000 species of insect, 3,60,000 species of microorganisms and many invertebrates and vertebrates. According to some recent estimates the number of insects alone may be as high as 10 millions, but many believe that it is more likely to be around 5 million (Singh *et.al.*, 2004).

Global biodiversity is affected by extinction and speciation. The background extinction rate varies among taxa but it is estimated that there is approximately one extinction per million species years (MSY). Mammal species, for example, typically persist for 1 million years. Biodiversity has grown and shrunk in earth's past due to (presumably) abiotic factors such as extinction events caused by geologically rapid changes in climate. Climate change 299 million years ago was one such event. A cooling and drying resulted in catastrophic rainforest collapse and subsequently a great loss of diversity, especially of amphibians. However, the current rate and magnitude of extinctions are much higher than background estimates. This, considered by some to be leading to the sixth mass extinction, is a result of human impacts on the environment.

Habitat change is the most important driver currently affecting biodiversity, as some 40% of forests and ice-free habitats have been converted to cropland or pasture. Other drivers are: overexploitation, pollution, invasive species, and climate change.

Biodiversity is very much important ecologically and economically and it also plays an important role in our daily life because it is applicable in different fields for the sake of better development in the modern world. Some of the important fields on which biodiversity is applicable are as follows:

Importance in Agriculture: In agricultural field biodiversity plays an important role to produce a new variety of plants or crops by producing a change in their genetic traits and it also help in preventing the crops from diseases such as coffee plants, rice plants etc. it is also called as agricultural biodiversity.

Importance in Human Life: Biodiversity plays a major role in our lives because they are very useful for the production of different useful products such as food, water and different type of medicines. It also involves in fighting against different disasters. It produces a great variety of pharmaceutical products which help in recovery.

Industrial Importance of Biodiversity: In the field of industry it is also used to produce different kinds of materials such as building material which derived from different kinds of biological resources and through biodiversity. The industrial products which are produce as a result of biodiversity are fibers, dyes, oil, rubber etc.

The Indian sub continent is the seventh-largest country in the world, is quite rich in biodiversity with a sizable percentage of endemic flora and fauna. The country has nearly 75,000 animal species about 80% are insects.India's biodiversities is one of the most significant in the world as many as 45,000 species of wild plant and 77,000 animals have been recorded, which comprises about 6.5% of world known diversity.

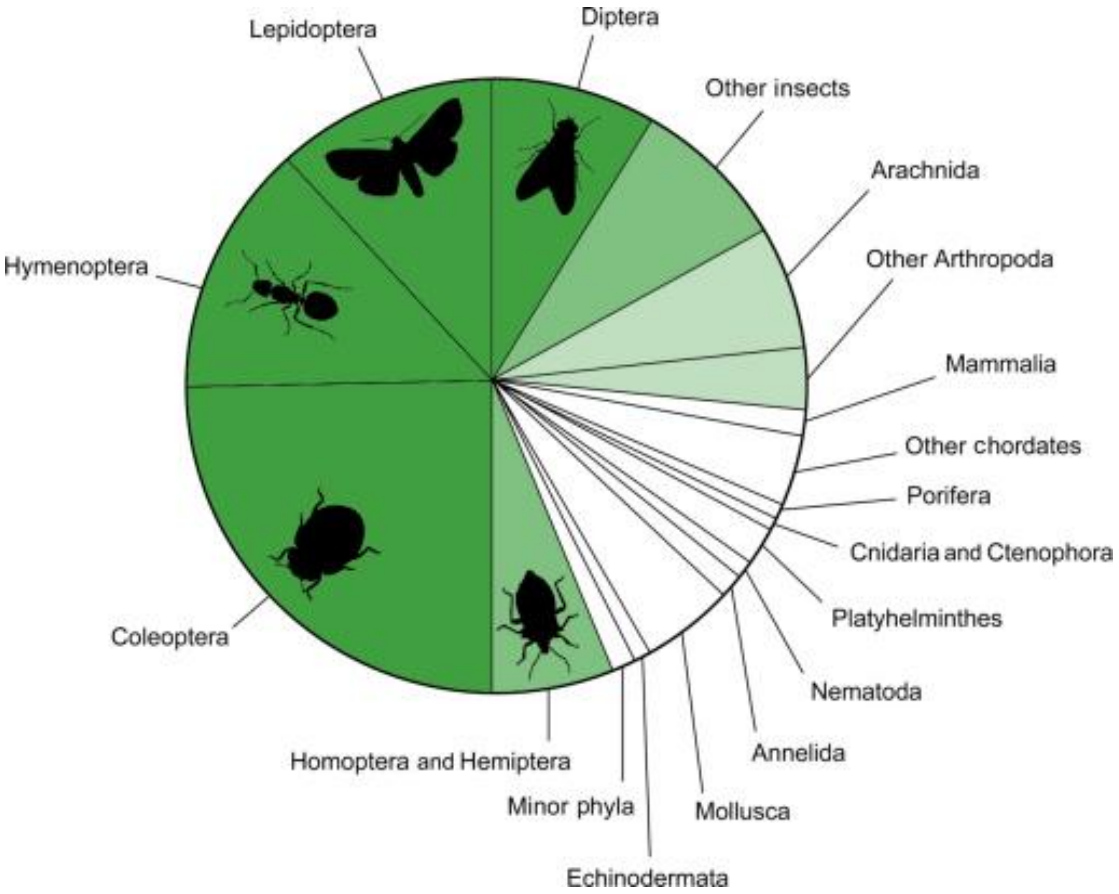

Fig. 1.1 Relative proportions of the animal groups of the animal species numbers presently known.

Insects comprise the largest group of organisms and are involved in various vital ecosystem services like pollination, decomposition, biological control, food chain etc. India is one among the twelve-mega biodiversity countries of the world and that 80% of the insects are endemic in India.

Insects are powerful and rapid adaptive organisms with high fecundity rate and short life cycle. Due to human interruption in agro-ecosystem and global climatic variations are disturbing the insect ecosystem. Erosion of natural habitats, urbanization, and pollution manifold the intensity of environmental variations. Insects constitute a substantial proportion of terrestrial species richness and biomass, and play a significant role in ecosystem functioning (Mc Geogh, 1998). Insects are frequently used as bioindicator species for

monitoring and detecting changes in the environment. By using indicators it is possible to assess the impact of human activities on the biota, instead of examining the entire biota.

In recent times, biodiversity has become easy targets for human over-exploitation due to burgeoning human populations and the quest for a "better life" through improvements in science and technology. Biodiversity, therefore, is being exploited at much faster rates than ever before with negative implications for sustainable human livelihood (Turner *et al.*, 1990). Biological diversity is of fundamental importance to the functioning of all natural and human-engineered ecosystems, and by extension to the ecosystem services that nature provides free of charge to human society

The loss of biodiversity is taking place at an alarming rate, but our understanding of biodiversity remains pitifully inadequate in most parts of the word. Lack of knowledge of species and its density in particularly a problem concerning invertebrates. Plants and animal life of vertebrates like mammals, birds and fishes are better known than invertebrates like insects. Insects are becoming extinct because of habitat loss, over exploitation, pollution over population and the threat of global climatic changes.

It is stated that the sixth period of extinction is currently underway and due to the rapid environmental changes brought about by human beings themselves. The high standard of living that accompanies the increased production and consumption of goods is the major cause of pollution and environmental degradation. (Wilson, 1994).The problems of overpopulation, overconsumption, development and industrialization are intertwined and the causes are not singular and straightforward.

We are losing biological diversity at an unprecedented rate. The emerging science of conservation biology in rapidly enriching our knowledge of loss of biodiversity. Scientist can estimate the size of animal populations that will

preserve a desired amount of genetic diversity and can foresee biological losses. The success of future efforts to conserve biodiversity rests to a large extent on whether they can be reconciled with development policy.

The International Union for the Conservation of Nature(IUCN) developed the system of classification for protected areas that ranges from minimal to intensive allowed use of the habitat by human (IUCN, 1994).Since all living things are interconnected in their cascading or radiating effects of biodiversity loss Removal of a species shakes the whole web of life.Habitat degradation occurs when a habitat is so diminished in quality that species are no longer able to survive, for example when a pond is filled or grassland is converted into housing or industrial projects (anthropogenic). Habitat loss occurs when habitat is converted into other uses.

The main objective of this research study was to collect, identify and document diversity, species abundance in disturbed, semi disturbed and undisturbed areas of Jhalawar region. And to observe the impact of anthropogenic activities on insect diversity. There is no doubt that human activities have had a negative impact on biodiversity particularly since the industrial revolution.

The present study focuses on contrast of different insect's diversity between the 4 locations. There is no record of study on insect biodiversity of Jhalawar district till date, up to my knowledge. The present study will pave way for further studies on the biodiversity and its conservation of the investigated area by setting up an inventory of insects and the various human activities encountered in the area.

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CHAPTER 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

2.1 INTERNATIONAL

Miller (1993) studied the composition and dynamics of ecosystems influenced by insects serving as providers ,eliminators and facilitators across multiple trophic levels. The role of insects in ecosystems may be documented by manipulative field studies involving exclusion techniques applied to species that are decomposers, herbivores or predators. The presence or absence of insects is important to the distribution, abundance and diversity of plants and vertebrates, which typically are the premier species in conservation efforts. Thus, policy-making in environmental management programmes should consider the role of insects in ecosystems when establishing objectives and procedures for species conservation and biodiversity.

Junent *et. al. (*2000) carried out research work in a warm shrub desert of Argentina, having particular biogeographical interest because it lies between the Neotropical and Antarctic regions. A preliminary list of some insect families shows a high proportion of endemic genera and species, supporting the hypothesis that it constitutes a natural area with its own biodiversity. The distribution of some insect species shows great concordance with the area occupied by the Monte Desert, indicating its limits. However the complete series of records are not enough to define the boundaries exactly. The distributional patterns of several endemic species suggest that within Monte there are five natural areas: Northern, Central, Uspallata-Calingasta, Southern, and PenmHnsula de ValdeHs. The limits of the Northern and Uspallata-Calingasta areas are due to physiographical features (mountains) whereas the remaining areas are delimited by climatic barriers. An analysis based on phylogenetic information shows that these areas of endemism reflect different values with respect to their biodiversity. The Northern area has the highest values of importance and has no protected areas.

Ullrich (2001) investigated the diversity of plants and insects in wildflower strips in an arable landscape in Switzerland. The aim is to assess the plant and insect diversity establishing in wildflower strips and the factors influencing this diversity, in order to evaluate the contribution of wildflower strips to biodiversity on a landscape scale, and to generate recommendations for their optimal management. What roles do colonization and environmental constraints play in the establishment of insect communities in wildflower strips? Are insect communities in wildflower strips restricted to generalist species or do specialist species also manage to establish, and how quickly? Can the insect communities in different types of wildflower strips be distinguished clearly and if so, what environmental factors are responsible? Do wildflower strips serve as a dispersal source for insects? Over what distance and how quickly can insects colonize patches of their host plants? All chapters aim to contribute answers to the question, how wildflower strips should be managed to achieve a maximum biodiversity on a landscape scale.

Stiller (2002) worked out that over a period of about 20 years more than 200 species in 53 leafhopper genera (Cicadellidae: Hemiptera) have been described from 247 localities in the fynbos biome in the South-western part of South Africa. This biome is characterized by its high plant species richness (7800 species) and endemicity (68% of plant species confined to the Cape Floristic Kingdom). It is however still uncertain whether specifically the leafhoppers (Cicadellidae: Hemiptera) have an equally high diversity in this region. Base-line information gathered mainly from taxonomic descriptions on distribution and abundance of species is presented.

Harvey *et. al.* (2006) explored the importance of indigenous agroforestry systems for biodiversity conservation. They compared the abundance, species richness and diversity of dung beetles and terrestrial mammals across a gradient of different land use types from agricultural monocultures (plantains) to agroforestry systems (cocoa and banana) and forests in the BriBri and Cabe´car indigenous reserves in Talamanca, Costa Rica. A total of 132,460

dung beetles of 52 species and 913 tracks of 27 terrestrial mammal species were registered. Dung beetle species richness and diversity were greatest in the forests, intermediate in the agroforestry systems and lowest in the plantain monocultures, while dung beetle abundance was greatest in the plantain monocultures.

Silva *et. al.* (2006) undertaken the study in the Counties of Montenegro and Pareci Novo located in the region of the Vale do Rio Caí, Rio Grande do Sul, Southern Brazil, aiming to determine the fruit fly species of Tephritidae and Lonchaeidae that occur in organic orchards of sweet orange [*Citrus sinensis* (L.) and Murcott tangor (*Citrus reticulata*), during the fruit ripening stages in 2003 and 2004.

Spungis (2006) studied Grasshoppers (Orthoptera) in dunes of the Baltic Sea at the Latvian western coast in 2001 and 2003-2006. Direct collection and pitfall trapping of individuals were used. In total 12 species of grasshoppers were identified, seven of them can be regarded as characteristic for dunes. Number of species and population density increased significantly along white dune – grey dune – dry grassland habitat gradient. Dominating species *Myrmeleotettix maculatus* had maximum of population density in the typical grey dune habitat. Significant correlation among population density of grasshoppers and plant species diversity and vegetation cover was stated. These correlations can be explained both by feeding and sheltering requirements of the grasshoppers.

Zurbru and Frank (2006) investigated the abundance and species richness of Heteropteran bugs and explored environmental factors which influence bug diversity in three types of semi-natural habitats (wildflower areas, extensively used meadows, extensively grazed pastures). Results indicate that vegetation structure and flower abundance are key factors for bug species richness, abundance and bug species composition. Since wildflower areas and meadows clearly increased bug species richness and contained several specialised bug

species that did not occur in pastures, we recommend the promotion of wildflower areas and extensively used meadows in order to restore both high Heteropteran diversity and overall insect biodiversity in agricultural landscapes.

Bouhachem *et. al.* (2007) studied winged morphs of aphids investigated from 2002 to 2004 in 4 Tunisian regions of potato seeds production in order to know the aphid diversity and the potential vectors of Potato Virus Y. This is a very important contribution to the knowledge of aphid fauna in Maghreb. A total of 50,030 aphids were caught using yellow water traps and one suction trap. 130 taxa were identified including 103 species. Ten species are well represented in all regions prospected and typical species were also observed in every region. Some differences in species diversity appeared between regions which are discussed considering weather condition and vegetation.

Fulan *et. al.* (2008) investigated the environmental variable that affected the dragonfly diversity and abundance in the Guadiana River in the period of March to July in 1999 and 2000. A total of 105 sites were investigated where 19 species of dragonflies, ten species of Anisoptera and nine species of Zygoptera were recorded. Canonical Correspondence Analysis (CCA) indicated that environmental factors were related to some species. *C. lindeni, C. tenellum, C. caerulescens, C. scitulum, E. viridulum* and *I. pumilio* (all Zygoptera) occurred in conditions of a relativity high percentage of cover of reeds. The occurrence of Anisoptera species such as *C. boltoni, O. coerulescens* and *O. nitidinerve* were influenced by shade.

Kalkman *et. al.* (2008) explained that larvae of almost all of the 5,680 species of the insect order Odonata (dragonflies and damselflies) are dependent on freshwater habitats. Both larvae and adults are predators. The order is relatively well studied, and the actual number of species may be close to 7,000. Many species have small distributional ranges, and are habitat specialists, including inhabitants of alpine mountain bogs, seepage areas in

tropical rain forests, and waterfalls. They are often successfully used as indicators for environmental health and conservation management. The highest diversity is found in flowing waters in rain forests of the tropics, the Oriental and Neotropical regions being the most speciose. This paper discusses diversity, summarizes the biogeography of dragonflies in the different biogeographical regions and gives the total number of species and genera per family per biogeographical region. Examples are given of areas of particular diversity, in terms of areas of endemism, presence of ancient lineages or remarkable recent radiations but no well-based review of areas with high endemism of dragonflies is available so far. The conservation status of dragonflies is briefly discussed. Species confined to small remnants of forest in the tropics are most under threat of extinction by human activities.

Rueda (2008) noted that mosquitoes that inhabit freshwater habitats play an important role in the ecological food chain, and many of them are vicious biters and transmitters of human and animal diseases. Relevant information about mosquitoes from various regions of the world are noted, including their morphology, taxonomy, habitats, species diversity, distribution, endemicity, phylogeny, and medical importance.

Abdullah and Isa (2009) studied the hemipteran families from 10th Nov 2009 to 14th Nov 2009 at Gunung Benom, Pahang. Hemipteran collections were made at Sg Kongsi Cina. The Hemiptera families were sampled along the river bank using light trapping and all the assembled specimens were brought back to the University of Malaya laboratory where it was dried in the oven, pinned and sorted into families for further identification. A total of 17 Hemiptera specimens were assembled during the study and 7 families were identified. The importance of this study is to provide a checklist as a reference for future research of Malaysian True bug.

Cardenas *et. al.* (2009) Catalogues, checklists and collections in national museums demonstrate that despite its size, Ecuador is at present the richest

country in number of tabanids species in the Neotropics after Brazil, Colombia and Mexico, and has one of the highest numbers of species per unit area. The tabanofauna is predominantly shared with Colombia (62.6%), Peru (47%), Brazil (35.9%), Panama (35.4%), and Venezuela (30.3%) that have biogeographic areas in common with Ecuador. Endemism rate of this group is around 12.6%, with *Diachlorus, Dicladocera, Esenbeckia, Eristalotabanus* (monotypic), and *Leucotabanus* genera as the most representatives. The genus *Hemichrysops* was recorded for first time. The number of species in Ecuador now totals 198.

Rafael *et. al.* (2009) investigated that insects will soon reach one million known species worldwide. Brazil, with about 9% of this total, and possibly another 400 thousand species yet to be discovered, harbors the highest insect diversity in the world. The country has a complement of about 140 active taxonomists, which means a quota of 3,600 insect species per professional.

Carbonell *et. al.* (2011) studied the ecological factors determining the distribution and assemblages of the aquatic Hemiptera (Gerromorpha & Nepomorpha) in the Segura River basin (Spain) although the Segura River basin is located in one of Europe's most arid regions; it features a wide variety of aquatic ecosystems, some of which are rare within the European continent. Between 1980 and 2010, a total of 38 species of aquatic Hemiptera were collected in 402 sites that have been classified into 12 types of habitats. Aquatic Hemiptera were well-represented among the different habitats. Hence, the lotic/lentic character of the habitat and its conductivity were the most important factors shaping the spatial distribution of the aquatic Hemiptera in the Segura River basin. Additionally, an indicator species analysis (IndVal) revealed four aquatic Hemiptera assemblage types: one was related with lotic headwater environments, a second was associated with rivers and reservoirs, a third win lotic saline environments and a fourth transitional assemblage type was associated with microhabitat availability and included species with a widespread distribution.

Petanidou *et. al*. (2011) studied the syrphid fauna of a Mediterranean scrub community near Athens, Greece. Collecting was carried out systematically using entomological net for flower-visiting insects (4-year survey: 1983–1987) and a Malaise trap for passive collection (2-year survey: 1991–1993). A total of 59 species were collected by both methods combined. Twenty-six species have a Mediterranean distribution and another 27 a European to worldwide distribution. Among the Mediterranean species one is new to science and another one new to Greece.

Sana and Ali (2011) presented a preliminary list of aquatic Coleoptera (Arthropoda: Insecta) collected from ponds and flood plains of Chalon Beel in Natore and Rajshahi districts of Bangladesh is presented. The list includes 27 species within 3 families and 6 subfamilies under 14 genera.

Elela *et. al.* (2012) surveyed the orthopteran assemblages in four different sampling sites in Satoyama area; fifty different species have been recorded. These species belong to 10 families, 17 subfamilies and 27 tribes. Family Acrididae was found to exhibit the highest number of subfamilies and tribes (four subfamilies and eight tribes). This was followed by Tettigoniida with six tribes. However, both of Gryllidae and Tettigoniida harbored the highest number of observed species (12 species). On the other hand, three families were considered comparatively poor families exhibiting a single subfamily, a single tribe and a single species. These families were Eneopteridae, Mecopodidae and Pyrgomorphidae.

Estay *et. al.* (2012) stated that the current rate of exchange of goods and people among geographic areas, the introduction of insect species into new habitats represents an increasing threat to insect diversity. The situation is especially acute in Mediterranean ecosystems where the high human population density incurs multiple sources of disturbance and high propagule pressure. In this study, we characterize the relationship between native and exotic forest insect richness and evaluate how human-mediated disturbances

can influence this relationship in the Mediterranean central Chile. When the effect of human-mediated disturbances was evaluated using generalized linear and additive models, we found that native richness, human population density and habitat diversity were the most important variables affecting exotic richness. Moreover, we detected strong nonlinearities in the effect of some variables. For instance, the influence of human population density on the exotic richness followed a threshold function, where below 1,000 hab/km2, the proportion of exotics in the community grew rapidly with increasing human density, but above this threshold density, human population did not produce further increases in exotic richness. Two important conclusions arise from these results: first, there is a positive effect of human-mediated disturbances on the exotic richness in central Chile, and second, the key role that human population density has on the invasibility of insect communities in rural and semi-rural Mediterranean areas.

Perveen and Ahmad (2012) stated that studies on butterflies have great aesthetic and commercial values as they are beneficial as pollinator and environmental indicator. In this study, 21 species were identified belonging to 3 different families and 6 subfamilies from Kohat, Pakistan during September-December 2008. Of the reported families, Nymphalidae covered 33%, Papilionidae 10%, and Pieridae 57% of total numbers of collected butterflies of Kohat. Six species were belonging to subfamily Nymphalinae and one to Satyrinae. Two species belong to Papilioninae, the only subfamily of Papilionidae. The family Pieridae includes 3 subfamilies namely Pierinae, Coliaclinae and Coliadinae contained 5, 1 and 6 species, respectively. The minimum wingspan of collected butterflies belongs to the little orange tip, *Colotis etrida* Boisduval (25 mm) which was the smallest butterfly, however, the maximum one belongs to the lime butterfly, *Papilio demoleus* Linnaeus (100 mm) as well as the common mormon, *P. polytes* Linnaeus which were the largest butterflies. A detail study is required for further exploration of butterflies' fauna of Kohat.

Spalinger *et. al.* (2012) Grasslands cover approximately 40% of the Earth's terrestrial landscape, supporting large communities of vertebrate and invertebrate herbivores. Orthoptera play an important role, consuming relatively large amounts of biomass. Their occurrence can be strongly affected by habitat diversity and structure, which can be shaped by large herbivores. Several studies have focused on the impact of livestock on Orthoptera communities, but little is known about how wild ungulates influence the abundance and diversity of these insects in grassland ecosystems. They studied Orthoptera abundance and diversity in subalpine grasslands in the Swiss Alps, where grazing by red deer and chamois has created a mosaic of short and tall-grass patches. Data on vegetation structure, habitat diversity and plant nitrogen (N) content allowed them to consider how these parameters affected the occurrence of Orthoptera at our study sites. They found a total of nine Orthoptera species with an average density of 2.6 individuals sq. m) Neither Orthoptera abundance nor diversity differed between short and tall-grass patches created by large ungulates. Both Orthoptera abundance and diversity were, however, positively influenced by increasing vegetation height, but negatively by increasing habitat diversity within patches. Increasing plant N content promoted a more even spread of species within the insect assemblage on short- but not on tall-grass patches. Large-scale habitat alteration by wild ungulates had no direct effect on the abundance and diversity of Orthoptera.

Stojnic *et. al.* (2012) conducted study to assess species diversity and population abundance of the two main orders of pollinating insects, Hymenoptera and Diptera. The survey was conducted in 16 grassland fragments within agro-ecosystems in Vojvodina, as well as in surrounding fields with mass-flowering crops. Pollinators were identified and the Shannon-Wiener Diversity Index was used to measure their diversity. Five families, 7 subfamilies, 26 genera and 63 species of insects were recorded. All four big pollinator groups investigated were recorded; hoverflies were the most

abundant with 32% of the total number of individuals, followed by wild bees – 29%, honeybees – 23% and bumblebees with 16%.

Weiss *et. al*. (2012) investigated that calcareous grasslands represent local hotspots of biodiversity in large parts of Central and Northern Europe. They support a great number of rare species which are adapted to these xerothermic habitats. Due to massive changes in land use, calcareous grasslands have become a rare habitat type and their conservation has been given a high priority in the habitats directive of the European Union. It is well known that grassland management may affect biodiversity substantially. However, the quality of calcareous grasslands is also influenced by abiotic conditions, such as aspect (i.e. sun exposure), which affects the local mesoclimate. South-facing pastures maintained a greater diversity than north-facing pastures, but both had a greater diversity than extensively used meadows. Intensively used meadows maintained the lowest diversity and abundances. A multivariate analysis revealed that the abundance of rare Orthoptera species correlated with bare ground cover and forb cover, both of which were greatest at south-facing pastures.

Rozenfelde and Vilks (2013) studied about military training area "Ādaži", a part of the ecological network of protected areas Natura 2000, includes the largest heathlands of Baltic States. One of the indicators widely used in biodiversity researches are crickets and grasshoppers. The goal of this study is to gather the first results of Orthoptera diversity in Ādaži. The research is made in 6 sampling sites, including territories where burning has been carried out in years 2009, 2010, 2011 and 2012. In every plot all morphologically determinable species of Orthoptera were collected, and additionally 5 Barber traps were situated in the soil. A total of 30 Barber traps were placed for an exposition period of one month, from 6th august to 6th September 2012.

Yesenbekova and Homziak (2013) identified that species rich (252 species) Heteroptera assemblages associated with four desert types: sandy, solonchak

(salt), clay and stony desert. The sandy desert was most species rich (153), followed by the solonchak desert (101), and clay desert (73). The stony desert was the poorest species (61). We found significant differences (P=0.05) in Jaccard similarity between pairs of Heteroptera assemblages among all four desert types. However, excluding ubiquitous generalist species, sandy desert Heteroptera assemblages were statistically similar (p=0.05) to both the clay desert and to solonchak desert assemblages. Species limited to only one desert type (habitat specialists) were the most common but were unevenly distributed: sandy and solonchak deserts had the highest proportion of habitat specialist species (50 and 54%), while the clay and stony deserts had the lowest (32 and 33%).

Khan (2014) demonstrated that butterflies are considered one of the most studied orders of class Insecta. However, the butterfly fauna of Bangladesh are not well documented. The current research was carried out from March 2014 to July 2014 with an aim to document new species to contribute and update the butterfly checklist of Bangladesh. From the butterfly survey in different regions of Bangladesh, three new butterflies were recorded as distribution. *Arhopala agaba agaba* Hewitson, 1862 (Purple-Glazed Oakblue) and *Deudorix epijarbas amatius* Fruhstorfer, 1912 (Cornelian) were documented from University of Chittagong (CU) campus whereas *Delias acalis* Godart, 1819 (Red Breasted Jezebel) was recorded from Shahjalal University of Science and Technology (SUST) campus. Butterflies are important element of ecosystem mainly because of their pollination activities. Moreover, they are considered as good ecological indicators because of their sensitivity towards the environmental and climatic changes. Hence, it is indispensable to know the exact number of butterflies, their diversity and distribution throughout the country to monitor ecological status.

Magagula and Nzima (2014) investigated that heterogenous agro ecosystems have the capacity to maintain high insect diversity despite alterations due to human activities. The distribution of carabid beetles and ants within a variety

of habitat mosaics was monitored at two climatically distinct locations. Both insect Families were monitored to compare community similarities between habitats, within and between the two sampling locations. Species occurrences were significantly different between the two locations ($p<0.05$), with distinct patterns of distribution, resulting in high dissimilarity between locations and habitats sampled. While the lowveld had highest populations and diversity of both ants and carabid beetles in unmanaged habitats, the middleveld had high carabid beetle diversity in managed habitat and populations in unmanaged habitat, while ant populations and diversity were highest in an unmanaged habitat. Although the two locations had no carabid beetle species in common, they had a few ant species in common. Due to their abundance, diversity and relation to management, both insect families have the potential to be used as indicators in the locations assessed.

Heads *et. al.* (2015) conducted a baseline inventory of terrestrial Heteroptera (true bugs) and Orthoptera (grasshoppers, Crickets and katydids) at four sites in Monroe And Randolph counties, Illinois In 2014, namely: Mill Creek Natural Area (MCNA); White Rock Nature Preserve (WRNP); Fogelpole Cave Nature Preserve (FCNP); and Kidd Lake State Natural Area (KLSNA). A Total of 95 Species in the focal taxa were recorded (67 Heteroptera and 28 Orthoptera). In addition, a further 96 Species of arthropods in groups other than Heteroptera and Orthoptera Were also recorded. Heteropteran Diversity was found to be typical of that expected for other natural areas in Illinois, Though Orthopteran diversity was much lower and may be related to structural aspects of the respective habitats. Cluster analysis of our presence/absence data revealed marked differences in site similarity between Orthopteran and Heteropteran species assemblages.

2.2 NATIONAL

Sharma and Joshi (2009) comprised detailed study on the butterfly species diversity at Dholbaha dam, in district Hoshiarpur, Punjab, India during 2002-04. The study area has a moist deciduous forest surrounding it. A total of 41 butterfly species belonging to 5 families of order Lepidoptera were recorded during the study period. The family Nymphalidae, represented by 19 species was the most dominant followed by Pieridae (10 species), Lycaenidae (8 species), Papilionidae (3 species) and Hesperiidae (1 species). *Eurema hecabe* (Linn.) was the most dominant species of Butterfly in terms of number of individuals followed by *Danaus chrysippus* (Linn.), *Euchrysops cnejus* (Fabr.), *Euploea core* (Cramer), *Junonia lemonias* Linn., *Catopsilia pyranthe* Linn. so on and least by *Graphium sarpedon luctatius* Fruhstorfer and *Delias eucharis* Drury. From the conservation point of view, the study area is undisturbed and rich in flora and fauna species.

Ghorpadé (2010) worked to supplement the earlier works on butterflies of the Palni Hills published in 1910 and 1960, and also to present a complete list of all species so far known from these ranges in the Tamil Nadu State in southern India. A total of 310 species, placed in 162 genera among six families are listed, with abbreviated references to them (illustrations and text) in most of the currently available and used guide books and papers. The scientific nomenclature of Western Ghats butterflies has been critically researched and brought up to date, in some cases based on taxonomic studies involving examination of primary types.

Hameed (2010) illustrated that butterflies are the best introduction to the amazing world of insects. Conspicuous due to their time of activity and colouration, they are also the best studied group of insects. The Farook college campus and Azhinjilam with floral components and topographic factors were monitored for diversity and host plant preference in butterfly communities. A total of 38 species belonging to five families were recorded. Species diversity

and abundance were high in Farook college campus. Marked variations have been observed in the distribution of butterfly species with season, high frequency of occurrence was noticed during late monsoon and post monsoon months. Most common species were Common Bush Brown (*Mycalesis perseus*), Common Grass Yellow (*Eurema hecabe*) , Tailed Jay (*Graphium agamemnon*) and Common Crow *(Uuploea cor*). The plant species such as *Leucas aspera* and *Lantana camera* were most preferred host plants in the area. Grazing and water level have a major impact on floral compositions which in turn affect butterfly diversity.

Sathe and Bhusnar (2010) believes that biodiversity protection and conservation is on national and international agenda and responsible for sustainable development of a region or a country and secondly dragonflies are potential bio control agents of mosquitoes. Therefore, biodiversity of mosquitovorus dragonflies of Kolhapur district including Western Ghats of Maharashtra has been studied. In all, 43 species of dragonflies were found feeding on mosquitoes. The important genera includes *Gomphus, Burmagomphus, Cyclogomphus Microgomphus, Anax, Macromia, Orthetrum, Potomarcha, Pantala, Chlorogomphus, Epophthalmia, Indionyx, Amphithemis, Hylaeothemis, Heliogompuhus, Davidiodies, Bradinopyga, Crocothemis* and *Lameligomphus.*

Singh (2010) sampled butterflies during February and September 2008 using pollard walk method to assess the species diversity in the tropical moist deciduous sal forest habitats of Ankua Reserve Forest, Koina Range, Saranda Division, West Singhbhum District, Jharkhand. This area, a total of 999.9ha, is being proposed for lease under an iron ore mining project. This short-term study revealed high beta diversity of butterflies in these forest tracts, with 71 species recorded. Of these, two species, Leopard Lacewing *Cethosia cyane* (Drury, 1773) and Restricted Demon *Notocrypta curvifascia* (C. & R. Felder, 1862) are new records for Jharkhand state while three other species recorded are listed in the Indian Wildlife (Protection) Act 1972. This study provides

support for long-term conservation of these fragmented sal forest tracts to ensure biodiversity protection.

Tamang (2010) made observations in the Butterfly Park, Bannerghatta showed the presence of a great number of variety of species of butterflies in the present study. Some rare species like Southern birdwing were also observed. Many other species like the Baronet, Common castor, Crimson rose, common Emigrant, common Mormon, Mottled Emigrants etc., were also observed. The park displayed a rich floral surrounding for the proliferation of the butterflies along with many other insects. Though many species were identified and many unknown species were observed, the populations of different species were not very high. This may be due to change in the climatic condition or impact of human activities.

Amala *et. al.* (2011) showed the butterfly fauna of selected areas in the Sirumalai Hills, Dindigul district, Tamilnadu, and observed 36 species of butterflies. The family Pieridae and Nymphalidae were represented more in numbers. The study showed a close relationship of the butterfly fauna with the flora of the Sirumalai Hills. Of all the insects, butterflies and moths are most admired and popular. They are good pollinators and some of their larval forms are agricultural pests. Butterfly fauna of India is rich with 1500 species, which is close to 90 percent of the total butterflies in the world (Kunte, 2000). Since butterflies are good indicators of environment, capable of supplying information on changes in the ambient features of any ecosystem and also economically important, in the present study an attempt has been made to find out the biodiversity of the Lepidopteron fauna in the selected pockets of Sirumalai Hills, Dindigul district, Tamilnadu.

Thakare *et. al.* (2011) conducted a survey of scarab beetle faunal diversity, abundance and composition in Kolkas region of Melghat Tiger Reserve, Amravati, Maharashtra, during May to October 2009. Scarab beetles were collected by dung baited pitfall traps and handpicking in five transects with

different vegetation type and microhabitat. Total 26 species of scarab beetles belonging to 14 genera and 8 subfamilies were reported. Scarabaeinae was the dominant subfamily with respect to species diversity (15 species) and abundance. *Onthophagus* Latreille, 1802 is the dominant genus observed in the study area.

Akhtar *et. al.* (2012) Surveyed Grasshoppers fauna from Uttar Pradesh state of India during the consecutive years 2010 and 2011from rice fields of both Rabi and Kharif season respectively. 26 species of grasshoppers representing 14 genera belonging to 2 families, 8 sub families and 12 tribes have been recorded. Maximum diversity shown by family Acrididae (85%) followed by pyrgomorphidae (15%). All the species of genera *Oxya*, *Hieroglyphus* and *Acrida* collected from field were found feeding on rice foliage. Severe damage shown in the later stage of the crop growth by these species and hence may be considered as major pest of rice.

Aland *et. al.* (2012) made concerted efforts to study diversity of beetles in and around Amba Reserve Forest of Kolhapur District Maharashtra. Incidentally, the study region is a part of Western Ghats which is included in hottest hotspots of the world. During the present surveys and collection a total of 152 species distributed over 101 genera belonging to 25 families of beetles were recorded. The Shannon-Weaver (2.29) and Simpson Diversity Indices (0.79) revealed rich diversity and abundance in the region under study. Arthropods and insects in particular, are the most species rich group of organisms on the planet. They dominate every major terrestrial biome and are responsible for many essential ecosystem processes. Order Coleoptera is enormously rich in species and wide spread in many terrestrial and freshwater environments throughout the world. Almost all biologists are well familiar that beetles are the most diverse in all animal groups, with 3,50,000 described species and approximately 15,088 species were recorded from India.

Chandra *et. al.* (2012) collected few scarab beetles from Govind Wildlife

Sanctuary, Uttarakhand, comprising 11 species belonging to 11 genera, 5 subfamilies and 2 families of superfamily Scarabaeoidea. All the species are recorded for the first time from the sanctuary while three species viz. *Anomala cantori* (Hope), *Mimela passerinii* Hope, and *Oryctes nasicornis* (Linnaeus) are new records to the fauna of Uttarakhand. An updated checklist of the scarab beetles under superfamily carabaeoidea of Uttarakhand comprising about 167 species belonging to 52 genera, 21 tribes, 9 subfamilies and 3 families is also provided.

Chandra *et. al.* (2012) made a collection of Hemiptera from Veerangana Durgavati Wildlife Sanctuary by different tour party of Zoological Survey of India, Jabalpur. It comprises 24 species distributed among 23 genera over 9 families. Veerangana Durgavati Wildlife Sanctuary (VDWLS) covering an area of 24 Km2 was declared vide Govt. of Madhya Pradesh (Diwedi 2003). The sanctuary is situated on state highway number 36 midway between Jabalpur and Damoh (approximately 50 Km either way) within 23°35' N latitudes and 79°40' and 79°50' E longitudes. The topography of WLS is hilly.

Chandra and Gupta (2012) documented diversity and composition of dung beetles (Scarabaeidae: Scarabaeinae and Aphodiinae) assemblages in Singhori Wildlife Sanctuary (SWLS), Madhya Pradesh. Collection of specimens yielded a total of 669 beetles representing 26 species belonging to 12 genera and two subfamilies. The subfamily Scarabaeinae with 24 species is dominating (71.59% of total individuals) over Aphodiinae (27.40%) with two species. Twenty species were collected in mixed forests (n=398) and nineteen species in agricultural lands (n=271), wherein thirteen species were present in both the habitats. Though the species richness is almost similar in SWLS, but there is significant difference in guild structure and composition. Tunnellers were the most speciose (22 species) and abundant (55.3%) followed by dwellers which constitute three species with 42.8% abundance in the assemblage.

Das & Gupta (2012) recorded seven families, 11 genera and 14 species of Hemipteran insect community in different seasons in a temple pond near Silchar, Cachar District, Assam, northeastern India. The pond is very rich in macrophytes like *Nelumbo nucifera* (Water Lotus), *Hygrorhiza aristata* (Indian Lotus), *Cynodon dactylon* (Bermuda Grass), *Philotria* sp. etc. The hemipteran families recorded in the system were Corixidae, Gerridae, Aphididae, Mesoveliidae, Notonectidae, Nepidae and Belostomatidae. The species were *Micronecta haliploides, Micronecta* (Basileonecta) *scutellaris scutellaris (Stål)* (Corixidae); *Neogerris parvula (Stål), Limnogonus nitidus* (Mayr), *Tenagogerris* sp., *Rhagadotarsus* sp. (Gerridae); *Enithares ciliata* (Fabricius), *Anisops lundbladiana Landsbury,* (Notonectidae); *Diplonychus rusticus* (Fabricius) and *Diplonychus annulatus* (Fabricius) (Belostomatidae), *Rhopalosiphum nymphaeae* (Linnaeus) (Aphididae), *Ranatra elongata* (Fabricius), *Ranatra varipes varipes* (Stål) (Nepidae) and *Mesovelia vittigera* Horváth (Mesoveliidae). The highest population of Hemiptera was recorded during the post-monsoon followed by the pre-monsoon and the monsoon periods. The lowest was recorded in the winter. Shannon Weiner diversity index (H/) and evenness index (J/) showed the highest diversity and evenness during the post monsoon period. Berger Parker index of dominance (d) was found highest in winter. In winter both diversity and density were the lowest. The study revealed the presence of four dominant species and three sub-dominant species in the pond. Insect diversity did not show any significant relationship with the environmental variables.

Das *et. al.* (2012) observed the Odonates diversity in buffer area of Similipal Biosphere Reserve was observed, where we recorded 58 species. Libellulidae was the richest family with 31 species and Orthretum was the most common genera. The sub-order Zygoptera was represented by 23 species and 35 species represents sub-order Anisoptera. Perennial river system with different habitat types provides good opportunities to these wonderful insect groups to flourish and survive. Mostly odonates were aggregated due to habitat specific nature and random distribution indicates availability of resource utilization to

survive. But, in the buffer area high anthropogenic disturbances were observed which creates high biotic pressure on forest. A detailed list of odonates recorded from buffer area is presented.

Kumar (2012) has undertaken the study in Jhansi; famous for the fort, gardens and surrounding hilly areas. These gardens and hilly areas have supported butterflies and other insects. The butterflies are essential part of any natural ecosystem as their adults performs pollination. They are highly mobile organism and are able to maintain connectivity between the fragmental habitats. The larval stages are herbivorous and cause economic damage but adult are beneficial as pollinators of several trees and herbaceous flora. They are vulnerable to changes in flower supply resulting from deforestation and environmental pollution hence they are the biological indicators of pollution. The present study was conducted regarding the different selected sites visited by butterflies, their foraging activity and abundance at different sites of Jhansi. During the visit some species of butterflies were collected as flower visitors on different species of flowering plants (garden, cultivated, semi wild and wild) in selected areas. The species of collected butterflies were showed the most common and highly active species throughout the day. Some species namely *Pieris canidia indica*, *lxias mrianne* (Cramer), *Catopsilia crocale* (Cramer), *Catopsilia pyranthe* (Linn.), *Eurema hecabe fimbriata* (Wallace) *Colias electo fieldi* and *Colias erate* (Esper) were observed mostly on the flowering plants of each site during the study. The nymphalids were found to be very common in the plane areas of Jhansi as flower visitors and only one species *Papilio demoleus* could be collected from only two sites.

Parandhaman *et. al.* (2012) has undertaken the present study in southern Western Ghats of Tamilnadu, India. It is one of the global biodiversity hotspots that includes Nilgiri biosphere and Kodaikanal Wildlife Sanctuary (proposed). He studied the Diversity, Dominance and Evenness of butterflies in three different habitats (forest area, river bank, and crop area) during the period January 2011 to December 2011. A total of 92 species, from 65 genera

and 5 families were recorded. Species diversity and abundance were maximum in the months of March-May and dropped to the minimum in the months of December-January. Forest area habitat had greater species diversity, while river bank habitat had greater number of individuals; crop area had the least diversity and abundance among the studied habitats. They have also recorded the endemism and flight period of some butterflies and their distribution within the habitats with their nectar source plants. Analyses were done to emphasize the importance of butterflies and the need for their conservation.

Roy *et. al.* (2012) observed the butterfly diversity in and around Neora Valley National Park (NVNP), West Bengal, India was studied from three different habitat types that included thick vegetation assemblage with closed canopy cover, edges of forest and areas of human intervention during April – May 2010. A total of 30 butterfly species belonging to the families of Hespeririidae (3.33%), Papilionidae (16.65%), Pieriidae (13.32%), Nymphalidae (53.28%) and Lycaenidae (13.32%) were identified in the present investigation. Highest butterfly diversity and abundance was recorded from areas of forest edges (54.83% of individuals represented by 16 different species), while dense forest (30.64 % of individuals represented by 11 different species) and areas with human habitats (14.52 % of individuals represented by 8 different species) showed lower butterfly diversity and abundance. Accordingly highest Shannon Weiner diversity score of 2.32 was recorded from areas of forest edges. The butterflies that showed high occurrences were Indian Tortoise Shell (*Aglais cashmiriensis*), Yellow Coster (*Acraea issoria*) and Himalayan Five Ring (*Ypthima sakra*). Only 1 butterfly species, Yellow Coster (*A. issoria*) was found to co-occur in all the three sites. Accelerating human civilizations has lead to destruction of much of the global natural habitats while it has often been found to exert adverse effects on biodiversity. Findings made during this study also indicate negative influence of anthropogenic intervention on overall butterfly diversity from the present location.

Sharma *et. al.* (2012) recorded diversity of butterfly fauna in the North Eastern Regional Institute of Science and Technology (NERIST) Campus of Nirjuli, Itanagar; Arunachal Pradesh, India. The habitat was divided into four major categories namely home garden, forest patch, road side plantation and open grassland. A total of 63 species of butterflies belonging to the five families were recorded during the survey and Nymphalidae were the most commonly recorded, accounting for 44% of total species recorded followed by Lycaenidae 17%, Pieridae 16% and Papilionidae 14% of total species and minimum was recorded for Hesperidae 8% (n=5) Maximum 51 species were recorded in the forest patches followed by home garden (46), road side plantation (44) and minimum in open grassland (36). A total of 398 individuals were recorded from the campus with highest abundance in home garden (n=129) followed by open grassland (n=96), forest patch (n=89) and road side plantation (n=84). The diversity was found high in the forest patch (H=3.76) followed by roadside plantation (H=3.68), home garden (H=3.65) and open grassland (H=3.39). Conservation of butterfly fauna in a small landscape particularly in human dominated might be a good model for maintaining optimal habitat within fragments and in that case academic institutional campus with high plant diversity might be a very good option for the conservation of the species.

Thakare and Zade (2012) investigated the coleopteran diversity in and around Tarubanda village, Gugamal Range, Melghat Tiger Reserve was conducted from October 2010 to November 2010. Melghat Tiger Reserve is located as a southern offshoot of Satpuda hill range in central India called Gawilgarh hill in the Indian State of Maharashtra. This village consists of a very diverse type of flora & fauna. A total of 16 species of beetles were collected and examined, out of which 13 species belonging to 6 different families were identified from various habitats.

Thakare *et. al.* (2013) collected ground beetles from the month of February 2009 to December 2010. Almost all the habitats were explored in Melghat

Tiger Reserve in search of carabids. Total 10 species of ground beetles belonging to 6 subfamilies of family Carabidae were collected and examined. The systematic account, checklist and distribution of the recorded species are given in the present paper. The diversity study of beetles of Amravati region is relatively untouched field; hence an effort was made in the present work to study the diversity of carabid beetles in this region. Carabids are usually predators and primary importance of the family

Chandra and Gupta (2013) conducted a faunistic survey in Barnawapara Wildlife Sanctuary, Chhattisgarh revealed 43 species belonging to 25 genera, 16 tribes and eight subfamilies in two families, Hybosoridae and Scarabaeidae of the superfamily Scarabaeoidea. All the species are recorded for the first time from the Sanctuary, while 31 species are new to the scarab fauna of Chhattisgarh, India. Scarab beetles comprise a species group and are a conspicuous component of the beetle fauna of the world. Adults of these beetles are noticeable due to their relatively large size, bright colors, often elaborate ornamentation, and interesting life histories. Life histories of scarab beetles are incredibly diverse and include adults that feed on dung, carrion, fungi, vegetation, pollen, fruits, compost, or roots. On the other hand, some scarab beetles live in the nests of ants (myrmecophiles), in the nests of termites (termitophiles), or in the nests of rodents or birds. Dung beetle is a common name applied to beetles in the subfamilies Scarabaeinae and Aphodiinae, while most species in the subfamilies Melolonthinae, Dynastinae, Rutelinae, and Cetoniinae feed on plant products and are occasionally agricultural pests of various commercial crops.

Grampurohit and Karkhanis (2013) studied the biodiversity that led to increasing interest in assessing the diversity of insects because this group dominates terrestrial and freshwater ecosystems and are valuable indicators of the health of these ecosystems. Presence of insects in the mangrove ecosystem is of importance because they feed, reproduce on plants and help in pollination. Certain level of natural damage caused by pest insects is of

ecological significance in mangrove ecosystem. Study of insect biodiversity is useful in managing the forest resources. The study area selected for this research project is a private land owned by Godrej & Boyce Mfg.Co.Ltd located along the Eastern Express Highway at Vikhroli, Mumbai. This land is covered with mangrove forest. Total eleven sites were selected randomly so as to cover maximum area of mangrove forest. At each site, during low tide, different insects were observed and photographed. Photo-essay of these insects was prepared. Diversity index, evenness index and dominance index was calculated. As per the results, Shannon index is 0.4, Simphon's diversity index is 0.93 and evenness index is 0.1. Species richness index is 1.94. The result shows that the study location being in the industrial area of Mumbai, the insect diversity is less but there is a natural balance of damage and reproduction. The present research paper highlights the need of conservation of floral and faunal biodiversity to preserve the natural balance of the ecosystem.

Jaganmohan *et. al.* (2013) showed that domestic gardens may play a vital role in supporting urban insect biodiversity, despite their small size. This paper assesses the abundance, diversity and distribution of insects in urban domestic gardens in the tropics, through a study in the rapidly expanding Indian city of Bangalore. Fifty domestic gardens were studied using a combination of light traps and pitfall traps. We recorded a large number of insects, 2,185 insects from 10 orders, of which ants, bugs, beetles and flies were the most common. We found 25 species of trees (from 160 individuals) and 117 species of herbs and shrubs in the 50 sampled domestic gardens. The number of insect orders encountered was significantly related to the number of tree and herb/shrub species. Garden management practices also influenced the abundance and richness of insect orders. Thus, greater numbers of insects were observed in gardens with a greater proportion of bare soil relative to grass area and with less intensive weeding practices. Insect numbers were significantly reduced in gardens subjected to pesticide application. Most residents avoided application of pesticides and herbicides, citing health concerns.

Jeevan *et. al.* (2013) carried out study on biodiversity of butterflies in Mandagadde of Shivamogga of Karnataka. Many butterfly species are strictly seasonal and prefer only a particular set of habitats and they are good indicators in terms of anthropogenic disturbances and habitat destruction. The richness and diversity of butterfly species is proportional to the food plant diversity, richness of flowers and intensity of rainfall. Unfortunately, butterflies are threatened by habitat destruction and fragmentation almost everywhere. A total of 52 species of butterflies belonging to 5 families were recorded during the study period. Among the 5 families, Nymphalidae dominated the list with 23 species, Paplionidae with 9 species, Pieridae and Lycaenidae with 8 species each and Hesperidae with 4 species. It is found that 9 species of butterflies are very common, 26 species are common and 17 species are rare in occurrence in Mandagadde.

Kurve (2013) worked on variety of ecosystems that provides suitable habitat for diverse fauna in Thane, a sister city of Mumbai,. The study area, "Jnandweepa" (college campus) is located on the edge of thane creek with mangroves on the periphery and well maintained garden with variety of plants species in 13.5 acre area providing natural habitat for biodiversity. In the present study, diversity of butterflies and their resources such as food plants within the college campus were studied. 52 species of butterflies were recorded with Nymphalideae showing dominance over other 4 families with 22 species, followed by Pierideae and Lycinideae with 10 species each, Papilionideae with 7 and Hespirideae with 3 species. The survey of plants showed around 30 species of larval food plants which justifies the diversity of butterflies. The survey also recorded some uncommon species such as Black Rajah and Common Palmfly in the campus which were not found in the earlier reports. Their presence can be attributed to newly introduced plant species during horticultural and gardening activities.

Mohan and Padmanaban (2013) illustrated that Coleopteran diversity is high in the tropics compared to temperate regions of the world. In the lives of

insects, temperature is one of the most critical factors. The present study is carried out in and around Bhavani, Erode district, Tamil Nadu, India. Different locations were selected for the collection of coleopteran insects around Bhavani in different months. Four hundred and ninety three coleopteran insects were collected in the present study around Bhavani. They were identified which belonged to 22 different species of coleopteran. The analysis of different coleopteran species in different months indicates was dominant in March 2011. Oct. 2010, Nov 2010, Dec 2010, Jan 2011 and Feb 2011 the insects were greatly decreased. Temperature plays a major role in distributions of Coleopteran insects as evidenced in the present study. The diversity index, species richness and evenness of coleopteran insects in Bhavani were 3.03, 3.38 and 0.98 respectively.

Sathe *et. al.* (2013) worked on forensic insects which helped in solving the mysteries of a crime like murder and essential component of court of law. Therefore, diversity of forensic insects has been studied from Western Maharashtra (Kolhapur, Sangli & Satara), India. In all 25 insect species of forensic importance have been reported belonging to the families Culicidae, Calliphoridae, Sarcophagidae, Muscidae, Psychodidae, Tabanidae, Piophilidae, Syrphidae, Chioropidae, Ceratopogonidae, Shaeroceridae and Trichoceridae of order Diptera. The occurrence, association, distribution, life cycle and the forensic role of members of above families have been discussed.

Sharmila and Thatheyus (2013) represented the diversity of butterflies in Alagarhills situated in Tamil Nadu, India, for two years using transect method. There was prevalence of one hundred and one species, representing five families. Nymphalidae was the most prevalent family and the least represented family was Hesperiidae.

Shende and Patil (2013) carried out studies in Gorewada International Bio-Park that provides a good habitat for biodiversity of Odonates. Dragonfly watching and recording has been done in each line transect during a week.

Total 34 species of dragonflies are recorded belonging to 24 genera and 4 families. Out of total dragonfly species examined, 26 (76.47%) are common and 8 (23.53%) are occasional. Libellulidae family is consisting of maximum number of genera and species followed by Aeshnidae, Gomphidae and Macromiidae. The present study encourages the conservation of a wide range of dragonfly species in this area.

Sitre (2013) found that Benthic macro-invertebrates are the bottom dwelling organisms found in all the aquatic ecosystems of the world which differ from ecosystem to ecosystem. The aquatic insects also reside in surface, column and bottom zone of fresh water lakes. In this context the benthic macro-invertebrates and aquatic insects of Ghotnimbala reservoir of Bhadrawati tehsil of Chandrapur district are qualitatively studied. The benthic macroinvertebrates were studied keeping in view their potential in indicating degree of pollution. The aquatic Dytiscidae (Predaceous diving beetle *Cybister* spp.), Gyrinidae (Whirling beetles) and aquatic hemipterans, Belostomidae (Giant Water bug), Nepidae (Water scorpion) and others were found in the littoral zone.The presence of dipteran larvae in the lake sediments point out towards the presence of organic pollution in the lake basin. In all 7 species of benthic macroinvertebrates and 9 species of insects were recorded in the lake waters. The molluscan species were recorded from the submerged plants as well as from sediments of the lake basin.

Qureshi *et. al.* (2013) undertook survey-cum-collection tour in the Kupwara district of J&K from 2007- 2009 to know the butterfly fauna of the area, highlighting their month wise distribution, seasonal distribution, and flight period and other bio-ecological components. Thirty six species of butterflies belongs to 8 families and 30 genera were collected. The butterfly activity was observed from March to November and the highest abundance was in summer season (June-August) whereas there was no butterfly activity in winter (December-February). The most dominant family was Nymphalidae followed by Pieridae, Satyridae and Lycaenidae. Highest distribution was observed in

habitats like forests, hilly areas, gardens near forests in areas like Batpora (Magam), Drugmulla, Karnah, Langate, Lolab Valley, Mawar, Panzgam, Rajwar, Trehgam, and Villgam. The other floral and faunal elements of the area need to be studied so that the biodiversity of the area can be compiled and documented.

Waghmare *et. al.* (2013) Explained that, grasshopper is one of the largest and diverse groups in the class Insecta. They are dominant above ground invertebrates in cultivated and in natural grasslands ecosystems and they are functionally important. For the first time survey and collection of short horned grasshopper (Orthoptera: Acrididae) was carried out from selected grasslands of Solapur district, Maharashtra, India. 7 species belonging to 7 different genera i.e. *Acrida, Gastrimargus, Trilophidia, Catantops, Calaptenopsis, Chrotogonus* and *Atractomorpha* and 4 different subfamilies Tryxalinae, Cedipodinae, Catantopinae and Pyrgomorphinae were recorded.

Belamkar and Jadesh (2014) conducted a preliminary study on the abundance and diversity of insect's species in agriculture fields of Hadgil Harutti village, Gulbarga, Karnataka. The present study was aimed to determine the species richness, dominance and evenness of insect fauna from agriculture fields. The study was carried out during the month from June 2013 to September 2013. A total of 11,318 insects from 6 orders, 26 families and 54 species were recorded. This study shows that Hymenoptera (78.86%) was the most dominant order according to total number of individuals, followed by Coleoptera (15.45%), Lepidoptera (3.22%), Hemiptera (1.47%), Orthoptera (0.95%) and Diptera (0.05%). The Simpson's Reciprocal Index diversity is highest in order Coleoptera (8.048) and lowest in order Diptera (1.000). The species richness, evenness and diversity of insects were calculated by Margalef's Index, Pielou's Index and Shannon-Wiener Index respectively.

Bharamal *et. al.* (2014) presented a preliminary study on Coleopteran of Sindhudurg district, in which five major localities were selected *viz*.

Sawantwadi, Amboli, Malvan, Kudal and Kankavli. The present study, includes 59 beetle species (Cicindellidae, Carabidae, Dytiscidae, Gyrinidae, Hydrophilidae, Histeridae, Lampyridae, Elateridae, Coccinellidae, Meloidae, Tenebrionidae, Bostrichidae, Scarabaeidae, Cerambycidae, Chrysomelidae, Curculionidae and Bruchidae) belonging to 48 genera and 17 families recorded from Sindhudurg district.

Kalita *et. al.* (2014) observed Odonates variety in Manchabandha Reserve Forest was observed, they recorded a total of 48 species of odonates. The sub-order Zygoptera was represented by 15 species out of which Coenagrionidae was the richest family with 9 species. And sub-order Anisoptera was represents 33 species out of 33species Libellulidae was the richest family with 27 species. For the first time observation of odonates diversity in Manchabandha Reserve Forest, Baripada, Mayurbhanj District, Odisha was reported. A detailed list of odonates recorded from Manchabandha Reserve Forest is presented.

Kirti and Kaur (2014) carried out intensive and extensive collection-cum-survey tours in three major regions of Punjab (Malwa, Doaba and Majha) to study mosquito diversity of the state from 2009- 2011. A total number of 26 species referable to 13 genera were recorded during three years period. All these species were earlier known from Punjab except *Culex* (*Culex*) *sitiens* Wiedemann, *Culex* (*Eumelanomyia*) *brevipalpi* (Giles), *Lutzia* (*Metalutzia*) *vorax* Edwards and *Mansonia* (*Mansonioides*) *indiana* Edwards which are reported for the first time from this agriculture state. Larval characteristics, collection sites, bionomics and vector potential for each of these species are described. A list of Culicinae of Punjab state has also been provided.

Patil and Shende (2014) demonstrated that Gorewada international bio-park is a good habitat for biodiversity of butterflies. Butterfly watching and recording was done in such a way that there should be least one visit in each line transect during a week with the aid of binocular and digital cameras. Total

92 species of butterflies were recorded belonging to 59 genera and 5 families. Out of total 92 butterfly species 48.92%, 38.04% and 13.04% are common, occasional and rare species respectively. Nymphalidae family is consisting of maximum number of genera and species. Maximum species richness reported from July to January and its number decline from late March to last week of June. The present study will encourage the conservation of a wide range of indigenous butterfly species in an area.

Pawara *et. al.* (2014) represented a record of 35 species belonging to 28 genera under 13 families of the order Coleoptera (Linnaeus, 1758) from Jalgaon district of Maharashtra, India. The families viz. Carabidae (4 genera and 4 species), Gyrinidae (1 genus and 1 species), Dytiscidae (1 genus and 2 species), eotrupidae (1 genus and 1 species), Scarabaeidae (9 genera and 9 species), Buprestidae (1 genus and 3 species), Coccinellidae (2 genera and 2 species), Tenebrionidae (3 genera and 3 species), Chrysomelidae (1 genus and 2 species), Cerambycidae (1 genus and 1 pecies), Curculionidae (2 genus and 2 species), Meloidae (4 genera and 4 species) and Cetoniidae (1 genus and 1 species). It is very rich in biodiversity.

Rathod *et. al.* (2014) carried out study to explore the diversity and abundance of dragonflies and damselflies (Order – Odonata, Class Insecta, phylum Arthopoda) in agro ecosystems around Amravati city in monsoon season (July 2012 to October 2012). Odonata fauna of agro ecosystem for present study was investigated, total 31 species belonging to six families of dragonflies and damselflies (order - odonata) were recorded, in which the most abundant family was Lebellulidae followed by Coenagrionidae, while Gomphidae, Lestidae Aeshnidae, Platycnemididae families were least abundant. Libellulidae family represents 17 species, Coenagrionidae represents 9 species, Gomphidae represents 2 while Aeshnidae, Platycnemididae and Lestidae were with one species each. They also calculated the Species diversity (H) and Evenness (E) which is 3.012 and 0.877 respectively. From above study we conclude that the present study area is rich in dragonflies and

damselflies fauna in monsoon season.

Saikia (2014) conducted a survey of butterfly diversity in Gauhati University Campus, Jalukbari, Assam from September, 2003 through August, 2010. Numbers of surveys, covering all four seasons were made in four different study zones of Gauhati University campus, Jalukbari, and altogether 140 species of butterflies were recorded belonging to the families of Papilionidae, Nymphalidae, Lycaenidae, Hesperiidae and Pieridae. The study revealed that the monsoon season has the highest diversity than winter, pre-monsoon and retreating monsoon. Lowest diversity was found during winter season. The higher butterfly diversity during monsoon season may be due to wide range species, whereas the low diversity during winter season may be due to non-availability of wide range species. The analysis of correlation between seasonal abundance and species phylogeny shows significance result.

Sethy *et. al.* (2014) carried out a detailed study on the butterfly species diversity at Namdapha Tiger Reserve, in Changlong district, Arunachal Pradesh, during 2008-2009. A total of 1415 individuals' butterflies belonging to 113 species covering, 5 families and 73 genera of order Lepidoptera were recorded during the study period and also 15 rare species were recorded in present study. The family Nymphalidae, represented by (48 species) was the most dominant followed by Papilionidae (24 species), Lycaenidae (17 species) Pieridae (16 species) and Hesperiidae (8 species). From the conservation point of view, the study area is remained rich in flora and fauna species. The most represent families were Nymphalidae and the majority of the species collected were from the family of, Nymphalidae Papilionidae and Lycaenidae. Nymphalidae, Papilionidae, Lycaenidae, Pieridae and Hesperiidae, represents (42.5%, 21.2%, 15.1%, 14.1% and 7.1%) respectively species sampled in all transects. Overall the family composition Nymphalidae represent 393 (48) individuals followed by Papilionidae 339 (24), Lycanidae 320 (17), Peiridae 302 (16) and Hespiiridae 61(8) were recorded during the study periods.

Bhagat (2015) observed 24 species of 19 genera of true bugs, belonging to Infra-order Cimicomorpha, under suborder Heteroptera, occurring in three different geographical regions of north-west Himalaya, *viz*. Jammu, Kashmir and Ladakh. The Cimicomorpha bugs in these regions are represented by four super families, including various families, *viz.*Cimicoidea (family Anthocoridae, Cimicidae, Nabidae), Miroidea (Miridae), Tingoidea (Tingidae) and Reduvioidea (Reduviidae). Miridae is found to be as dominant family, incorporated a total of 8 species of 6 genera, and followed by family Anthocoridae and Tingidae, including 5 species each. The family Reduviidae is represented by 4 species, whereas Cimicidae and Nabidae, having 1 species each. An updated systematic checklist of Species has been provided. Apart from this, biodiversity of Cimicomorpha-fauna has been discussed.

Bhusnar (2015) studied Diversity of Acridid (Orthoptra) at the Solapur district in 2012-2013, Acridid Grasshoppers were collected by one man one hour search method at 15 days interval. Total 18 species from seven sub families were identified with their average population and studied distribution patterns also from different tahsils of Solapur district. Maximum species reported from Pandharpur, Mohal and Malshirous tehsil. Out of 18 species, *P. infumata* is dominant species. In overall observation maximum population of grasshoppers reported in post monsoon period and minimum population in pre-monsoon period.

Kumar (2015) conducted a survey between April 2010 to October 2011 in the forest strip extending 50 Km along Sirhind Canal Mainline in Punjab. A total of 54 species of butterflies belonging to 37 genera referable to 7 families viz., Lycaenidae (10 species under 9 genera), Nymphalidae (11 species under 7 genera), Danaidae (04 species under 2 genera), Satyridae (06 species under 4 genera), Pieridae (16 species under 9 genera), Papilionidae (03 species under 2 genera) and Hesperidae (04 species under 4 genera) have been recorded from the study area.

2.3 RAJASTHAN

Sharma (2011) carried out studies on Lepidopterous insects associated with vegetables in different localities of Aravalli Range of Rajasthan i.e. Mount Abu, Udaipur, Rajsamand, Puskar, Ajmer, Jaipur, Sikar, Jhunjhunu, Sariska, Alwar, Dausa and Bharatpur during 2008-11. During present study 38 species of Lepidopterous insects associated with vegetables in Aravalli Range of Rajasthan were recorded, out of 152 species of Lepidopterous insects recorded from India. The families Crambidae and Noctuidae were the dominant families each represented by 8 species followed by Arctiidae having 4 species; Lycaenidae 3 species; then Nolidae, Pieridae and Sphingidae each having 2 species and least by Cosmopterigidae, Gelechiidae, Geometridae, Hesperiidae, Lymantriidae, Nymphalidae, Plutellidae, Pterophoridae and Saturniidae each having 1 species. On the basis of nature of damage the lepidopterous insects were also categorized as leaf feeders, pod borers, fruit borers, defoliators and leaf rollers, bud borers and leaf webbers, cut worms, leaf miners and stem borers etc. The salient details of their hosts, pest status or otherwise and their updated classification are provided.

Jain and Jain (2012) Four sites of Hadoti region of Rajasthan, India were studied for butterfly diversity. The butterflies were collected by transect sampling method in day time. A total number of 18 species, belonging to 4 families, were identified. Maximum species richness was in Herbal park, Jhalawar and species abundance was greatest in Kota park.

Jain *et. al.* (2013) studied the insect diversity at Abhera-Karnimata an eco tourist place in the outskirts of Kota city, Rajasthan with gardens and natural lake in March 2010. A total of 36 species of insects were collected of which 17 species were Lepidopteran, 10 Odonates, 3 Coleopterans, 2 Hemipterans and 1 each of order Diptera, Hymenoptera, Orthoptera, Dermaptera.

Dhakad *et. al.* (2014) carried out study on the Orthopteran fauna in sugarcane

in the Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, during August to December, 2012. The orthopteran diversity comprised 32 genera belonging to 5 families during the period of survey. Members of the family Acrididae had the highest mean density values in August (29%), September (33.50%), October (55.50%), November (33.50%) and December (23.50%). Crickets of family Gryllidae were recorded to have the maximum mean density value of 12.50 per cent during the month of October, 2012. The families Pyrgomorphidae, Tetrigidae and Tettigonidae were thinly populated and thus had low mean density values. Among Acrididae, the relative density was the highest for the genus *Hieroglyphus* (10.02 to 16.47%) followed by that for *Oxya* (10.03 to 13.18%) and *Spathosternum* (8.07 to 12.61%). Similarly, among the gryllids, the genus *Trigonidium* was more abundant (29.30 to 36.70%); among pyrgomorphids, the genus *Chrotogonus* (42.58 to 49.99%); whereas, genera of Tetrigidae and Tettigonidae had an almost equal representation throughout the period of observation.

Koli *et. al.* (2014) conducted the study in south Rajasthan to explore diversity and species composition of Odonata from January 2013 to June 2013. Odonates were sampled from 13 localities i.e., Pichola lake, Udaisagar lake, Badi lake, Ghasa lake, Menar lake, Badwai lake, Rup sagar lake, Roli todgarh Wildlife Sanctuary, Sitamata Wildlife Sanctuary, Karmoi river stream in Sitamata WLS, College campus, Rajsmand lake and Meja dam. During the study period, a total of 1,290 individuals from 8 families and 54 species were recorded. 4 families and 28 species were related to Anisoptera, while 4 families and 26 species belonged to Zygoptera. Suborder Zygoptera were represented by the families Chlorocyphidae, Coenagrionidae, Lestidae and Platycnemididae, and suborder Anisoptera by the Aeshnidae, Gomphidae, Libellulidae and Macromiidae. Libellulidae was the largest family with 24 species, while the most dominant species was *Brachythemis contaminate* (21.80 %). *Orthetrum chrysis* and *Lestes* sp. were found randomly distributed in the study area, while other were aggregated and showed habitat preference.

Srivastava (2014) investigated that water is the most important limiting factor for existence and distribution of biotic communities in arid and semi arid regions of western Rajasthan. In the region, fewer but varied bodies of water are present. These offer typical physical - chemical conditions including shallow, turbid, well-oxygenated waters which are mostly alkaline, hard and a little saline. The biota of such waters has to be hardy enough to survive under concentration and desiccation condition. The present study was undertaken from September, 2012 to February 2013 to explore insect diversity and its ecology. Aquatic insects were represented by 13 genera besides larval forms of many. The adult insect fauna belonged to only two orders namely Coleoptera and Hemiptera. Coleoptera was represented by four families namely Dytiscidae (5,3 Genera), Hydraenidae (1,1), Hydrophilidae (2,2) and Psephenidae (1,1). Hemiptera was also represented by four families Corixidae (1,0), Nepidae (1,1), Notonectidae (0,1) and Veliidae (1,1 Genera) in the village ponds of Sagar and Devikundsagar respectively in Bikaner District (Western Rajasthan.)

Tak and Srivastava (2015) studied that anthropogenic pressures, holy rituals and tourism have adverse impact on the water quality of the sacred lakes. Physico-chemical parameters are directly affecting to diversity of insect fauna of the water bodies. The present communication deals with the year round study on of insect fauna and its ecological aspects in the Pushkar lake, Ajmer from April, 2012 to March, 2013. Physical-chemical limnology revealed that the lake was shallow with turbid, alkaline, hard, slightly saline and well oxygenated water. The adult insect fauna displayed a diversity of 18 species belonging to families namely Dytiscidae (4), Helodidae (1), Hydraenidae (1), Hydrophilidae (4), Psephenidae (1), Corixidae (1), Gerriidae (2), Nepidae (2), Notonectidae (1) and Velidae (1) besides the larval forms of aquatic and terrestrial insect. The data on population turnover and periodicity of occurrence is viewed upon to adjudge the sensitivity of species to environmental condition.

Kulshrestha and Jain (2016) conducted the study on biodiversity of insects in the college campus which covers around half square kilometer area. One boundary of college campus is along NH12. The major vegetation of college campus is Neem, Banyan, Asoka and Amaltas trees and some ornamental and medicinal plants. The main objective of the study was to determine the insect diversity and the relative abundance of the insect species in the campus. The collection of insects was carried out in the month of Feb.-March and Sept-Oct in the year 2012. Species diversity and abundance of insects were investigated in college campus and we recorded insects belonging to 7 orders 16 families and 38 species. The largest numbers of insect identified were of Lepidoptera followed by Hymenoptera, Odonata, Hemiptera, Orthoptera, Coleoptera and Neuroptera. Anthropogenic activities influenced the abundance of insect orders. Thus, greater numbers of insects were observed in small gardens with a greater proportion of bare soil relative to concrete pathways and places with human interference. The study revealed the higher abundance of butterflies among the insects identified. A total 38 different insect species were recorded giving an indication of the species diversity of the college campus.

Kulshrestha and Jain (2016) Jhalawar is located in the south east corner of Rajasthan at the edge of the Malwa plateau. The study of diversity and richness of butterflies was carried out mainly in three areas of Jhalawar: College Campus, Shree Jairaj Park and Jhiri area in 2012. The butterflies were collected by using nets and hand picking. Collection was done in themonths of February- March and September-October, between 11:00 to 02:00 hours. A total of 20 species of butterflies belonging to 4 families (Pieridae, Papilionidae, Lycaenidae and Nymphalidae) were captured and identified. The most dominant family was Pieridae (7 species) and Nymphalidae (7 species) followed by Papilionidae (3species) and Lycaenidae (3 species). The abundance of species collected was also recorded.

CHAPTER: 3

STUDY AREA

Rajasthan ("Land of Kings") is India's largest state by area (342,239 square kilometres (132,139 sq mi) or 10.4% of India's total area).

Out of the 5 regions of Rajasthan Hadoti is one of the major region which is flagged by Baran, Bundi, Kota and Jhalawar.

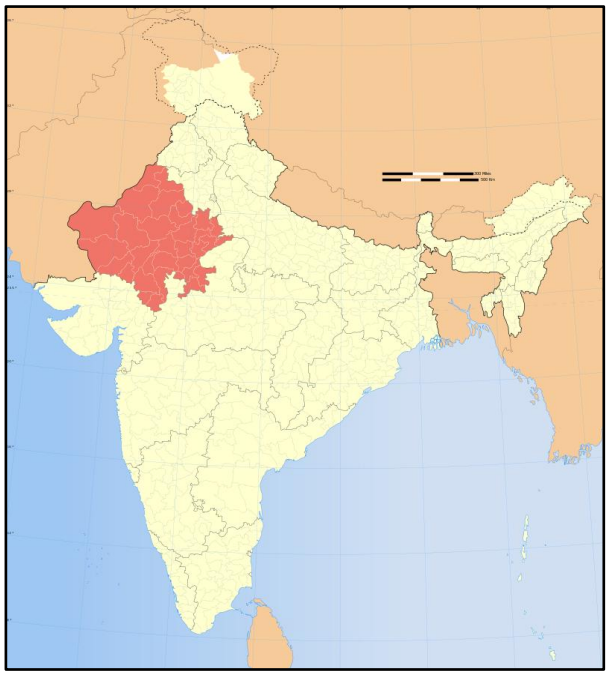


Fig.3.1 Map showing Rajasthan state

3.1 ABOUT JHALAWAR

Jhalawar is the 'land of the Jhalas' - a clan of brave Chauhan Rajput warriors.

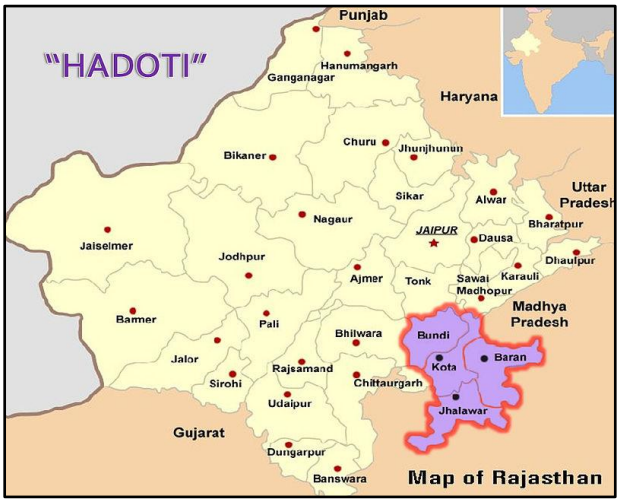


Fig.3.2 Map showing Hadoti region in Rajasthan state

The city of Jhalawar (once known as Brijnagar) was founded by Jhala Zalim Singh (First), who was the then Dewan of Kota state (1791 A.D.). He established this township, then known as Chaoni Umedpura, as a cantonment. The township was surrounded with dense green forests and wild animals Jhalawar is located in the south east corner of Rajasthan at the edge of the Malwa plateau. The State of Madhya Pradesh borders Jhalawar on the south west and in the east of Jhalawar district, while to the north west, north and north east are Ramganj Mandi, Sangod tehsils of Kota district and north east are Atru and Chhipabarod tehsils of Baran district. To the north the Mukandara Range, running from north-west to east. From a

rough boundary between the two districts but Khanpur is beyond the main range. The district is situated between 23°45'20" and 24°52'17" north latitudes and 75°27'35" and 76°56'48" east longitudes.

The district is divided into six sub divisions Jhalawar, Aklera, Bhavani mandi, Pirawa, Khanpur and Manorthana. Jhalawar has stony but water laden lush landscape, winters are colourful and mesmerizing with poppy field and orange laden.

TOPOGRAPHY OF JHALAWAR DISTRICT

It has an average elevation of 317 metres (1040 feet) Jhalawar district is an expanse of fertile plain having rich black-cotton soil. It is watered by several rivers, giving it a verdant look. The largest river flowing through the area is Kali Sindh which flows through the territory to join the Chambal, Rajasthan's largest river. Other rivers include Ujaad, Ahu, Parvan, Chavli, etc.

Climate of the area is identical to the Indo-Gangatic plain, in summer the temperature generally is around 40°C and at maximum can exceed 45°C. While in winter the coldest temperature can touch 1°C. Jhalawar district has the highest rainfall in the Rajasthan state; known as '***Cherrapunji' of Rajasthan.*** An average of 35 inches of rainfall keeps it cool, and gentle breezes ward off the stifling humidity.

The present study was carried out at four locations in the Jhalawar, disturbed (2), semi- disturbed (1) and undisturbed (1) areas *viz.*, College Campus, Shree Jairaj Park, Jhiri area, and Bagher Forest. The location, vegetation types and the major reasons of disturbance in each of the sites selected for the present study are discussed below.

3.3 SITE 1: COLLEGE CAMPUS

Location: Along the one side of NH-12 **Area**: Disturbed Area

Govt. P.G. College is located on one side of national highway 12 and the campus area of college is 31,000 sq.meters. The college has adequate infrastructural facilities. It has 45-50 class rooms, laboratories, central library, computer center, playgrounds etc. It has a botanical garden with various ornamental, medicinal plants; and few green patches with a variety of flora and fauna.

The area is extremely disturbed by the movements of hundreds of students which affects the life span of insects, specially the grassland insects. During the study period several human activities such as new plantation, grass mowing, trimming of trees and hedges seems to have disturbed the normal activities of insects. The college campus is inhibited by lot of ‘ langoors’ which definitely disturb the habitat of some insects. Heavy traffic on one side of campus due to NH-12 which disturbs the site to some extent.

Fig.3.3 Map showing College Campus (SITE 1)

Fig.3.4 Garden of College campus

Fig.3.5 Botanical garden of college campus

VEGETATION

In college campus most of the vegetation has been planted by college management which include herbs, shrubs, trees, medicinal plants, ornamental plants and wild grass.

Thespisia, *Terminalia balaria* (Baheda) , *Ficus religiosa* (Pipal) , *Ficus carica* (Bargad), *Halia* (Hedge); *Ctatoria*, *Tenosphora*, *Casia*, *Ocimum tenuiflorum*, *Saraca asoca* (Ashok), *Sentry palm*, *Sago palm*, *Cycus*, *Azadirachta indica* (neem), *Bougainvillea*, *Phanera variegata* (kachnaar), *Nerium indicum* (kaner) (red and yellow), *Nyctanthes arbor-tristis* (harshringar), *Casia fastule* (amaltas), *Dalbergia sissoo* (sheesham), *Pithelo selolg* (Jungle jalebi), *Rosaceae* (rose plant), *Calotropis procera*, *Aloe Barbadensis Miller* (alovera) etc.

3.4 SITE 2: SHRI JAIRAJ PARK

Location: Murti Chauraha **Area**:Disturbed Area

The park is located beside the Bhavani Club park, with an area of 25,900 square meters. It is triangular park which has a statue of late ruler Bhavani Singh of Jhalawar; connected with club garden on the third side. And known as Shri Jairaj park.

Fig.3.6 Map showing Jairaj park (SITE 2)

It has various shrubs, ornamental, evergreen and deciduous trees, and a jogging track. This area is disturbed as it has roads on 2 sides and a club on the third side. And the park has a daily attendance of morning walkers and playing children.

Fig.3.7 Statue at Jairaj park

Fig.3.8 Vegetation and pathway in Jairaj park

Fig.3.9 Play area in the Jairaj park

VEGETATION

The vegetation of Jairaj park is of mixed types which includes various trees, shrubs, herbs, climber and ornamental plants. Some of the plants were similar as that of college campus.

Delonix regia (gulmohar), *Psidium guajavai* (guava), *Millettia pinnata* (karanch), *Neolamarckia cadamba* (kadam), *Chinese hibiscus* (gudhael), *Callistemon* (bottle brush), *Augenth usbenia* (sheesham), *Ficus benjamina*, *Tabernaemontana divaricata* (chandani), *Jasminum species* (chameli), *Cestrum nocturnum* (raat ki rani), *Chrysanthemum indicum* (guldaodi), *Ixora*.

3.5 SITE 3: JHIRI AREA

Location: Bhavani mandi road **Area:** Semi-disturbed Area

It is located near akashvani Jhalawar, along the road connecting Jhalawar and Bhavani mandi. At the entrance of temple there are various bamboo trees which block the disturbance caused by the traffic on road. The site is flat hilly area behind the Sai temple with an approx area of 2,25,000 sq. meters.

Fig.3.10 Map showing Jhiri area (SITE 3)

The area is semi-disturbed as there is no major human activity except some cattle grazing on the site area. It has various shrubs, wild grass, plants and few trees.

Fig.3.11 View from hilly side of the site

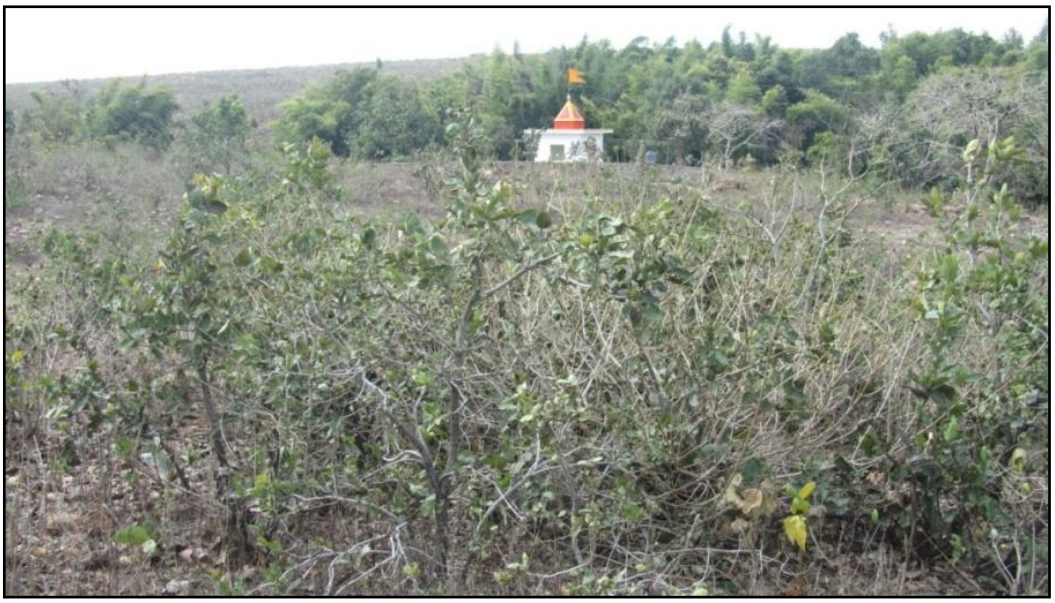


Fig.3.12 View of sai temple and vegetation of Jhiri area

VEGETATION

The hilly area was bushy and dense vegetation at the base of hill. Various plants on the site are as follows:

Tectona grandis (Sagwan), *Butea monosperma* (Palash), *Diospyrous* (Tando), *Posopis juliflora* (Halia), *Ziziphus mauritiana* (Ber), Bamboo, *Lawsonia* (Heena), *Euphorbia* (garden spurge), *Lantana camara* (Wild sage), *Jatropha* (spurge), *Acacia catechu* (Kher), *Cassia tora*, etc.

3.6 SITE 4: BAGHER FOREST

Location: Khanpur road **Area:** Undisturbed Area

Bagher is a Village in Khanpur Tehsil in Jhalawar District of Rajasthan State, India. It belongs to Kota Division. It is located 14 km towards East from District head quarters Jhalawar 18 km from Khanpur. The dry deciduous shrub forest area is located before the Bagher village starts and has approx area of 45,475 sq. meters. It is a dry deciduous forest. The forest area is free from the hustle and bustle of a city life,it is peaceful, calm, quite and full of greenery.

Fig.3.13 Map showing Bagher forest (SITE 4)

Fig.3.14 Various plants at Bagher forest

Fig.3.15 Showing vegetation of Bagher forest

Fig.3.16 Bagher forest view from road side

VEGETATION

The proposed area is a typical ecosystem of dry deciduous shrub forest where the big trees are not in existence. Important species are *Proposopis, Anogissus pendula, Diospyros melanoxylon* (Tandu), *Lannea grandis, Acacia nelotica, Zizyphus* sp., *Butea frondosa*, *Butea monosperma* (palash), etc.

CHAPTER: 4

MATERIAL AND METHODS

The present study was carried out during 2011-12 and 2012-13. A detail of methodology followed was:

1. Site selection
2. Collection/ sampling
3. Sorting
4. Preparation / stretching
5. Identification
6. Vegetation
7. Survey of anthropologic activities
8. Data management

4.1 SITE SELECTION

The site selection was done on the basis of disturbed (gardens, parks, urban area etc.) semi-disturbed (grazing area) and undisturbed (forest) area of Jhalawar district.

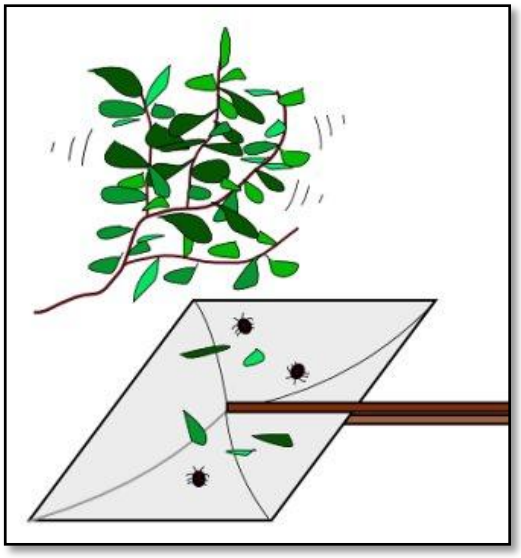
The two (2) sites selected for disturbed areas were college campus and Jairaj Park. Semi-disturbed area was Jhiri area, as it had cattle grazing and lesser human influence and undisturbed area was Bagher forest. The other details (area, location, vegetation, etc.) of selected sites are mentioned in the Chapter - Study areas.

4.2 COLLECTION AND SAMPLING

In present work collection of most of the insects (species) was done twice in the year 2011- 12 and 2012 – 13 in the month of February –March and September – October in 3-4 visits of at least 2 -3 hours; generally in between 11:00 – 1400 hour. The abundance of different species was also recorded.

In the present study majority of the insects were collected from all variety of plants: grass, flowers, weeds, shrubs, herbs, trees and some from cow dung surface of soil and under the stones. Some were found on and around building walls and nearby water sources.

Methodology used was: hand picking, beating, sweeping, and strapping



BY HAND PICKING: Small insects, specially the soft bodied insects were collected by hand picking. Bugs, ants, termites, living under stones and dry leaves; were collected by hand carefully so that their body is not damaged.

Fig.4.1 Hand picking insects from dry leaves, at Jhiri area

BY BEATING: This method was used to catch some crawling insects of those which rest on branches. The method was used occasionally.

BY SWEEPING: In sweeping technique insects were collected by sweeping net. Net used was simply a light cloth bag hung from loop that is attached to a handle. Insects collected by this method were – butterflies, moths, grasshoppers, dragonflies and the other large winged insects. Most of the collection was done by this method.

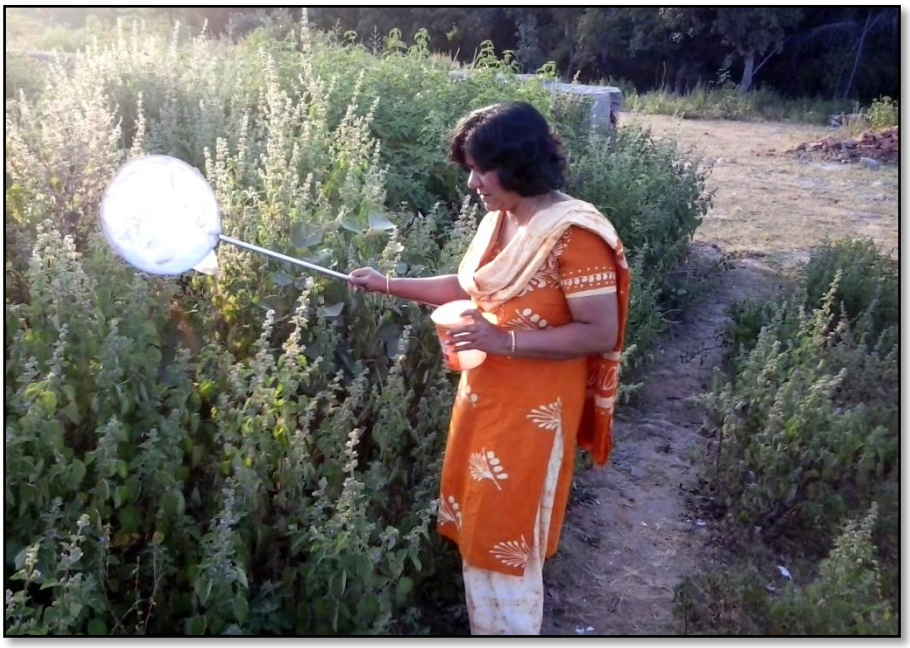


Fig.4.2 Collecting insects by sweeping net, at Jhiri area

Fig.4.3 Collecting insects by sweeping net, at Bagher forest

BY TRAPPING: Though there are 4-5 methods of trapping the insects like light trap, sticky trap, water traps, pit fall trap and baits trap, but pit fall method was used only for crawling and running insects.

Specimens caught by any of the methods were immediately transferred into the killing bottles. To prevent any damage proper care was taken while transferring the insects (like – butterflies, moths, grasshoppers, dragonflies) and for their preservation. We have used wide mouthed glass jars containing piece of cotton wool soaked with ethyl acetate. Photographs of some insects were taken to avoid the killing of any species of insects.

4.3 SORTING:

After killing the insects were sorted out into different taxonomic groups according to order and family, within 4-5 hours as they become brittle and stiff which would affect the stretching.

4.4 STRETCHING OR SPREADING:

After collection and sorting in different orders and families insects were stretched for temporary and permanent storage in boxes or cabinets. Spreading was done in a manner which provides scope to examine the specimens for identification and study also guarantees long period of storage; with proper care.

Fig.4.4 Pinned butterfly

Insects were pinned vertically through the body. Place of pinning varies with the group of insects. Large Heteroptera (bugs) through the mesoscutellum; while large Coleoptera (beetles) through right elytron; bees, wasps, butterflies, moths through the thorax between the basis of front wings; grasshoppers through the posterior part of pronotum. However, the wings of butterflies, moths and other insects were spreaded properly before pinning or insect was put into the collection box. The wings of insects were spread out on a compressed thermocol, dorsal side up, and the pin was left in the insect. In the case of butterflies, moths and flies the rear margins of the forewings were straight

across at right angles to the body.The wings were held in position by strips of paper, pinned to the compressed thermocol. After pinning, the specimens were labeled. Neat white paper stripes were used as labels to denote the name, locality, date and time of collection.

Fig.4.5 Dragonfly pinned with entomological pin

4.5. IDENTIFICATION

Identification of collected insects was done by Dr. Swaminathan (ICAR Network Project on Insect Biosystematics, Department of Entomology, Rajasthan College of Agriculture, MPUAT), Udaipur and Dr. V. V. Ramamurthy (Insect Identification Service Division of Entomology, Indian Agricultural Research Institute, New Delhi-110012) and few of them were identified with the help of Google images.

4.6 STUDY OF VEGETATION

The vegetation cover of the earth is extremely complex, the various type of vegetation on sites was: trees, bushes, herbs, grasses, hedge, climbers, ornamental plants, medicinal plant, etc. Vegetation of specific sites have been discussed in Chapter: Site Study Area.

Vegetation of all the sites was observed and was identified with the help of book “The Flora of Rajasthan” by N.K.Sharma and Botany department.

4.7 SURVEY OF ANTHROPOGENIC ACTIVITIES

We came across various human activities like: construction of building, garbage burning, cleaning and plantation by NSS students, vehicular disturbance in and around sites, movement of people (walking), fuel burning, cattle grazing, cutting of trees for fuel by local villagers, construction of pathways, from different locations.

Fig.4.6: Shows student movement in College campus

Fig.4.7 Shows vehicles inside the College campus

Fig.4.8 Road adjacent to Jhiri area

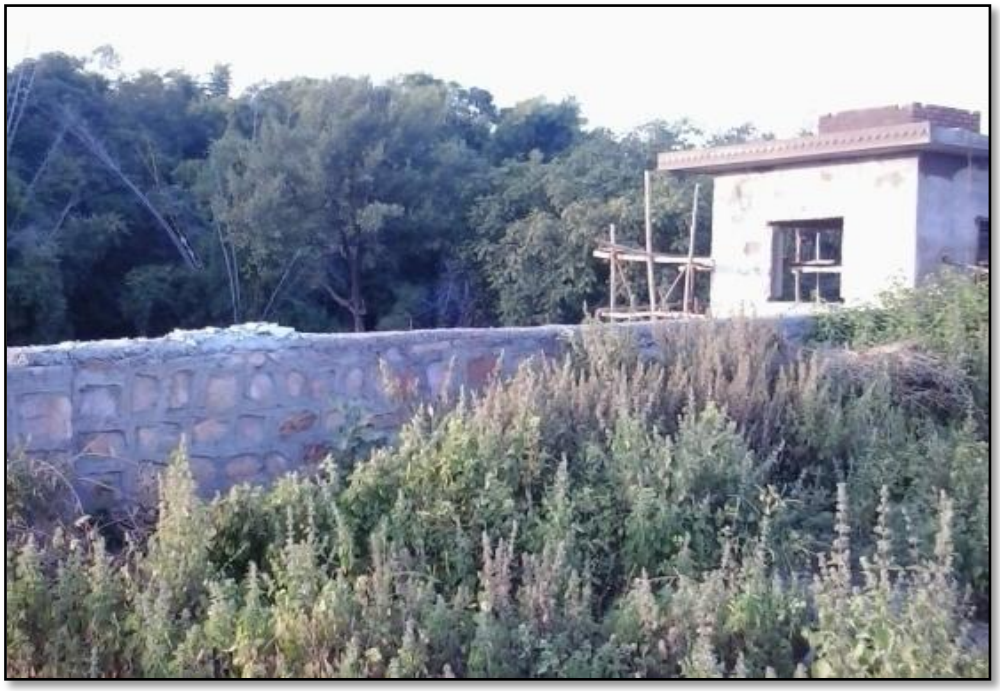


Fig.4.9 Construction of new mandir at Jhiri area

4.8 <u>DATA MANAGEMENT</u> was done after identification of insects from different identification institutes. Various tables, pie charts, graphs, were made from collected data with the help of computer.

CHAPTER: 5

OBSERVATIONS

After the collection of insects from four different sites, they were observed, identified at centers and got separated into their groups. Abundance of insects was also recorded.

Though a serious attempt has not been made in the past to record insect diversity in Hadoti region of Rajasthan. A preliminary effort has been made by Jain *et. al.* (2013) at Abhera – Karnimata, an eco tourist place in the outskirts of Kota City. They recorded 36 species of insects belonging to 6 orders and 13 families. Order Lepidoptera was dominating.

In the present study, the total numbers of insects collected from four locations of Jhalawar were 75 insect species. Further, 4 of them were not identified and remaining 71, belonging to 12 Orders and 33 families. The dominating order was Lepidoptera with 22 species followed by Odonata: 11 species; Hymenoptera: 8 species; Diptera: 7 species; Hemiptera, Coleoptera and Orthoptera: 6 species each; Dictyoptera: 2 species; Thysanura, Isoptera and Neuroptera: 1 species respectively. The maximum approx abundance noted was of *Lampides boeticus* (250 in number) and minimum was of *Mentis religiosa* and *Chrysocoris chinonsis*. The identified species and their average abundance of two years were tabulated in the Table: 5.1 and Fig.5.1 :-

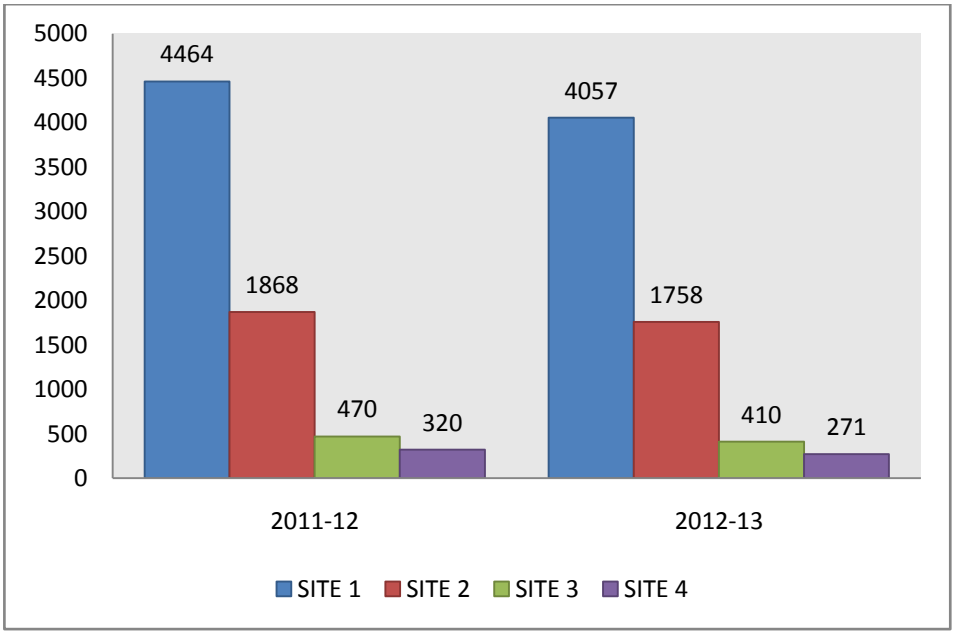


Fig.5.1 Comparative total abundance of insects of two years (2011-12; 2012-13) of four Sites.

Table 5.1: List of insects collected from four locations

S. NO.	ORDER	FAMILY	GENUS SPECIES
1.	Lepidoptera	Pieridae	*Ixias marianne (Linnaeus)*
2.	Lepidoptera	Pieridae	*Catopsilia pyranthe*
3.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*
4.	Lepidoptera	Pieridae	*Catopsilia pomona*
5.	Lepidoptera	Pieridae	*Anaphaeis aurota (Fabricius)*
6.	Lepidoptera	Pieridae	*Eurema laeta (Boisduval)*
7.	Lepidoptera	Pieridae	*Appias albina (Boisduval)*
8.	Lepidoptera	Nymphalidae	*Junonia lemonias*
9.	Lepidoptera	Nymphalidae	*Junonia (Precis) atlites (Linnaeus)*
10.	Lepidoptera	Nymphalidae	*Junonia almona*
11.	Lepidoptera	Nymphalidae	*Junonia orithya*
12.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*
13.	Lepidoptera	Nymphalidae	*Telchinia violae (Fabricius)*
14.	Lepidoptera	Nymphalidae	*Parantica aglea*
15.	Lepidoptera	Papilionidae	*Pachliopta aristolochiae*
16.	Lepidoptera	Papilionidae	*Papilio demoleus*
17.	Lepidoptera	Papilionidae	*Zetides agamemnon*

18.	Lepidoptera	Lycaenidae	*Lampides boeticus*
19.	Lepidoptera	Lycaenidae	*Catochrysops enjus*
20.	Lepidoptera	Lycaenidae	*Castalius rosimon*
21.	Lepidoptera	Arctiidae	*Utethesia pulchella*
22.	Lepidoptera	Noctuidae	*Helicoverpa zea*
23.	Odonata	Libellulidae	*Orthetrum glaucum*
24.	Odonata	Libellulidae	*Neurothemis intermedia (Rambur)*
25.	Odonata	Libellulidae	*Brachythemis cantaminata (Febricui)*
26.	Odonata	Libellulidae	*Orthetrum pruinosum (Rambur)*
27.	Odonata	Libellulidae	*Brudinopyga geminata*
28.	Odonata	Libellulidae	*Orthetrum Sabina*
29.	Odonata	Libellulidae	*Orthetrum chrysis*
30.	Odonata	Libellulidae	*Crocothemis servilia*
31.	Odonata	Libellulidae	*Trithemis aurora*
32.	Odonata	Coenagrionidae	*Ceriagrion coromandelianun (Fabricius)*
33.	Odonata	Coenagrionidae	*Ischnura elegans*
34.	Hymenoptera	Apidae	*Xylocopa fenestrata*
35.	Hymenoptera	Apidae	*Apis florea*

36.	Hymenoptera	Apidae	*Apis dorsata*
37.	Hymenoptera	Sphecidae	*Cerceris sp.*
38.	Hymenoptera	Sphecidae	*Liris sp.*
39.	Hymenoptera	Vaspedae	*Ropalidia sp.*
40.	Hymenoptera	Vespidae	*Dolichovespula sp.*
41.	Hymenoptera	Formicidae	*Aenictus*
42.	Diptera	Tabaidae	*Unidentified*
43.	Diptera	Stratonyidae	*Unidentified*
44.	Diptera	Muscidae	*Musca domestica*
45.	Diptera	Drosophilidae	*Drosophila melongaster*
46.	Diptera	Culicidae	*Anopheles sp.*
47.	Diptera	Culicidae	*Culex sp.*
48.	Diptera	Asilidae	*Unidentified*
49.	Hemiptera	Pentatomidae	*Halys parvus (Chopra)*
50.	Hemiptera	Pentatomidae	*Erthesina fullo (Thunberg)*
51.	Hemiptera	Lygacidae	*Spilostethus pandurus*
52.	Hemiptera	Reduviidae	*Acanthaspis sp.*
53.	Hemiptera	Reduviidae	*Rhinocoris sp.*
54.	Hemiptera	Coreidae	*Petalocnemis obscura (Dallas)*

55.	Coleoptera	Buprestidae	*Chrysocoris chinonsis*
56.	Coleoptera	Tenebrionidae	*Adesmia sp.*
57.	Coleoptera	Tenebrionidae	*Rhytinota sp.*
58.	Coleoptera	Carabidae	*Diplocheila sp.*
59.	Coleoptera	Meloidae	*Mylabris puslutata*
60.	Coleoptera	Scarabacidae	*Orphnus picinus*
61.	Orthoptera	Acrididae	*Catantops sp.*
62.	Orthoptera	Acrididae	*Acrididae exalatata*
63.	Orthoptera	Tettigonidae	*Himertula pallisignata*
64.	Orthoptera	Gryllidae	*Gryllus campestris*
65.	Orthoptera	Gryllidae	*Halochlera indica*
66.	Orthoptera	Gryllidae	*Schistocera gregania*
67.	Dictyoptera	Blattidae	*Periplaneta americana*
68.	Dictyoptera	Mantidae	*Mantis religiosa*
69.	Thysanura	Lepismatidae	*Lepisma saccharina*
70.	Isoptera	Termitidae	*Prorhinotermes sp.*
71.	Neuroptera	Myrrnelontidae	*Creoleon sp.*

Chapter: 6

RESULT AND DISCUSSION

6.1 RESULT

The present investigation on biodiversity of insects was done in the year 2011-12; 2012-13. The four locations selected were college campus, Jairaj park (disturbed); Jhiri area (semi-disturbed) and Bagher forest (undisturbed). The following data was accumulated from the four locations.

6.1.1 RESULT OF COLLEGE CAMPUS (Site 1)

In college campus the total number of insects observed in the study period was 63. Insects recorded belonged to 10 orders 29 families and 50 genus. The largest number of insect identified were of order Lepidoptera followed by Hymenoptera, Odonata, Hemiptera, Orthoptera, Coleoptera, Neuroptera, Dictyoptera and Thysanura. (Table:6.3; Table:6.4).

LEPIDOPTERA

Butterfly diversity depends upon the floral diversity.The maximum number of insects recorded in college campus were of order Lepidoptera belonging to 6 different families. The species identified were 21. The dominanting family was Pieridae; it was followed by Nymphalidae, Papilionidae, Lycaenidae and Arctiidae. The number of species identified of family Pieridae and Nymphalidae were 7 of each. Pieridae (32%) include: *Ixias marianne (Linnaeus), Catopsilia pyranthe, Terias hecabe (Linnaeus), Catopsilia pomona, Anaphaeis aurota (Fabricius), Eurema laeta (Boisduval), Appias albina (Boisduval).* Nymphalidae (32%) include: *Junonia lemonias, Junonia (Precis) atlites (Linnaeus), Junonia almona, Junonia orithya, Danaus chrysippus (Linnaeus), Telchinia violae (Fabricius), Parantica aglea.* While in family Papilionidae (14%) and Lycaenidae (14%) there were 3 species each. They are: *Pachliopta aristolochiae, Papilio demoleus, Zetides agamemnon* and *Lampides boeticus, Castalius rosimon, Catochrysops enjus* respectively. The moth recorded were *Utethesia pulchella* of family Arctiidae(4%) and *Helicoverpa zea* of family Noctuidae (4%).

The butterfly observed in maximum number was *Lampides boeticus* of

family Lacynidae and the minimum number was *Castalius rosimon* of family Nymphalidae. Some identified butterflies were very common, some were common and two of them were rare. The rare ones were: *Junonia atlites* and *Ixias marianne*.

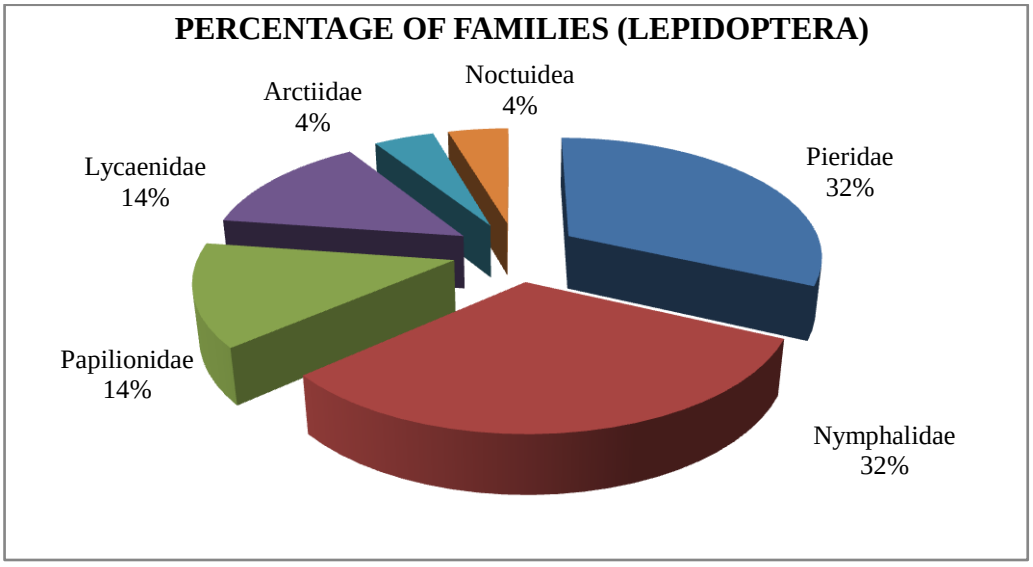


Fig.6.1 Status of butterflies and moths

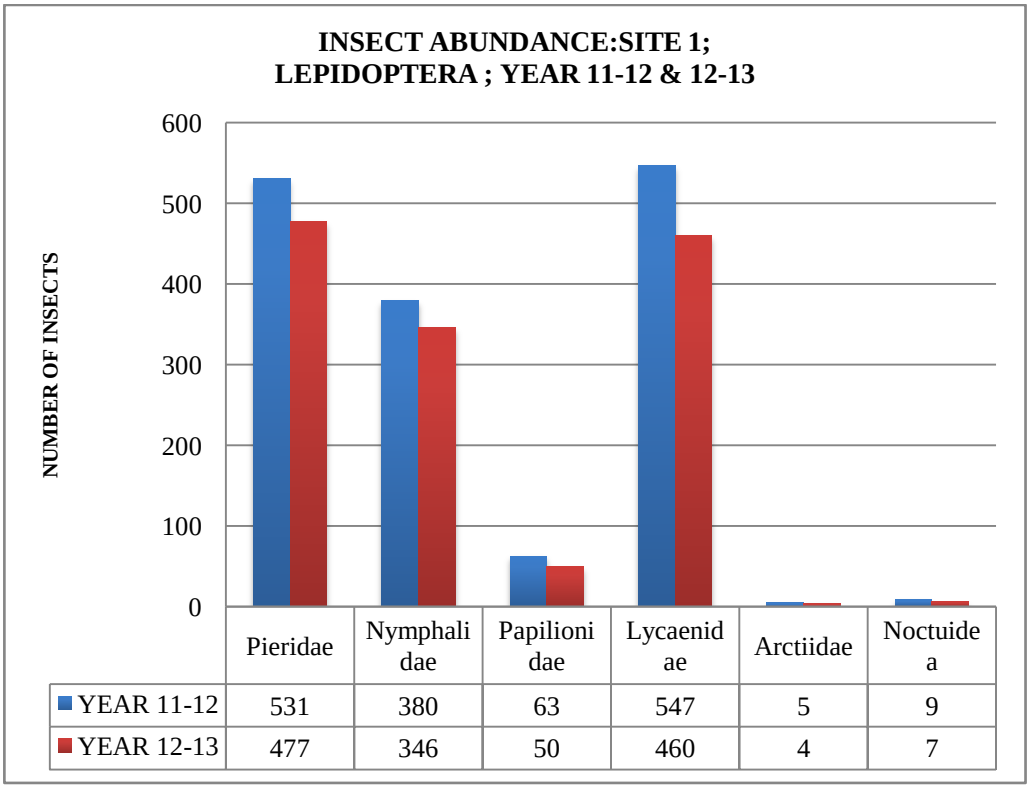


Fig.6.2 Comparative study of Abundance of individuals of families of order Lepidoptera in the year 2011-12 and 2012-13

The study of butterfly diversity was also carried out by Saikia (2014) in urban altered forest at Guwahati university campus, Assam. The numbers of species identified in four seasons were 150 species belonging to 4 families.

Similar study of diversity of butterflies at Guru Ghasidas university campus, dam, Arpa river and urban areas; was undertaken in Bilaspur district Chhattisgarh (2013) by Kaneria *et. al.* The total number of species identified was 51. *Terias hecabe* (Linnaeus) and *Lampides boeticus* were dominant. The above observation is similar to the present observation.

Similarly Arya *et. al.* (2014) have reported 897 individuals of butterflies belonging to 27 species and 8 families in and around Kumaun University Nanital and Uttrakhand, India. Pieridae was dominant family of this area followed by Nymphalidae, Danaidae, Papilionidae, Lycaenidae, Acraeidae and Erycinidae. A detailed report on minor project on diversity of butterflies in the Farok College campus and adjacent areas, of Kozhikode, Kerala was undertaken by Hameed (2010). Studies on butterfly diversity in the college campus: Jnandaweepa V.M.P Campus, Thane, Maharashtra was carried out by Kurve *et.al.* (2013) they reported 41 species in the year 2002-03 and 52 species in 2012.

HEMIPTERA:

In the present study the insects of order Hemiptera observed in the college campus was 5 species belonging to 3 families. Two species of family Pentatomidae identified were *Halys parvus (chopra)* and *Erthesina fullo (Thunberg)*. Two species of family Reduviidae include: *Acanthaspis sp* and *Rhinocoris sp.* Family Lygacidae had only one species *Spilostethus pandurus.*

The abundance of species among dominating Hemiptera was *Erthesina fullo (56)* followed by *Spilostethus pandurus* (55) and *Halys parvus* (18).

Individuals of bugs were reported from Madhya Pradesh by Chandra *et.al.* (2012).They studied 53 species of bugs belonging to 29 genera under 7 sub families of Reduviidae.

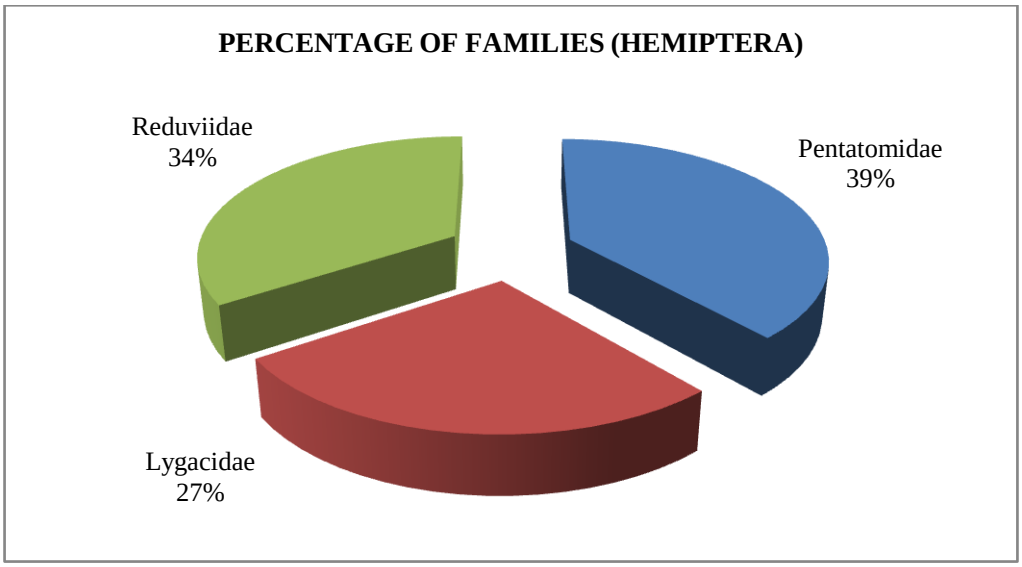


Fig.6.3 Status of Hemiptera (bugs)

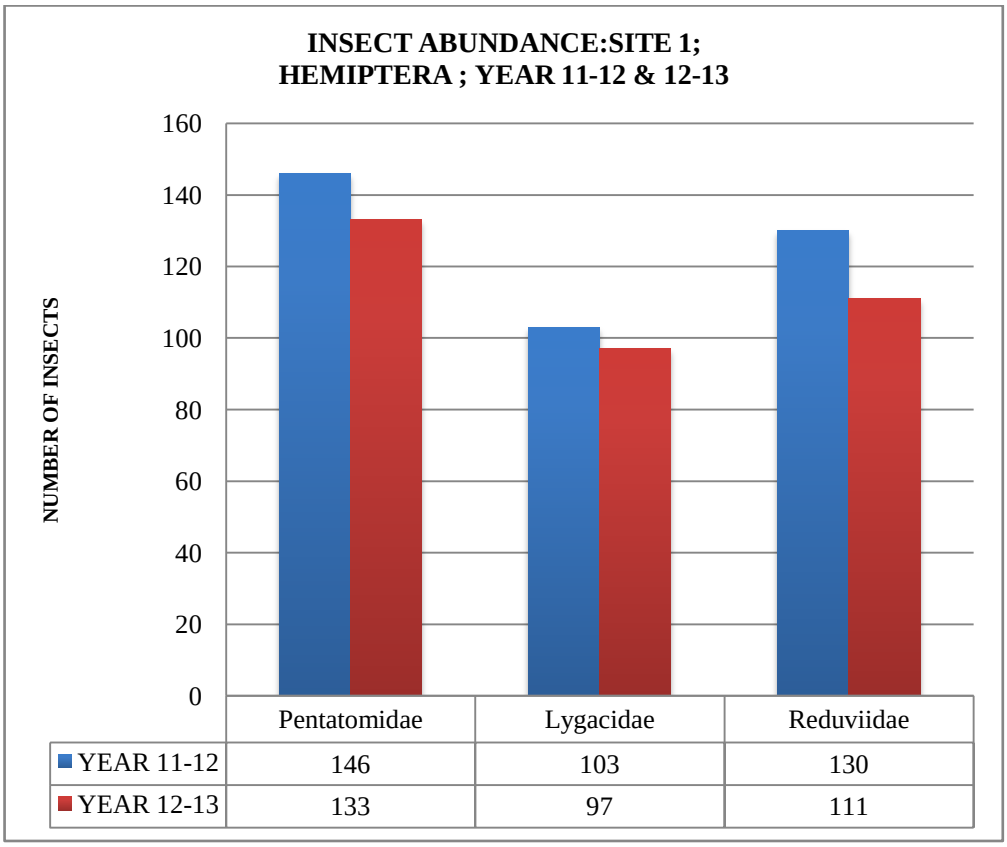


Fig.6.4 Comparative study of Abundance of individuals of families of order Hemiptera in the year 2011-12 and 2012-13

Insect fauna of order Hemiptera was also undertaken by Kumar and Naidu (2010) in 62 gardens and urban ecosystem of Vadodara University campus. They recorded 58 species belonging to 51 genus of 22 families.

Study on Indian assassin bugs (Insecta- Hemiptera Reduviidae) was undertaken by Ambrose (2006) A checklist of 464 Indian species of bugs under 144 genera and 14 sub families were given by them.

HYMENOPTERA

In the college campus of Jhalawar the number of Hymenopteran species observed were six, belonging to 4 families. As per the data recorded the dominating family was Apidae followed by Sphecidae, Formicidae and Vespidae. *Xylocopa fenestrate, Apis florae, Apis dorsata* were of family Apidae; species identified of family Sphecidae was *Liris sp*. of family Vespidae was *Ropalidia marginata* and Formicidae was *Aenictus sp.*

Total numbers of individuals observed were approx 80 of *Apis florae* which was maximum and minimum was of *Aenictus sp.*

Limited study on Hymenoptera (limited to macro forms) was undertaken by Kumar and Mathew (1999). They recorded 84 species belonging to 16 families from Parambikulam wildlife sanctuary.

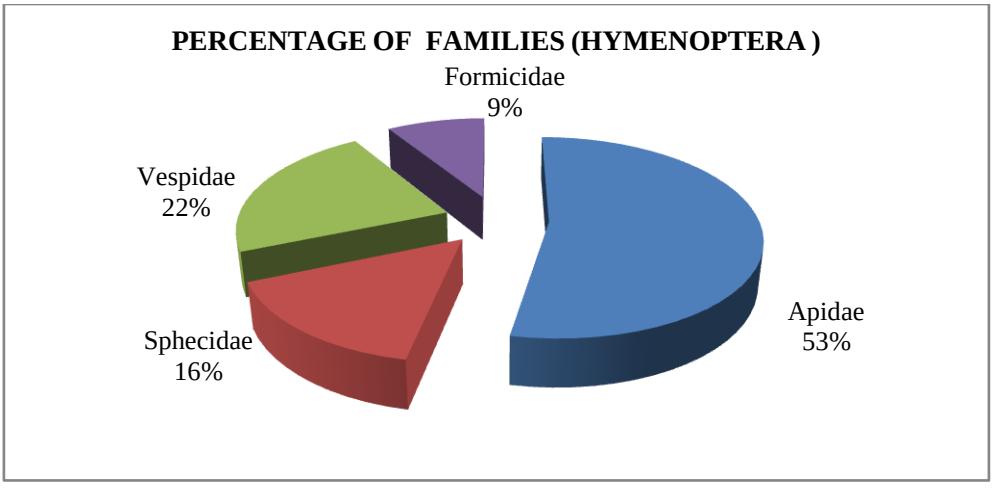


Fig.6.5 Status of Hymenoptera (bees and wasp)

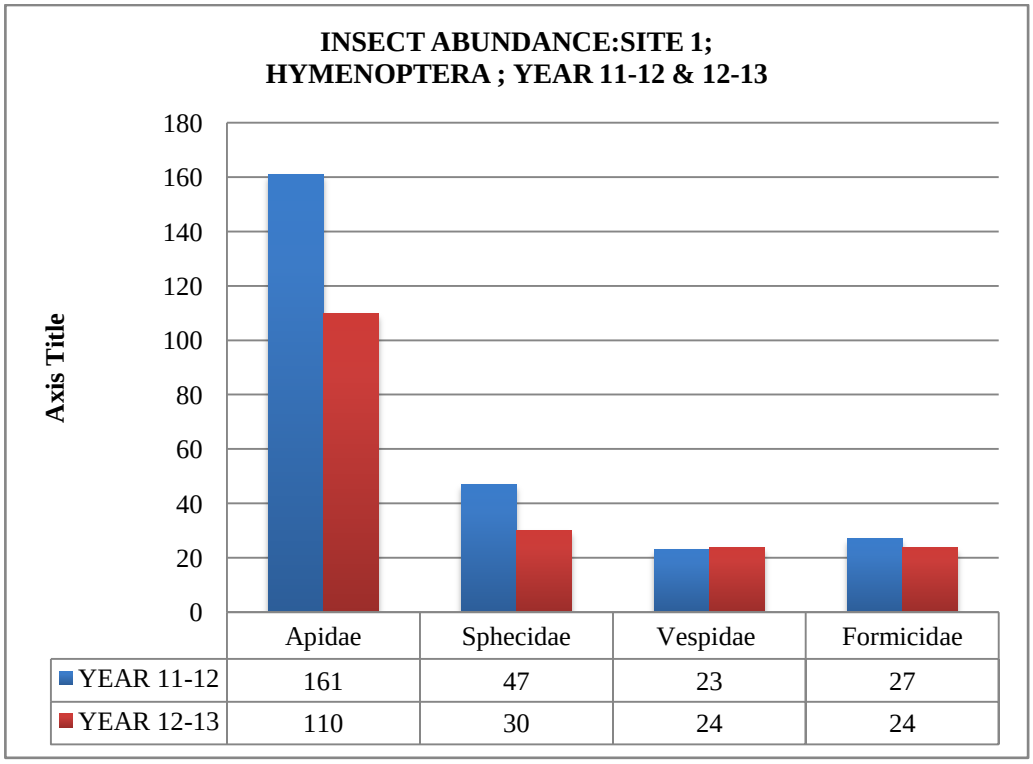


Fig.6.6 Comparative study of Abundance of individuals of families of order Hymenopterain the year 2011-12 and 2012-13

ODONATA

Total 11 species of Odonata were observed belonging to family Libellulidae and Coenagrionidae. All the dragonflies and damselflies were sighted on the long wild grass. Some of them were very bright in colour and few of them were yellow and dull in colour .The grayish brown dragonflies were generally sighted on the walls of building.

The dragonflies of dominating family Libellulidae observed belonged to 6 genus and 9 species. The 4 species of genus *Orthetrum* identified were: *glaucum, chrysis, sabina* and *pruinosum.* Other dragonflies identified were *Brachythemis cantaminata, Neurothemis intermedia intermedia, Crocothemis servilia, Trithemis aurora, Brudinopyga geminata.* Two species of damselfly identified were *Ischnura elegans and Ceriagrion coromandelianun (febricui)* belonging to family Coenagrionidae.

The dragonflies found in abundance was of *Neurothemis intermedia (Rambur)* [30-35] followed by *Trithemis aurora* [22]. Species of genus *Orthetrum* observed were in very few numbers [09].

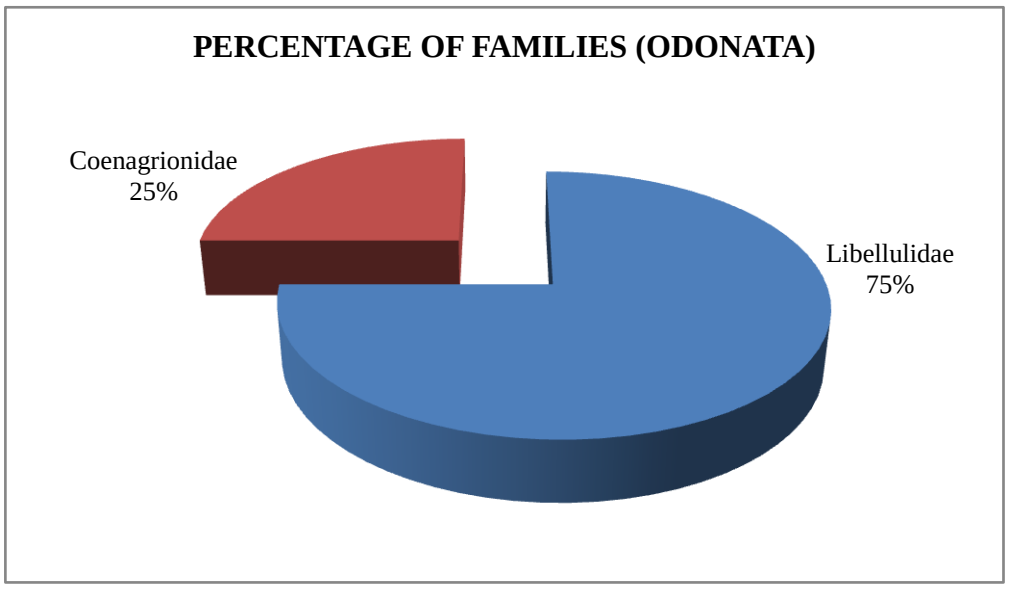


Fig.6.7 Status of Odonata (dragonfly and damselfly)

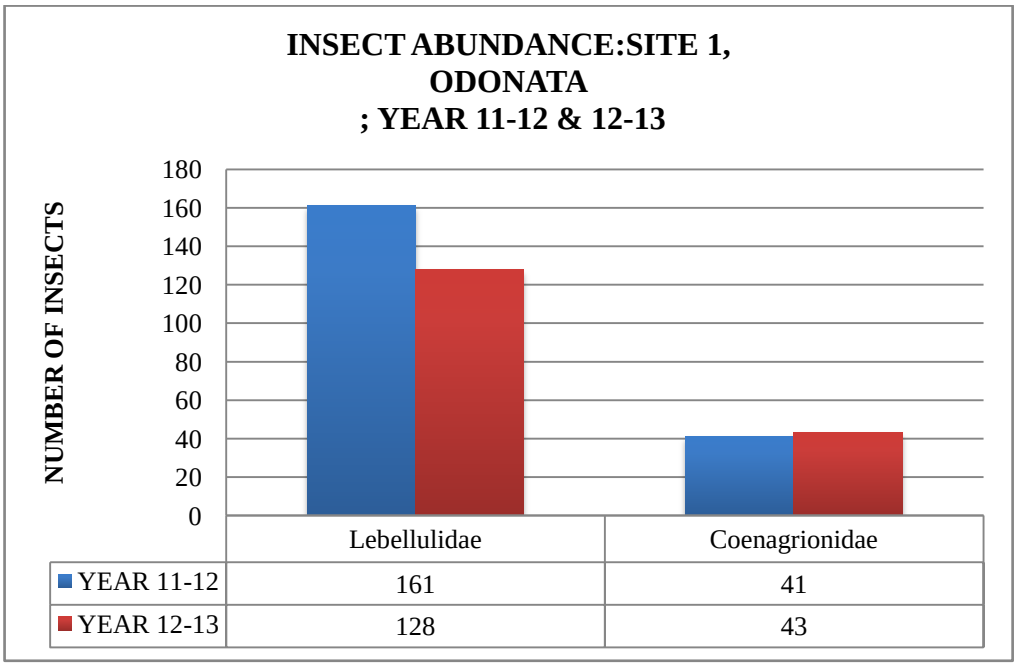


Fig.6.8 Comparative study of Abundance of individuals of families of order Odonata in the year 2011-12 and 2012-13

Abundance and diversity of dragonflies were also studied by Fulan *et. al.* (2008). They observed 17 dragonfly species. In 2007 Keppner (2005)

reported dragonflies and damselflies in the St. Andrew Bay eco system, Bay County, Florida. Studies on the dragonflies and damselflies in agro eco system around the Amaravati city in India in monsoon season was conducted by Rathod, *et. al.* (2012). They recorded 31 species of dragonflies and damselflies belonging to 6 families. Damselflies were seen in minimum number (2-3) in area with long grass.

A total of 34 species of Odonates belonging to 26 sp. of dragonflies and 8 sp. of damselflies were recorded from the Bodoland University, Kokrajhar, Assam and its vicinity by Basumatary *et. al.* (2015). Here also Libellulidae was dominant family.

A similar type of work on the dragonflies was conducted in the college campus and other 13 places of Southern Rajasthan (including 6 lakes, 3 wildlife sanctuaries, Meja dam and college campus), India by Koli *et. al.* (2014). Total 1290 individuals from 8 families and 54 species were recorded. Libellulidae was the largest family. *Orthetrum chrysis* and *Lestes sp.* was randomly distributed.

COLEOPTERA

In the study period the only Coleopteran observed was *Chrysocoris chinonsis* belonging to family Buprestidae. *Chrysocoris chinonsis* was found on a particular *Dalbergia sissoo* (sheesham) tree. The individual was easy spot visually as it had florescent green colour. Only two individuals were observed in the year 2011 but in the year 2012 only one (01) was sighted.

Pawara et. al. (2014) surveyed 35 species belonging to 28 genera under 13 families from Jalgaon district of Maharashtra India. Family Scarabaeidae was found to be dominant.

Chandra *et. al.* (2012) recorded some new species of beetle from Jabalpur, MP India. He also noticed 26 species of dung beetles belonging to 12 genera from Singhori wildlife sanctuary, Raisen, MP India. Scarabaeidae was dominating family.

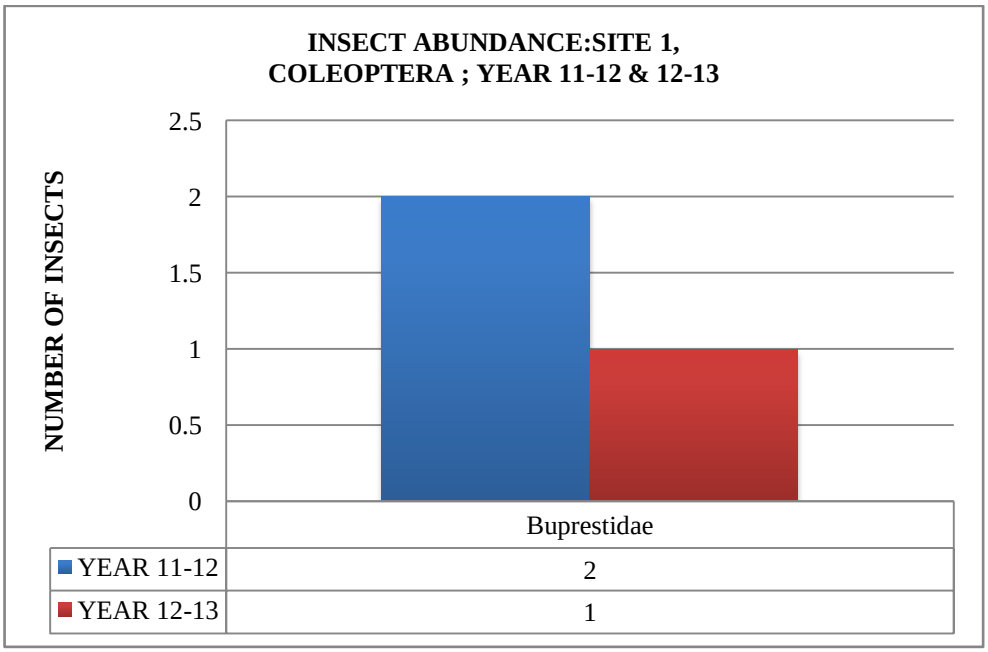


Fig.6.9 Comparative study of Abundance of individuals of families of order Coleoptera in the year 2011-12 and 2012-13

An inventory of the Coleopteran fauna of Sindhudurg District, Maharashtra, India was compiled by Bharamal *et. al.* (2014) in the major five localities viz. Sawanatwadi, Amboli, Malvan, Kudal and Kankavli. They recorded 59 beetle species belonging to 48 genera and 17 families.

Limited study on Coleoptera was undertaken by Kumar and Mathew (1999). They recorded 78 species from Parambikulam wildlife sanctuary.

ORTHOPTERA

Only six (06) species of orthoptera were recorded, belonging to 3 families Gryllidae: *Gryllus campestris, Halochlera indica* and *Schistocera gregania*; family Acridiae: *Acrididae exalatata* and *Catantops sp.*, and Tettigonidae: *Himertula pallisignata*. All these Orthopterans appeared in large number. The dominating family was Gryllidae. Highest number of individuals was of *Gryllus campestris* and lowest was of *Himertula pallisignata*.

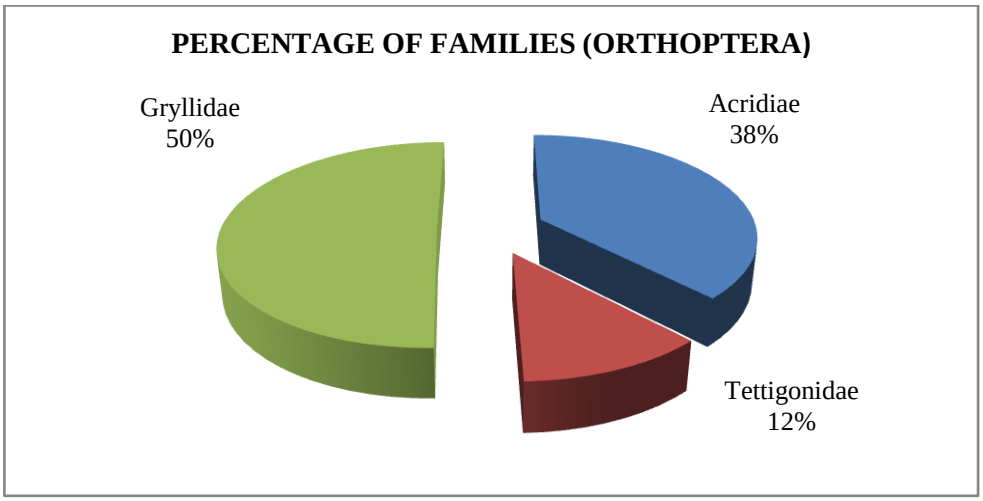


Fig.6.10 Status of Orthoptera (crickets, grasshoppers and locusts)

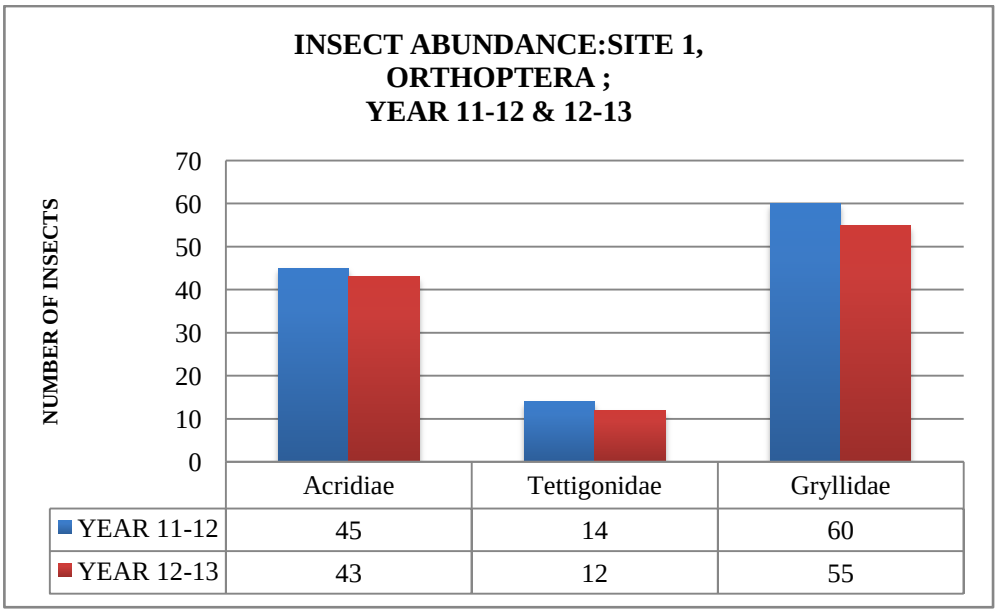


Fig.6.11 Comparative study of Abundance of families of order Orthoptera in the year 2011-12 and 2012-13

DIPTERA

The observed insects of order Diptera were common house fly *Musca domestica* of family Muscidae, *Drosophila melenogaster* of family Drosophilidae on waste of food etc. in the dustbins. Beside these 3 flies were also observed which were of family Asilidae, Tabanidae and Stratonyidae. Genus and species were not identified of these families (due to sample damage). *Anopheles* and *Culex* mosquitoes were also observed in the campus in large number during the study period.

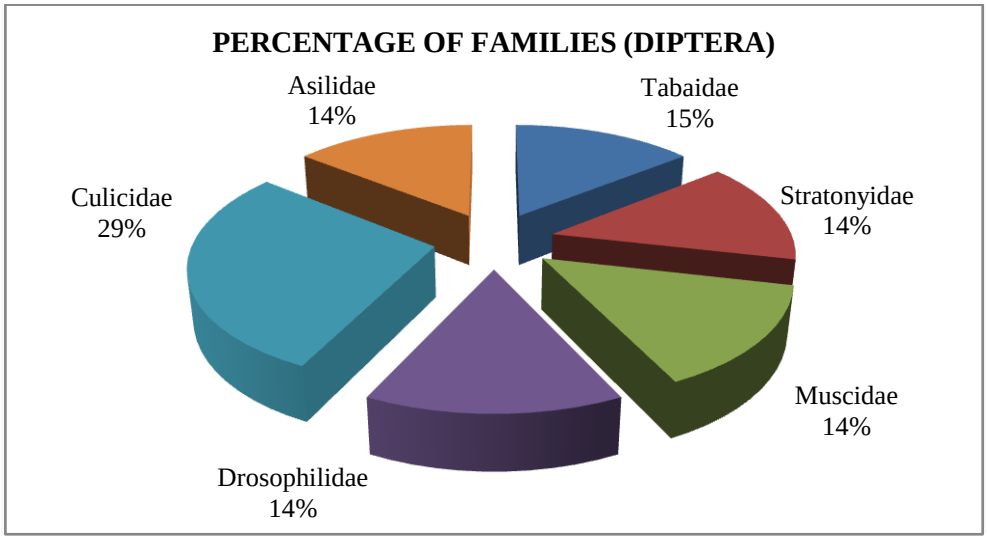


Fig.6.12 Status of Diptera (flies)

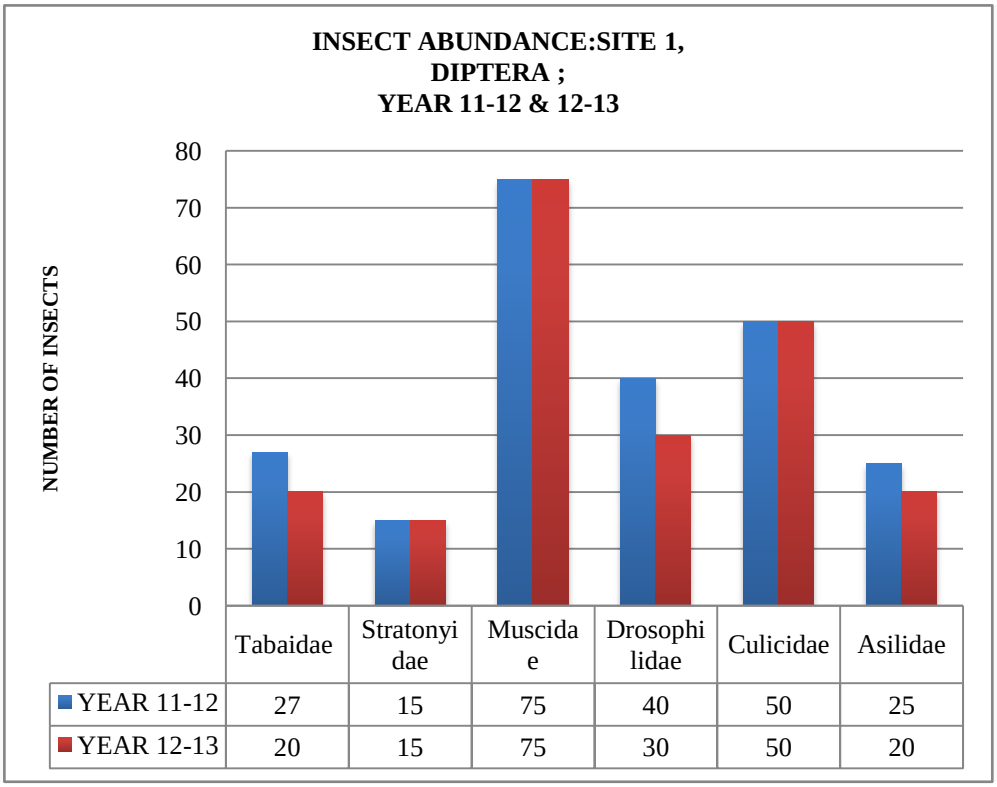


Fig.6.13 Comparative study of Abundance of individuals of families of order Diptera in the year 2011-12 and 2012-13

DICTYOPTERA

The very common Indian Cockroach or *Periplaneta americana* was found in the store of college campus belongs to family Blattidae.

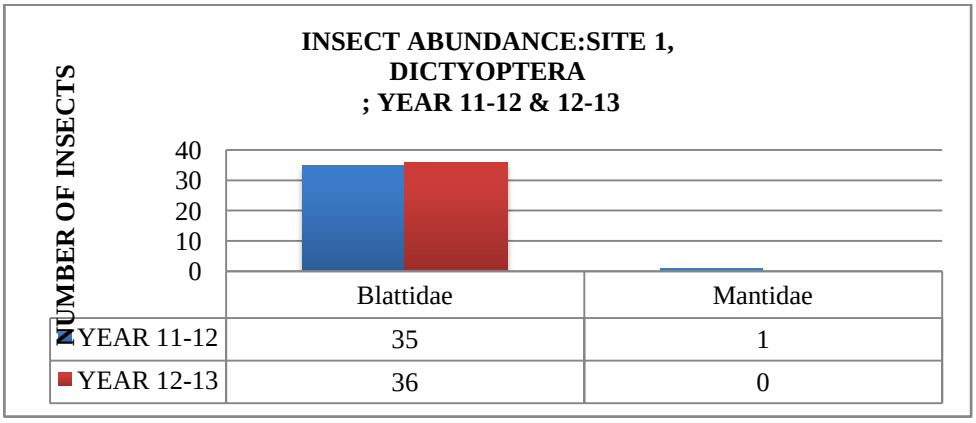


Fig.6.14 Comparative study of Abundance of individuals of families of order Dictyoptera in the year 2011-12 and 2012-13

THYSANURA

Lepisma saccharina belongs to family Lepsimatidae. Silver fishes were found in the books (with little moisture) of college library. It was not possible for me to count the number; hence exact numbers of individuals were not recorded.

Table: 6.1 Comparative study of Abundance of families of order Thysanura in the year 2011-12 and 2012-13

S.NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Lepsimatidae	01	>30	>30

ISOPTERA

Termites were sighted on the walls and subterranean parts of the building (as it's an old construction). Some individuals were found in the plant roots and around the dry bushes.

Table: 6.2 Comparative study of Abundance of individuals of families of order Isoptera in the year 2011-12 and 2012-13

S.NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Termitidae	01	>100	>100

Table 6.3 Identified insects at site 1 (college campus), Jhalawar; year 2011-12

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	**Feb-March 2011-12**	**Sept. - Oct. 2011-12**
1.	Lepidoptera	Pieridae	*Ixias marianne (Linnaeus)*	22	15
2.	Lepidoptera	Pieridae	*Catopsilia pyranthe*	08	05
3.	Lepidoptera	Pieridae	*Catopsilia pomona*	30	23
4.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	184	155
5.	Lepidoptera	Pieridae	*Anaphaeis aurota (Fabricius)*	12	07
6.	Lepidoptera	Pieridae	*Eurema laeta (Boisduval)*	16	14
7.	Lepidoptera	Pieridae	*Appias albina (Boisduval)*	22	18
8.	Lepidoptera	Nymphalidae	*Junonia lemonias*	27	26
9.	Lepidoptera	Nymphalidae	*Junonia (Precis) atlites (Linnaeus)*	15	13
10.	Lepidoptera	Nymphalidae	*Junonia almona*	18	15
11.	Lepidoptera	Nymphalidae	*Junonia orithya*	54	50
12.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*	42	35

13.	Lepidoptera	Nymphalidae	*Telchinia violae (Fabricius)*	32	30
14.	Lepidoptera	Nymphalidae	*Parantica aglea*	12	11
15.	Lepidoptera	Papilionidae	*Pachliopta aristolochiae*	11	09
16.	Lepidoptera	Papilionidae	*Papilio demoleus*	11	10
17.	Lepidoptera	Papilionidae	*Zetides agamemnon*	12	10
18.	Lepidoptera	Lycaenidae	*Lampides boeticus*	225	185
19.	Lepidoptera	Lycaenidae	*Catochrysops enjus*	68	60
20.	Lepidoptera	Lycaenidae	*Castalius rosimon*	05	04
21.	Lepidoptera	Arctiidae	*Utethesia pulchella*	03	02
22.	Lepidoptera	Noctuidae	*Helicoverpa zea*	05	04
23.	Odonata	Libellulidae	*Brudinopyga geminata*	14	12
24.	Odonata	Libellulidae	*Neurothemis intermedia (Rambur)*	04	03
25.	Odonata	Libellulidae	*Brachythemis cantaminata (febricui)*	12	10
26.	Odonata	Libellulidae	*Orthetrum pruinosum (Rambur)*	04	02
27.	Odonata	Libellulidae	*Orthetrum glaucum*	15	11

28.	Odonata	Libellulidae	*Orthetrum sabina*	15	10
29.	Odonata	Libellulidae	*Orthetrum chrysis*	04	-
30.	Odonata	Libellulidae	*Crocothemis servilia*	11	09
31.	Odonata	Libellulidae	*Trithemis aurora*	14	11
32.	Odonata	Coenagrionidae	*Ceriagrion coromandelianun (Fabricius)*	13	10
33.	Odonata	Coenagrionidae	*Ischnura elegans*	17	11
34.	Hymenoptera	Apidae	*Xylocopa fenestrata*	09	06
35.	Hymenoptera	Apidae	*Apis florea*	26-30	25-28
36.	Hymenoptera	Apidae	*Apis dorsata*	46	42
37.	Hymenoptera	Sphecidae	*Cerceris sp.*	26	21
38.	Hymenoptera	Sphecidae	*Liris sp.*	92	88
39.	Hymenoptera	Vespidae	*Ropalidia sp.*	38	30
40.	Hymenoptera	Formicidae	*Aenictus sp.*	15	12
41.	Hemiptera	Pentatomidae	*Halys parvus (chopra)*	22	18
42.	Hemiptera	Pentatomidae	*Erthesina fullo (Thunberg)*	56	50
43.	Hemiptera	Lygacidae	*Spilostethus pandurus*	55	48
44.	Hemiptera	Reduviidae	*Acanthaspis sp.*	24	20

45.	Hemiptera	Reduviidae	*Rhinocoris sp.*	46	40
46.	Diptera	Tabanidae	Unidentified	12	11
47.	Diptera	Stratonyidae	Unidentified	18	15
48.	Diptera	Muscidae	*Musca domestica*	>100	>150
49.	Diptera	Drosophilidae	*Drosophila melongaster*	51	58
50.	Diptera	Culicidae	*Anopheles sp.*	>125	>200
51.	Diptera	Culicidae	*Culex sp.*	>125	>200
52.	Diptera	Asilidae	Unidentified	>75	>100
53.	Orthoptera	Acrididae	*Catantops sp.*	18	15
54.	Orthoptera	Acrididae	*Acrida exalatata*	28	25
55.	Orthoptera	Tettigonidae	*Himertula pallisignata*	16	14
56.	Orthoptera	Gryllidae	*Gryllus campestris*	37	33
57.	Orthoptera	Gryllidae	*Halochlera indica*	32	29
58.	Orthoptera	Gryllidae	*Schistocera gregania*	22	19
59.	Dictyoptera	Blattidae	*Periplaneta americana*	35	32
60.	Dictyoptera	Mantidae	*Mantis religiosa*	0	0
61.	Thysanura	Lepismatidae	*Lepisma saccharina*	>50	>65
62.	Isoptera	Termitidae	*Prorhinotermes sp.*	>100	>100
63.	Coleoptera	Buprestidae	*Chrysocoris chinonsis*	0	02

Table 6.4 Identified insects at Site 1 (College Campus), Jhalawar; year 2012-13

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	**Feb-March 2012-13**	**Sept. - Oct. 2012-13**
1.	Lepidoptera	Pieridae	*Ixias marianne (Linnaeus)*	17	13
2.	Lepidoptera	Pieridae	*Catopsilia pyranthe*	07	04
3.	Lepidoptera	Pieridae	*Catopsilia pomona*	26	21
4.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	165	145
5.	Lepidoptera	Pieridae	*Anaphaeis aurota (Fabricius)*	10	08
6.	Lepidoptera	Pieridae	*Eurema laeta (Boisduval)*	14	11
7.	Lepidoptera	Pieridae	*Appias albina (Boisduval)*	19	17
8.	Lepidoptera	Nymphalidae	*Junonia lemonias*	26	23
9.	Lepidoptera	Nymphalidae	*Junonia (Precis) atlites (Linnaeus)*	13	11
10.	Lepidoptera	Nymphalidae	*Junonia almona*	17	14
11.	Lepidoptera	Nymphalidae	*Junonia orithya*	51	45
12.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*	40	32

13.	Lepidoptera	Nymphalidae	*Telchinia violae (Fabricius)*	30	25
14.	Lepidoptera	Nymphalidae	*Parantica aglea*	11	08
15.	Lepidoptera	Papilionidae	*Pachliopta aristolochiae*	09	07
16.	Lepidoptera	Papilionidae	*Papilio demoleus*	10	08
17.	Lepidoptera	Papilionidae	*Zetides agamemnon*	10	06
18.	Lepidoptera	Lycaenidae	*Lampides boeticus*	195	145
19.	Lepidoptera	Lycaenidae	*Catochrysops enjus*	60	54
20.	Lepidoptera	Lycaenidae	*Castalius rosimon*	04	02
21.	Lepidoptera	Arctiidae	*Utethesia pulchella*	02	02
22.	Lepidoptera	Noctuidae	*Helicoverpa zea*	04	03
23.	Odonata	Libellulidae	*Brudinopyga geminata*	13	10
24.	Odonata	Libellulidae	*Neurothemis intermedia (Rambur)*	03	03
25.	Odonata	Libellulidae	*Brachythemis cantaminata (febricui)*	09	08
26.	Odonata	Libellulidae	*Orthetrum pruinosum (Rambur)*	04	03
27.	Odonata	Libellulidae	*Orthetrum glaucum*	10	08

28.	Odonata	Libellulidae	*Orthetrum sabina*	12	08
29.	Odonata	Libellulidae	*Orthetrum chrysis*	02	-
30.	Odonata	Libellulidae	*Crocothemis servilia*	08	06
31.	Odonata	Libellulidae	*Trithemis aurora*	12	09
32.	Odonata	Coenagrionidae	*Ceriagrion coromandelianun (Fabricius)*	11	08
33.	Odonata	Coenagrionidae	*Ischnura elegans*	15	09
34.	Hymenoptera	Apidae	*Xylocopa fenestrata*	08	06
35.	Hymenoptera	Apidae	*Apis florea*	25-30	25-28
36.	Hymenoptera	Apidae	*Apis dorsata*	41	38
37.	Hymenoptera	Sphecidae	*Cerceris sp.*	25	22
38.	Hymenoptera	Sphecidae	*Liris sp.*	32	28
39.	Hymenoptera	Vespidae	*Ropalidia sp.*	87	83
40.	Hymenoptera	Formicidae	*Aenictus sp.*	13	11
41.	Hemiptera	Pentatomidae	*Halys parvus (chopra)*	20	17
42.	Hemiptera	Pentatomidae	*Erthesina fullo (Thunberg)*	51	45
43.	Hemiptera	Lygacidae	*Spilostethus pandurus*	52	45
44.	Hemiptera	Reduviidae	*Acanthaspis sp.*	21	17
45.	Hemiptera	Reduviidae	*Rhinocoris sp.*	38	35

46.	Diptera	Tabanidae	Unidentified	10	07
47.	Diptera	Stratonyidae	Unidentified	15	09
48.	Diptera	Muscidae	*Musca domestica*	>100	>150
49.	Diptera	Drosophilidae	*Drosophila melongaster*	48	52
50.	Diptera	Culicidae	*Anopheles sp.*	>125	>200
51.	Diptera	Culicidae	*Culex sp.*	>125	>200
52.	Diptera	Asilidae	Unidentified	>50	>100
53.	Orthoptera	Acrididae	*Catantops sp.*	17	15
54.	Orthoptera	Acrididae	*Acrida exalatata*	25	23
55.	Orthoptera	Tettigonidae	*Himertula pallisignata*	13	11
56.	Orthoptera	Gryllidae	*Gryllus campestris*	35	32
57.	Orthoptera	Gryllidae	*Halochlera indica*	30	27
58.	Orthoptera	Gryllidae	*Schistocera gregania*	20	16
59.	Dictyoptera	Blattidae	*Periplaneta americana*	31	28
60.	Dictyoptera	Mantidae	*Mantis religiosa*	01	0
61.	Thysanura	Lepismatidae	*Lepisma saccharina*	>50	>65
62.	Isoptera	Termitidae	*Prorhinotermes sp.*	>100	>100
63.	Coleoptera	Buprestidae	*Chrysocoris chinonsis*	0	01

6.1.2 RESULT OF JAIRAJ PARK (Site 2)

Jairaj park is a disturbed site as it is a public place (park), it has pathways where number of people come for morning and evening walk and it also serves as playground for children.

A total of 26 species insects belonging to 8 orders and 12 families were observed in this area. (Table:6.7; Table:6.8).

LEPIDOPTERA:

Butterflies recorded from the Jairaj park belonged to two families. Family Nymphalidae include 5 species out of which four are of same genus: *Junonia* and other is *Danaus chrysippus (Linnaeus).* Genus *Junonia* had four species: *J. lemonias, J. atlites, J. almona, and J. orithya. Junonia orithya* was maximum in number while *J. almona* was minimum in abundance. Butterfly species observed of family Pieridae in this area was : *Terias hecabe (Linnaeus), Catopsilia pomona,* and *Eurema laeta (Boisduval). Terias hecabe (Linnaeus)* was sighted in maximum abundance.

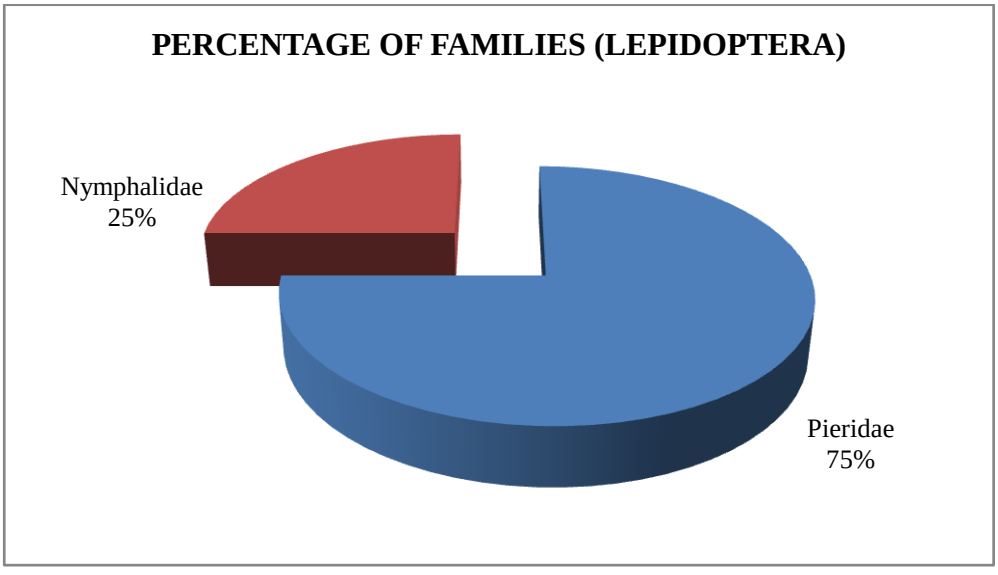


Fig.6.15 Status of Lepidoptera (butterflies)

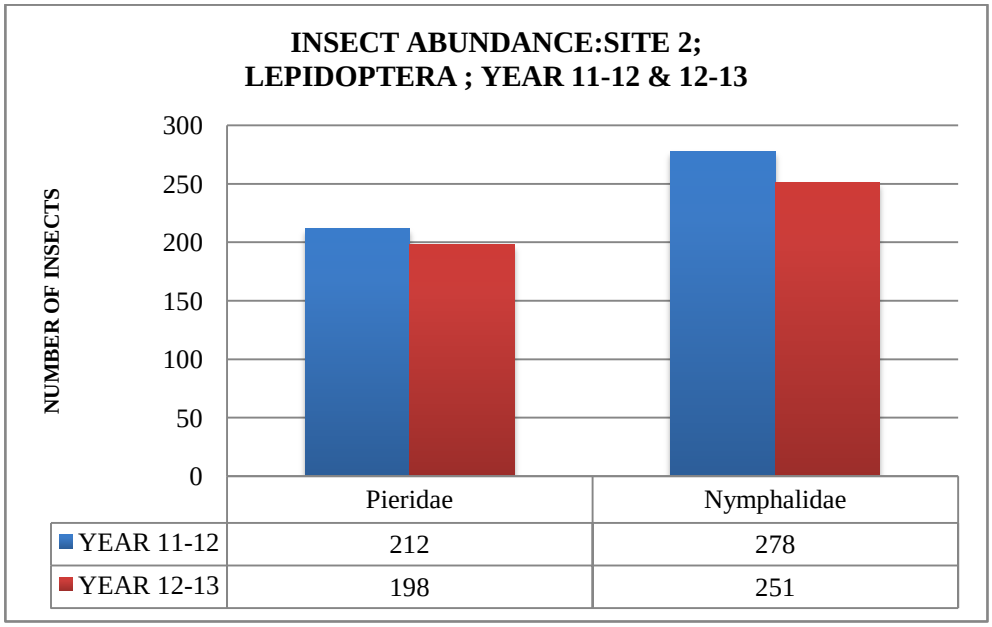


Fig.6.16 Comparative study of Abundance of individuals of families of order Lepidoptera in the year 2011-12 and 2012-13

All these butterflies were also recorded from the college campus (Site 1). Due to more vegetation in Site 1 the abundance was greater.

Tamang (2010) observed 42 species of butterflies at butterfly park , Bannerghatta (Population was not very high .this may be due to change in climatic conditions or impact of human acitivities). Sarma *et.al.* (2012) studied butterfly diversity of Itanagar, Arunachal Pradesh, India. Most of the butterflies were common and generalist species, none was rare. Diversity of butterfly of Mantagaddi of Shivamangga, Karnataka was carried out by Jeevan *et. al.*(2013).

HEMIPTERA:

The only species observed of order Hemiptera of family Lygacidae was *Spilostethus pandurus*. Its abundance was quite good in the season.

In UK worker Gaston *et. al.* (2005) increased the environment of domestic urban garden by various methods and observed the difference in increasing biodiversity of insects of bugs in that area.

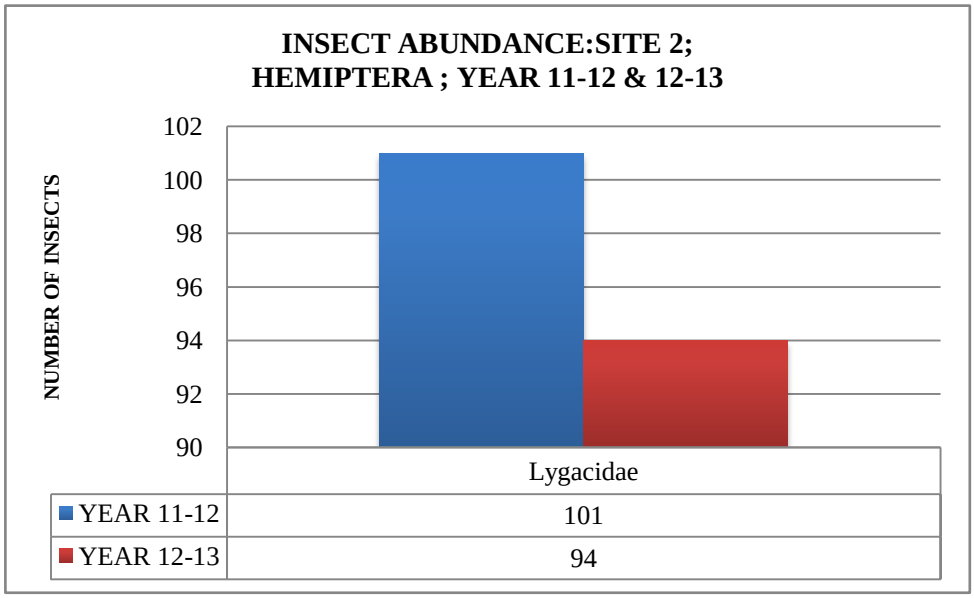


Fig.6.17 Comparative study of Abundance of individuals of family of order Hemiptera in the year 2011-12 and 2012-13

HYMENOPTERA

Honey bees and wasp were recorded as the park had few large *Neolamarckia cadamba* and *Butea Monosperma* (Palash) trees. A total of 5 species were identified from family Apidae (*Apis florae* and *Apis dorsata)* and families Vespidae include *Ropalidia sp., Polistes stigma (Fabricius), vespa orientalis.* Maximum abundance was of: *Apis florae* and minimum was that of *Ropalidia sp.*

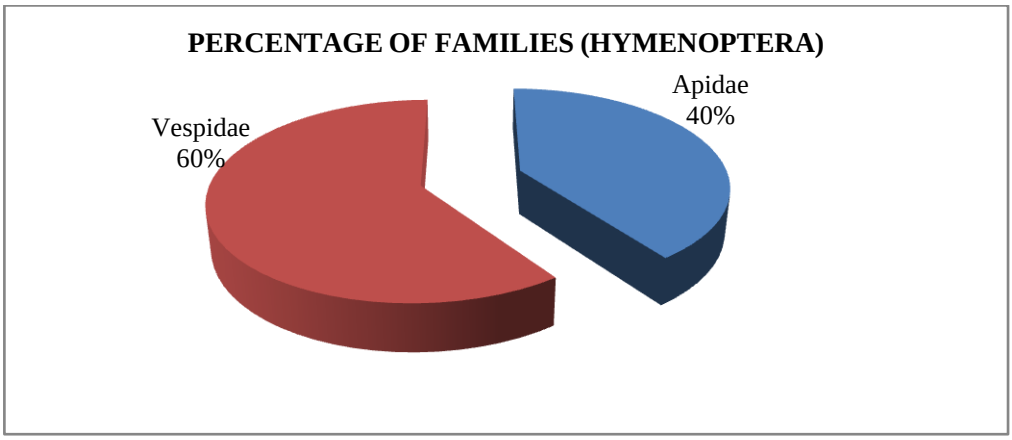


Fig.6.18 Status of Hymenoptera (bees and wasp)

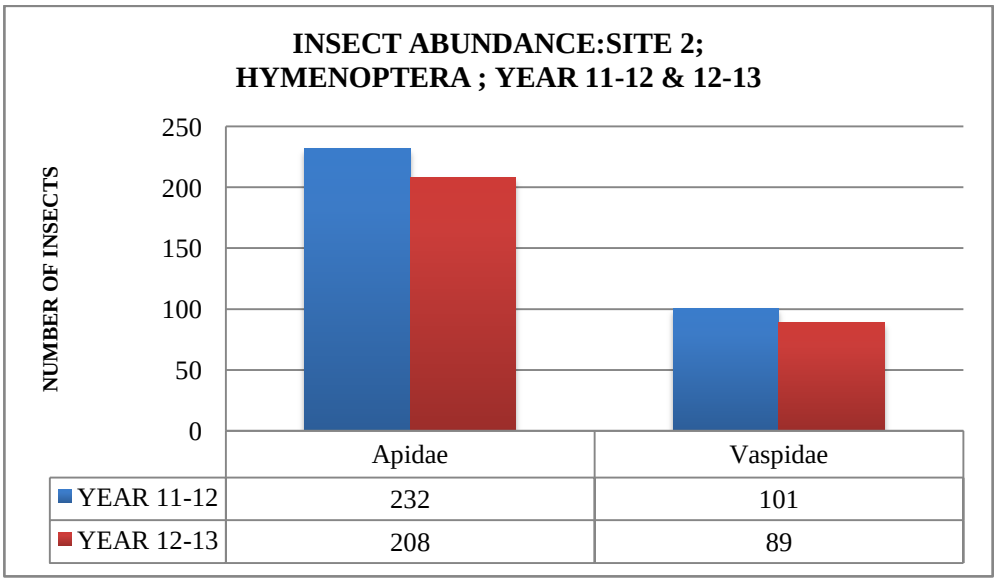


Fig.6.19 Comparative study of Abundance of individuals of families of order Hymenoptera in the year 2011-12 and 2012-13

ODONATA

In Jairaj park the only three species of order Odonata were identified from family Libellulidae: *Neurothemis intermedia (Rambur), Crocothemis servilia* and *Trithemis aurora*.

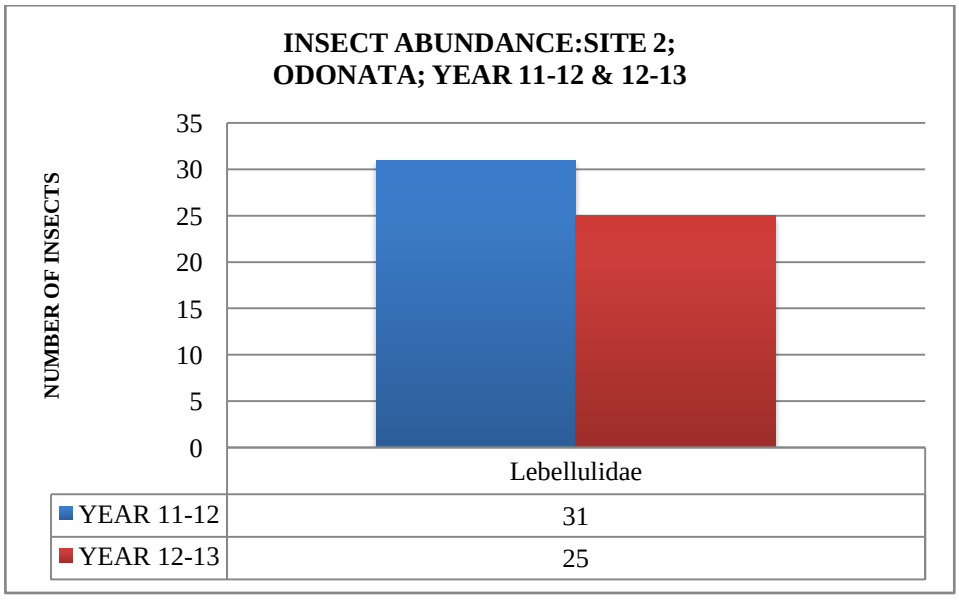


Fig.6.20 Comparative study of Abundance of individuals of families of order Odonata in the year 2011-12 and 2012-13

Study of diversity of dragonflies (Anisoptera) in Gorrewada international biological park, Nagpur, center India was done by Shende and Patil (2013). A total of 34 species of dragonflies were recorded belonging to 24 genera and 4 families.

ORTHOPTERA

The individuals identified were of 3 families: family Cryllidae include 3 species- *Cryllus compestris, Holochlora indica, Schistocera regania.* Family Acridiae include *Catantops karnys*, *Catantops sp.* and *Acrida exalatata.* While family Tettigonidae include only *Himertula pallisignata.*The maximum number was of field cricket in rainy season.

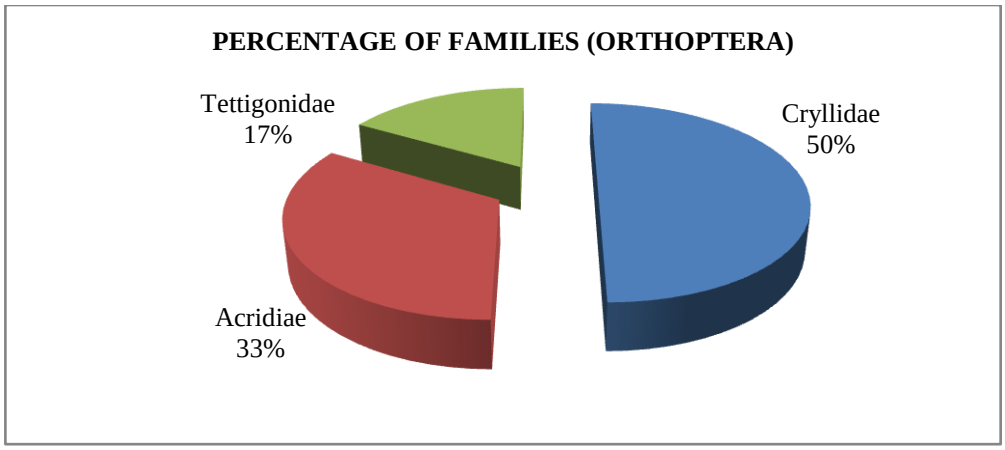


Fig.6.21 Status of Orthoptera (crickets, grasshoppers and locusts)

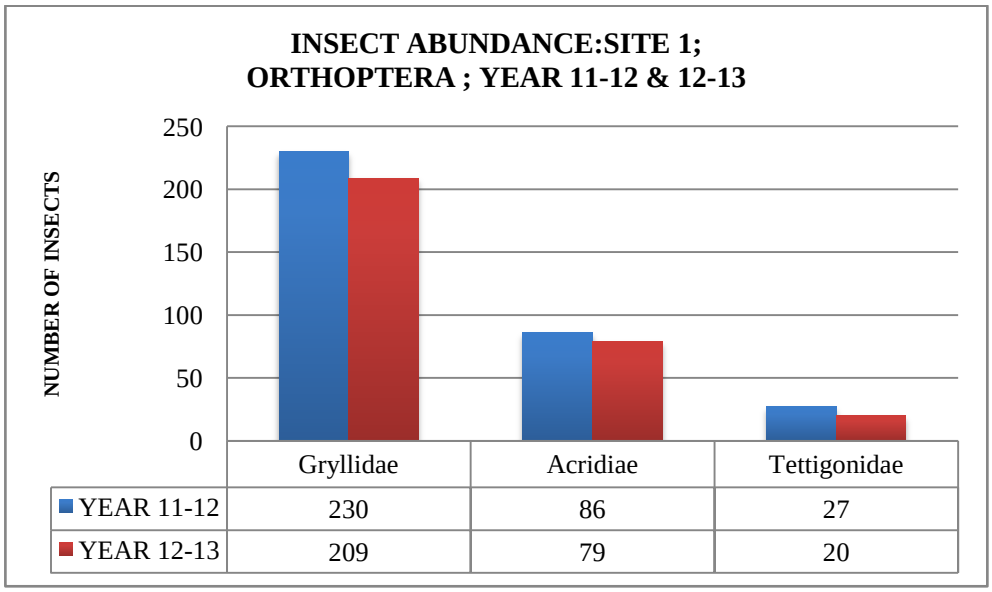


Fig.6.22 Comparative study of Abundance of individuals of families of order Orthoptera in the year 2011-12 and 2012-13

DICTYOPTERA

The insect observed was one (01) in number *Mantis religiosa* belongs to family Mantidae.

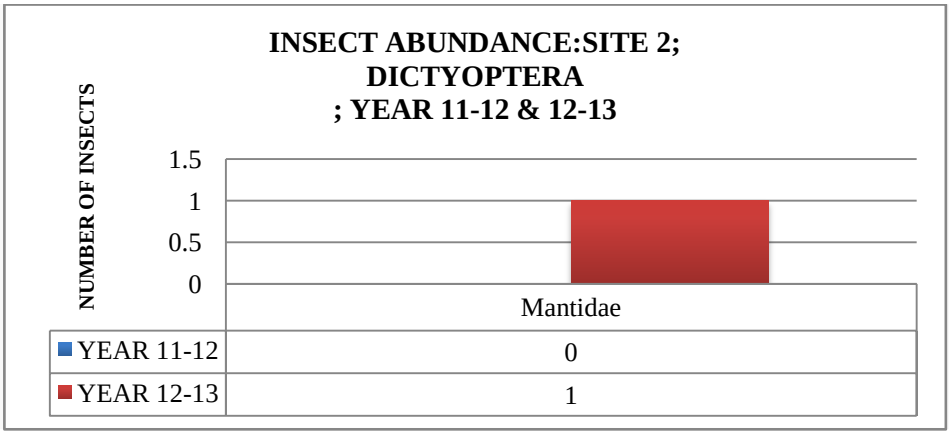


Fig.6.23 Comparative study of Abundance of individuals of family of order Dictyoptera in the year 2011-12 and 2012-13

ISOPTERA

The common termite was also observed in the park as there was no regular maintenance of park.

Table: 6.5 Comparative study of Abundance of individuals of family of order Isoptera in the year 2011-12 and 2012-13

S. NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Termitidae	01	>100	>100

DIPTERA

It was very usual to observe housefly *Musca domestica* of family Muscidae in the park in rainy season.

Table: 6.6 Comparative study of Abundance of individuals of family of order Diptera in the year 2011-12 and 2012-13

S. NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Muscidae	01	>100	>100

Table: 6.7 Identified Insects at Site 2 (Jairaj Park), Jhalawar; Year 2011-12

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	**Feb-March 2011-12**	**Sept.-Oct. 2011-12**
1.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	76	62
2.	Lepidoptera	Pieridae	*Eurema laeta (Boisduval)*	16	12
3.	Lepidoptera	Pieridae	*Catopsilia pomona*	26	20
4.	Lepidoptera	Nymphalidae	*Junonia lemonias*	27	25
5.	Lepidoptera	Nymphalidae	*Junonia (Precis) atlites (Linnaeus)*	13	10
6.	Lepidoptera	Nymphalidae	*Junonia almona*	15	12
7.	Lepidoptera	Nymphalidae	*Junonia orithya*	54	45
8.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*	42	35
9.	Hemiptera	Lygacidae	*Spilostethus pandurus*	55	46
10.	Hymenoptera	Apidae	*Apis florea*	80	85
11.	Hymenoptera	Apidae	*Apis dorsata*	32	35

12.	Hymenoptera	Vespidae	*Ropalidia marginata*	17	12
13.	Hymenoptera	Vespidae	*Vespa orientalis*	21	18
14.	Hymenoptera	Vespidae	*Polistes stigma (Fabricius)*	18	15
15.	Odonata	Libellulidae	*Trithemis aurora*	04	04
16.	Odonata	Libellulidae	*Nurothemis intermedia*	05	04
17.	Odonata	Libellulidae	*Crocothemis servilia*	07	07
18.	Orthoptera	Acrididae	*Catantops sp.*	18	15
19.	Orthoptera	Acrididae	*Acrididae exalatata*	28	25
20.	Orthoptera	Tettigonidae	*Himertula pallisignata*	14	13
21.	Orthoptera	Gryllidae	*Gryllus campestris*	40-50	40-50
22.	Orthoptera	Gryllidae	*Halochlera indica*	32	30
23.	Orthoptera	Gryllidae	*Schistocera gregania*	35	33
24.	Dictyoptera	Mantidae	*Mantis religiosa*	-	-
25.	Diptera	Muscidae	*Musca domestica*	>100	>200
26.	Isoptera	Termitidae	*Prorhinotermes sp.*	>125	>100

Table: 6.8 Identified insects at site 2 (Jairaj park), Jhalawar; year 2012-13

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	Feb-March 2012-13	Sept.-Oct. 2012-13
1.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	70	65
2.	Lepidoptera	Pieridae	*Eurema laeta (Boisduval)*	13	11
3.	Lepidoptera	Pieridae	*Catopsilia pomona*	22	17
4.	Lepidoptera	Nymphalidae	*Junonia lemonias*	24	21
5.	Lepidoptera	Nymphalidae	*Junonia (Precis) atlites (Linnaeus)*	11	07
6.	Lepidoptera	Nymphalidae	*Junonia almona*	13	11
7.	Lepidoptera	Nymphalidae	*Junonia orithya*	50	42
8.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*	38	34
9.	Hemiptera	Lygacidae	*Spilostethus pandurus*	50	44
10.	Hymenoptera	Apidae	*Apis florae*	70	76
11.	Hymenoptera	Apidae	*Apis dorsata*	30	32

12.	Hymenoptera	Vespidae	*Ropalidia marginata*	15	11
13.	Hymenoptera	Vespidae	*Vespa orientalis*	18	15
14.	Hymenoptera	Vespidae	*Polistes stigma (Fabricius)*	16	14
15.	Odonata	Libellulidae	*Trithemis aurora*	03	03
16.	Odonata	Libellulidae	*Nurothemis intermedia*	04	04
17.	Odonata	Libellulidae	*Crocothemis servilia*	06	05
18.	Orthoptera	Acrididae	*Catantops sp.*	16	14
19.	Orthoptera	Acrididae	*Acrididae exalatata*	26	23
20.	Orthoptera	Tettigonidae	*Himertula pallisignata*	11	09
21.	Orthoptera	Gryllidae	*Gryllus campestris*	35-45	35-45
22.	Orthoptera	Gryllidae	*Halochlera indica*	28	26
23.	Orthoptera	Gryllidae	*Schistocera gregania*	34	31
24.	Dictyoptera	Mantidae	*Mantis religiosa*	01	-
25.	Diptera	Muscidae	*Musca domestica*	>100	>200
26.	Isoptera	Termitidae	*Prorhinotermes sp.*	>125	>100

6.1.3 RESULT OF JHIRI AREA (Site 3)

This is third site which is semi-disturbed. It is a small hill area not disturbed by human activities except little grazing by cattle. Here we observed few beetles which were not found in any other area (site). The following groups of insects were observed Lepidoptera, Odonata, Coleoptera, Orthoptera and Neuroptera; comprising of 11 families and 19 species. (Table:6.10; Table:6.11).

LEPIDOPTERA:

During study time (2011-13) total of 9 species of butterflies were observed and identified in this area. They belong to 4 families Nymphalidae, Pieridae, Papilionidae and Lycaenidae. In family Nymphalidae the genus *Junonia* was represented by 3 species *J. lemonia, J. almona* and *J. orithya* and other was *Danaus chrysippus (Linnaeus).*

While family Pieridae include *Terias hecabe (Linnaeus)* and *Catopsilia pomona.* Family Papilionidae and Lycaenidae each represent only one species each *Papilio demoleus* and *Lampides boeticus.*

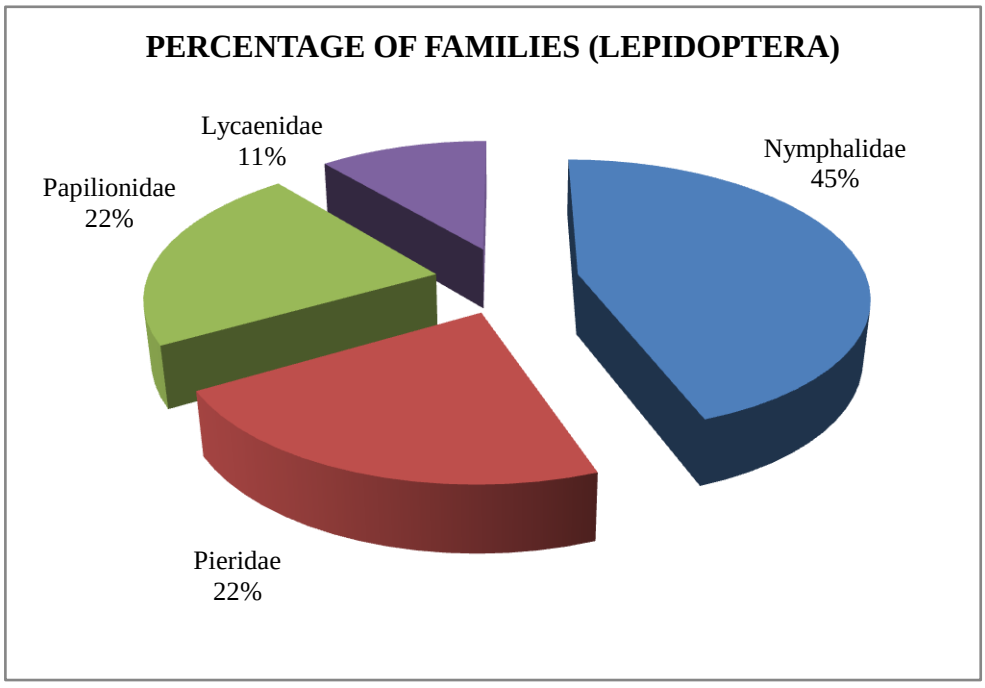


Fig.6.24 Status of Lepidoptera (butterflies)

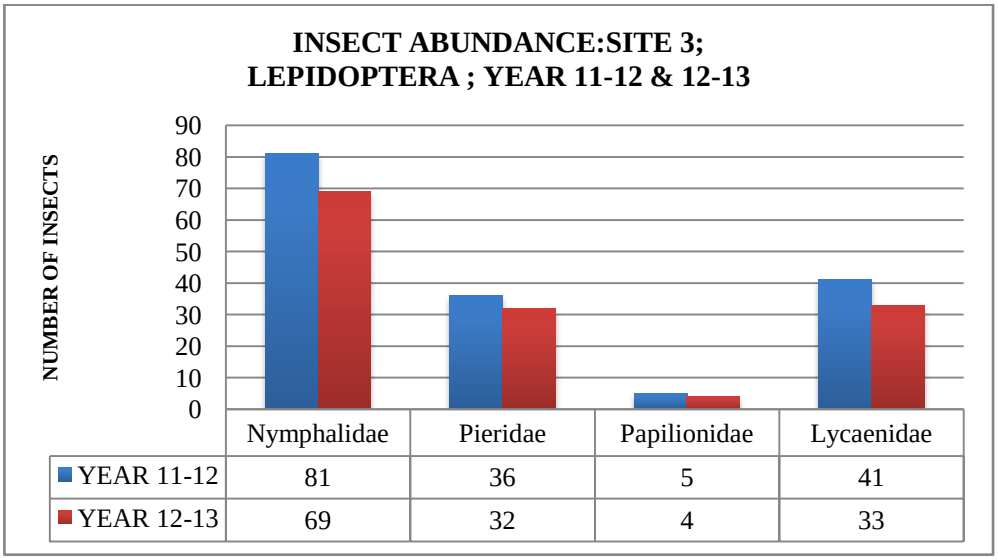


Fig.6.25. Comparative study of Abundance of individuals of families of Order Lepidoptera in the year 2011-12 and 2012-13

ODONATA

A total of three species representing only Libellulidae family was recorded from the Jhiri area. They were *Brachythemis cantaminata*, *Neurothemis intermedia (*Rambur*), Trithemis aurora.* Sathe and Bhusnar (2010) recorded the biodiversity of mosquitovorus dragonflies of Kolhapur district India including Western Ghats of Maharashtra. In all 43 species were found feeding on mosquitoes.

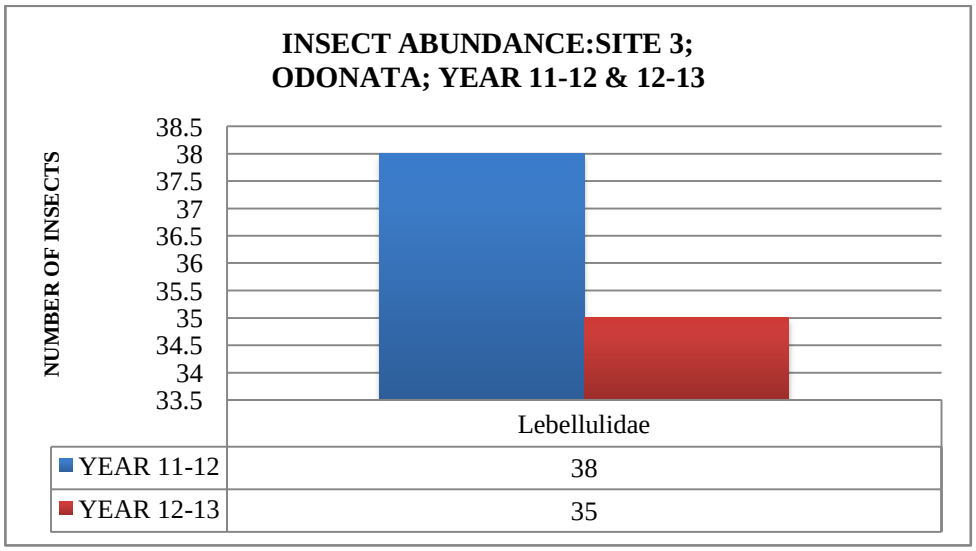


Fig.6.26 Comparative study of Abundance of individuals of families of order Odonata in the year 2011-12 and 2012-13

COLEOPTERA

During the study 4 genus of Coleopteran insects were recorded from this site. Species of these four beetles were not identified. The recorded four beetles belong to three families. Family Tenebrionidae comprises of two genus *Adesmia sp.* and *Rhytinota sp*

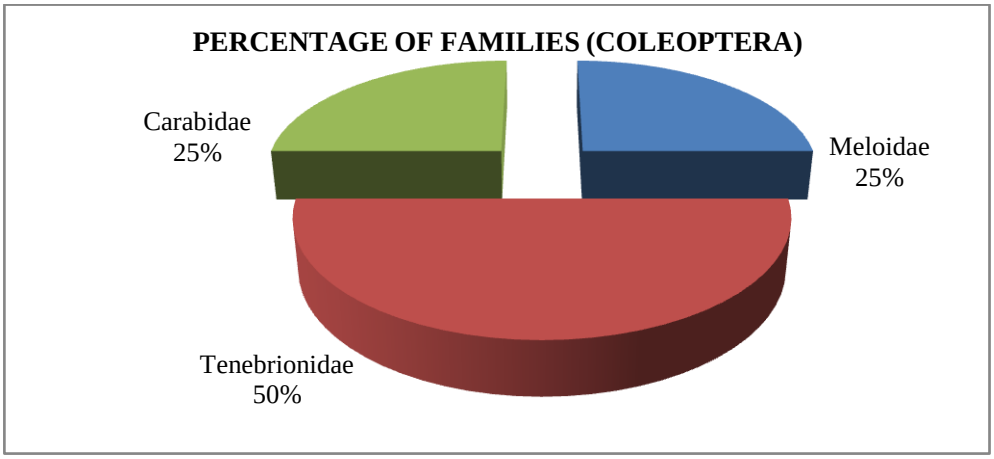


Fig.6.27 Status of Coleoptera(beetles)

Family Carabidae include *Diplocheila sp.*and family Meloidae represents *Mylabris puslutata.*

Mohan and Padmanaban (2013) reported coleopteran diversity in and around Bhavani Taluk Erode District, Tamil Nadu , India.493 individuals were collected and identified which belong to 22 different species and 12 families.

A total of 10 species ground beetles belonging to 6 sub families of family carabidae were collected and examined by Thakare *et. al.* (2013) in the protected area of the Melghat Tiger Reserve (MTR) Vidarbha region Maharashtra.

Comprehensive research on scarab beetles diversity at center India was made by Chandra and Gupta (2013) in Barnawapara sanctuary, Chhattisgarh revealed 43 species belonging to 16 families and 8 sub families. Similar type of study on scarab beetles was also conducted in Kolkas region of Melghat Tiger Reserve (MTR) Amravati , Maharashtra during 2011 by Thakare *et. al.* they recorded 26 species of scarab beetles belonging to 14 genera.

Thakare and Zade (2012) further worked on coleopteran species in and around Tarubanda village, Gugamal range. They observed and identified 16 species of beetles out of which 13 species belonged to 6 different families.

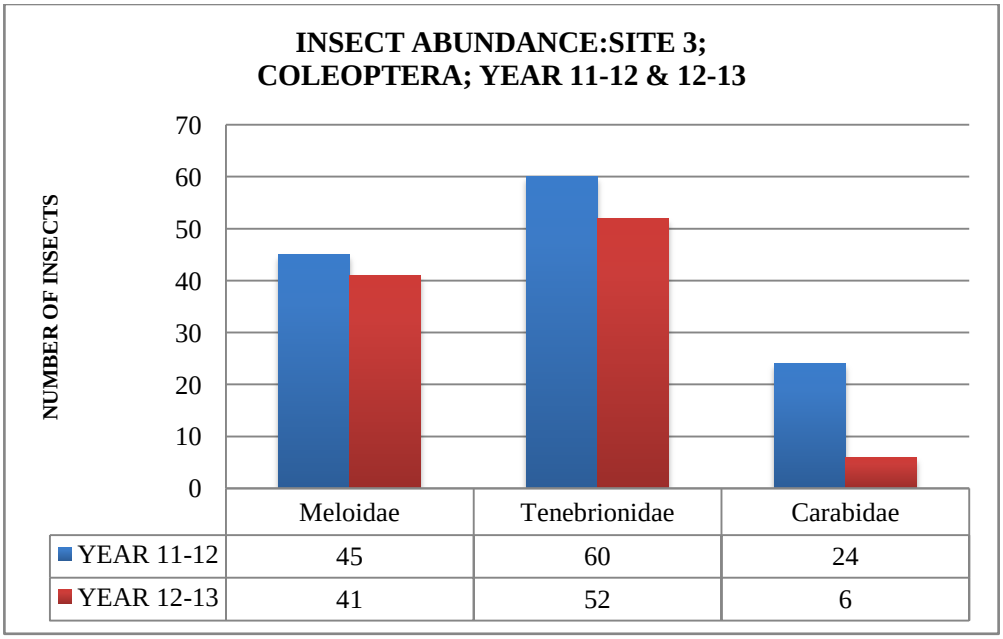


Fig.6.28 Comparative study of Abundance of individuals of families of order Coleoptera in the year 2011-12 and 2012-13

ORTHOPTERA

The individuals observed and identified in this area belongs to two families. Family Acrididae include *Catantops sp.* and *Acrida exalatata.* The family Tettigonidae represents only *Himertula pallisignata.*

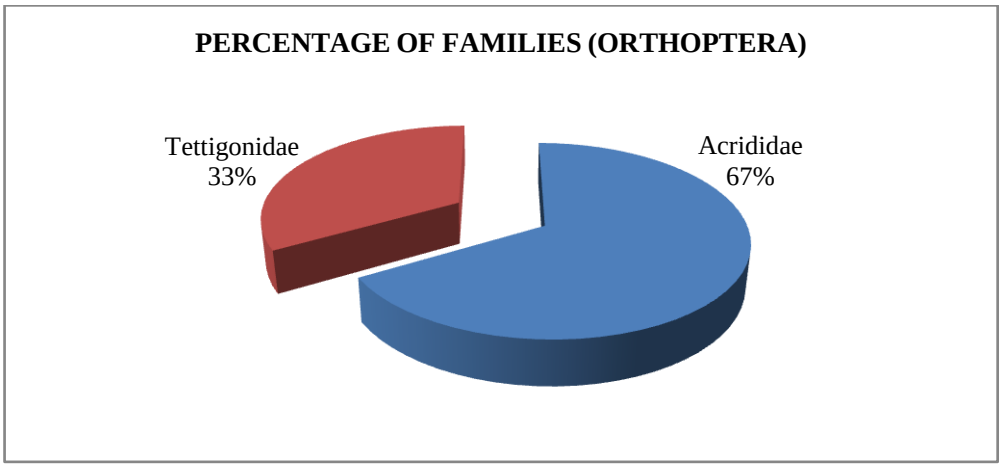


Fig6.29. Status of Orthoptera(grasshoppers, locust and crickets)

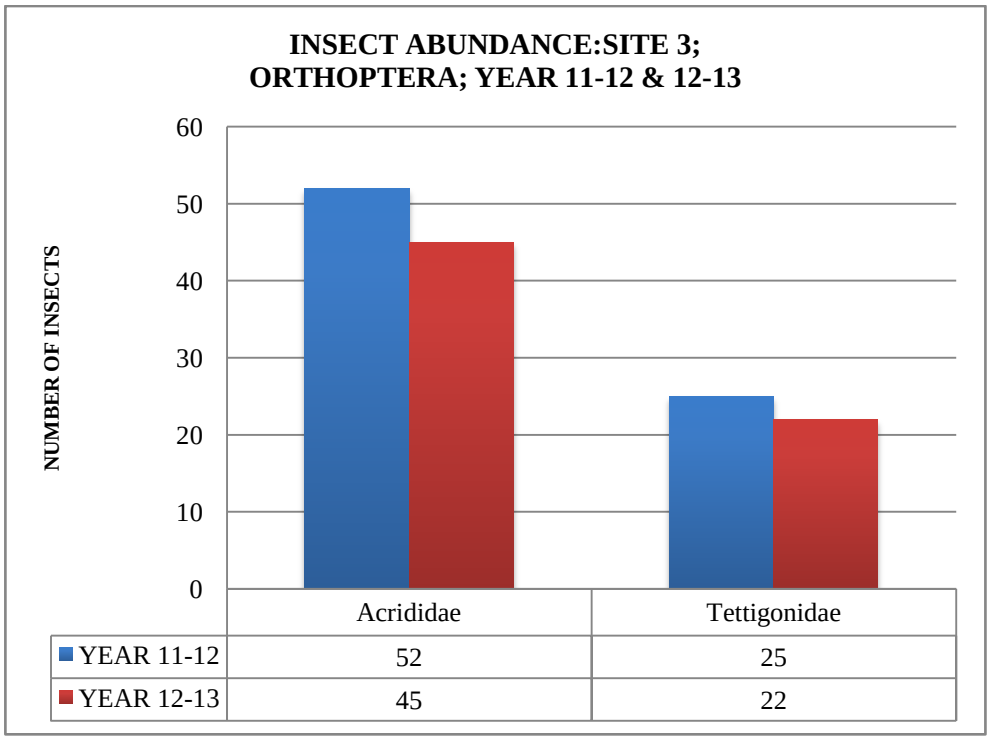


Fig.6.30 Comparative study of Abundance of individuals of families of order Orthoptera in the year 2011-12 and 2012-13

NEUROPTERA

The only genus identified and observed of this order neuroptera was *Creoleon sp.* belong to family Myrrnelontidae.

Table: 6.9 Comparative study of Abundance of individuals of family of order Neuroptera in the year 2011-12 and 2012-13

S. NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Myrrnelontidae	01	29	24

Table: 6.10 Identified insects at site 3 (Jhiri area), Jhalawar; year 2011-12

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	Feb-March 2011-12	Sept.-Oct. 2012-13
1.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	15	12
2.	Lepidoptera	Pieridae	*Catopsilia pomona*	05	04
3.	Lepidoptera	Nymphalidae	*Junonia lemonias*	26	21
4.	Lepidoptera	Nymphalidae	*Junonia almona*	04	03
5.	Lepidoptera	Nymphalidae	*Junonia orithya*	05	04
6.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*	10	08
7.	Lepidoptera	Papilionidae	*Papilio demoleus*	03	02
8.	Lepidoptera	Lycaenidae	*Lampides boeticus*	22	19
9.	Odonata	Libellulidae	*Neurothemis intermedia (Rambur)*	08	08

10.	Odonata	Libellulidae	*Brachythemis cantaminata (Fabricius)*	06	05
11.	Odonata	Libellulidae	*Trithemis aurora*	07	06
12.	Coleoptera	Tenebrionidae	*Adesmia sp.*	12	15
13.	Coleoptera	Tenebrionidae	*Rhytinota sp.*	15	18
14.	Coleoptera	Carabidae	*Diplocheila sp.*	10	14
15.	Coleoptera	Meloidae	*Mylabris puslutata*	20	25
16.	Orthoptera	Acrididae	*Catantops sp.*	17	15
17.	Orthoptera	Acrididae	*Acrida exalatata*	28	24
18.	Orthoptera	Tettigonidae	*Himertula pallisignata*	14	11
19.	Neuroptera	Myrrnelontidae	*Creoleon sp.*	16	13

Table: 6.11 Identified insects at site 3 (Jhiri area), Jhalawar; year 2012-13

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	Feb-March 2012-13	Sept.-Oct. 2012-13
1.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	13	11
2.	Lepidoptera	Pieridae	*Catopsilia pomona*	04	04
3.	Lepidoptera	Nymphalidae	*Junonia lemonias*	22	18
4.	Lepidoptera	Nymphalidae	*Junonia almona*	04	03
5.	Lepidoptera	Nymphalidae	*Junonia orithya*	04	04
6.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*	08	06
7.	Lepidoptera	Papilionidae	*Papilio demoleus*	02	02
8.	Lepidoptera	Lycaenidae	*Lampides boeticus*	18	15
9.	Odonata	Libellulidae	*Neurothemis intermedia (Rambur)*	08	06

10.	Odonata	Libellulidae	*Brachythemis cantaminata (Fabricius)*	05	04
11.	Odonata	Libellulidae	*Trithemis aurora*	06	06
12.	Coleoptra	Tenebrionidae	*Adesmia sp.*	12	13
13.	Coleoptra	Tenebrionidae	*Rhytinota sp.*	12	15
14.	Coleoptra	Carabidae	*Diplocheila sp.*	09	15
15.	Coleoptra	Meloidae	*Mylabris puslutata*	18	23
16.	Orthoptera	Acrididae	*Catantops sp.*	16	13
17.	Orthoptera	Acrididae	*Acrida exalatata*	25	20
18.	Orthoptera	Tettigonidae	*Himertula pallisignata*	12	10
19.	Neuroptera	Myrrnelontidae	*Creoleon sp.*	14	10

6.1.4 RESULT OF BAGHER FOREST (Site 4)

Bagher forest is the fourth site of the study. The site is undisturbed by human activities. The diversity of fauna observed was not rich in the limited area covered under the study period.

We did our research work in the outer periphery of the dense Bagher forest; as we didn't have proper forest team with us. It was not safe for us to go deep inside because of wild, dense vegetation and wild animals

We observed total 12 individuals belonging to five different orders: Lepidoptera, Hemiptera, Coleoptera, Hymenoptera and Odonata. Only 9 of them were identified. (Table:6.15; Table:6.16).

LEPIDOPTERA

Butterflies of this order were represented by family Pieridae and Nymphalidae. Pieridae population comprises only one very common species i.e. *Terias hecabe (Linnaeus)* and similarly Nymphalidae represent only *Junonia almona*.

The extensive studies on diversity of butterflies were also conducted in Rajasthan state of India by Sharma in Aravali range during 2008-11. He recorded 38 species of Lepidoptera insects.

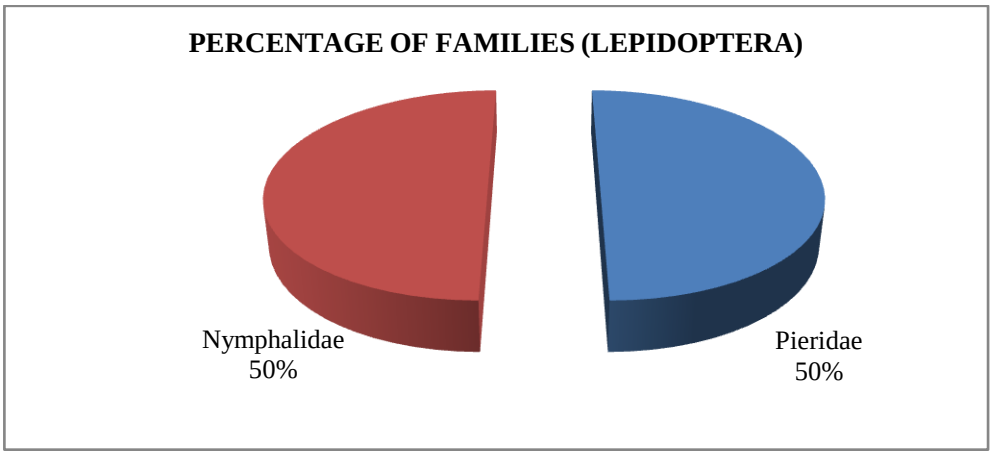


Fig.6.31 Status of Lepidoptetra (butterflies)

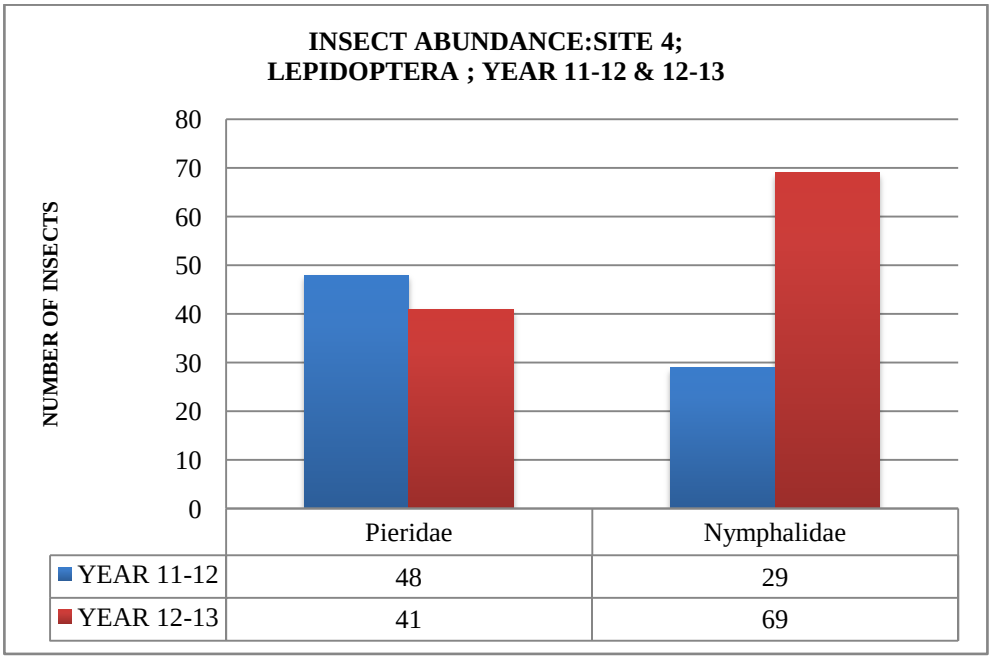


Fig.32 Comparative study of Abundance of individuals of families of order Lepidoptera in the year 2011-12 and 2012-13

HEMIPTERA

Hemipteran recorded from this area represent by three families Reduviidae, Lygacidae and Coreidae. Reduviidae comprises *Acanthaspis sp.and Rhinocoris sp.* whereas family Coreidae represented by *Petalocnemis obscura (dallas)* and Lygacidae by *Spilostethus pandurus* respectively.

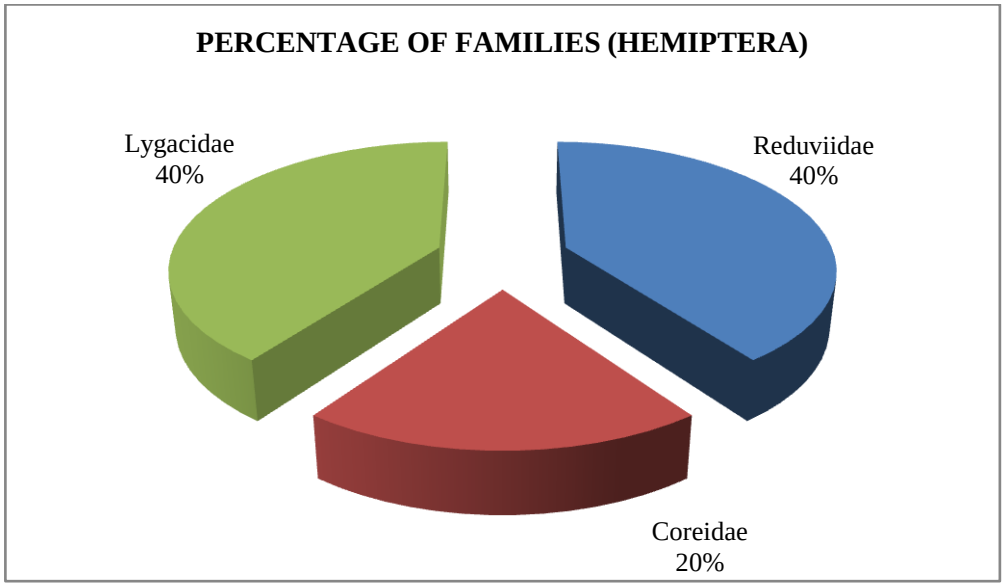


Fig.6.33 Status of Hemiptera (bugs)

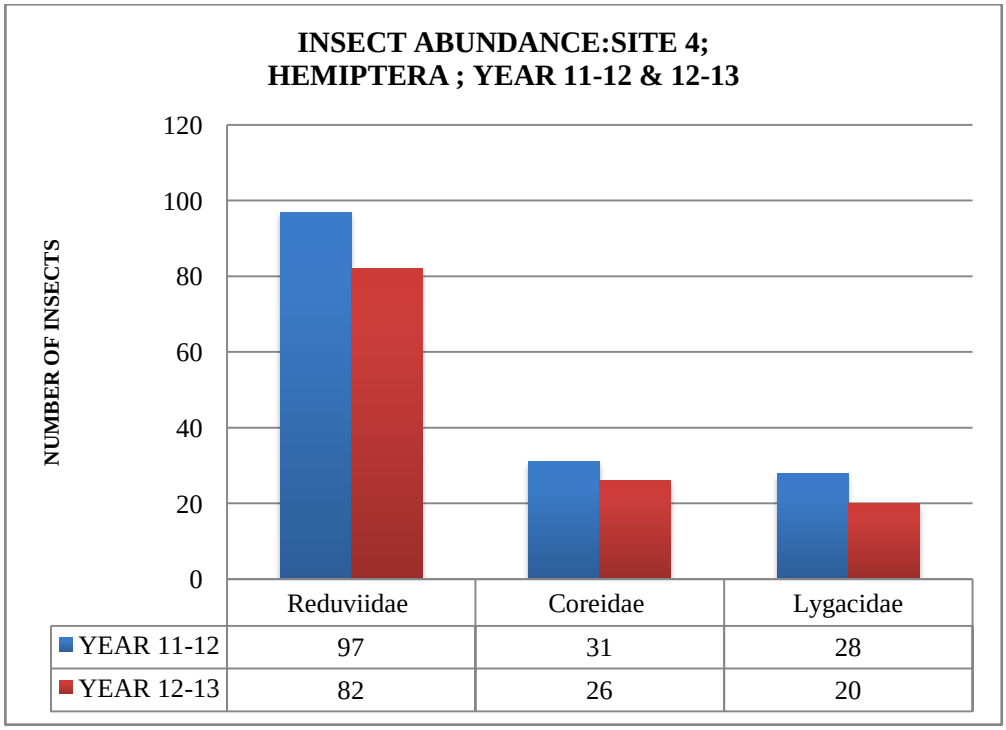


Fig.6.34 Comparative study of Abundance of individuals of families of order Hemiptera in the year 2011-12 and 2012-13

ODONATA

Odonata comprises species named *Neurothemis intermedia intermedia (Rambur)*. An observation on Odonata (damselfly and dragonflies) fauna of Manchabandha reserve forest, Baripada, Odisha, was carried out by Kalita *et. al*. (2014). They recorded 48 species of Odonates belonging to 3 genera and 8 families. Libellulidae was richest family. Diversity of Odonates were reported for the first time in this forest.

Table 6.12: Comparative study of Abundance of individuals of family of order Hemiptera in the year 2011-12 and 2012-13

S. NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Libellulidae	1	41	33

COLEOPTERA

The only species of Coleoptera was *Orphnus* species. This species was observed in the cow dung only in the year 2012.The number of individuals observed was 8 in number.

Table 6.13: Comparative study of Abundance of individuals of family of order Coleoptera in the year 2011-12 and 2012-13

S. NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Scarabacidae	1	0	08

Small collection of scarab beetles from Govind wildlife sanctuary Uttrakhand comprising 11 species belonging to 11 genera was conducted by Chandra *et. al.* (2012).

Aland *et. al.* (2012) reported 152 species distributed over 101 genera belonging to 25 families of beetles from in and around Amba reserve forest of Kolhapur district Maharashtra.

HYMENOPTERA

Dolichhovespula species was observed in the edges of Bagher forest in the year 2012.

Table 6.14: Comparative study of Abundance of individuals of family of order Hymenoptera in the year 2011-12 and 2012-13

S. NO.	FAMILY	NO. OF SPECIES	NO. OF INDIVIDUALS	
			YEAR 2011-12	YEAR 2012-13
1.	Vespidae	1	46	38

Table:6.15 Identified insects at site 4 (Bagher forest), Jhalawar; year 2011-12

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	Feb-March 2011-12	Sept.-Oct. 2011-12
1.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	26	22
2.	Lepidoptera	Nymphalidae	*Junonia almona*	16	13
3.	Hemiptera	Reduviidae	*Acanthaspis sp.*	22	20
4.	Hemiptera	Reduviidae	*Rhinocoris sp.*	30	25
5.	Hemiptera	Coreidae	*Petalocnemis obscura (dallas)*	17	14
6.	Hemiptera	Lygacidae	*Spilostethus pandurus*	15	13
7.	Odonata	Libellulidae	*Neurothemis intermedia (Rambur)*	22	19
8.	Coleoptera	Scarabacidae	*Orphnus picinus*	0	0
9.	Hymenoptera	Vespidae	*Dolichovespula sp.*	25	21

TABLE:6.16 Identified insects at site 4 (Bagher forest), Jhalawar; year 2012-13

	I N S E C T I D E N T I F I E D			**ABUNDANCE (Approx. no. of insects)**	
S.NO.	**ORDER**	**FAMILY**	**GENUS SPECIES**	Feb-March 2012-13	Sept.-Oct. 2012-13
1.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	22	19
2.	Lepidoptera	Nymphalidae	*Junonia almona*	12	11
3.	Hemiptera	Reduviidae	*Acanthaspis sp.*	20	17
4.	Hemiptera	Reduviidae	*Rhinocoris sp.*	25	20
5.	Hemiptera	Coreidae	*Petalocnemis obscura (dallas)*	15	11
6.	Hemiptera	Lygacidae	*Spilostethus pandurus*	11	09
7.	Odonata	Libellulidae	*Neurothemis intermedia (Rambur)*	18	15
8.	Coleoptera	Scarabacidae	*Orphnus picinus*	08	0
9.	Hymenoptera	Vespidae	*Dolichovespula sp.*	20	18

6.2 DISCUSSION

The present study emphasize to investigate the diversity and abundance of insects with special reference to anthropogenic activities of that area. The site chosen were disturbed (College campus and Jairaj Park) semi disturbed (Jhiri area) and undisturbed (Bagher Forest).

STUDY OF DIVERSITY OF INSECT OF ALL FOUR SITES

The table below illustrates the comparative study of number of orders, families, genus and species; and total abundance of the 2 years (2011-12; 2012-13) of all the four sites.

Table: 6.17 Comparative diversity of insect of all four sites studied

Sites	No. of orders	No. of families	No. of genus	No. of species	Total abundance (2011-12)	Total abundance (2012-13)
SITE 1	10	29	52	50	4464	4057
SITE 2	08	12	22	24	1868	1758
SITE 3	05	11	17	14	470	410
SITE 4	06	08	09	05	320	271

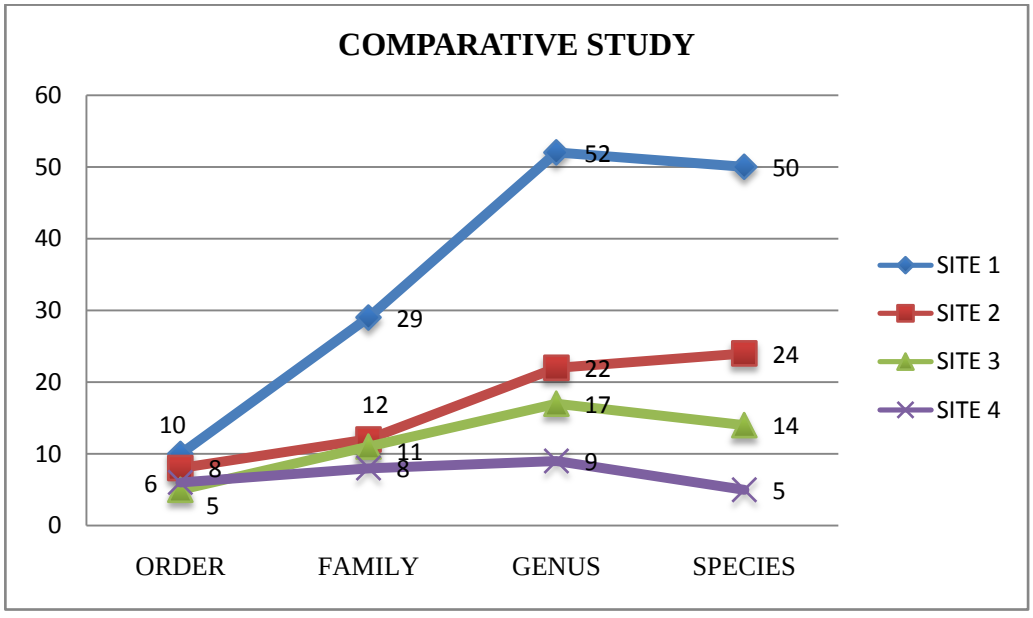


Fig. 6.35 Representing comparative study of order ,family, genus, species of four locations.

Growth of human population is major factor affecting the environment. Almost all the environmental problems we face today can be traced back to the increase in population in the world.(Miller ,1992). The high standard of living that accompanies the increased production and consumption of goods is the major cause of pollution and environmental degradation (E.O. Wilson, 1994).

Table: 6.18 illustrated the four areas selected for studies have different percentage of human activities. Maximum disturbances were in college campus followed by Jairaj park, Jhiri area and minimum were in Bagher forest.

Table: 6.18: Percentage of anthropogenic activities of different sites.

Sites / Anthropogenic Activity		Disturbed site		Semi disturbed site	Undisturbed site
		Site 1: COLLEGE CAMPUS	**Site 2: JAIRAJ PARK**	**Site 3: JHIRI AREA**	**Site 4: BAGHER FOREST**
1.	Cattle grazing	★	-	★ ★★	★
2.	People movement	★ ★★★	★ ★★★	★ ★	-
3.	Vehicular movement	★ ★	★	-	-
4.	Building construction	★ ★	★	★	-
5.	Gardening/ plantation	★ ★ ★	★ ★★	★	-
6.	Cutting of trees	★	★	★	★
7.	Burning of garbage/fuel	★ ★	-	-	-
8.	Sweeping /cleaning	★ ★	★		-
TOTAL		17	11	08	02

KEY:

0-20% ★ 21-40% ★ ★ 41-60% ★ ★ ★
61-80% ★ ★ ★ ★ 81-100% ★ ★ ★ ★ ★

6.2.1 IMPACT OF ANTHROPOGENIC ACTIVITIES ON BIODIVERSITY OF INSECTS AT SITE 1 AND SITE 2 (DISTURBED SITES)

As shown in the Table: 6.18, the site one and two were disturbed by many human activities. In the college campus and Park, presence of small patches of gardens and variety of plants and trees, developed by college management and government provide habitat for butterfly diversity. Thus the areas though disturbed represent maximum diversity of butterflies than in any other study area.

Rosin *et.al.* (2012) studied the relative effects of habitat patch and landscape characteristics on butterflies in habiting calcareous grasslands in southern Poland. Butterflies species and abundance are positively affected by patch size and wind shelter.

Conservation of butterfly fauna in a small landscape particularly in human dominated area might be a good model for maintaining optimal habitat within fragments and in that case academic institutional campus with high plant diversity might be a very good option for the conservation of species (Sarma *et. al.* 2012).

Butterfly fauna observed in the Jairaj park were similar but with lesser abundance, as found in the college campus. Some butterflies witnessed were quick flyers, high swift dwellers and some on low ground level; *Uthesia* species was observed on and around the water taps. Most of the butterflies were colourful and large. Among the sighted butterflies the rare ones were: *Ixias marianne, Junnonia atlites* and *Pachliopta aristolochia.*

Other human activities in the campus include: student movements, construction of rooms, burning of fuel, and regular sweeping and cleaning of campus. Hence we do not observe any ground beetles in both the areas. Park was disturbed mainly by: morning walkers, kids playing, etc.

Fig.6.36: Library building block, college campus (site 1)

Fig.6.37 Vehicular traffic on NH-12 adjacent to college campus (site 1)

Air pollution by vehicles due to the roads on the two sides of the campus is the main cause of absence of insects in the ground adjacent to NH12.

Fig.6.38 Cattle grazing in the college campus (occasionally)

Fig.6.39 : Jogging pathways in the Jairaj park

Fig.6.40 : Children playing the Jairaj park (site 2)

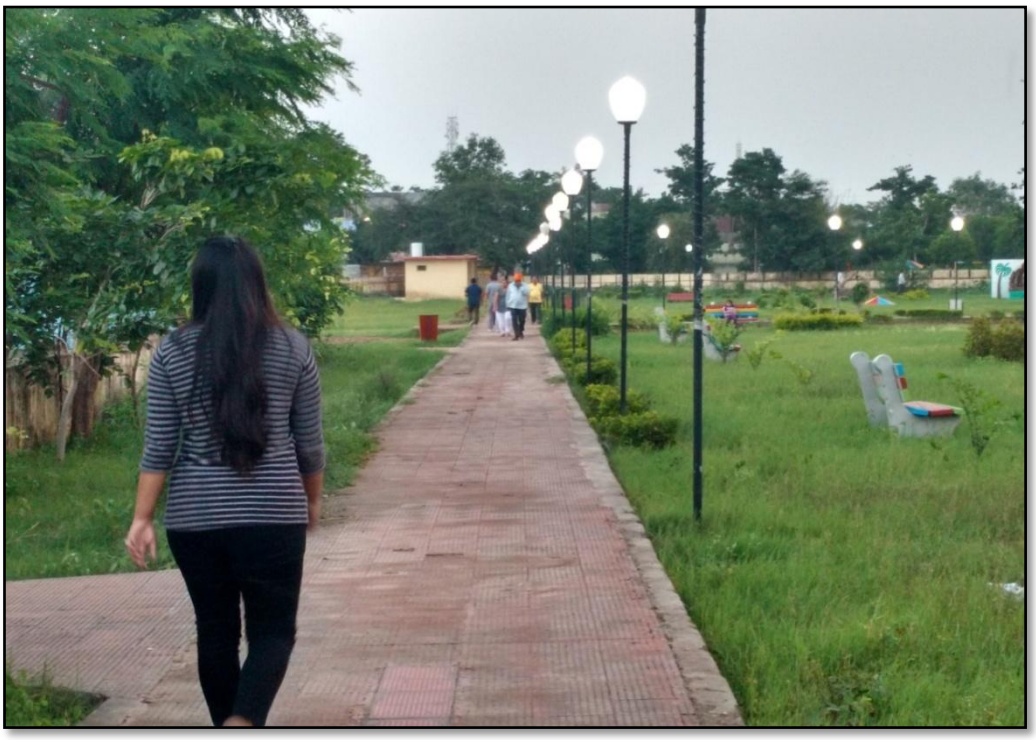


Fig.6.41 : People walking on the pathways in the Jairaj park (site 2)

Water tanks for drinking water (moisture) and old wall supports the presence of dragonflies. Diversity of dragonflies were also higher in this area, as were sighted when there was lesser movement (after 2 pm) of the students. It was observed that the dragonflies shifted to other walls when these old walls were painted. Presence of termites was also observed on the walls. Hemipteran species were also observed in their season. Orthoptera were sighted in the rainy season.

Though both the areas were disturbed, still we found maximum number of insect species and their abundance; reason being the habitat of the area. Hence, control of the exploitation of natural habitat for butterflies, having shrubs, herbs, and trees, dried and green grasses would definitely help to maintain and increase the diversity of butterflies in areas like the campus.

6.2.2 IMPACT OF ANTHROPOGENIC ACTIVITIES ON BIODIVERSITY OF JHIRI AREA SITE 3 (SEMI-DISTURBED)

The site was semi-disturbed with lower diversity of insects. It was hilly, bushy area with medium velocity winds. Cattle grazing was

the only human interference observed on the site. Coleopterans were found under the stones in the hilly area; which were not common to other sites.

At the base of the hills, the area was vegetated thus providing habitat for butterflies, dragonflies and Orthopterans. During the study period construction of new Sai temple was going on near the existing temple; where people came for worship. Bamboo trees were abundant in the area.

Fig.6.42 : Bamboo trees at the base of Jhiri area near the road

Fig.6.43: Bushes at the hill of Jhiri area

6.2.3 IMPACT OF ANTHROPOGENIC ACTIVITIES ON BIODIVERSITY OF BAGHER FOREST SITE 4 (UNDISTURBED)

The forest was dry deciduous. It was undisturbed area but as Table: 6.18 showed this area had some cattle grazing and cutting of trees for wood (fuel) by villagers; occasionally on the outer edge of the forest. The rest of the forest was unaffected by any human influences.

Minimum diversity was documented as we did our research work in the outer periphery of the dense Bagher forest; and it was not safe to go deep inside the forest.

Forest clearance destroys the habitat and generally causes a decline in forest species abundance and diversity, particularly for species that are restricted in range. (Lawton et.al. 1998).

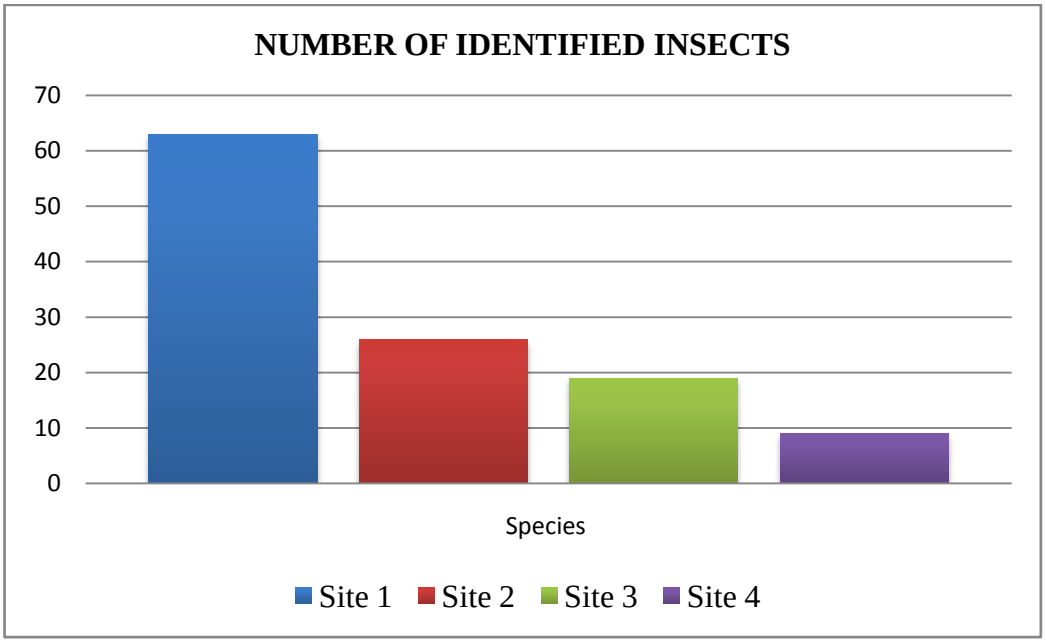


Fig.6.44 : Representing the comparison of species diversity of the four sites

Site 1:College campus Site 2: Jairaj park Site 3: Jhiri area Site 4: Bagher forest

The result of the present study on biodiversity and anthropogenic activities of four site showed that the college campus (site 1) which was highly disturbed by human activities held maximum number of species and their

abundance, while the number of species identified and individuals recorded from the Bagher forest was minimum which was undisturbed. It shows urban green infrastructure can be used to improve and build environment and provide ecosystem services.

6.2.4 CONCLUSION

The Fig.6.45 justifies that the number of individual at different habitat were little less as observed in the year 2012 than the year 2011 the reason must be the environmental changes taking place due to direct or indirect human activities.

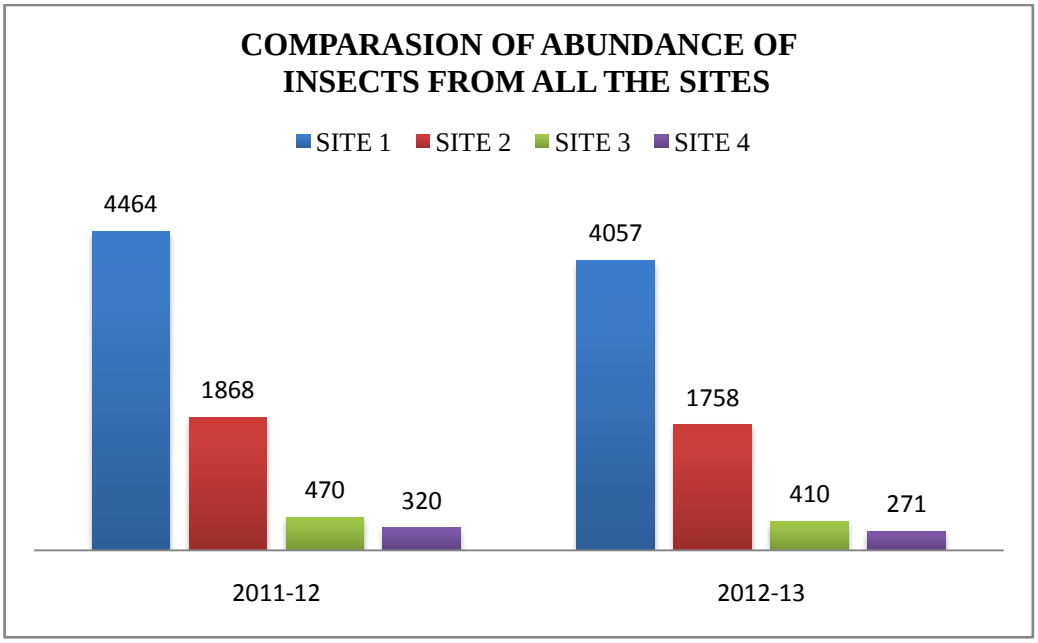


Fig.6.45: Showing comparison of abundance of individuals in two years of study period

Almost all human activities cause alteration to the natural environment to a greater or lesser degree. It was not possible to observe human impacts on biodiversity within 2-3 years of study period.

There is no doubt that human civilization has had negative impact on biodiversity, particularly since the industrial revolution. The destruction of

habitat through agriculture and urban sprawl. But it is not all bad news. Many animals and plants species have adapted to the new stress, food sources, predators and threats in urban and sub-urban environment, where they thrive in close proximity of humans.

Some methods used for increasing the biodiversity of garden environment (artificial nest, small ponds etc.) may be very effective.There is a positive effect of human- mediated disturbances on the Exotic richness in center Chile (Estay *et. al.* 2012).

The present study on insect biodiversity and impact of anthropogenic activities in different habitats reveals that human activities may not be always negative, they may be positive by providing favorable environment to insects for their survival.

The disturbed areas i.e. areas having maximum percentage of anthropogenic activity had the highest diversity of insects. This proves that artificially revegetated areas are good habitats for insects. Also the insects collected in these areas are adapted to the disturbances. The forest area could not be investigated thoroughly therefore less number of insects were reported in Site 4 (Bagher forest). The reasonably good diversity of insects in and around Jhalawar city is a signal to the town planners and conservationists to keep a watch on the urbanization process and preserve the ecosystem of Jhalawar.

The present study is a preliminary survey of insect diversity and human activities of these areas. So a long-term study is needed to observe the species occurrence in all seasons and their interactions with environmental changes and human activities for better results.

CHAPTER 7

SUMMARY

Man has always been fascinated by the diversity of life. Biodiversity is the new international buzzword. Term ‘biodiversity’ was coined by Walter and Rosen (1985) which is formed by contraction of the term biological diversity. Biological diversity refers to the variety and variability among living oraganisms and ecological complexes in which they live. Biodiversity and natural resources forms the root of all living system. It forms the foundation for sustainable development, constitutes the basic for environmental health of our planet, and is a source of economic and ecological security for future generation.

The Indian sub continent (8°- 30° N and 60° and 97.5' E) having a geographical area of 329 million hectares is quite rich in biodiversity with a sizable percentage of endemic flora and fauna. This richness in biodiversity is due to immense variety of climate and altitudinal conditions coupled with varied ecological habitats. Our country is also rich in faunal wealth. The country has nearly 75,000 animal species about 80% are insects.

Insects are powerful and rapid adaptive organisms with high fecundity rate and short life cycle. Due to human interruption in agro-ecosystem and global climatic variations are disturbing the insect ecosystem. Erosion of natural habitats, urbanization, pollution manifold the intensity of environmental variations.Insects constitute a substantial proportion of terrestrial species richness and biomass, and play a significant role in ecosystem functioning (McGeogh, 1998). Insects are frequently used as bioindicator species for monitoring and detecting changes in the environment. By using indicators it is possible to assess the impact of human activities on the biota, instead of examining the entire biota.

The main objective of this research study was to collect, identify and calculate insect diversity, species abundance in disturbed, semi- disturbed and undisturbed areas of Jhalawar region.

There is no record of study on insect biodiversity of Jhalawar district till date, up to my knowledge. The present study will pave way for further

studies on the biodiversity and its conservation of the investigated area by setting up an inventory of insects.

The present study was carried out during 2010-12. The site selection was done on the basis of disturbed (gardens, parks, urban area etc.) semi-disturbed (grazing area) and undisturbed (forest) of Jhalawar district.

The two (2) sites selected for disturbed areas were college campus and Jairaj Park. Semi-disturbed area was Jhiri area, as it had cattle grazing and lesser human influence and undisturbed area was Bagher forest.

In present work collection of most of the insects (species) was done twice in the month of February –March and September – October in 3-4 visits of at least 2 -3 hours; generally in between 11:00 – 1400 hour. Methodology used was: hand picking, beating, sweeping, and trapping.

After collection and sorting in different orders and families insects were stretched for temporary and permanent storage in boxes or cabinets. Identification of collected insects was done by Dr. Swaminathan (ICAR Network Project on Insect Biosystematics) Department of Entomology, Rajasthan College of Agriculture (MPUAT), Udaipur and Dr. V. V. Ramamurthy (Insect Identification Service Division of Entomology) Indian Agricultural Research Institute, New Delhi.

7.1 RESULT OF COLLEGE CAMPUS (Site 1)

In college campus the total number of insects observed in the study period was 63. Insects recorded belong to 7 orders 29 families and 50 genus. The largest number of insect identified were of order Lepidoptera followed by Hymenoptera, Odonata, Hemiptera, Orthoptera, Coleoptera, Neuroptera, Dictyoptera and Thysanura.

LEPIDOPTERA:

Butterfly diversity depends upon the floral diversity.The maximum number of insects recorded in college campus were of order Lepidoptera belonging to 6 different families. The species identified were 21. The dominanting family was Pieridae; it was followed by Nymphalidae, Papilionidae, Lycaenidae and Arctiidae. The number of species identified of family Pieridae and Nymphalidae were 7 each. Pieridae (32%) include: *Ixias marianne (Linnaeus), Catopsilia pyranthe, Terias hecabe (Linnaeus), Catopsilia pomona, Anaphaeis aurota (Fabricius), Eurema laeta (Boisduval), Appias albina (Boisduval).* Nymphalidae (32%) include: *Junonia lemonias, Junonia (Precis) atlites (Linnaeus), Junonia almona, Junonia orithya, Danaus chrysippus (Linnaeus), Telchinia violae (Fabricius),* and *Parantica aglea.* While in family Papilionidae (14%) and Lycaenidae (14%) there were 3 species each. They are: *Pachliopta aristolochiae, Papilio demoleus, Zetides agamemnon* and *Lampides boeticus, Castalius rosimon, Catochrysops enjus* respectively. The moth recorded were *Utethesia pulchella* of family Arctiidae (4%) and *Helicoverpa zea* of family Noctuidae (4%).

The butterfly observed in maximum number (150) was *Lampides boeticus* of family Lacynidae and the minimum number (04) was *Telchinia violae (Fabricius)* of family Nymphalidae. Some identified butterflies were very common, some were common and two of them were rare. The rare ones were: *Junonia atlites* and *Ixias marianne*.

HEMIPTERA:

In the present study the insects of order Hemiptera observed in the college campus was 5 species belonging to 3 families. Two species of family Pentatomidae identified were *Halys parvus (chopra)* and *Erthesina fullo (Thunberg)*. Two species of family Reduviidae include: *Acanthaspis sp* and *Rhinocoris sp.* Family Lygacidae had only one species *Spilostethus pandurus.*

The abundance of species among dominating Hemiptera was *Erthesina fullo (56)* followed by *Spilostethus pandurus* (55) and *Halys parvus* (18).

HYMENOPTERA:

In the college campus of Jhalawar the number of Hymenopteran species observed were six, belonging to 4 families. As per the data recorded the dominating family was Apidae followed by Sphecidae, Formicidae and Vespidae. *Xylocopa fenestrate, Apis florae, Apis dorsata* were of family Apidae; species identified of family Sphecidae was *Liris sp*. of family Vespidae was *Ropalidia marginata* and Formicidae was *Ainictus sp.* Total numbers of individuals observed were 83 of *Apis florae* which was maximum and minimum was 05 of *Liris sp.*

ODONATA:

Total 11 species of Odonata were observed belonging to family Libellulidae and Coenagrionidae. The dragonflies of dominating family Libellulidae belonged to 6 genus and 9 species. The 4 species of genus *Orthetrum* identified were: *glaucum, chrysis, sabina* and *pruinosum.* Other dragonflies identified were *Brachythemis cantaminata, Neurothemis intermedia intermedia, Crocothemis servilia, Trithemis_aurora, Brudinopyga geminata.* Two species of damselfly identified were *Ischnura elegans and Ceriagrion coromandelianun (febricui)* belonging to family Coenagrionidae.

The dragonflies found in abundance was of *Neurothemis intermedia intermedia (Rambur)* [30-35] followed by *Trithemis aurora* [22]. Species of genus *Orthetrum* observed were in very few numbers [09].

COLEOPTERA:

In the study period the only Coleopteran observed was *Chrysocoris chinonsis* belonging to family Buprestidae. *Chrysocoris chinonsis* was found on a particular *Dalbergia sissoo* (sheesham) tree. The individual was easy spot visually as it had florescent green colour.

Only two individuals were observed in the year 2011 but in the year 2012 only one (01) was sighted.

ORTHOPTERA:

Only six (06) species of orthoptera were recorded, belonging to 3 families Gryllidae: *Gryllus campestris, Halochlera indica* and *Schistocera gregania*; family Acridiae: *Acrididae exalatata* and *Catantops sp*., and Tettigonidae: *Himertula pallisignata*. All these Orthopterans appeared in large number. The dominating family was Gryllidae. Highest number of individuals was of *Gryllus campestris* (37) and lowest was of *Himertula pallisignata* (16).

DIPTERA:

The observed insects of order Diptera were common house fly *Musca domestica* of family Muscidae, *Drosophila melenogaster* of family Drosophilidae on waste of food etc. in the dustbins. Beside these 3 flies were also observed which were of family Asilidae, Tabanidae and Stratonyidae. Genus and species were not identified of these families (due to sample damage). *Anopheles* and *Culex* mosquitoes were also observed in the campus in large number during the study period.

DICTYOPTERA:

The very common Indian Cockroach or *Periplaneta americana* was found in the store of college campus belongs to family Blattidae.

THYSANURA:

Lepisma saccharina belongs to family Lepsimatidae. Abundant silver fishes were found in the books (with little moisture) of college library. It was not possible for me to count the number; hence exact numbers of individuals were not recorded.

ISOPTERA:

Termites were sighted on the walls and subterranean parts of the building (as it's an old construction). Some colonies were found in the plant roots and around the dry bushes.

7.2 RESULT OF JAIRAJ PARK (Site 2)

Jairaj park is a disturbed site as it is a public place (park).A total of 26 species of insects belonging to 8 orders and 12 families were observed in this area.

LEPIDOPTERA:

Butterflies recorded from the Jairaj park belonged to two families. Family Nymphalidae include 5 species out of which four are of same genus: *Junonia* and other is *Danaus chrysippus (Linnaeus).* Genus *Junonia* had four species: *J. lemonias, J. atlites, J. almona, and J. orithya. Junonia orithya* was maximum in number while *J. almona* was minimum in abundance. Butterfly species observed of family Pieridae in this area was: *Terias hecabe (Linnaeus), Catopsilia pomona,* and *Eurema laeta (Boisduval). Terias hecabe (Linnaeus)* was sighted in maximum abundance. All these butterflies were also recorded from the college campus (Site 1). Due to more vegetation in Site 1 the abundance was greater.

HEMIPTERA:

The only species observed of order Hemiptera of family Lygacidae was *Spilostethus pandurus*. Its abundance was quite good in the season.

HYMENOPTERA:

A total of 5 species were identified from family Apidae (*Apis florae* and *Apis dorsata)* and family Vespidae includes *Ropalidia sp., Polistes stigma tamula (Fabricius), Vespa orientalis.* Maximum abundance was of: *Apis florae* and minimum was that of *Ropalidia sp.*

ODONATA:

In Jairaj park the only three species of order Odonata were identified from family Libellulidae: *Neurothemis intermedia intermedia (Rambur), Crocothemis servilia* and *Trithemis aurora*.

ORTHOPTERA:

The individuals identified were of 3 families: family Gryllidae includes 3 species- *Gryllus compestris, Holochlora indica, Schistocera regania.* Family Acridiae include *Catantops karnys, Catantops sp.* and *Acrida exalatata.* While family Tettigonidae include only *Himertula pallisignata.*The maximum number was of field cricket in rainy season.

DICTYOPTERA:

The insect observed was one (01) in number *Mantis religiosa* belongs to family Mantidae.

ISOPTERA:

The common termites were also observed in the park as there was no regular maintenance of park.

DIPTERA:

It was very usual to observe housefly *Musca domestica* of family Muscidae in the park in rainy season.

7.3 RESULT OF JHIRI AREA (Site 3)

This is third site which is semi-disturbed. Here we observed few beetles which were not found in any other area (site). The following groups of insects were observed Lepidoptera, Odonata, Coleoptera, Orthoptera and Neuroptera; comprising of 11 families and 19 species.

LEPIDOPTERA:

During study time (2011-13) total of 9 species of butterflies were observed and identified in this area. They belong to 4 families Nymphalidae, Pieridae, Papilionidae and Lycaenidae. In family Nymphalidae the genus *Junonia* was represented by 3 species *J. lemonia, J. almona* and *J. orithya* and other was *Danaus chrysippus (Linnaeus).*

While family Pieridae include *Terias hecabe (Linnaeus)* and *Catopsilia pomona.* Family Papilionidae and Lycaenidae each represent only one species each *Papilio demoleus* and *Lampides boeticus.*

ODONATA :

A total of three species representing only Libellulidae family was recorded from the Jhiri area. They were *Brachythemis cantaminata, Neurothemis intermedia intermedia (Rambur), Trithemis aurora.*

COLEOPTERA:

The recorded four beetles belong to three families. Family Tenebrionidae comprises of two genus *Adesmia sp.* and *Rhytinota sp.* Family Carabidae include *Diplocheila sp.*and family Meloidae represents *Mylabris sp.*

ORTHOPTERA:

The individuals observed and identified in this area belongs to two families. Family Acrididae include *Catantops sp.* and *Acrida exalatata.* The family Tettigonidae represents only *Himertula pallisignata.*

NEUROPTERA :

The only genus identified and observed of this order neuroptera was *Creoleon sp.* belong to family Myrrnelontidae.

7.4 RESULT OF BAGHER FOREST (Site 4)

Bagher forest is the fourth site of the study. The site is undisturbed by human activities. The diversity of fauna observed was not rich in the limited outskirt area covered under the study period.

We observed total 12 individuals belonging to five different orders: Lepidoptera, Hemiptera, Coleoptera, Hymenoptera and Odonata. Only 9 of them were identified.

LEPIDOPTERA:

Butterflies of this order were represented by family Pieridae and Nymphalidae. Pieridae population comprises only one very common species i.e. *Terias hecabe (Linnaeus)* and similarly Nymphalidae represent only *Junonia almona*.

HEMIPTERA :

Hemipteran recorded from this area represent by two families Reduviidae and Coreidae. Reduviidae comprises *Acanthaspis sp.and Rhinocoris sp.* whereas family Coreidae represented by *Petalocnemis obscura (dallas).*

ODONATA:

Odonata comprises species named *Neurothemis intermedia intermedia (Rambur).*

COLEPTERA:

The only species of Coleoptera was *Orphnus* species. This species was observed in the cow dung only in the year 2012.The number of individuals observed was 8 in number.

HYMENOPTERA:

Dolichhovespula species was observed in the edges of Bagher forest in the year 2012.

7.5 IMPACT OF ANTHROPOGENIC ACTIVITIES ON BIODIVERSITY OF INSECTS AT SITE 1 AND SITE 2 (DISTURBED SITES)

The site 1 and 2 were disturbed by many human activities. In the college campus and Park, presence of small patches of gardens and variety of plants and trees, developed by college management and government provide habitat for butterfly diversity. Thus the areas though disturbed represent maximum diversity of butterflies than in any other study area.

Conservation of butterfly fauna in a small landscape particularly in human dominated area might be a good model for maintaining optimal habitat within fragments and in that case academic institutional campus with high plant diversity might be a very good option for the conservation of species (Sarma *et. al.* 2012).

Butterfly fauna observed in the Jairaj park were similar but with lesser abundance, as found in the college campus.

Other human activities in the campus include: student movements, construction of rooms, burning of fuel, and regular sweeping and cleaning of campus. Hence we do not observe any ground beetles in both the areas. Park was disturbed mainly by: morning walkers, kids playing, etc.

Air pollution by vehicles due to the roads on the two sides of the campus is the main cause of absence of insects in the ground adjacent to NH12.Water tanks for drinking water (moisture) and old wall supports the presence of dragonflies.

Though both the areas were disturbed, still we found maximum number of insect species and their abundance; reason being the habitat of the area.

Hence, control of the exploitation of natural biotopes for butterflies, including shrub, herb, and trees, dried and green grasses (e.g. grazing) would definitely help to maintain and increase the diversity of butterflies in areas protected like the campus.

7.6 IMPACT OF ANTHROPOGENIC ACTIVITIES ON BIODIVERSITY OF JHIRI AREA SITE 3 SEMI-DISTURBED

The site was semi-disturbed with lower diversity of insects. It was hilly, bushy area with medium velocity winds. Cattle's grazing was the only

human interference observed at the site. Coleopterans were found under the stones in the hilly area; which were not common to other sites

.

At the base of the hills, the area was quite green thus providing habitat for butterflies, dragonflies and Orthopterans. During the study period construction of new Sai temple was going on near the existing temple; where people come for worshiping. Bamboo trees were specialty of the area.

7.7 IMPACT OF ANTHROPOGENIC ACTIVITIES ON BIODIVERSITY OF BAGHER FOREST SITE 4 UNDISTURBED

The forest was dry deciduous. It was undisturbed area but it had some cattle grazing and cutting of trees for wood (fuel) by villagers; occasionally on the outer edge of the forest. The rest of the forest was unaffected by any human influences.

The forest represents minimum diversity as we did our research work in the outer periphery of the forest. It was not safe to go deep inside the forest because of dense vegetation and wild animals.

7.8 CONCLUSION

There is no doubt that human civilization has had negative impact on biodiversity, particularly since the industrial revolution. The destruction of habitat through agriculture and urban sprawl. But it is not all bad news. Many animals and plants species have adapted to the new stress, food sources, predators and threats in urban and sub-urban environment, where they thrive in close proximity of humans.

Some methods used for increasing the biodiversity of garden environment (artificial nest, small ponds etc.) maybe very effective.There is a positive effect of human- mediated disturbances on the Exotic richness in center Chile (Estay *et. al.* 2012).

The present study on insect biodiversity and impact of anthropogenic activity in different habitats reveals that human activities may not be always negative, they may be positive by providing favorable environment to insects for their survival.

The disturbed areas i.e. areas having maximum percentage of anthropogenic activity had the highest diversity of insects. This proves that artificially revegetated areas are good habitats for insects. Also the insects collected in these areas are adapted to the disturbances. The forest area could not be investigated thoroughly therefore less number of insects were reported in Site 4 (Bagher forest). The reasonably good diversity of insects in and around Jhalawar city is a signal to the town planners and conservationists to keep a watch on the urbanization process and preserve the ecosystem of Jhalawar.

The present study is a preliminary survey of insect diversity and human activities of these areas. So a long-term study is needed to observe the species occurrence in all seasons and their interactions with environmental changes and human activities for better results.

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ANNEXURE

APPENDIX I

INSECT PLATES (I – X)

I

A. *Danaus chrysippus*

B. *Catopsilia pomona*

C. *Junonia (Precis) almona*

II

A. *Junonia atlites*

B. *Junonia orthiya*

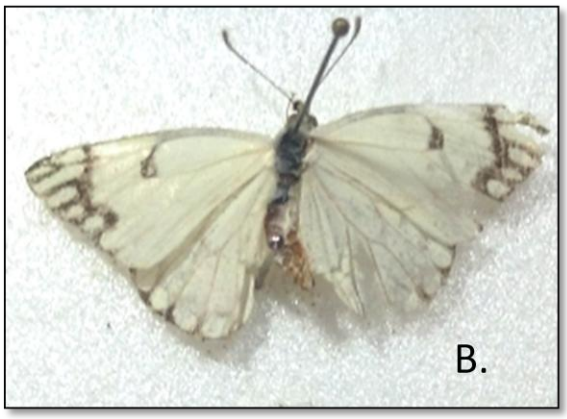
C. *Catopsilia pyranthe*

D. *Catopsilia pyranthe*

E. *Terias hecabe*

F. *Terias hecabe*

III



A. *Pachliopta aristolochiae*

B. *Anaphaeis aurota*

C. *Appias albina*

D. *Telchinia violae*

E. *Lampides boeticus*

F. *Utethesia pulchella*

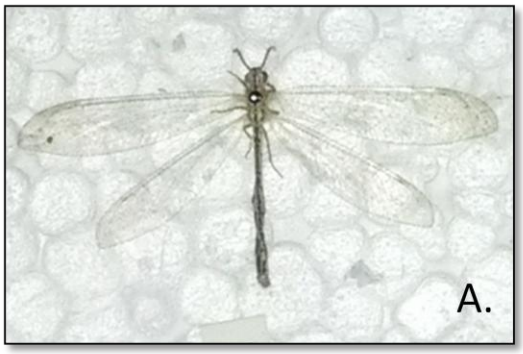
IV

A. *Zetides agamemnon*

B. *Pepilio demoleus*

C. *Helicoverpa zea*

V



A. *Creoleon sp.*

B. *Orthetrum glaucum*

C. *Neurothemis intermedia (Rambur)*

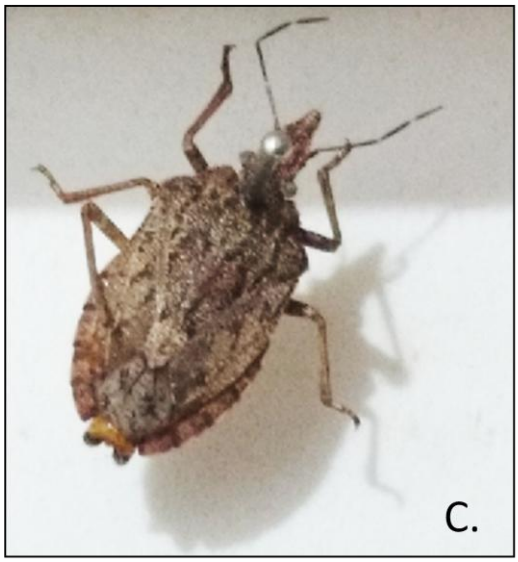
D. *Orthetrum pruinosum (male)*

E. *Crocothemis servilia*

VI

A. *Orthetrum pruinosum (female)* **B.** *Brudinopyga geminata*

VII



A. *Acanthaspis sp.*

B. *Petalocnemis obscura*

C. *Erthesina fullo*

D. *Halys parvus*

VIII

A. *Diplocheila sp.*

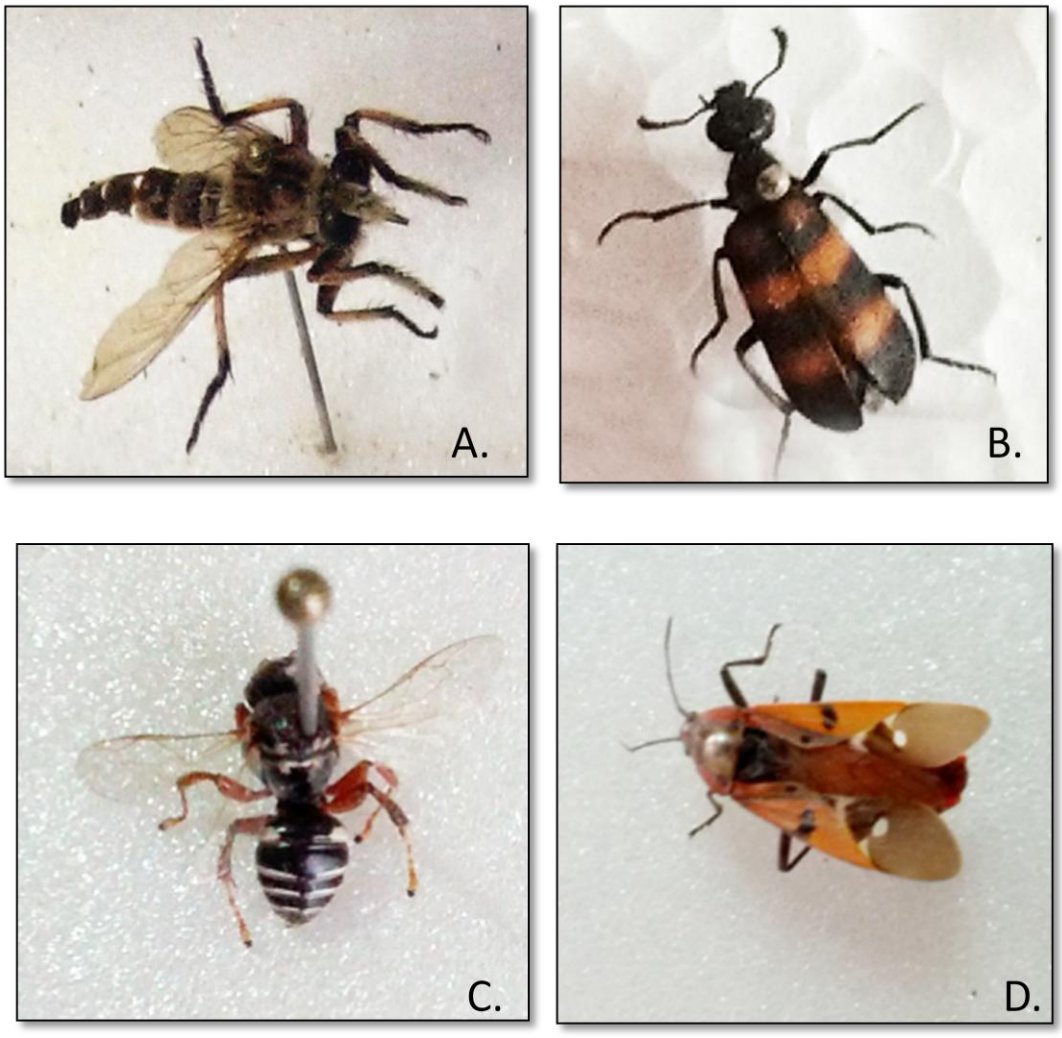
B. *Chrysocoris chinonsis*

C. *Adesmia sp.*

D. *Rhytinota sp.*

E. *Orphnus picinus*

IX



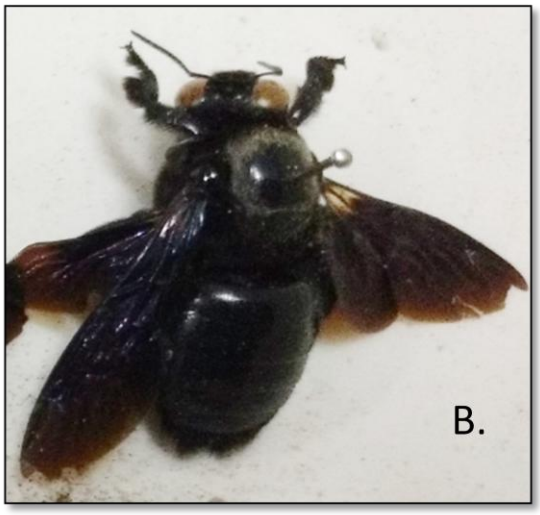
A. Family: Asilidae (robber fly)

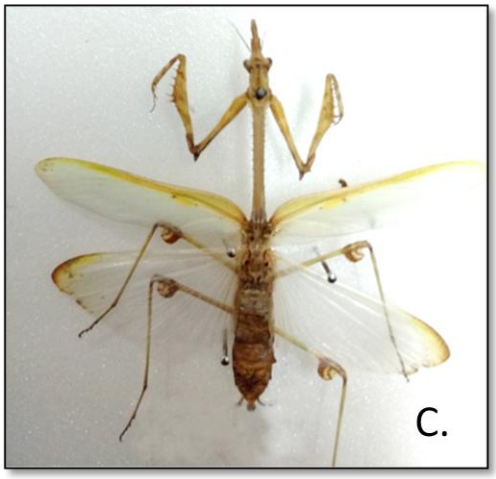
B. *Mylabris puslutata*

C. *Dolichovespula sp.*

D. *Spilostethus pandurus*

X





A. *Cerceris sp.*

B. *Xylocopa fenestrata*

C. *Mantis religiosa*

D. *Drosophila melongaster*

APPENDIX II

LIST OF RESEARCH PAPERS

PUBLISHED

LIST OF RESEARCH PAPERS PUBLISHED

- Paper entitled "Assessment of diversity of butterfly species at Jhalawar, (Rajasthan) India" published in *Flora and Fauna An International Research Journal of Biological Sciences; 2016, Vol. 22 (1): 105-107.*

- Paper entitled "A note on the biodiversity of insects collected from a college campus of Jhalawar District, Rajasthan" published in *Bioscience Biotechnology Research Communications; 2016, Vol. 9 (2): 327-330.*

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ASSESSMENT OF DIVERSITY OF BUTTERFLY SPECIES AT JHALAWAR, (RAJASTHAN) INDIA

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ABSTRACT

Jhalawar is located in the south east corner of Rajasthan at the edge of the Malwa plateau. The study of diversity and richness of butterflies was carried out mainly in three areas of Jhalawar: College Campus, Shree Jairaj Park and Jhiri area. The butterflies were collected by using nets and hand picking. Collection was done in the months of February-March and September-October, between 11:00 to 02:00 hours. A total of 20 species of butterflies belonging to 4 families (Pieridae, Papilionidae, Lycaenidae and Nymphalidae) were captured and identified. The most dominant family was Pieridae (7 species) and Nymphalidae (7 species) followed by Papilionidae (3 species) and Lycaenidae (3 species). The abundance of species collected was also recorded.

Figure : 00 References : 08 Table : 01
KEY WORDS :Abundance, Butterfly, Diversity, Jhalawar

Introduction

Jhalawar is located in South-east Rajasthan, India, has an average elevation of 317 metres (1040 feet). It is watered by several rivers, giving it a verdant look. The largest river flowing through the area is Kali Sindh. Other rivers include Ujaad, Ahu, Parvan, Chavli, *etc.* Jhalawar district has the highest rainfall in the Rajasthan state.

Biodiversity is the bandwagon of this century and a lot of discussions are going on throughout the world on the conservation and sustainable use of natural resource. Species diversity can be measured in a number of ways, but is usually calculated as a function of both the number of species (species richness) and the proportional number of individuals within each species (abundance or evenness).

Insects comprise more than half of earth's diversity of species. Butterflies (Lepidoptera) the lovely and graceful insects provide economic and ecological benefits to the human society[2]. Butterflies are one of the unique groups of insects, which grasp the attention of nature lovers worldwide[5]. They are known for their pollination services and as key indicators of environmental health[6]. The main objective of this study was to collect, identify and calculate diversity and abundance in three different areas (College Campus, Shree Jairaj Park and Jhiri area) of Jhalawar.

Material and Methods

Butterflies were collected from three areas

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TABLE-1 : List Of Identified Butterflies (Lepidoptera)

S. NO.	FAMILY	NAME	COMMON NAME	ABUNDANCE (Approx. no. of insects)
1.	Pieridae	*Ixias marianne (Linnaeus)*	White orange tip	22
2.	Pieridae	*Catopsilia pyranthe*	Mottled emigrant	14
3.	Pieridae	*Terias hecabe (Linnaeus)*	Common grass yellow	152
4.	Pieridae	*Catopsilia pomona*	Common emigrant	27
5.	Pieridae	*Anaphaeis aurota (Febricius)*	Pioneer	12
6.	Pieridae	*Eurema laeta (Boisduval)*	Spotless grass yellow	16
7.	Pieridae	*Appias albina (Boisduval)*	Common Albatross	22
8.	Nymphalidae	*Junonia lemonias*	Lemon pansy	25-30
9.	Nymphalidae	*Junonia (Precis) atlites (Linnaeus)*	Grey pansy	28
10.	Nymphalidae	*Junonia almona*	Peacock pansy	18
11.	Nymphalidae	*Junonia orithya*	Glass blue tiger	37
12.	Nymphalidae	*Danaus chrysippus (Linnaeus)*	Plain tiger	45
13.	Nymphalidae	*Telchinia violae (Febricius)*	Tawny coster	4
14.	Nymphalidae	*Parantica aglea*	Glassy tiger	12
15.	Papilionidae	*Pachliopta aristolochiae*	Common rose (Hubn.)	7-8
16.	Papilionidae	*Papilio demoleus*	Lime butterfly	11
17.	Papilionidae	*Zetides agamemnon*	Tailed jay (Linnaeus)	12
18.	Lycaenidae	*Lampides boeticus*	Pea blue	250
19.	Lycaenidae	*Catochrysops enjus*	Gram blue (Febricius)	68
20.	Lycaenidae	*Castalius rosimon*	Common pierrot	5-6

of Jhalawar : College Campus, Shree Jairaj Park and Jhiri area.The observations were made regularly from 11:00hr to 02:00hr, which is the peak time for butterfly activity.

During the survey, butterflies were caught using a sweep net and hand picking; then transferred to killing jars. The captured butterflies were spread and these butterflies were stored in

insect box by pinning them. Identification of butterflies was done at IARI, New Delhi and MPUAT, Udaipur.

Result and Discussion

A total number of 20 species of butterflies belonging to 4 families (Pieridae, Papilionidae, Lycaenidae, Nymphalidae) were collected from the selected areas during the study period (February-March and September-October, 2012). The major number of butterflies collected were from college campus and Jai raj Park followed by Jhiri area. The number of species identified under family Pieridae and Nymphalidae were seven respectively, while that of Papilionidae and Lycaenidae were three species each.

Terias hecabe (L.) and *Lampide boeticus* species of butterfly were found in abundance in college campus while *Telchinia violae* species was found in 2-3 numbers.

It was seen that the species found in college campus and Jairaj park were almost same. As both the areas are very close to each other and have similar type of vegetation, trees and ornamental plants.

Similar butterflies studies were also conducted earlier[1,3,4,7,8].

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A note on the biodiversity of insects collected from a college campus of Jhalawar District, Rajasthan

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ABSTRACT

The study of biodiversity of insects was conducted in the college campus which covers around half square kilometer area. One boundary of college campus is along NH12. The major vegetation of college campus is neem, banyan, Asoka and amaltas trees and some ornamental and medicinal plants. The main objective of the study was to determine the insect diversity and the relative abundance of the insect species in the campus. The collection of insects was carried out by using sweep nets, hand picking and beating tray in the month of Feb.-March and Sept-Oct in the year 2012. Species diversity and abundance of insects were investigated in college campus and we recorded insects belonging to 7 orders 16 families and 38 species. The largest number of insect identified were of Lepidoptera followed by Hymenoptera, Odonata, Hemiptera, Orthoptera, Coleoptera and Neuroptera. Anthropogenic activities influenced the abundance of insect orders. Thus, greater numbers of insects were observed in small gardens with a greater proportion of bare soil relative to concrete pathways and places with human interference. The study revealed the higher abundance of butterflies among the insects identified. A total 38 different insect species were recorded giving an indication of the species diversity of the college campus.

KEY WORDS: ABUNDANCE, BIODIVERSITY, INSECTS, JHALAWAR

INTRODUCTION

Biological diversity is one of the most fascinating aspects of biology. Evolution by natural selection has produced, and is still producing different species. Biodiversity also encompasses functioning, intact plant and animal communities and the processes that affects them. Today India, is occupying a significant space, documenting nearly 7 percent of global faunal diversity. There are 1.4 millions species of insects described in the scientific literature which is 80% of life currently recorded on earth. The estimation indicates there may be as many as 30-50 million species of insects making this perceives terrestrial orthopodial groups 97% of global diversity.

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(Erwin, 1982, 1983b, Ghosh, 1990, 1994, Hammond, 1992, Hammond, 1999, Chandra 2011, Patel *et.al.* (2015) and Ditchkoff, 2016).

Great insect diversity is indeed an intrinsic part of the Earth's ecosystem. They are what make the ecosystems tick, remarked (Samways, 1994). However, the insect fauna of India is vast. In the present study the largest number of species (21) identified was of order Lepidoptera. In India the researches work of Sharma *et.al.* (2012) in foothills of Itanagar, Arunachal Pradesh; Parandhaman 2012) in different habitats from Tamilnadu part of Western Ghats; Kaneria *et.al. (*2013) in Bilaspur District, Chhattisgarh; Qureshi *et.al. (*2013) in District Kupwara from Jammu and Kashmir State; Saikia (2014) in Gauhati University campus, Assam; Arya *et al.*, (2014) in and around Kumaun University, Nainital, Uttarakhand; all these workers have provided valuable information on various insects and butterflies with reference to their diversity and abundance.

A comprehensive account of insect diversity of Sikkim has been provided by Chandra (2011) where insect diversity of Sikkim, was studied. Altogether, 5892 species belonging to 2382 genera under 261 families and 22 orders of Insect have been reported from the state of Sikkim. In an intensive study made by Patel *et.al.* (2015) in Jabalpur Community Forest Reserve, a total of 774 individual of insects from 13 orders were recorded during the study. A preliminary study on abundance and diversity of insect fauna in Gulbarga District, Karnataka, India was conducted by Belamkar and Jadesh in 2012. A total of 11,318 insects from 6 orders, 26 families and 54 species were recorded.

In present investigation the insects were collected from the Post Graduate Goverment College campus, Jhalawar. Insects live in highly diverse habitats and could be found practically everywhere on the campus. In present study, collection of most of the insects (species) was done, between 1100 -0200 hrs and twice in the year 2012; in the month of Feb.-March and Sept-Oct. Majority of the insects were collected from all sorts of plants: grass, flowers, weeds, shrubs and trees. Some were found around and on the walls of building blocks. The main objective of this study was to collect and identify insect species, diversity and abundance of insects in the college campus, Jhalawar. Vegetation of campus was of mixed type which includes trees, climbers, grass, medicinal plants, shrubs, ornamental plants and herbs. Many groups of insects recognized were: Lepidoptera, Hymenoptera, Odonata, Hemiptera, Orthoptera, Coleoptera and Neuroptera. They are unique in their own way and have an important ecological role for survival of life on Earth.

Most of the insects in this study were collected manually i.e. by sweep netting, hand picking and beating tray or by visual search method. Collected insects were transferred in bottles for killing that contains cotton soaked with ethyl acetate covered with lid. Later on specimens were sorted out into different taxonomic groups. All the specimens were stretched, pinned, labeled and left for 72 hrs to prevent decomposition. As some species dragonflies were sighted in very few numbers in college campus, it was difficult to catch them, but we have taken the best possible photographs of those dragonflies. Identification of insects was done at IARI New Delhi and MPUAT, Udaipur. A total of 38 individuals belonging to 07 orders were recorded from the campus of Government College Jhalawar.

Insects of 07 orders belonging to 16 families 38 species were collected and identified. Maximum species of Lepidoptera identified was 21 in number belonging to 5 families. In other parts of Rajasthan abundance of Lepidoptera individuals was observed. The extensive studies on Lepidopterous insects associated with vegetables were conducted indifferent localities of Aravalli Range of Rajasthan i.e. Mount Abu, Udaipur, Rajsamand, Pushkar, Ajmer, Jaipur, Sikar, Jhunjhunu, Sariska, Alwar, Dausa and Bharatpur during 2008-11.

A total of 38 species of Lepidopterous insects associated with vegetables in Aravalli Range of Rajasthan were recorded, out of 152 species of Lepidopterous insects recorded from India (Sharma, 2011). Further in the present study, number of indentified species was followed by Hymenoptera (5), Odonata (4), Hemiptera (3), Orthoptera (3), Coleoptera (1) and Neuroptera (1). The 5 species of Hymenoptera belonging to 3 families; 3 species of Hemiptera belonging to 2 families were identified.

Likewise number of species of Odonata identified was 4, belonging to 2 families which were captured and identified by Koli *et al.*, in the year 2014 in a study, of south Rajasthan, which explored the diversity and species composition of Odonata.. Odonates were sampled from13 localities i.e., Pichola lake, Udaisagar lake, Badi lake, Ghasa lake, Menar lake, Badwai lake, Rup sagar lake, Rolitodgarh Wildlife Sanctuary, Sitamata Wildlife Sanctuary, Karmoi river stream in Sitamata WLS, College campus, Rajsmand lake and Meja dam.

In the present study, out of these insects, individuals of the order Lepidoptera: *Terias hecabe and Lampides boeticus*, were found to be dominant (Table:1.1), while minimum was of beetle *(Coleoptera) Chrysocoris chinonsis and (*Neuroptera) *Crolen species;* as shown in the table. In Central India a total of only 10 species of ground beetles were recorded (All the species were recorded for the first time from Melghat Tiger Reserve) Thakare *et al.*, (2013) and in our study we have recorded only one species of beetle.

Table 1: Identified Insects in College Campus, Jhalawar; Year 2011-12

S. NO.	ORDER	FAMILY	GENUS SPECIES	ABUNDANCE (Approx. no. of insects)
1.	Lepidoptera	Pieridae	*Ixias marianne (Linnaeus)*	22
2.	Lepidoptera	Pieridae	*Catopsilia pyranthe*	14
3.	Lepidoptera	Pieridae	*Terias hecabe (Linnaeus)*	152
4.	Lepidoptera	Pieridae	*Catopsilia pomona*	27
5.	Lepidoptera	Pieridae	*Anaphaeis aurota (Febricius)*	12
6.	Lepidoptera	Pieridae	*Eurema laeta (Boisduval)*	16
7.	Lepidoptera	Pieridae	*Appias albina (Boisduval)*	22
8.	Lepidoptera	Nymphalidae	*Junonia lemonias*	25-30
9.	Lepidoptera	Nymphalidae	*Junonia (Precis) atlites (Linnaeus)*	28
10.	Lepidoptera	Nymphalidae	*Junonia almona*	18
11.	Lepidoptera	Nymphalidae	*Junonia orithya*	37
12.	Lepidoptera	Nymphalidae	*Danaus chrysippus (Linnaeus)*	45
13.	Lepidoptera	Nymphalidae	*Telchinia violae (Febricius)*	4
14.	Lepidoptera	Nymphalidae	*Parantica aglea*	12
15.	Lepidoptera	Papilionidae	*Pachliopta aristolochiae*	8
16.	Lepidoptera	Papilionidae	*Papilio demoleus*	11
17.	Lepidoptera	Papilionidae	*Zetides agamemnon*	12
18.	Lepidoptera	Lycaenidae	*Lampides boeticus*	250
19.	Lepidoptera	Lycaenidae	*Catochrysops enjus*	68
20.	Lepidoptera	Lycaenidae	*Castalius rosimon*	5
21.	Lepidoptera	Arctiidae	*Utethesia pulchella*	3
22.	Hymenoptera	Apidae	*Xylocopa fenestrate*	9
23.	Hymenoptera	Apidae	*Apis florae*	24
24.	Hymenoptera	Apidae	*Apis dorsata*	46
25.	Hymenoptera	Vespidae	*Ropalidia marginata*	38
26.	Hymenoptera	Sphecidae	*Liris species*	9
27.	Odonata	Lebellulidae	*Orthetrum taeniolatum (schreides)*	18
28.	Odonata	Lebellulidae	*Neurothemis intermedia intermedia (romber)*	18
29.	Odonata	Lebellulidae	*Brachythemis cantaminata (febricui)*	22
30.	Odonata	Coenagrionidae	*Ceriagrion coromandelianun (febricui)*	21
31.	Hemiptera	Pentatomidae	*Halys parvus (chopra)*	19
32.	Hemiptera	Pentatomidae	*Erthesina fullo (Thunberg)*	45
33.	Hemiptera	Lygacidae	*Spilostethus pandurus*	55
34.	Orthoptera	Acrididae	*Catantops karnys / pinguis*	20
35.	Orthoptera	Acrididae	*Acrididae exalatata*	28
36.	Orthoptera	Tettigonidae	*Himertula pallisignata*	14
37.	Coleoptra	Buprestidae	*Chrysocoris chinonsis*	2
38.	Neuroptera	Myrrnelontidae	*Creoleon spc.*	16

It is concluded that a small compact area like a segregated college campus supports a diverse butterfly community. Similar type of study on insect biodiversity has been carried out by Grampurohit and Karkhanis (2013). However, the results which are being presented in this paper might be the first comprehensive list of insects in the Jhalawar district. Hopefully, there will be a further research study on the insect biodiversity of this area, in order to get better and comprehensive information on those aspects to be documented for future reference.

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APPENDIX III

LIST OF SEMINARS
AND CONFERENCES ATTENDED
DURING RESEARCH WORK

LIST OF SEMINARS AND CONFERENCES ATTENDED DURING RESEARCH WORK

- Research paper presented in an International workshop cum seminar "Science communication: A dialogue between scientist and the masses" on 25 June 2016" at KLC Society's College of Science and Commerce Kalamboli, Mumbai.

- Participated in the National Conference on Environmental Challenges, Human Health And Society; from 08^{th} -10^{th} September 2016 held at Jaipur, by International Society for life Sciences (ISLS).

KLE Society's College of Science and Commerce Kalamboli

Commemorating the Centenary 1916- 2016

International Workshop cum Seminar

titled

"Science Communication: A Dialogue between Scientists and the Masses"

June 25, 2016

In Technical and Academic Collaboration with Vigyan Prasar, DST, Govt. Of India, Nuclear Power Corporation Limited, Anushakti Nagar, Mumbai and Lucknow University

Certificate of Participation

This is to certify that ~~Dr.~~ / Ms. / ~~Mr.~~ Roopam Kulshrestha of Govt. P.G. College, Thalawar has participated in the ~~Poster~~/ ~~Workshop~~/ Seminar.

The title of his/ her paper / ~~poster~~ Assessment of Diversity of Butterflies Species in College Campus Thalawar, Rajasthan

Ela Atheaya

Dr. Ela Atheaya
IQAC

KLE Society's College Kalamboli

Dr. Jyoti Marwah
Principal

Dr.Rachana Mahashabde
Science Association

National Conference on
ENVIRONMENTAL CHALLENGES, HUMAN HEALTH AND SOCIETY

INTERNATIONAL SOCIETY FOR LIFE SCIENCES

Organized by : University Maharaja College & ISLS
September 8-10, 2016, JAIPUR

NCEHS-2016

Certificate

This is to certify that Prof./ Dr./ Mr. /Ms. ROOPAM KULSHRESTHA

has participated in the Conference as ~~Chairperson~~/ Invited Speaker/~~Oral Presenter~~/ ~~Poster~~ Presenter/ Delegate. His/Her participation was highly appreciated.

Prof. M.K. Pandit
Chairperson

Prof. Kailash Agrawal
Principal
Maharaja College

Dr. G.P. Singh
Organizing Secretary

Dr. Hemant Pareek
Organizing Secretary