INTRODUCTION

THIS UNIVERSE IS THE CREATION OF SUPREME POWER MEANT FOR BENEFIT OF ALL; INDIVIDUAL SPECIES MUST THEREFORE LEARN TO ENJOY ITS BENEFITS BY FORMING A PART OF THE SYSTEM IN CLOSE RELATIONSHIP WITH OTHER SPECIES. LET NOT ANY ONE SPECIES ENCROACH UPON THE OTHERS RIGHTS. – ISAVASYA UPANISHAD

Planet earth is unique in many ways; it's most important feature being the presence of the biosphere with life support system. Life originated here, multiplied here, diversified through the ages, and now exists on it in myriads of forms and shapes. The variation of the living nature on planet earth is Biodiversity or the diversity of life. Biodiversity however, has multifaceted nature. It deals with biological and geographical units such as genes, chromosomes, species, families and biogeographical regions. In most definition biodiversity is generally defined as total sum of genetic, taxonomy and ecosystem diversity; but biodiversity is generally defined as total variability of life on earth (Lovejoy 1980a, b; Wilson 1985; Norse *et al.*1986; Wilson and Peters 1988, Reid and Miller 1989, McNeely *et al.*, 1990, Chauvet and Olivier 1993).

Whatever the scale, biodiversity is something that arises from the total range of native creatures present. The greatest and smallest species count more or less equally towards a sum. While biodiversity in the broad sense regulates the cycling of carbon and other ecosystem processes, the total number of species involved in these processes has relatively little effects on the processes themselves (Hooper and Vitousek, 1997, Huston, 1997; Huston *et al.*, 2000 and Loreau *et al.*, 2001).

Biodiversity has immeasurable, intrinsic value for the humankind and thus need to be protected. It is essential for supporting human life and maintaining relation between man and nature. Every aspects of our life are sustained by the earth's biodiversity. Therefore, there is need to conserve the biological resources to continue supporting life on earth. The earth is relatively unexplored planet in terms of its biospheres. Inequality in the global distribution of biodiversity is the mirror image of the global distribution of wealth, as estimated by per capita Gross Net Productivity (Huston, 1993). Within region, either tropical or temperate, there is variation in the distribution

of biodiversity, and this variation tends to correlate with conditions that influence human activities such as agriculture and forestry. These goods represent important and familiar parts of the economy. These biological resources are freely available for exploitation and development (McNeely, 1982). Human induced perturbations under the term global change directly affects ecosystem and humans who depends on ecosystem services (Ehrlich and Mooney, 1983).

A conservative estimate of the rate of species loss is about one per hour, which unfortunately exceeds the rate of evolution of new species by a factor of 10,000 or more (May *et al.*, 1995). However, complete extinction of species is only the final act in the process. The rate of loss of local populations of species is orders of magnitude higher (Daily and Ehrlich 1995). Destroying other life forms also disrupts the web of interactions that could help us discover the potential usefulness of specific plants and animals (Thompson 1994).

We live at a critical time for the conservation resources on earth. The living Planet index, a measure reflecting the state of world's forests, freshwater and marine ecosystem fell by 37% between 1970 and 2000. It has been predicted that as many as 25% of the world's species could be lost in the next several decades (Living Planet Index Report, 2002). Forests are the earth's most spectacular wonders. They have served as cradle for biological evaluation and provide sustenance to animals and human beings for millions of years. Forest controls the water budgets in the lands around them and influences the climate to considerable extent. Apart from their ecological functions, they serve as valuable gene pool. Forests are the most species rich terrestrial habitats (Maser, 1988; Whitemore and Saver, 1992). Animals are indispensable part of forest ecosystem. About a quarter of all species listed as threatened or endangered are found within protected area or depend on them for at least part of their habitat needs. There is consensus on the importance to reserve system to prevent the rapidly declining biodiversity due to human impact (Wright 1996; Primack and Ros, 2002). The creation of over 30,000 protected areas (PAs) around the world has been one of the greatest achievements of the 20th century and thus a great inheritance for the 21st. All of them put together cover over 12.8 million sq. km, which amounts to over 9.5% of planet's land area, an astonishingly large extent, larger in fact, than China and India combined. This has further increased to 44,000 PA s covering over 10% of the land area. Thus, forests are "Green Gold" of a country (Singh, 2001).

INDIAN BIODIVERSITY

India possesses a distinct identity, not only because of its geography, history and culture but also because of the great diversity of its natural ecosystems. The panorama of Indian forest ranges from evergreen tropical rain forests in Andaman and Nicobar Islands, the Western Ghats, and the Northeastern states, to dry alpine scrub high in the Himalaya to the north. Between the two extremes, the country has semi-evergreen rainforests, deciduous monsoon forest, thorn forests, subtropical pine forests in the lower montane zone and temperate montane forests (Lal, 1989). It has 20.55% of its geographical area under forest (F.S.I., 2001). India is one of the 12 - mega diversity countries of the world due to a great wealth of biological diversity in its forests, its wetlands and its marine areas. India occupies only 2.4% of the world's land area but its contribution to the world's biodiversity is approximately 8% of the total number of the species (Khoshoo, 1996).

The protection of wildlife has a long tradition in Indian history. Wise use of natural resources was prerequisite for many hunter-gatherer societies, which dates back to at least 6000 BC. Extensive clearance of forests accompanied the advance of agricultural and pastoral societies in subsequent millennia, but an awareness of the need for ecological prudence emerged and many so called pagan nature conservation practices were retained. As more and more land became settled or cultivated, these hunting reserves increasingly became refuges for wildlife. Many of these reserves were subsequently declared as national parks or sanctuaries, mostly after independence in 1947 in different states like Madhya Pradesh, Assam, Kerala, Gujarat, etc (Puri,2004).

GUJARAT BIODIVERSITY

Gujarat with a geological area of 1,96,024 sq. km has been endured with plentitude of biodiversity and natural ecosystems, which include moist forests (in Valsad, Dang, Vyara forests, Shoolpaneshwar sanctuary); dry deciduous forests (in Panchmahal, Sabarkantha, Girnar, Gir); thorn scrub (in Saurashtra, Kutch and North Gujarat), grasslands, deserts, wetlands and costal wetlands. Area under forest is approximately 18,830 sq. km., but actual cover is only 12,965 sq. km (Figure i). Of the total geographic area, 9.6% of area is under forest cover, which is much less than the national average of 20.55% (F.S.I, 2001). Mountain ranges like Aravallis in the north, Vindhyas and Satpuras in the east and Western Ghats in the south terminate in Gujarat and some of them converge and merge at one place. This helps

in migration of wildlife and hence building species diversity of the state (Singh, 2001). Diverse Geophysical conditions, coupled with varied eco-climate, have given rise to rich diversity of ecosystem and wildlife. To conserve and protect, the rich biodiversity and rare and endangered life forms, 25 protected areas have been notified in Gujarat. These include 21 sanctuaries and 4 National parks.

Gujarat contributes significantly to the richness of India's biodiversity and is sixth largest state rich in diversity of natural ecosystems. The state has very rich wildlife heritage and enjoys a unique place in the country supporting some of the rare and endangered wildlife. Gujarat is the only state in the country, probably in the world, which protects top three big cats – Asiatic Lion, Tiger and Leopard. Out of eight endangered mammalian species each having only one habitat in the entire country, two of them Asiatic Lion and Indian Wild Ass are endemic to Gujarat representing over 27% diversity of Indian vertebrates (Gujarat Forest Department 1999).

On the basis of geographical position and drainage characteristics, the state of Gujarat can be divided into three broad regions *viz.* South Gujarat, North and Central Gujarat and Saurashtra and Kutch. Saurashtra, earlier an Island, but now surrounded by sea on three sides is historically recognized as a cradle of fascinating wildlife, warriors and 'maldharies' (Singh, 2001). Gir and Girnar constitute the only area in the region, which support dry teak forest bringing maximum rains in this part of Saurashtra. Gir is one of the seven identified protected areas by the Global Environment Fund and World Bank and being the last abode of Asiatic Lion, the Gir forest has earned an international acclaim and thus, Gir sanctuary and National Park enjoys protection status of the highest order (Chellam, 1993).

The sanctuary and National Park has diverse and rich vegetation. It is the largest compact tract of dry deciduous forest in semi arid western part of the country. The main forest types are teak forest, non-teak forest and riverine forests. Gir therefore, is considered one of the best biodiversity rich preserves (Singh, 2001).

Gir forests are studied for its fauna and flora. Studies conducted so far include some compilation of the floral component (Santapau and Raizada, 1956; Habibullah, 1983; Rao, 1983 and Senan, 2002). Several workers carried out research on fauna. Ungulates were studied by Hodd (1970), Berwick (1974) and Khan *et al* (1990); where as the endangered big cat – lion drew attention of several naturalists and wildlife enthusiasts as well as scientists like Dharmkumarsinhji and Wynter-Blyth

(1951), Dharmakumarsinhji (1968), Joslin (1973), Soni (1992), Chalem (1993), Saberwal *et al.*, (1994). Important parameters in habitat selection by peafowl *Pavo cristatus* was studied by, Trivedi (1993). Studies on lesser-known fauna of Gir PA with special reference to invertebrates have thrown some insight regarding Invertebrate diversity (Parikh, 2001). An intensive study on the geology of Gir was undertaken by Patel (1992), which included the quantification of mineral composition of soil and water.

STATUS OF INVERTEBRATE CONSERVATION

The number of species on earth has been estimated from 5 to 80 million species or more but it is most probably in range of 30 million. Only about 1.4 million of these living species have been briefly described. Of these known species of animals about 3% are vertebrates and 97% are invertebrates. However, it has always been the vertebrates, with a mere 3% of all living species which has been given the first priority for study and conservation. For invertebrates it is rare to hear any report or activity, which involves invertebrates conservation. Despite this, we hardly give them any importance, considering their number and role in various ecosystems, which support our lives. Why is that? Is it because they are small? They may be small individually but as a community, such a constituency, they out number us.

The concept of conserving invertebrates per se is still in its infancy world over, but has garnered tremendous interest among scientific community off lately. Invertebrate conservation efforts are still to be initiated in the Indian sub continent. Relatively speaking, invertebrate conservation in India is at a very premature stage. Even many ecology and conservation conscious people do not fully realize the need for invertebrate conservation.

ARTHROPOD DIVERSITY

This is not, as the Victorians called it, the age of mammals. The planet today is almost completely dominated by a single phylum of animal life, on land, in sea and even in the air; they are the masters of the earth, "The Arthropods". Phylum Arthropoda has 82% of total identified animal species all over the world. The sheer number and mass of arthropods reflect their ecological impact. Arthropods are so plentiful that a huge number of plants and animals have evolved to specialize only on them (Docent Bulletin, 2004). Due to their ability to survive in any type of habitat, they are thriving in all habitat types may it be aquatic or terrestrial habitat. Either in

Arid, semiarid or forested ecosystems this group of animals are plentiful. In forested ecosystem they play major role as pollinators, predators, decomposer etc (Lattin, 1990). Animals belonging to phylum Arthropoda constitute 74% of all-faunal species occurring in India. However, species recorded from Gujarat belonging to this group is very few may be because studies have not been done or records are not compiled for most of the areas in this regard (Singh, 2001). The available literature indicates that the sanctuary area has been well explored for its floristic components and its vertebrate fauna (Dharmkumarsinhji and Wynter-Blyth, 1951; Santapau and Raizada, 1956; Dharmakumarsinhji, 1968; Hodd,1970; ;Berwick 1974; Habibullah, 1983; Rao, 1983;Khan *et al* 1990; Soni, 1992; Chalem, 1993 Trivedi, 1993;; Saberwal *et al.*, 1994; Senan, 2002). Nevertheless systematic studies on invertebrates in general and Arthropods in particular are very scanty (Parikh, 2001). **The first objective of the present study therefore, was to identify Arthropods from this area and enlist them** (Chapter 1). Identifying Arthropods is necessary for knowing what is present today and later, a similar list will make it possible to evaluate the nature and extent of changes that have taken place.

INSECT DIVERSITY

Insects among arthropods are distributed all over the world in all habitats and constitute about three-quarters of all the living species in the universe. Extremely few species are distributed on all the continents and have worldwide distribution. However, insect distribution on earth is not uniform, insect diversity increases from poles to the equator (Brown, 1981; McCoy, 1990). The distribution of insects in particular area may be regular, occasional, seasonal, persistent or sporadic. It can be determined by physical barriers like large masses of water for land insects, climatic conditions, biological barriers like food, existence of competitors and natural enemies. The dispersal of insects differs according to species and environmental conditions (Ananthakrishnan, 2000). Genetic variability or diversity of many insects is diminishing and hence, reduces their ability to withstand environmental adversity. The loss of genetic diversity of beneficial insects looms as a threat to human welfare. Habitat loss or drastic alteration of habitat, overexploitation of resources and pollution are the three major reasons for loss of insect species (Ambrose, 1995).

Patterns of biodiversity are very unique in many of our forest ecosystems. There prevails a general misconception for the conservation of insects and the notion that insects can be studied by observing them in the field like birds or mammals is

invidious. There are hundreds of thousand of insects, which have been collected and studied in the laboratory. For determining species variations, no progress can be made without in depth study of samples from different populations. For both basic and advanced studies, collection of specimens is essential prerequisites (Narendran and Cherian, 2002). However, the need to know more about insect faunal wealth is really great. Because of their small size and modest needs, most insects and other invertebrate occupy ecological niches that are more numerous and smaller in dimensions (space, time and so on) and therefore, more sensitive than those of vertebrates. We have to know what we have, before planning any conservation measures, as insects have played an important part as those played by other environmental factors in determining ecological trends and in hastening and retarding primary succession and regression of forests (Gaston, 2000).

The litter ecosystem provides a suitable habitat to variety of insects and other invertebrates. Natural forest litter ecosystem support more diverse consumer and decomposer organisms at various trophic levels for the breakdown of litter as well as in sustaining the food web in different forest types. Litter decomposition is the major pathway for the return of dead organic matter and its nutrient to upper soil layers which accounts for restoration of fertility (Seastedt, 1984, Ananthkrishnan, 1988).

Very few serious and systematic attempts have been made to study forest insects due to the role played by them in maintaining the equilibrium of the forested ecosystem (Stebbing, 1914, Beeson, 1941). Nevertheless, there is a great dearth of expertise for vast majority groups of insects in India (Narendran and Cherian, 2002), and all the more in Gujarat. However, scanty information is available regarding insect diversity of Indian forests. An assumption has been made that Gir forests harbor at least 2000 species of Insects (Singh and Kamboj, 1996). During mid to late nineties attempts were made to collect and identify animals of class insecta (Sing *et al.*, 1998). Therefore, as a prime goal of the present study an extensive entomological survey in the Gir PA was undertaken. **A thorough study on insect diversity, and the temporal variation in abundance and relative density of different orders of insects was under taken in Gir PA** (Chapter 2). One of the major benefits of such studies in forested habitat and estimation of abundance of insect is that the studies when repeated after several years could help in knowing the status of insect themselves and their habitat.

Based on number of taxa, coleoptera is the largest order of class insecta. This is not only the largest order of insecta, but has also been a favorite group of the collectors for a long time, due to their versatile habits, marvelous coloration and sculpture, as well as their economic importance. Beetles are of immense economic importance; some of them are beneficial, help in controlling many injurious insects. The major ecological impact of beetles results from their effects on green plants, their contribution in the breakdown of plant and animal debris and formation of soil, and their predatory activities. Beetles make up more than 40% of all the known species of insects, and thus comprise the largest insect order. However, many beetles have yet to be described, and estimates for the total number of species range from one to twelve million (Booth *et al.*, 1990; Pearse *et al.*, 1987). This group includes more species than the entire plant kingdom does, and scientists agree that many thousands or even millions, more beetles have yet to be discovered. In fact, about one of every four animal species known on earth is a beetle (Chadwich, 1998). **Hence, in the current study an attempt was also made to learn the systematics of coleoptera – the dominant insect group – along with their abundance and distribution in space and time at Gir PA** (Chapter 3).

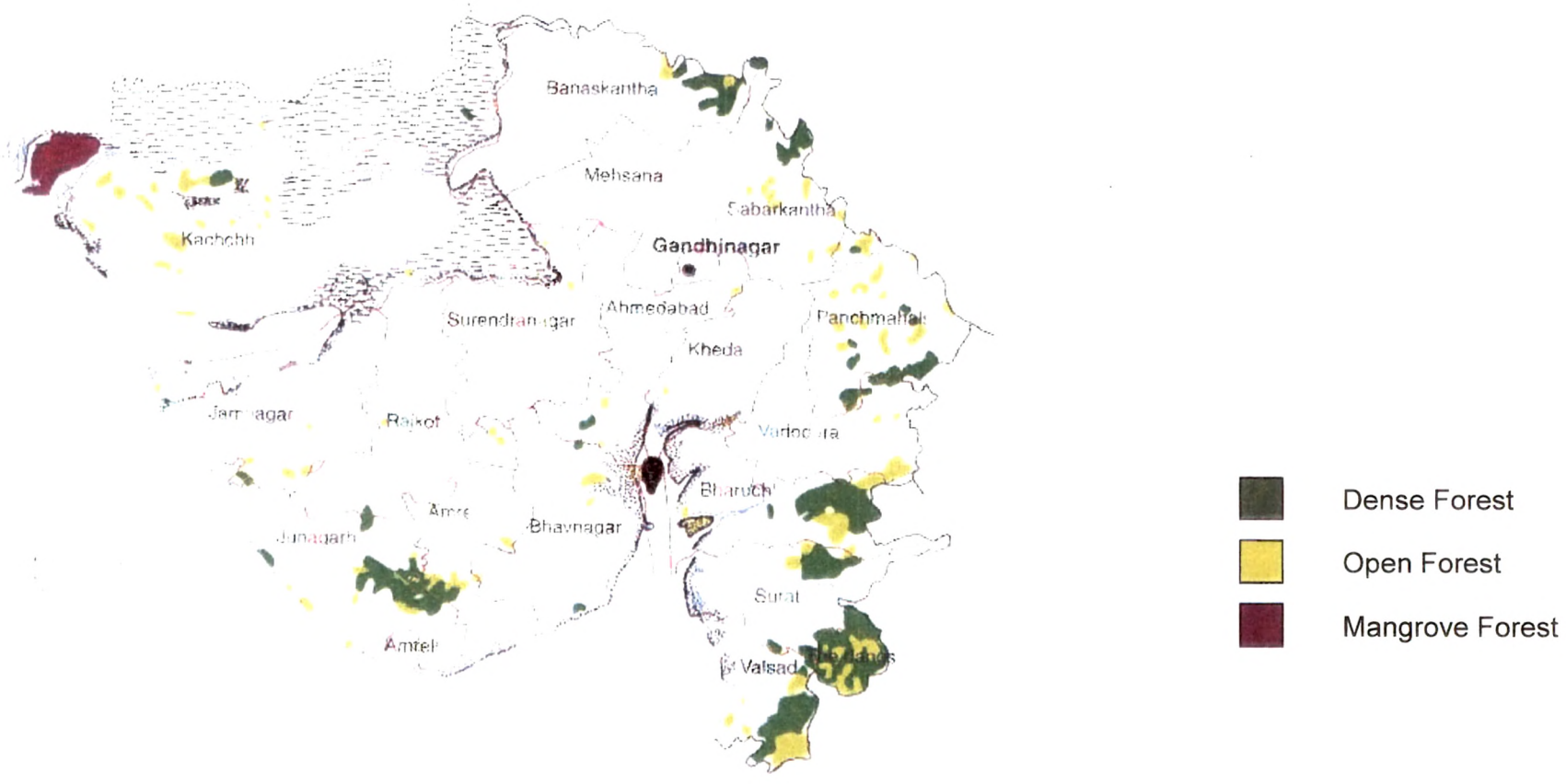

FIGURE i. Major forest types of Gujarat