CHAPTER 5

DISCUSSION

"Biodiversity is being lost at an unprecedented rate, global response to this challenge needs to move much more rapidly and with more determination at all levels." said U.N Secretary General in the conference held in Germany on 19th May 2008, where 191 countries participated.

This thesis is definitely a research contribution towards maintenance and promoting insect diversity in Vadodara. With the massive garden spaces within the city and beautiful agricultural fields around, the entire Vadodara sustains a good population of insect biodiversity.

Some interesting trends with regard to the biodiversity of insects were observed. 382 species of insects were found in the four habitats of Vadodara with Lepidoptera being the dominant order, Noctuidae of Lepidoptera as the dominant family and *Apis florae of Apidae* from Hymenoptera the dominant species. Pereira *et al.*(2006) also said that the Apoidea group are the most important plant pollinators in natural and agricultural ecosystems .Biodiversity is not about focusing on increase in population of one family or one genus but about the coexistence of all. A ladybird beetle can survive with a honey bee and a grasshopper, treehopper can survive with ants, and such coexistence also shows a healthy flora. This wide spectrum of insect diversity is possible only when all the necessary requirements for growth of insect diversity like:

i. Food plants e.g. *Polyalthia longifolia, Ficus bengalensis ,Calotropis procera, Mangifera indica,* etc.
ii. A healthy prey predator relationship e.g presence of *Hydromitra vittata* and zooplanktons like *Daphnia, Cyclops* within the ponds, within the fields availability of grasshoppers for the wasps, in gardens presence of grubs of *Chrysomelid* beetles and *Podisus maculiventris.*
iii. Optimum temperature from 28°c to 32°C as well as relative humidity of 65 to 80% and

iv. Least anthropogenic activities.

Year wise assessment of the Entomofauna: 2005-2007

Three orders Hemiptera, Coleoptera and Lepidoptera have shown noticeable change in population in three years duration. 2 species namely *Belostoma indicum* and *Sphaerodema annulatum* from family Belostomatidae of Hemiptera showed alarming decline from 36.3% (2005) to 9 % (2007) and 32.1% (2005) to 7.1% (2007) respectively.

11 species from Scarabaeidae family (Coleoptera) showed alarming change in numbers.A steep decline was seen in *Catharsius molossus Fab.* from 36.7 % in 2005 to 7.7% in 2007. Lycaenidae family (Lepidoptera) has suffered a decrease in percentage of its 12 species.

The Year 2005

Vadodara experienced severe floods from June till August. This had a considerable impact on biodiversity within different habitats. This downpour affected the population of animals in general but on record we can place that **'insect population was disturbed'.**

Chlaenius nitidulus predated on *Crotogon lugubris* which in turn was dependent on roots of plants which were all affected by floods. Same was the case with all those insects thriving on plants like *Gryllotalpa fossor* , Grubs of *Holotrichia*, *Cydnus indicus*,*Onchocephalus anulipes, Scirtothrips dorsalis* , *Mocis undata*, *Tetralonia duvaucelli* etc.

During floods the garden area, compounds in residential areas, agricultural fields in all directions, fragmented patches of vegetation in University campus under lower bridge area where river Vishwamitri flows, all were inundated. The breeding and feeding sites of insects were disturbed. The food plants of butterflies like *Lantana camara, Zornia diphylla, Salvadora persicae* were damaged as the soil was washed off affecting the butterfly population.

The familiar sound produced by *Gryllus domesticus* and *Platypleura octoguttata was* missing and this void continued for a few months.

While the population of Hemiptera, Coleoptera and Lepidoptera seemed to have dwindled, others such as Diptera (*Musca domestica, Tabanus striatus*

Lucilia illustrias Tabanus rubidus, Calliphora sp., Drosophila melanogaster) and Odonata (*Orthetrum sabina, Ictinogomphus rapax, Platysticea deccanensis, Tholymis tillarga*) were seen in large numbers due to availability of breeding sites, decomposing matter and feeding materials like larvae of Culicids, winged ants, etc

As adult trees are flood tolerant to such climatic catastrophes, common trees like *Polyalthia longifolia, Terminalis catappa*, *Mangifera indica* sustained their insect populations. But spotting and sighting of insects became difficult due to changes in habitat and irregular visits of insects.

One possible reason of decline in specific insect population due to floods could be increased predation pressure. This was observed by Nedved *et al.* (2002) during their study of effects of floods on larvae of *Neptis rivularis* (Lepidoptera). These larval lepidopterans were observed to have faced greater predator risk as only non submerged food was available to birds like warblers.

Agricultural fields experienced severe water logging which affected the soil characteristics leading to loss of agricultural production.The diversity of orders Orthoptera, Neuroptera, Coleoptera, Hemiptera, Lepidoptera and Hymenoptera was affected. In the following winter of year 2005, the effect of floods remained due to habitat changes, change in type of soil and overall environment. Hence the post monsoon period did not show much variation.

The Year 2006

The following year (2006) was definitely a recovery period .The garden areas were full of ornamental butterflies. Both the community gardens had a very healthy flora and fauna. Rich flora, optimum sunlight, soil condition, temperature and humidity gave shelter to maximum possible insect diversity. Matteson (2006) in his report on conservation of insects also pointed out that increase in number and area of garden or the amount of sunlight ,flowers and trees within gardens optimizes the diversity of insects .He also pointed out that urban insects are limited more by local resource availability than regional habitat resource. University campus was flourishing with *Delias eucharis, Graphium agememnon, Petillia lobipes, Chrysocoris stolli.* The fragmented landscapes became ideal for nurturing the diversity of insects as it has multiple

habitats. The Laxmivilas palace ground sustains insects like *Anthia sexguttata*, *Chlaenius nitidicolis, Scarites subterraneus*, etc.

The visits to agricultural fields which had become irregular also started being regular. Agricultural fields gave shelter to *Melanolestes piscipes, Riptortus linearis, Aspidomorpha diformis, and Gonocephalum planatum* insects. Residential areas and lanes of those areas had less puddles this year. Insects observed predominantly in the residential area were *Chaismia eleonara, Dysgonia stuposa, Xanthopimpla stemmator, Evania appendigaster* etc.

The Year 2007

In the year 2007, some unfortunate results were observed .The number of vehicles in the city of Vadodara increased many folds. According to a report published by Vadodara Municipal Corporation the number of vehicles registered in Vadodara city was close to 9 lakhs in 2005 and the number is expected to be around 15 lakhs by 2010. On an average, the vehicular population is increasing at a rate of around 8-9 % per year. (www.vadodaracity.com)

The pollution due to vehicular emission, excessively high temperature during summers, increasing number of multiplexes and malls, new multistoried buildings occupying all available open land area, had a drastic effect on insect population.

The growing urbanisation and the demand for more housing and transportation have led to a decline in urban greens and water bodies. A similar situation exists with the water bodies; these have reduced nearly by half, from 4.38 sq. Km in 1991 to 2.77sq.km in 2005, causing concern. If this trend continues the city would deterioriate both in terms of life quality and environmental parameters. It is thus imperative to strike an ecological balance by taking appropriate steps to rejuvenate the greenery and recharge the water bodies of the city.

Table 24 Insects found in all study sites from 2005-2007

INSECT ORDER	Number of insects found		
	2005	2006	2007
Thysanura	30	21	19
Ephemeroptera	42	22	25
Odonata	129	60	54
Orthoptera	48	89	58
Phasmida	5	7	2
Dictyoptera	58	27	25
Hemiptera	395	743	700
Thysanoptera	64	94	90
Neuroptera	23	49	48
Coleoptera	446	1259	1113
Diptera	1082	778	702
Lepidoptera	910	1752	1414
Hymenoptera	427	686	605

Habitat comparison

From the agricultural fields 323 species of 286 genera from 106 families were recorded. The fragmented habitats can sustain a good variety of insect species diversity- 327 species from 290 genera of 109 families. From the community gardens 310 species of 271 genera from 106 families were recorded .From residential sites the number was little less. It was 284 species of 252 genera from 104 families. Carabids are distributed in almost all the habitats. In Laxmivilas palace compound I found *Anthia sexguttata* crawling towards the mound which looked to be barren whereas in the University campus, during monsoon, *Anthia* was spotted near the cricket ground. Many a times *Pheropsophus leinifrons* was spotted in the residential areas within the lanes of houses a little away from the vegetation. In the agricultural fields *Scarites bengalensis*, *Homoecerus variabilis, Odynerus ovalis* was spotted in the hedges. Such insects are indicators of normal ecosystem.

Agricultural fields

In agricultural fields excessive human interference, continuous use of pesticides and unawareness about monoculture practices are diverting insects from the fields. Carpaneto *et al.*(2007) attributed the high risk of extinction in Italy for six species of roller dung beetles to a gradual change in land use, consisting of a reduced extension of grasslands in favour of either intensive agriculture or reforestation was likely the main factor inducing decline and local extinction of these scarab dung beetles. Late Dr. J.K. Maheshwari fellow of the National Institute of Ecology and Retd. Scientist , NBRI , Lucknow, in his long duration of research had emphasized that decline in the population of butterflies is due to weed killers, atmospheric pollution, man made environmental changes like deforestation, extension of farming , disturbance of larval as well as adult food plants, feeding grounds and shelters. For Vadodara also it is true that land use pattern is changing in urban areas .Those areas which had vegetation are now being converted into large complexes and concrete roads. All this also leads to lesser cattle rearing which affects the population of dung rollers. The same reason was noted for reducing number of

roller dung beetle populations in the Iberian Peninsula during the 20th century (Lobo, 2001).

The fields in Padra have good hedges of trees and hence a good population of insects .Fields in Savli have few large trees only and therefore lesser insect populations. The fields in Dabhoi which make use of pesticides in limited proportions were observed to be having even greater diversity of insects as compared to the fields of Padra. Dabhoi and Waghodia, there was indiscriminate use of pesticides in the fields. Zahoor *et al.* (2003) have reported a decrease in diversity of Coccinellids in Pakistan due to the disturbance in crop area in the form of agricultural practices and the use of chemicals. Logs of large trees on the field margins of Waghodia give shelter to termites like *Microtermis obesi* , which builds tunnels in the roots of the main crop (Pardeshi, 2008) damaging the plant and diverting the insect fauna depending on those plants.

Alomor *et al.* (2001) described the importance of predatory insects, that utilize field margins for part of their life cycle, in influencing pest populations on crops.

E.J. P Marshall (2006) in his editorial on field margin ecology stated that field margins can contribute both as sources of natural control agents and as potential corridors, but only if a sound understanding of their ecology is available.

Fragmented habitats

The underlying reason for the success of fragmented landscapes is that they provide ideal multiple microhabitats for nurturing insect species. The two fragmented habitats studied were Laxmivilas Palace and The M.S University campus. The cricket grounds and the ponds of both the habitats provide ideal conditions for flourishing insect populations. Laxmivilas Palace is a well maintained, undisturbed, protected habitat which supports a good population of Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.

The University campus being the prime body of education is used by student-teacher community which is an educated, civilized, cultured society. There is no destruction of vegetation by humans and there are no stray dogs

and cattle seen. In addition, the Botany department, with high quality of flora and well nourished soil in its botanical garden, contributes to the sustenance of high insect diversity.

Habitat Fragmentation and disturbance mostly affects specialized organisms. Generalists do not depend on one well–defined habitat. This has also been observed in butterflies by Steffan *et al.* (2000).

The Community gardens

The community gardens are also well planned and maintained by the competent Government municipal corporation body of Vadodara (VMC). It has well maintained flora with many native and exotic varieties of plants as mentioned in Table 3 ,proper water supply and good well fertilized soil ; all the prerequisites of a habitat capable of sustaining good insect diversity.

The community gardens provide a wealth of insect population. The Sayajibaug established by the erstwhile Maharaja Sayajirao Gaekwad with massive 113 acre area is an ideal place for insect populations to thrive. Lal baug garden, with a pond in it, is a haven for aquatic insects.

The Residential Areas

Within residential areas the old city has arrangement of houses in such a way that there is hardly any green space. No green space, all possible types of disturbances, traffic congestion, and pollution and less insect abundance was the direct equation of these areas. A decline in diversity has been observed in these areas and if adequate measures are not taken this too will soon disappear.

The small public gardens and private gardens in the houses and compounds of the new residential areas could sustain insect populations better than the old residential areas.

General Remarks

"The splendor of the insect world which mystified me as an Entomology student some years back seems to have faded."

- The great boom in the number of malls and multiplexes in Vadodara, have taken their toll on grasslands and open spaces of this green city,

where generally insects thrive. Due to the shrinkage of such habitats, the diversity has declined.

- Loss of vegetation cover associated with urbanization also had a negative effect on the abundance and species richness of advanced eusocial wasps in Brazil as reported by Zanette *et al.* (2005).
- By knowing the diversity of biocontrol agents in different habitats, we can point out that maintaining and sustaining the specific type of area preferred by those insects can lead to an increase in their population e.g adults of *Brachynemurus abdominalis*, *Helicomitus sp*, *Asclaphus sp*. were normally spotted around the hedges of field margins and its immatures were spotted around the sandy areas of the hedges.
- Some species are found throughout the year irrespective of the temperature like *Musca domestica, Apis florae, Tabanus striatus, Lucilia illustris, Calliphora species, Allocotasia aurata, Tabanus rubidus, Drosophila melanogaster, Dytiscus, Gerris ,Hydrophilus acuminatus, Scelifron madraspatanum, Ammophila laevigata, Bradinopyga geminata etc.*

The beautiful and colourful patterns of *Graphium agememnon* fluttering on the *Asopalav* trees in the University campus, *Colotis danae* in the lawns in front of the Zoology Department, *Daphnis nerii* on the flowers of oleander in the gardens, *Pachliopta aristolochia* flying on *Quisqualis indica* near my house, *Delias eucharis* visiting lanes of cities where I live are visions of the past.

Diversity, Ecology and Conservation

The Harvard Biologist E .O. Wilson predicted in his book 'The Future of Life' that half of all species will suffer extinction in 50 years if current land use pattern continues.

- Construction and maintenance of the habitat will result in minimal loss of bio-diversity at the local level due to restriction of habitat, habitat fragmentation, mortality or invasive species.
- There may be influence of predators utilizing field margins on pest populations of crops (Alomor *et al.* 2001).

- Field margins can contribute both as sources of natural control agents and as potential corridors, but only if a sound understanding of their ecology is available (Marshall, 2006)
- The areas and habitats significant to the conservation of insect species of special interest should be identified.
- Importance of compiling and sequencing of data of the present insect population species and maintaining a dairy is definitely an effort every entomologist should make. If human population wants to survive, an eye on every single species' existence and its appearance or disappearance should be kept otherwise a time will come when population of supreme power will disappear.

The probable reasons for decline in some species noted are as follows:

- Habitat destruction due to construction of commercial and residential buildings.
- Pollution due to ever increasing number of vehicles and industries which expels toxic products into environment including air, water and land.
- Chemical pesticide usage in agriculture affecting the non target species along with the pest (but there are not enough biological pesticides to replace all chemical pesticides).
- Extremes of climates change the temperature favorable for breeding of almost all insect species.

If this trend of decline continues, we will be heading towards narrowing of diversity in all habitats. The advent of latest trends like Molecular Biological Taxonomy in the field of Entomology could further the cause of conservation of insect diversity. But it would not be wise to offer to these future fields a narrowed down diversity range .Therefore it is mandatory to take all possible measures to determine, document and conserve this insect wealth.

Recommending conservation steps for the sustenance of population in a thesis is easy but its application in a country like India is complicated.

"Is Conservation in our hands or has gone beyond us?"