CHAPTER 1
INTRODUCTION

Green plants form the major natural and renewable resource on earth. These forms produce their own food material and support all kinds of organisms. The dependence on plants by other living beings including human beings dates back to the time of heterotrophs.

Biodiversity

Biodiversity is the abbreviated word for Biological Diversity. The concept of Biodiversity had its origin in mid 1980s, though the earth and evolutionary processes are very ancient phenomena.

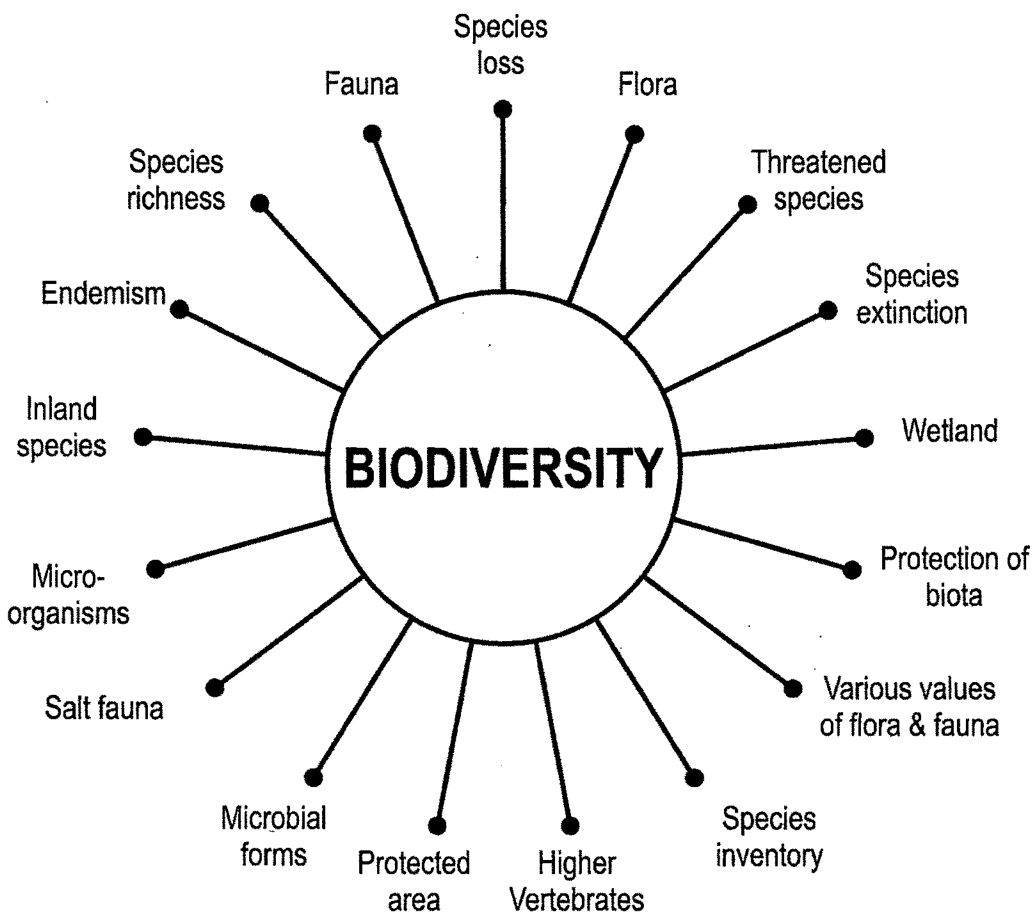

Fig. 1: Components of biodiversity

The word Biodiversity is now very widely used not only by the scientific community, but also the general public, environmental groups, conservationists, industrialists and economists. It has also gained a very high profile in the national and international political arena. In fact, the term has become more fashionable with no clear understanding of what it means. Such loose usage has given the word so many different meanings, connotations and intentions that the actual concept of biodiversity has been lost in obfuscation and confusion. Hence there is a real need to unequivocally define the concept of biodiversity, which is today a recognized separate science with its own components (Fig.1), principles and facts, and to define the scope of this new science as well.

Biodiversity is generally considered an 'umbrella term' referring to organisms found within the living world. Infact, the variation in number, variety and variability of living organisms. It may thus be assumed to be synonym for **'Life on Earth'**, or **'variety of life and its processes'** (Anonymous, 1992). Darwin (1859) exclaimed biodiversity as **'Life's endless forms'**. Taken in this general sense, biodiversity is indeed **'the essence of life'** (Frankel, 1988). In reality, however, biodiversity is a very vast and complex concept and its ramifications extend deep into all spheres of human life and activity.

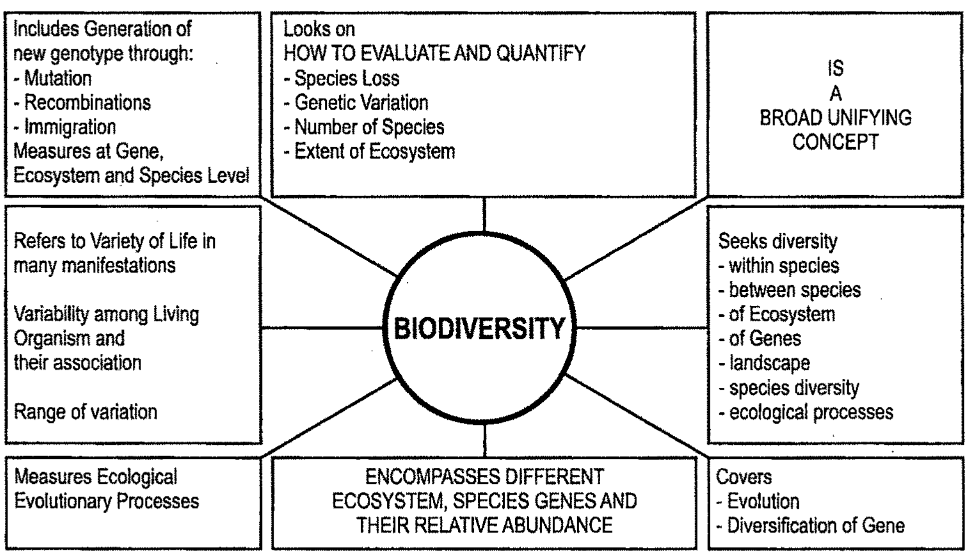

Fig. 2: Facets of biodiversity

Biodiversity is normally treaded in terms of genes, species and ecosystems in correspondence with the three fundamental hierarchical levels of biological organization. These three diversities are respectively referred to as Genetic, Species and Ecosystem diversities. Diversity within species is Genetic Diversity, diversity between species is Species Diversity (also often referred to as Taxonomic or Organismal Diversity), and diversity at the ecological or habitat level is Ecosystem Diversity. Noss (1996), Szaro and Shaprio (1990), Szaro and Salwasser (1991) and Wilson (1988 a,b), among many others, have included a fourth form of biodiversity called Landscape Diversity. Landscape is **'a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form**

throughout' (Forman and Godron, 1986). Landscapes therefore have a pattern and this pattern consists of repeated habitat components. For example, a landscape may be interspersed with grasslands, meadows, ponds, streams, shrubby areas and forests. Thus, landscape diversity is in fact a pattern diversity (Scheiner, 1992).

Biodiversity, the variety of life, is distributed heterogeneously across the earth. Some areas seem with biological variation others are virtually devoid of life and most fall somewhere in between. Determining why these differences occur has long been a core objective for ecologists and biogeographers. It constitutes a continuing, an important and to many an enthralling, challenge. Indeed, the past decades has seen a veritable explosion of studies documenting broad-scale spatial patterns in biodiversity, seeking to explain them, and exploring their implications. The reasons for this interest are two fold. It reflects increased opportunity provided by improvements in available data and analytical tools, the former resulting mostly from extensive collation of existing specimen and species occurrence records, the establishment of dedicated distribution - mapping schemes and the use of remote-sensing technology. It reflects concern over the future of biodiversity and the resultant need to determine its current status, to predict its likely response to global environmental change and to identify the most effective schemes for *in situ* conservation and sustainable use. Many of these issues can be addressed satisfactorily only by resolving the historical mis-match between the fine resolution of study plots in ecological field work and by comparison, the poor resolution of land-use planning and models of environmental change.

The complexity of the biodiversity concept is reflected in the existence of numerous definitions for this word. The most acceptable definition of biodiversity is the one held by the Convention of Biological Diversity (CBD), which was signed by more than 150 nations on June 5, 1992 at Rio-De-Janeiro. The CBD states that **'Biological Diversity'** means the variability among living organisms from all sources, inter-alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes diversity within species, between species and of ecosystems.

The World Conservation Monitoring Centre (1992) in their edited work **"Global Biodiversity"** holds the following definition. Diversity is a concept which refers to the range of variation or differences among some set of entities. The biological diversity thus refers to variety within the living world. The term biodiversity is indeed commonly used to describe the number and variability of living organisms. This very broad usage, embracing many different parameters is essentially a synonym of Life on Earth.

International Council for Bird Preservation (1992) defines- biodiversity is the total variety of life on earth. It includes all genes, species and ecosystems and the ecological processes of which that are part of biodiversity.

Several definitions framed by distinguished Scientists are also laid below:

Fidler and Jain (1992) defines Biological diversity as full range of variety and variability within and among living organisms, their associations and habitat oriented ecological complexes. The term encompasses ecosystem, species and landscape as well as intra specific levels of diversity.

Meffe and Carroll (1994) define- Biodiversity is the variety of living organisms considered at all levels, from genetics through species, to higher taxonomic levels and including the variety of habitats and ecosystems.

McNeely et al (1990) define Biodiversity as a term for the degree of nature's victory. It encompasses all species of plants, animals and micro-organisms and the ecosystem and ecological processes of which they are part. Biodiversity can be seen as a measure of nature and its diversity, rather than an entity in itself and is usually measured at three levels genes, species and ecosystems.

Wilson (1992) similarly has proposed biodiversity as the variety of organisms considered at all levels, from genetic variants belonging to the same species through arrays of species to arrays of genera, families and still higher taxonomic levels. It also includes the variety of ecosystem, which comprise both the communities of organisms within particular habitats and the physical condition under which they live.

Biodiversity can be considered as the manifestation of the constantly changing diversity of form and function in the biosphere. The sum total of the heterogeneity at all tropic levels alone can provide the stability to ensure the survival of individual beings. This total diversity is needed for each ecosystem for the component species evaluation to continue and for the collective spectrum of life including that of mankind to flourish and diversify further.

The above definitions make it amply clear that biological diversity and biodiversity though are defined differently in various ways. However, estimating precise loss or even the current status of species is challenging because no systematic monitoring system is in place and much baseline information is still lacking. Since information available is very limited on which genes or species are particularly important in the functioning of the ecosystem. Therefor it is difficult to specify the extent to which we are dependend and suffer from the loss of biodiversity. It has been estimated that almost 40 percent of the Earth's net primary terrestrial photosynthetic productivity is now directly consumed, converted or wasted as a result of human activities (Vitoosek et al, 1997).

Taxonomy

The earth ecosystem contains a vast crowd of plants upon which all other living forms are directly or indirectly dependent. Man's total dependence on plants for his existence has been of vital importance. The three great necessities of life – food, clothing and furnishing for shelter are supplied in great part by plants. It is not surprising that plants classification is a process which mankind naturally and instinctively carries out and has been carrying out since he recognized the use of plants as a source of food, fuel, building materials etc. As the age and scientific temperament advanced, characterization, identification, classification and nomenclature of the plants, irrespective of their utility became an unavoidable task of the taxonomists (Patel, 2002).

The foremost and most difficult constraint to overcome is the current status of Taxonomy. It is well known that Taxonomy is the most essential infrastructure for biodiversity development (Janzen, 1993 a,b) and that the recognition and characterization of biodiversity depends critically on Taxonomy as it provides the reference system for depicting the pattern of biodiversity. Only a very limited number of all species believed to exist on this earth are known to us. Many species are yet to be discovered and described. Even for the known species, the information available, especially on functional attributes, is extremely meager. In spite of this, the number of new taxonomists the world over is very small, due primarily to lack of career incentives. Further, the geographic distribution of even these few taxonomists is lop-sided. While it is estimated that in the developed countries there is one taxonomist for every 10 species occurring there, in many developing countries there is only one taxonomist for every 1000 species, even if we include taxonomists of below average competency (Manilal, 1997). There is also a mal-distribution of taxonomists, due to which **the amount of taxonomic effort** made so far **varies widely from group to group** among the biota of the world (May, 2002). This mal-distribution reflects the vagaries of intellectual fashion, and most certainly does not reflect the relative importance of the different groups in maintaining the structure and functions of the ecosystems. Good taxonomists have indeed become a highly endangered category among biologists (Khoshoo, 1995).

Systematics is that branch of Biology, which is involved in the recognition, comparison, classification and naming of the millions of organisms that existed and exist at present on the Earth. Thus the basic framework for the whole of Biology is provided by Systematics (Vane-Wright, 1992). Consequently, Systematics is also a very fundamental aspect of Biodiversity science. It becomes imperative for Systematics to document and understand the extent and significance of biodiversity by carrying out the following functions: recognition of taxa (Differentiation), universal diagnosis of taxa (Identification), providing universally accepted names to taxa (Nomenclature), analyzing relationships of taxa (Comparison) and finally, assembly and grouping of taxa on the basis of relationships (Classification). The initially recognized groups are then assembled into more and more inclusive higher groups. Thus different levels of groups are produced as a series of hierarchical categories. The resultant structure is often called taxonomic structure. In this structure, the species is now almost universally accepted as the basic unit of the hierarchy. As detailed below, the species is also considered one of the leading players in biodiversity, conceptually, biologically and legally. It has also been almost universally used as the unit in which biodiversity is measured for all practical purposes.

The basic question of what is a species, however, has teased, both biologists and non-biologists, for more than two centuries and continues to do so even today. Most practicing taxonomists often have an intuitive feeling for species of plants and are able to identify and name many species apparently with ease and considerable confidence.

An inventory is a formal surveying, sorting, cataloguing, quantifying and mapping of the occurrence of defined elements of biodiversity such as genes, individuals, populations, species, habitats, ecosystems and landscapes at a particular point of time in a defined geographical unit (spatial scales range from nanometers to countries or even continents). This inventory must be done for specific purposes and according to standard and well-established field procedure. It must also be done in accordance with statistically valid sampling designs and using rigrous quality, control and data administration practices. Due to lack of funds, time and trained personnel, this inventory almost invariably constitutes a sampling rather than a complete listing of the species of an area (di Castri et al, 1992). Thus no inventory is ever complete, as there will always be additions and disappearances, as well as changes in abundance.

Dennis and Ruggiero (1996) suggested four possible approaches for orienting an inventory: (i) survey of major elements; (ii) identification of keystone species and indicator elements (iii) identification of targeted elements, such as threatened species; and (iv) comprehensive assessment of all other important elements, such as Exotic or Flagship species, and economically useful taxa. The purpose and orientation of an inventory will determine the choice of methods, which in turn will influence the completeness of the inventory in terms of taxonomy, community/ecosystem representation, geographical space, and seasonal/temporal representation (Solbrig, 1991, Stohlgren and Quinn, 1991).

An inventory which records all occurrences of chosen taxonomic groups of plants can be claimed to be taxonomically complete but not necessarily either ecologically or spatially. An inventory that covers inventorying each type of ecological element in a study area can be considered as ecologically complete but not necessarily taxonomically or spatially. Similarly, an inventory that covers every grid of a geographic area will be complete geographically but not necessarily taxonomically or ecologically (Denis and Ruggiero, 1996). There could be three general levels of intensity in an inventory. A qualitative inventory will merely provide information about the presence or absence of a biodiversity element. A quantitative inventory will detail population sizes, frequency distribution, or coverage of an element of biodiversity. A relational inventory will combine either or both the above two inventories with an inventory of other biotic or abotic elements with a view to studying the factors affecting the distribution and abundance of a desired element of biodiversity.

Several considerations is known to influence a good inventory;

(i) The existing knowledge base on which the proposed inventory is to be commenced; the greater the existing knowledge, the better the inventory

(ii) The level of expertise of personnel and technical capabilities available; the sounder these are, the better the inventory. For example, a team having advanced facilities in remote sensing, field knowledge, optics, GIS, computing statistics and laboratory would definitely compile a better inventory than a team without these facilities

(iii) The level of funding; the larger the funding, the better the inventory

(iv) The purpose and intensity of inventory

(v) The presence of multiple performers contributing to a common network of data administration and analysis will promote greater success in the inventory

(vi) Lastly, the level of enthusiasm, dedication and commitment of the personnel and institutions involved in the inventory significantly determine its coverage (Dennis and Ruggiero, 1996).

Our knowledge about the diversity and distribution of plant species is indeed very poor and inadequate so that we still do not know exactly how many species exist on earth. Taxonomy is basic to other science and at the same time dependent on them. The existence and also the improvement of taxonomy depends entirely on the information from other disciplines, such as morphology, anatomy, embryology, cytology, genetics, ecology including forest ecology. As long as the plant world exists, there will always be more to learn about plants, plant products and plant taxa, for both practical and theoretical purposes (Chaudhari and Sarkar, 2002).

Forests

Within forest regions there are a great number of forest types and other natural ecosystems. It is critical to preserve these samples, which are sufficiently large to be re-perpetuating. Particularly important is the conservation of forests on fertile soils, because such forests are under the greatest pressure for conversion to agriculture and often supports ecosystem and species not found earlier. It is true that conserving forests does compete with other land uses but the extent of such competition is often exaggerated.

Plants in the wild are the soil builders and the true creators of food that can be passed indirectly from one plant to another or directly from plant to animal form, perhaps through several successions and finally back to the soil. In addition to being a factor in building soil, forests are of immense value in regulating stream flow and controlling erosion, providing cover and food for various wild animals, grazing for domestic herds and food commodities and recreation for man. Many of our denuded forest areas are now converted back to normal vegetation for timber and other MFP by converting them to protected areas with natural reproduction. Some of the lands are so badly eroded however, that artificial planting and a long and slow process of soil building must take place before they can reach again to a stage so as to produce same volume of forest products as earlier.

When a climax type of vegetation is disrupted as often it is, locally great changes follow. It makes no differences whether the changes are due to man or to the nature, the result is the same. Where climax forest is destroyed certain events follow in a more or less regular way a process known as succession. A fire sufficiently not enough to destroy the trees leaves a blackened scar on the landscape. However, the ground is soon clothed with vegetation and not a forest but mosses, ferns and annual flowering plants, the spores and seeds of which are light enough to be carried by the wind. Perennial herbs, shrubs and trees come in more slowly manner. The animal life as well as the plant growth shows stages in succession resulting from changes in composition, some species disappearing and others replacing them or the same species remaining but varying greatly in the proportional numbers present. Such changes are natural biological responses to alternation in vegetative cover whether as a result of natural events or man's efforts (Natiyal and Kaul, 1999).

The current decline in the world's biodiversity is largely the result of human activities, resulting in the habitat destruction of the life forms. Intensive assessment studies followed by urgent and decisive action are needed to conserve and maintain genes, species and ecosystems with a view to sustainable management and use of biological sources. All living things interact with their environment such that the one species is closely interacting to with others. Even a small change can have complex and unpredictable results. The loss of one species for example, could trigger an increase in other species, which use the same resources and same environment. The most serious aspect of the loss of biodiversity is the extinction of species. Communities can be degraded and resulting in the depletion of forest area, but as long as all of the original species survive (Kumar and Asija, 2001), the communities still have the potential to recover.

Sustainability

The most serious issue is habitat alteration due to land use changes involving massive reductions in natural vegetation. In forests where large areas have been cleared to provide fuel, wood and timber, natural regeneration may not occur because the human beings may have degraded seed sources. Thus, biodiversity conservation with sustainable development is a matter of immense concern in India and all over the world. Biodiversity is very much a cross- sectoral issue, and virtually all sectors have an interest in its conservation and the sustainable use of its components. Biological resources are renewable and with proper management can certainly support human needs indefinitely. These resources, and the diversity of the systems which support them, are therefore the essential foundation of sustainable development. No single nation can by itself ensure that biological resourses are managed to provide sustainable supplies of products, rather natural cooperation is required between all strata and various sectors, ranging from research to tourism. The conclusion of the Convention on Biological Diversity represents a first step in achieving this goal.

Sustainable development means improving and maintaining the well being of people and ecosystem. It entails integrating economic, social and environmental objectives. The present concepts centers around the facts that Biodiversity can be conserved through an alliance of local fringe people, but the context varies since some threats can be solved by communities themselves, while others are too potent for local people to meet without help and they can help conserve the ecosystem on which they depend. But to do so they must have enough basic education, concepts and confidence to protect the country's and their own interest and a data base of varied resources.

When conservationists began thinking of the biodiversity protection and sustainable development, they found the necessity to learn more about nature and about the people living in the vicinity, about how communities work and how decisions are made. The science of biological education, anthropology, politics and economics have to be known which lead to the creation of the new, synthetic, discipline of conservation. All protected areas should have a management plan to determine priorities, guide the allocation of resources, control all development activities and implement management actions. Such plan takes into account a wide range of biological, physical and social factors and the changing nature of ecosystem. Protected area management was primarily a biological challenge, while the present concept is that the management of wildlife and habitat is only a small part of the picture.

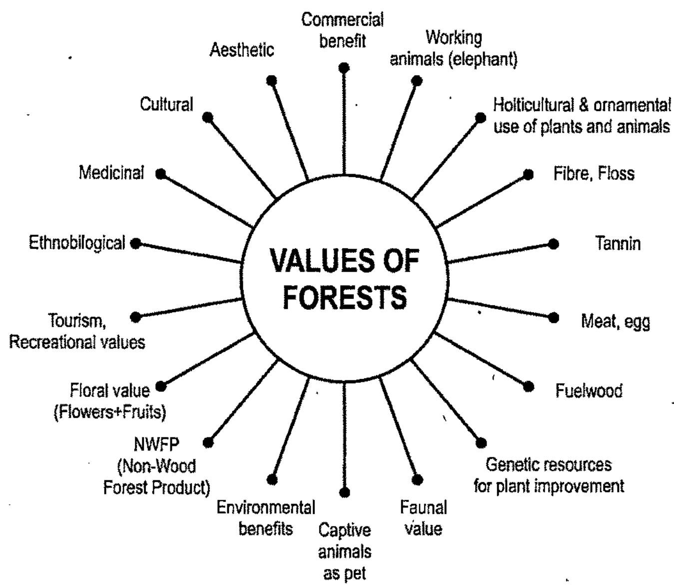

Fig. 3: Values of forest and benefits

It is agreed that challenging management task is finding the means to ensure that human behave in ways that are consistent with conservation objectives and that social science plays a much more prominent role in training of managers for protected area and that insights offered by economics, psychology, history, anthropology, political science and sociology be harnessed for the benefit of conservation. Conservation management of a site involves knowing what species and communities are present and also the understanding the ecology of the site, identifying management prescription and work program.

Plant Diversity

According to IUCN (1980) estimates, our planet earth supports about 5-10 million species of plants and animals. This has been the result of almost 3 billion years of evolution generating new species as well as extinction of others. Unlike most natural changes, human impacts are often directed at selected species and habitats. The present-day life forms probably constitute only about 1% of the total diversity and that within few decades we may well witness the elimination of another 1 million species. It is estimated that during last 100 years or so, at least 10% of the living forms have become extinct or are threatened or vulnerable.

Worldwide biodiversity

Out of the 1.4 million known species of living organisms only about 2, 50,000 are higher plants and 1.03 million are animals. According to another estimate, world-wide there are 2,70,000 known species of vascular plants (Table-1), which include ferns, algae, gymnosperms and flowering plants (IUCN, 1995).

Table-1: Estimated number of known species worldwide

Taxonomic Group	No. of Species
Bacteria	3600
Blue green algae	1700
Fungi	46983
Bryophytes	1700
Gymnosperms	750
Angiosperms	250000

Biodiversity in India

India is the seventh largest country of the world with an area of about 32, 67,500 sq kms. India ranks sixth among the 12 mega-biodiversity centers of the world, being home for an unusually large number of endemic species. It supports 15,000 species of flowering plants, 5000 of them exclusively providing shelter to 317 species of mammals. India is unique, not so much because of its numerical species but for the range of biodiversity attributable to a variety of biographically and physico-environmental situation. A characteristic feature of Indian forests is the presence of human inhabitation, people being dependent on the biological resources for their sustenance and livelihood.

Nature has endowed India with a rich biological diversity, which includes over 40,000 species of plants and 75,000 species of animals. India has about 12% of the global plant wealth. Amongst these are nearly 3000 tree species. However, nearly a third of the total plant species of India are endemic.

The angiosperms or flowering plants constitute an extremely diverse group of vascular plants. There are about 2, 35,000 to 3, 00,000 species (Gentry, 1996; Heywood, 1997a). Another 5, 00,000 species are estimate to be present on the Earth, awaiting discovery. Angiosperms are the most recent group of plants to evolve in geological history, having made their probable first appearance around 35 million years ago. But within a very short span of geological time, they have become the most dominant of all plant elements on the globe, probably because of their great evolutionary capabilities. Most of the food and other requirements for humans come from angiosperms. The plants range in size from 1 mm across (*Wolffia*) to over 100 meters tall (*Eucalyptus*). The flower can reach more than a 1-metre span in *Rafflesia arnoldi* growing in Summatra and Borneo.

The 2, 35,000 to 3, 00,000 species of flowering plants are grouped in about 17,000 genera under about 200-600 families depending on the classification system. Orchidaceae with 25,000 to 35,000 species and Leguminosae with about 15,000 species are the largest families among angiosperms. In fact, approximately 30 families account for almost 62% of the known angiosperms and 36 families are unispecific (for example Adoxaceae).

Floral Diversity in India

Indian flora is extremely varied in extent, composition and endemism. In India there are over 30,000 species of higher plants. There are over 600 species of pteridophytes including ferns (Table-2). Of the higher plants, there are 11,124 species of dicots with 1,831 genera. The family Orchidaceae is the largest family of flowering plants, contributing nearly 1,700 plant species.

Table-2: Estimated number of plant species in India

Taxon	No. of Species	Percentage
Bacteria	850	1.87
Fungi	23,000	50.79
Algae	2500	5.52
Bryophytes	2.843	6.2
Pteridophytes	1022	2.25
Gymnosperms	0.64	0.14
Angiosperms	15000	33.1
Total	45,279	100

Most of the plant species in India are found in the forest areas, which occupy nearly 20% of the total geographical area of the country. The forests belonging to various categories are found distributed all over India depending upon the geographical condition.

Plant diversity of Gujarat

Gujarat is situated in the central – western part of India between 20 and 25 north latitudes and 68 and 75 east latitudes with an area of 1,96,020 sq kms and 1,600 km long coastline. Gujarat has a variety of climatic and edaphic conditions. In spite of a continuous onslaught on the biological resources, the overall range of biodiversity of Gujarat is still unmatched. Gujarat has varied natural ecosystems due to different environmental conditions. The Gujarat flora represents nearly 13% of the flora of our country.

The state of Gujarat though covers about 19.6 million km^2 but accounts for about 6.5% of the total geographical area of our country. Four out of ten biogeographic regions of the country-the highest among all states- are present in the Gujarat state and thus supporting a diversity of ecosystems. This state also has a large population of tribals who are still dependent on the natural biological resources for their livelihood.

Justification for present study

Floral wealth is one of the vital part/aspect of biodiversity. This is well supported by article 7 of the CBD (Rio-de-Janeiro, 1992). This states that there should be proper identification and monitoring of biological diversity (Floral diversity). India is one of the 12 mega biodiversity countries; within the country the state of Gujarat holds unique position in terms of biological richness. These include various agro climatic zones, forest types, diverse fauna and flora. Gujarat is situated in the Central-Western part of India, with the longest coastline in the country. The Eastern hilly region is formed by Southern, Western and Northem extensions of Aravalli, Satpura and Sahyadri (Western Ghat) mountain ranges respectively. The broad spectrum of the eco-climate is defined by rainfall varying from 250 mm in South-east parts and minimum in Kutch. Gujarat State can be divided into four major biogeographic zones viz Semi arid, Deserts, Western Ghat Mountains and Mangrove rich Costal belts. These four zones support a wide range of flora covering 2200 species of plants (Anonymous, 1996). However, the current state of angiospermic plant species from Gujarat is 2205 (Singh and Parabia, 2003). The state has extensive protected area network comprising of 21 Wildlife Sanctuaries and 4 National Park with one proposed Biosphere Reserves- Rann of Kachchh.

Various reports on flora of Saurashtra has been published from time to time like Jaykrishna Indraji (1910), Kapadia (1950), Santapau and Raizada (1954), Santapau and Janardhanan (1966) including Bole and Pathak (1988). The Gir National Park and Sanctuary was explored by many workers before its declaration as Gir National

Park and Sanctuary. After the declaration of the area as Gir National Park and Sanctuary there has been an extensive survey done in the area with reference to the wildlife but very little work has been done on the floristic and ecological studies. The present study was undertaken for vegetation, floristic components and ecological studies of the area. The present study therefore was undertaken with following objectives.

1. The vegetational aspects of the entire Gir National Park and Sanctuary
2. Generating the complete exhausted list of plants occurring in GNPS (Plant Inventory)
3. The major components of vegetation (floristic elements) with respect to their the phenology and description of enumerated plants of GNPS
4. Dominant angiospermic families which form the major part of the vegetation in GNPS
5. Floristic elements which show restricted distribution in GNPS
6. Different anthropogenic pressure in the areaGNPS
7. Ecological studies of different life forms (tree, shrubs, herbs, climbers and grasses) in terms of frequency, abundance, density and diversity indices
8. Preparation of area wise flora (Temple and Tourist places) in GNPS
9. Comparison of the plant inventory with past records
10. Preparation of the list of plants which are used in different ways (medicinal, ornamental, weed, browsable and palatable species) in GNPS
11. Management suggestions for GNPS based on the present study

Keeping all the above mentioned objective in mind the entire Gir national Park and Sanctuary (GNPS) was surveyed during November 1999 to November 2003.