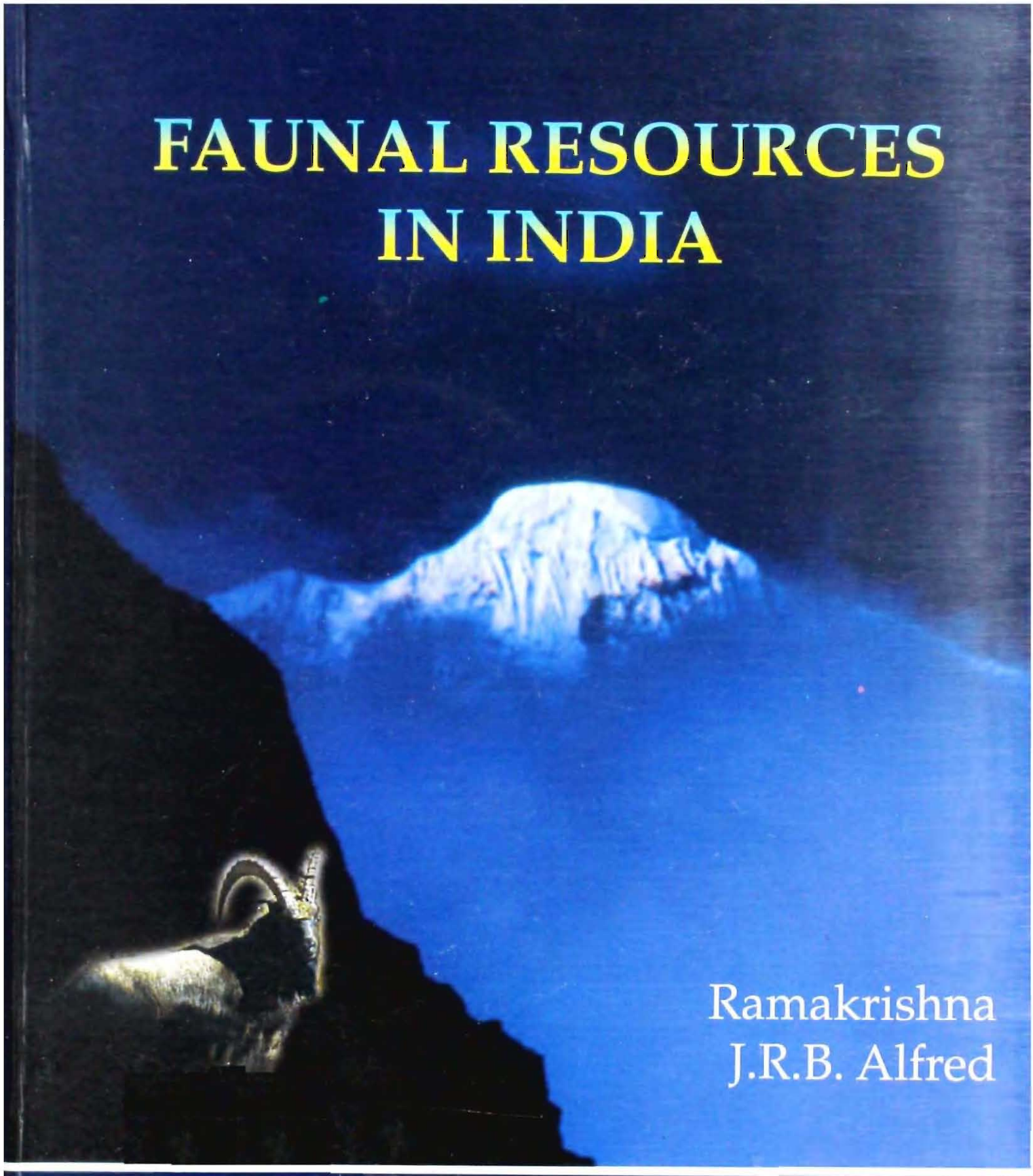
FAUNAL RESOURCES IN INDIA



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FAUNAL RESOURCES IN INDIA

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PREFACE

The biological resources are the physical manifestation of globe's biological diversity, which simply stated as the variety and variability among living organisms and ecological complexes in which they occur (Mc Neely, 1988). Our planet's greatest resource is contained in natural forests, plains, mountains, wetlands and marine habitats. And the species are the primary focus of evolutionary mechanisms, and the origination and extinction of species are the principal agents in governing biological diversity in most senses in which the latter can be defined. Therefore, the ultimate task of taxonomists in to document and understand the extent and significance of biological diversity (Groombridge, 1992). This involves field explorations leading to the collection of museum specimens, involving the process of identifying, cataloguing and adding base line information to the database of faunal resources. Thus the documentation of biological diversity calls for an understanding of the distribution of different species and their assemblages in different ecological habitats.

India's immense biological diversity encompasses ecosystems, populations, species and their genetic make-up. This diversity can be attributed to the vast variety in physiographic and climatic situations resulting in a diversity of ecological habitats ranging from tropical, subtropical, temperate, alpine to desert. Documentation of faunal resource of a country therefore, focuses on developing 'indicators' to be used in the assessment which are reflected in combination of ecological fundamentals, such as biodiversity, critical habitat and key ecological relationships; site-specific considerations, environmental stress and potential impacts.

The Zoological Survey of India was established on 1st July 1916 to promote survey, exploration and research leading to the advancement of knowledge on the faunal resources of the country. Besides publication of Fauna of India, Fauna of States and several other publications since its inception, an attempt was first made before the commencement of CBD in the form of publication on *Animal Resources of India* during 1991, followed by the publication of *Faunal Diversity in India* (1998) by Zoological Survey of India. The books on *Collection, Preservation and Identification* of various group of animals published by the department has given us an impetus to further elaborate the scope of need to conduct carefully designed cost-efficient surveys that yield the greatest potential future use of data. The present book is next in the series focusing on the importance of taxonomic nomenclature and its regulation, species concept, role of natural history museums followed by the species inventory and diversity in different ecological conditions. An attempt has also been made to assess the economic value of the taxon at different levels and the

conservation efforts initiated to sustain the biodiversity against the anthropogenic influences. The glossary at the end will help in understanding the terminologies employed while compiling the book.

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CHAPTER–1

INTRODUCTION

Classical taxonomy with the conservative outlook is yet to assimilate the modern trends in taxonomy. It appears to the beginners as a monotonous and less interesting subject without any applied value. The elaborate description, lengthy synonomy and specimen citation are helpful only to taxonomists. According to Mayr (1969) "If taxonomy remains circumscribed with the domain of identification of dead specimens without considering the mode and manner of life and living, the very charm of studying biology is lost" In fact, the taxonomy has been a core subject in identifying the biodiversity conservation component, agricultural pests, pollinators, diseases, as well management of commercial species including fish, crabs, lobsters, pearls and many more. Recently, it is gaining its importance in improving productivity by applying biotechnological tools and identifying the bioactive components (bioprospecting), identification of alien species, quarantine laboratories and biological warfare. Therefore, the trained field taxonomists who have genuine interest in understanding the faunal associations should compare with the museum based specimens and attempt to evaluate the conservation oriented, public oriented and consumer oriented fauna. The taxonomists should also understand the size, structure and number of populations under a given species in the areas of exploration.

The need for the conservation of biological resources and biodiversity assessment has increased during the last few years; taxonomic studies are being encouraged now. If taxonomy has to flourish and fulfill the needs of the society, there is an urgent need to generate more manpower to handle the increasing pressure on taxonomists. Training of taxonomists and increasing the number of taxonomists is the priority agenda of the present century. Therefore, the need of the hour is the taxonomic understanding of the alternate sources of food, energy, drug, industrial raw materials, genetic resources, wild variety of animals for conservation and utilisation in breeding programmes, in view of habitat loss and fast depleting biological resources. The rich resources present in a few pockets such as hotspots are to be surveyed and inventorisation of the faunal components are to be taken up.

The origin of the word taxonomy dates back to 1813 by de Candolle, however, has its root in Greek "taxis" meaning "arrangements" and "nomos" meaning "law", where as the Systematics also has its origin in Greek but dates back to the time of Linnaeus (1735), 'Systema' meaning to systems of classification. It is universally agreed that " *Systematics*" includes the formal technical classification of animals. Simpson (1961) considers "*systematics as the scientific study of the kinds and diversity of organisms and of any and all relationships among them*" He further adds that the classification of organisms is an activity that belongs exclusively to systematics, but exclusive relationship does not warrant equation of the

two. *Taxonomy is the theoratical study of classificaiton, including its bases, principles, procedures and rules.* With the inclusion of all biological sciences such as comparative anatomy, physiology, cytology, biochemistry, ethology, biogeography, ecology, and the study of relationships among various orgnanisms in systematics, the scope of zoological classification has increased. Therefore, according to Simpson (1961), the zoological classification is the ordering of the animals into groups on the basis of their relationships, that is, of associations by contiguity, similarity or both. In contrast to Simpson's definition, Abbot, Brisby and Rogers (1985) and Hawksworth and Brisby (1988) regard the products of taxonomy as "a taxonomic information system comprising classification, nomenclature, description and identification aids" where as the systematics "is the taxonomy plus the biological interrelations–breeding systems, genetics, phylogeny and evolutionary processes, biogeography and synecology" Therefore, often the "systematics" and "taxonomy" are equated or synonymous. According to Minelli (1993), it is not a matter of dispute about the confines of the academic provinces but identifying the targets worth considering and problems worth solving. Further, this should result in improving knowledge and communication of results. Clasification of animals at all levels is only one of the functions of taxonomy. The other and more important function is to define animal populations in relation to ecological, genetic and non-morphological characters and to correlate these data with evolutionary processes.

Animal taxonomy is one of the earliest of all zoological disciplines and started as "Folk Taxonomy" to differentiate between economic plants and animals around the human settlement. The earliest available works on the classification of animals were by Indians, since it was written in sanskrit, these remained unknown to the western biographers and historians (Sinha and Shankaranarayan, 1955). Mention may be made of Charaka (600 BC), the father of Oriental medicine, who was the first to classify animals into four major groups viz., Jarayuja (Born from the uterus of mammals) 2. Andayuja (From eggs eg. Fishes, Reptiles and Birds) 3. Svedaja (Born of moisture and heat eg. Worms and Mosquitoes) and 4. Udvija (Born of vegetable matter). Prasasthapada (500 BC) also classified animals into Sexual forms and Asexual forms (Kapoor, 1998). A good beginnng was made by Aristotle (384–322 BC) not only in Taxonomy but also in the field of anatomy, ecology & embryology, who erected orders like Coleoptera, Diptera and Lepidoptera (Psychae). Aristotelian taxonomy proceeds by logical subdivision, in which member of a pair of taxa is characterised respectively, by the presence or absence of a chosen feature. He may thus be considered as "Father of biological classification". Jhon Ray (1627-1705) in his systematic work " *Synopsis Methodica animalium Quadrepede - dum et. Serpentine Generis*" (1663) divided the animals into those with blood and those without blood, the former was again divided into gill & lung breathing animals. Infact the contemporary naturalists attempts to arrange animals in a single grade, ***Scala naturae*** on the suggestion of Aristotle, who believed that there was an inharent tendency among the organisms in nature to attain greater and greater perfection with corresponding changes in environment, which ultimately resulted in perfect gradation from lower to higher categories of animals. This gave rise to the idea of evolutionary thinking.

During the later part of 16th and in 17th centuries, more and more biological materials were collected and brought through voyages and collection trips from all over the globe. Several herbaria and museums were established in Europe; this provided an opportunity to scientists to evaluate and to understand taxa as the units of natural system. Carl Linnaeus published first volume of 11 pages in 1735 and introduced the hierarchical system of classification both in plants and animals. In 1758, Linnaeus published *"Systema Naturae"*, propounding the concept of binomial nomenclature. According to the International Code of Zoological Nomenclature, it is considered as the starting point of the zoological nomenclature, as he emphasized the usage of hierarchal categories such as species, genera, family, order and class.

The publication of "Origin of Species" by Charles Darwin in 1859 led to the theory of classification based on evolutionary relationships between different groups. The similarities based on the homologous structure related to the common ancestry and dissimilarities based on the analogous structure are the result of adaptation and convergent evolution. The idea of common descent of various animals provided meaningful theoretical interpretations to taxonomic work. Darwin-Wallace Theory (1859)–*Origin of Species through Natural Selection*–was supported by Lamarck (1744-1829) on the basis of evolutionary thought and Cuvier (1769-1832) based on the anatomical features and extinct fossil types. The drawback of Darwin in explaining the inherited variation leading to speciation was overcome by Mendel (1822-1884), through his controlled experiments and cross breeding on garden pea, leading to the discovery of principles of heridity. These principles formed the basis for evolutionary and biological classification.

Taxonomists confined their studies mainly on the morphological characters, ignoring the intraspecific variations and most of their descriptions were based on single "Type" specimens. Michael Adanson (1727-1806) believed that the classification could not be based on single or even a few characters and believed in the comparison of many characters. Haeckel (1834-1919) introduced the phylogenetic tree based on embryonic development and propounded the theory *"Ontogeny recapitulates the Phylogeny"*; this was in close resemblence to the Von Baer's Law–*"Younger the embryo, more closely it resembles the embryos in same stage of development"*

The concept of "New Systematics" was introduced by Huxley (1940) and Mayr (1942) to express that the species are a group of interbreeding populations in nature which are reproductively isolated from other such populations, thus creating yet another subject *viz.*, Population taxonomy. The new systematics led to the re-evaluation of the species concept from the biological point of view. It may be said that the new systematics is not a substitute for the classical taxonomy but only complimentary to it. Therefore, taxonomists are forced to believe that all organisms occur in nature as members of populations and these cannot be studied and properly classified unless they are treated as samples of natural populations. This made the taxonomists to realise the importance of other characters to supplement the morphological characters for sound classification, commonly known as Biological Taxonomy. Peter Raven (1974) summarises "Perhaps the most important

discovery of the past 25 years has been the realisation that biosystematic study DO NOT LEAD to an unequivocal definition of taxonomic categories–genera, species, subspecies; they contribute to our understanding of the populations and processes by which they have changed but donot DICTATE the taxonomic decisions that have to be taken in the light of this information"

PRESENT SCENARIO

The number of animal species known from the surface of the earth is far from complete, and nearly 1.75 million species are described and about 70 per cent of them come from tropical countries. The need for a holistic information on all faunal groups is of prime importance but, the number of taxonomists throughout the world has drastically declined (vanishing tribe). Similarly, the challenge of completing the explorations and inventorisation still to achieve its goal. Secondly, there is already tons of biodiversity information available on the Internet, but it is absolutely chaotic. One of the major efforts during these years is the plan based on the existing information to create a comprehensive and uniform index of all known species together with linked catalogues of the species databases through Global Taxonomic Initiative. This will aim to complete and link together databases for roughly 1.75 million described species of plants and animals including microorganisms. The effort is of particular value in helping the Governments and countries which are signatories of CBD with the intention of fulfilling commitments to take stock of and conserve their biological resources.

CHAPTER–2

ZOOLOGICAL NOMENCLATURE

The earth is estimated to harbour as many as 30 million kinds (species) of animals of which about 1.75 million have been described and classified by Zoologists (IUCN, 2004). New species are described at a rate of about 5000 per year. The scientific process of identifying, describing, classifying and naming is zoological taxonomy, which is an essential component of zoological SYSTEMATICS that deals with the study of the diversity, origin and relationship of animals. With about 28.25 million species of animals yet to be described and known, our gap in taxonomic knowledge really matters particularly in view of the global environmental changes and degradation that have been going on for the past 40 years or so. The natural habitats and ecosystems are being reduced, replaced or modified to such an extent that the remaining areas can no longer support their former biological diversity. This means a global loss of genetic diversity including the large-scale extinction of species, a great majority of which even before we get a chance to know. It is now well realized that any significant reduction in the biodiversity has its consequences on human population ranging from the loss of potential disease - curing drug to population explosion of pests when predators are reduced or lost. We have sufficient evidence by now to illustrate that if the extinction rate increases, changes to the earth's environments can be very significant enough to be harmful to human populations. The primary step in evaluating the consequences of the changes that man is bringing about in his environment is to document the nature of such changes which include changes in the diversity, distribution and composition of animal and plant communities. Identifying and compiling as complete an inventory as possible of the world's animal and plant species is the basic work involved in the process of such documentation. Thus, taxonomy is not only man's natural pursuit for knowledge but also an essential science to understand many processes in evolutionary biology, more importantly; it is also an applied science basic to the human welfare. Taxonomy is the basis for all meaningful research in biology and it is absolutely essential to know the name of an organism before undertaking any kind of research on it. It has great relevance in various areas of research including biodiversity, conservation, ecology, agriculture, fisheries, medicine etc. In classification and naming, a taxonomist employs a variety of methodologies. However, in all these methodologies, the basic tools of the taxonomist's job are attributes of the organism that he studies such as its structural features, external and internal morphology etc.

Names are a means of reference to all living and non living things while nomenclature (*nomen* - name, *calore* -to call) refers to allocation of names to all taxa. Common names of animals vary from place to place; however, the scientific names are uniform and universal. Therefore, the scientific names should be unambiguous and stable since they serve as the only means of reference thereby avoiding the need of continuous usage of descriptive

phrases. For uniformity and consistency, the scientific names are binomial, *i.e.*, having a generic and specific name. For those forms which have varieties and forms, the names are trinomial i.e., generic name, specific name, and name of variety or form.

Names are given to animals according to a set of rules or codes. It was Linnaeus who first proposed a set of rules for generic names of plants in his *Critica Botanica* (1737) and *Fundamenta Botancia* (1736). This was improved upon by Fabricius (1778) in his *Philosophica Entomologica,* for naming insects. The first set of rules for nomenclature of plants was drafted by A. De Condolle and passed by the *International Botanical Congress* at Paris in 1867. The British Association for the Advancement of Science, under the leadership of H.E. Strickland in June, 1843 adopted the *"Stricklandian code"* for animal nomenclature. Its official title was "Series of Propositions for Rendering the Nomenclature of Zoology, Uniform and Permanent " This Stricklandian code was universally accepted, and formed the basis for other codes approved subsequently. However, Dall's code framed by the W.H. Dall (1877) at American Association for the Advancement of Science; French code (in 1881), Douville code (1881) for the nomenclature of fossils; American Ornithologist's Union code (1885); German code (1893), etc. instead of solving problems, created more confusion in animal taxonomy.

During the last hundred years the application and practice of the rules necessitated many clarifications, recommendations, explanatory notes and even changes as and when needed. The first one in this direction was the presentation of a set of rules at International Congress of Zoology held in Paris in 1889, which was accepted later in 1892 at Moscow, during the Second Congress. The Third International Congress held at Leiden in 1895 disapproved these rules and appointed a Commission to provide a uniform system of zoological nomenclature. Finally, on 11th January 1961, a revised draft prepared was approved by the Commission and voted as *"International Code of Zoological Nomenclature"* Even this code was subjected to minor revisions as a result of amendments made by the XVI International Congress of Zoology, held in Washington in 1963. The XVII International Congress of Zoology held at Monaco (1972) took decisions to amend the 1961 code. This code was further subjected to revisions and alterations by way of amendments and the entire responsibility of framing the codes was shifted to the International Union of Biological Sciences (IUBS). The XVIII General Assembly of IUBS held at Norway in 1973, appointed a commission to revise the *Code* and the draft paper was circulated incorporating the amendments. The final text of the third edition, with the authority of IUBS was approved in 1983. The editorial committee of the 4th edition, met in Vicenza (Italy) in June 1996, considered every article of the draft and in the meeting of ICZN held on August 1996 at Budapest, Hungary approved it. The 4th edition came into effect in January 1999.

PRINCIPLES

The code, *"International Code of Zoological Nomenclature,"* (ICZN) has certain principles, rules and recommendations adopted by the International Congress of Zoology, since

1973. The general principles of nomenclature have the following features :

- Promotes maximum stability and universality in the scientific names of animals
- Ensures that each name is unique, distinct, and unambiguous
- Zoological nomenclature is independent of botanical nomenclature
- The application of names of taxonomic groups is determined by means of nomenclature types
- The nomenclature of taxonomic group is based on the principles of priority
- Each taxonomic group with a particular circumscription, position and rank can bear only one correct scientific name, in accordance with the rules.
- Precision and consistency in the use of terms are essential to a code
- Scientific names of taxonomic groups are treated as *Latin* regardless of their derivation
- The Code provides guidance for zoologists while establishing new names and rules to determine whether any name, previously proposed, is available and with what priority, whether the name requires amendment for its correct use etc.
- The Code also provides for its interpretation and administration, when necessary, by prescribing the establishment and operation of the international commission on zoological nomenclature and the conditions under which the code may be amended
- Problems in nomenclature are decided through the application of the code, and never by reference to precedent.
- The code refrains from infringing upon taxonomic judgement, which must not be made subject to regulation or restraint

THE RULES OF NOMENCLATURE

The rules provide detailed provisions of the system, and are laid down in 88 articles of the International Code of Zoological Nomenclature and by the Division of Zoology of the International Union of Biological Sciences. Names contrary to rules are considered illegitimate and cannot be maintained. The articles are discussed in the following paragraphs.

Article 1. relates to the definition and scope–Zoological Nomenclature is the system of scientific names applied to taxonomic units of animals known to occur in nature, whether extinct or extant. The Code regulates the names of the taxa in the family, genus and species. The article also provides provisions of exclusions, independence and collective groups and ichnotaxa.

Article 2. relates to the eligibility of certain names in zoological nomenclature.

Article 3. relates to the starting point and accordingly, January 1, 1758 is arbitarily fixed in the code as the date of starting point of zoological nomenclature. Two works are deemed to have been published on that date viz., Linnaeus's *Systema Naturae*, (10th edition) and Clerck's *Aranei Svecici.*

Article 4. relates to the names of taxa of ranks above the species. The scientific names of a taxon of higher rank than that of a species is always Uninominal. Similarly, the scientific name of subgenus, although uninominal, must not be used as the first name in binomen or trinomen.

Article 5. relates to the names of taxa of ranks in the species group (principles of binominal nomenclature). The scientific name of a species, and not of a taxon of any other rank, is a combination of two names (binomen), the first being the generic name and the second, the specific name. The scientific name of a sub species is a combination of three names (trinomen).

Article 6. relates to interpolated names i.e., names of subgenera, names of aggregates of species or subspecies.

Article 7. relates to application of publication of new names or nomenclatural act likely to affect nomenclature.

Article 8. relates to the Publication. A work is regarded as published, if it meets the following criteria a) Should be published in a scientific record b) Easily accessible c) Produced in editions containing simultaneously obtainable copies. The article also gives guidelines for the work published prior to 1986, published after 1985 and the responsibilities of the authors.

Article 9. relates to what does not constitute a publication. Under this code the following are not considered as Publications :

(1) After 1930 hand written works reproduced by mechanical or graphic processess

(2) Photographs, photocopies, microfilms, proof sheets, computer printouts, acoustic recordings

(3) Those distributed to only colleagues or students and

(4) Labels of a specimen, those mentioned at a meeting or deposit of a document or thesis in a library or other archives.

(5) Recently on December, 1999, the ICZN felt that scientific communication should not be published in aquarium literature which is difficult to obtain, and which is sometimes in a local language difficult to understand for the majority of interested researchers.

Article 10. relates to the general provisions. A name or nomenclatural act is available, and takes authorship and date only or, when it has satisfied the provisions of the article

10–20. If the nomenclatural act is interrupted and continued at a later date, nomenclatural act becomes available only when it satisfies all relavent provisions. A name once available remains so irrespective of its invalidity as a junior synonym, a junior homonym, unjust emendation or unjustified replacement of name.

Article 11. relates to the requirements such as publication and date, language (Latinized word or uses the Latin alphabet), application of binominal nomenclature, valid name, a junior synonym, family – group names, genus – group names, species group names etc.

Article 12. relates to the names that are published before 1931.

Article 13. relates to the names that are published after 1930.

Article 14. relates to the anonymous publications.

Article 15. relates to the conditional proposals of scientific name.

Article 16. relates to the names proposed with the terms "variety" and "form" after 1960 as infrasubspecific and excluded from the zoological nomenclature; however, such proposal before 1961 does not prevent availability.

Article 17. relates to the availability of a name that is not affected, if it is found that the original description relates to more than one taxon or to an animal later found to be a hybrid or proposed for parts of animals. The name is also not affected, for an animal of one sex, or in one stage in the life history, or in one of several dissimilar generations, or one form of polymorphic species.

Article 18. relates to the inappropriate and tautonymous names i.e. usage of names such as *polydon, apus, albus, sinensis,* specific names such as *bison,* in *Bison bison, apus* in *Apus apus* that are not to be rejected.

Article 19. relates to the status of emendations, incorrect spellings and mandatory changes. In the meaning of the Code or an emendation whether justified or unjustified is an available name, provided that it meets the other requirements for availability, but an incorrect spelling, whether original or subsequent, is not.

Article 20. relates to the name applied only to the fossils and formed by adding *-ites, -ytes,* or *ithes* to the stem of an available genus-group name, but without clear evidence of proposal of a new genus - group taxon. Such an available genus-group name is used for the purpose of the Principles of Homonomy but not for the Principles of Priority, or for the formation of a family group name.

Article 21. relates to the determination of date to be adopted in a publication. The effective date of publication is the date on which the author describes in the form of a printed material and the matter is made available to the public through a journal or its distribution to the libraries.

Article 22. relates to the citation of the date of publication and that a name is optional, if cited, to be followed by the name of the author.

Article 23. relates to the Principle of Priority. The valid name of taxon is the oldest available name applied to it, provided that the name is not invalidated by any provision of the Code or by any ruling of the commission. The correct name of the taxon is the earliest validly published name of the taxon. The validity of the taxon is decided by the *rule of priority, i.e.,* the valid name of the taxon is the oldest available name with certain exceptions such as the name conserved by the commission or the *nomen oblitum* (forgotten name or the limitations associated with the change of rank).

NEW NAMES

New names become necessary for the following : i. To a new taxa (when a new taxonomic group such as family, genus or a species is founded) ii. When it is realised that an existing name of the animal is in contravention of the rules and is illegitimate and a new name becomes necessary iii. After careful revisionary studies of the species, when it is felt that the species should be removed from one genus to another, a new name becomes a necessity iv. When a taxon is referred at different times by different names, and it is difficult to decide with certainity as to which name should really be applied to this taxon or a name given to a taxon having ambiguity about its legitamacy and it's application. To end this confusion a new name is given.

A zoologist before publishing new names should observe the following principles which form the *Code of Ethics,* which is included in the form of Appendix - A of the code :

1. A zoologist should not himself establish a new taxon if he has reasons to believe that another zoologist has already recognised the same taxon and is in the point of establishing it.
2. A zoologist should not publish a new replacement name for a junior homonym during the lifetime of its author without informing him giving a reasonable time.
3. A zoologist should not propose a name that, to his knowledge, gives offence on any grounds.
4. A new genus or species name should be short and euphonious in latin.
5. A word already in use above the family level should not be used a new genus or species group name.
6. A zoologist should not publish a new species-group name identical with one already in use in a closely related genus or that differs from such a name only in its termination or small differences in spelling.
7. A zoologist should not base a new species - group name on personal or geographical name derived from the same words.
8. The word *typus* and *typicus* should not be used as new names.
9. In forming a compound name, a zoologist should not use components of which one is *greek* and the other in *latin.*

10. The prefix *sub-*, *pseudo-* and the suffix *-ides* and *-oides* should be used only with the Greek or Latin nouns.

11. The use of personal names in the formation of compound genus-group names is objectionable.

12. Preference should be given to the usage of genetive singular case ending *-i* in preference to the termination of *-ii.* (*smithi* instead of *smithii*).

Article 24. relates to the principles of the first revisor. If two or more different or identical names or nomenclatural acts are published on the same date, in the same or different works, by same or different authors based on same or different types and when they are subsequently considered to be synonyms or homonyms, the relative precedence is determined by the first revisor. The article also relates to the original spellings i.e., the spelling chosen by the first revisor as the correct original spelling.

Article 25. relates to the formation and treatment of names. A scientific name must be formed in accordance with the relavent provisions of the article - 11 and articles 26-34.

Article 26. relates to the assumption of greek or latin for treatment of names.

Article 27. relates to the diacritic or other marks (use of apostrophe or hypehn is regulated by article 31(d).).

Article 28 relates to the initial letters - family or genus - group name must be printed with a capital letter and a species - group name with a lower case - initial letter, regardless of how they were originally written.

Article 29. relates to the formation of family - group names. The Zoological Code stipulates standardised endings for the names of the superfamily (- *oidea*), family (*-idae*), subfamily (*-inae*), tribe (- *ini* and rarely subtribe (- *ina*). The names of the species is always binomial (binominal nomenclature) and those of subspecies are trinomial. The presence of subgenus does not affect the status of nomenclature.

Article 30. relates to the gender of genus - group names. i.*e.*, ending in Greek or Latin words take the gender given for that word in the standard Greek or Latin dictionaries unless the commission rules othewise. A genus-group name that reproduces exactly a noun in modern Indo-European language having genders takes the gender of that noun. Gender of names that are not Greek, Latin or modern Ino- European, takes the gender expressly attributed by its author. If no gender was attributed, the name is to be treated as masculine.

Article 31. relates to the species - group names. If species - group name is a noun in the genitive case formed directly from a modern personal name or from Latin, it is to be formed in accordance with the rules of the Latin grammer or formed by adding to the stem of that name *-i*, if the personal name is that of a man, *-orum* if of men or of man and woman(women) together, *ae* if of a woman, and *-arum* if of women (under this provision the names of *podai* from Poda, *victori* from Victor and *cuveri* from Cuvier).

Article 32. relates to the original spelling. In terms of the Code, the original spelling of a name is the spelling used in the work in which the name is established. Correct original spelling is to be preserved unaltered. An original spelling is an "incorrect original spelling" if it contravenes the provision of the articles 27-31 or if an inadvertent error has crept in (*lapses calami*). Printer's error is not to be considered inadvertent. Correction of incorrect original spellings is to be made, if it has no separate availability in the original form and can not in that form enter into homonomy or to be used as a replacement name.

Article 33. relates to the subsequent spellings. Any intentional change of the original spelling of a name other than the mandatory change is an emendation. Justified emendation is the correction made in accordance with the provision of the article 32. Any other emendation is an "unjustified emendation"; the name thus emended has status in nomenclature with its own date and author, and is a junior objective synonym of the name in its original form.

Article 34. relates to the mandatory changes in the spelling consequent upon changes in rank or combination. The suffix of a family - group name must be changed when the taxon bearing the name is raised or lowered in rank.

Article 35. relates to the family group, which includes all taxa at the rank of superfamily, family, subfamily, tribe and any other rank below superfamily and above genus.

Article 36. relates to the principles of coordination. A name established for a taxon at any rank in the family - group is deemed to be simultaneously established with the same author and date for the taxa based on the same name bearing type-genus at other ranks in the family group, with appropriate mandatory change of suffix. Further, when a nominal taxon is raised or lowered in rank in the family - group, its type genus remains same.

Article 37. relates to the nominotypical taxa or subordinate taxa. When a family - group taxon is subdivided, the subordinate taxon that contains the type genus of the superior taxon bears the same name, except for suffix with the same author and date.

Article 38 and 39 relates to the Homonymy (dealt with Articles- 53 and 55) in family-group and type genus respectively.

Article 40. relates to the synonomy of the type genus. When a generic name on which a valid family group name is based is rejected as a junior synonym, that family group name is not to be replaced, if this happens to be after 1960. If a family group name is replaced before 1961 because of generic synonomy, the replacement name (*nomen novum*) has won general acceptance.

Article 41. relates to the misidentified type genera and overlooked type fixation. If the stability and continuity of a family group is threatenned by the misidentification of a type species or by overlooked type fixation, the case is to be referred to the commission.

Article 42. relates to the genus group which is next below the family group and next above the species group, includes genus and subgenus and the name is determined by the type species and in accordance with the provisions of Articles 10,11, and 25-33.

Article 43 deals with the principles of coordination and the date corresponding to the establishment of species applies to the genus also.

Article 44 deals with the nominotypical genus.

Article 45. relates to the species group, which includes taxa at the rank of species and subspecies. The application of names, formation, treatment and infrasubspecific names are all in accordance with the provisions of various articles of the code. The zoological code does not recognise the names of the taxa of infrasubspecific rank *i.e,* a scientific name proposed expressly as the name of a "variety" or "form" after 1960 is excluded from zoological nomenclature (Article 1b (5); Article-16, but those designated before 1961, these are regarded as subspecific names (Article 45 g).

Article 46. relates to the principles of coordianation.

Article 47 deals with the nominotypical taxa.

Article 48. relates to the transfer of species from one genus to another.

Article 49 deals with the use of species - group names wrongly applied through misidentification or doubtful identification (*"species inquirenda"*).

Article 50. relates to the authorship. The author of a name is the person who first publishes in a periodical or made available in the minutes of the meeting and if the identity of an author cannot be determined from the contents of the publication, then the author is deemed to be anonymous. Change in the rank of a taxon shall not affect the authorship (refer Article – 24).

Article 51. refers to the citation of name of author. The name of the author does not form part of the name of a taxon and its citation is optional, and if cited, follows the name of the taxon without intervening mark of punctuation. If the species name is combined with the generic name other than the original one, the name of the author of the species group name, if cited, is to be enclosed in the parenthesis.

Article 52-60. refers to the principles of homonymy. Homonymy refers to the availability of two or more names having the same spelling denoting different nominal taxa in the genus - group (Article - 56) or species - group (Article - 57) either originally (primary homonym , Article - 53) or subsequently (secondary homonym Article - 59). International code of zoological nomenclature stipulates when two or more homonyms are found, the senior homonym is used while the junior homonym is excluded from use (Article - 60). This may occur when identical names based on different types are used at the same rank, eg., subspecies in a species, species in a genus etc. Article - 58 stipulates species - group names established for different nominal taxa that differ in spelling only in any of the respects mentioned here, and which are of the same origin and meaning are deemed to be homonyms e.g., use of *ae, oe or e;* use of *ei, i, or y;* presence or absence of *c* before *t;* use of single or double consonants; use of *f* for *ph;* presence or absence of *i* before suffix.

Article 61 – 75 refers to the Type Concept in Nomenclature.

TYPE CONCEPT

The Principles and Articles of the *International Code of Zoological Nomenclature* provide that all taxonomic groups will be based on the *nomen-clatural types*. This is generally known as "Typification" This indicates that all names are permanently attached with some taxon or specimen designated as Type. For species, type is the specimen on which species (variety or form) was based and originally described. The first name given to the species (variety or form) by the founding author is permanently attached. The type once designated cannnot be changed, not even by the original author except by the plenary powers of the Commission (Article - 79), through the designation of a Neotype (Article - 75). Neotypes are designated by an author, if no holotypes, lectotypes, syntypes or prior neotype is believed to exist (Article - 75).

Concept of Type was different during Linnaen era, as he never designated any specimen as type (*pre Linnean name*). Further to this, he substituted the old specimens by the new and better ones. Therefore, Linnean types were never regarded as reliable. Names of taxa above species *viz.* Subgenus, genus, tribe, family are based on the name of that immediate lower taxon on which that group was originally based. The **International Congress of** Zoology held in Boston in 1947 for the first time provided provisions for designating types of the genera but types of the species even later. The Article -72b in its various subsections (i - vii) on "Type Series" now defines the true status of the type on modern lines.

EXPLANATION OF TYPE

When a species is described, the author of the new species has before him one or more specimens having characters which are distinctive enough to his satisfaction and which he considers necessary to segregate from the existing taxa and make into new species. This material comprising of one or more specimens which the author has studied and on which the author decides to name a species is the type material. This comprise of animals collected by one or more collectors and on one or more occassions. One of these is labelled as holotype or the Primary Type or Proterotype (Article - 73).

According to the Rules of Nomenclature, it is obligatory that the Holotype must be definitely indicated and the publication of new taxon without clear indication of Holotype is invalid. Earlier, in several cases the designation of type material in the original descriptions mention a number of specimens studied by the founding author. Either none of these specimens bear the annotation as Type or several of them are seen labelled Types. In such cases, according to the code, all these specimens have the status of syntypes, and it is for the specialist later to choose one of them to serve as the Type, which is called Lectotype (Article - 74). Valid designation of a lectotype fixes the status of the specimen, no later designation of a lectotype has any validity. The place of origin of a Lectotype (Article - 72 h) becomes the type locality of the nominal species and the valid designation of a lectotype permanently deprives all specimens that were formerly syntypes of that

nominal taxon, those specimens then becomes paralectotypes. Further, if it is found that the specimen designated "Lectotype" was not a Syntype, it loses is status of lectotype. If in original descriptions, any one of the specimen is cited as Type and even if the word Holotype is missing, it is to be presumed to be Holotype. A name which is published according to the requirement of the Articles 8 - 10 of the Code is known as the "Available name" or valid name" or "Legitamate name"

While designating the Holotype, the following relavent data known to the author are recommeded for incorporation (Article - 73 c) viz., size, locality, name in full, other data such as altitude, meters below sea level for aquatic material, geological age in case of fosssil taxon, sex, developmental stage, name of the collector, collection in which it is situated, collection number and host species in case of a parasite.

DIFFERENT KINDS OF TYPES

Blackwelder (1967) grouped such names of the types into following categories.

(1) Primary types (single nomenclatural types e.g. Holotype, Lectotype, Neotype)

(2) Secondary types (the specimen from which the primary type must be selected eg., Syntypes or Paralectotypes)

(3) Tertiary types (other specimens originally set aside as of special taxonomic interest to supplement the primary types eg., Paratype and Allotype)

(4) Topotype (specimens identified as of special origin)

(5) Metatype, Homo or Homeotypes (specimens identified as to time or person of identification)

(6) Plesiotype, Hypotypes (specimens identified for special treatment or use)

(7) Plastotypes (replicas of type specimens)

The following kinds of usage is employed in taxonmy, the explanations of which are given below :

Holotype : It is that single specimen with which the name of the taxon is attached. The single specimen selected by the author of a species as its type, or the only specimen known at the time of description. A holotype based on a single specimen, is known as the Monotype.

Allotype : This is the specimen of the opposite sex of the type. This can be designated at the time of typification or subsequently. An Allotype (opposite sex of the type) described after publication of the original description is known as Neoallotype.

Isotype or Cotype : The duplicate of the type specimen. In case of plants, these are the fragments from the same plant from which the holotype was made. The term Cotype is

now not used. However, Cotypes are any one of all specimens present before the describer at the time when description is drawn from a syntype or paratype.

Paratype : The specimen other than the holotype (and the isotypes in case of plants) studied by the author at the time of the description of the taxon. These specimens bear numbers different from the holotype and can even be from different localities and by different collectors, but they must have been studied by the author of the taxon prior to the founding of the new taxon.

Syntype : These are those specimens which were studied by the founding author and form the basis of the new taxon, but when the author did not designate any single specimen as holotype. A duplicate type of a syntype, not cited in the original description of the name is known as Isosyntype.

Lectotype : It is type chosen to serve as holotype, when either an earlier designated holotype was lost or destroyed or Holotype was never designated. In such cases a specimen is chosen from the paratype or syntype by a specialist to serve as the type (it may be noted that, it is not a Holotype in any sense but a specimen is chosen to serve as Holotype). It is also defined as one of the series of syntypes which, subsequent to the publication of the original description, is selected and designated through publication to serve as "The Type"

Neotype : The specimen selected and designated from the other specimens as type, when the holotype, paratype or syntypes are lost or destroyed. A Neotype for a nominal species - group taxon should be chosen from any surviving paratypes or paralectotypes, unless there are compelling reasons to the contrary, such as poor condition of the specimen or the probable mixture of taxa (Article - 75a).

Topotype : When no original type material is available and the specimen collected from the original type locality is chosen to serve as type. Earlier the term Geotype was used to indicate a specimen from the type locality. The word Geotype is now not in usage.

Homeotype or Homotype : A specimen compared with the type by a person other than the describer and determined by him as conspecific with the type.

Morphotype : A selected specimen of the second or later form of a dimorphic or polymorphic species; its use is permitted only by international Code of Nomenclature of Bacteria and not by Zoological Code.

Genotype : The species which is designated the type species of a genus, upon which it is based. However, recommendations of 1985 code (67 a) does not allow its use in referring to the type of a genus as the term creates confusion in its use in genetics.

Autotype : Any specimen identified by the describer as an illustration of his species and compared with the type.

Typotype : The type of type i.e., if the type of name, studied by an author, is a

description or an illustration previously published by an earlier author, then the specimen on which the earlier author's description or illustration was based, and which as such, the later author did not study, is the typotype of the later author's name.

Generally the terms like holotype, paratype, syntype, lectotype, paralectotype and neotype are used in Zoological Nomenclature. Apart from the above, the following terms are also used in taxonomy. These are not recognised; however, it serve a useful purpose in the identification of the type specimen.

Chirotype : A type specimen upon which a mansucript name is based.

Genoholotype : The species on which a genus is founded whether unique or one of a series, specifically named as generiotype by the author. The term is not in usage.

Genolectotype : A species of a series selected as the type of the genus in which the describer of the genus placed it subsequently to the description. The term is not in usage.

Geotype : A specimen from the type locality.

Haplotype : A generic type by a single reference.

Icotype : A typical specimen which serves the purpose of identification but has not been used in literature.

Ideotype : A specimen named by the author after comparison with the type, but not belonging to the type locality.

Pseudotype : A type species of the genus by erroneous description.

Articles 76-82 relates to the International Commission on Zoological Nomenclature to International Congress of Zoology or their successors in authority. Accordingly, the International Commission on Zoological Nomenclature, a permanent body derives its power and its constitution from the International Congress of Zoology. The Commission exercises the interpretation of the code, amendments to the code (Article - 77), status of declarations, opinions and directives and of names and works in the official lists and indexes (Article - 78), the plenary powers in Article - 79, status of the case, exemption, constitution and bylaws in the Article - 80-82, respectively.

Articles 83 to 88 regulates the governing of the code. The title of the rules is known as International Code of Zoological Nomenclature, the third edition comes into effect from the date of publication viz. February , 1985, which supersedes all previous editions. The official language of this Code is French and English and no name or act published before 1758 enters zoological nomenclature and the zoological work published after 1757 are governed by the provisions of this Code. The meaning attributed in the glossary to a word or expression is to be taken as its meaning for the purpose of the Code. Lastly, Article - 88 stipulates that the code can be amended only by the congress acting on the recommendations of the commissions.

General recommendations adopted by the XX General Assembly of the International Union of Biological Sciences

1. Comparisons should be included while describing a new taxon.
2. The scientific name for taxa of the genus and species should be different from the printing style used in the main text, i.e., *italics* are used.
3. Vowels should not be linked while printing and should be separate (eg. *ae* and *oe*)
4. When a taxa described is not in English, French, German, or Latin, it should be accompanied by the translation in any one of the language.
5. The author should state the class, order and the family clearly.
6. A new name should be followed immediately by an appropriate statement in abbrevated form such as *"gen. n"* or *"sp. n"* etc.
7. The new name of the taxa or the author's name should be cited in full; abbreviations should not be used.
8. When a nominal species has been later divided on taxonomic grounds, the name of the author who restricted the taxonomic species may be cited with a suitable notation, after the name of the original author.
9. Full bibliographic reference should be given, while citing the name of a genus or its lower rank or while establishing a replacement name in a taxonomic work.
10. Bibliographic reference and full illustration should be given while describing a new taxon.
11. All measurements should be in the metric system.
12. The expression of *"nomen novum"* should be used only to denote a replacement name for a preoccupied name.
13. The author of the new taxa should not use the same name in different publications without mentioning that the matter has already appeared elsewhere.
14. The zoologist should not publish a name for the first time in an abstract, table of contents, introduction or key published in advance.
15. In view of the paramount importace of the wider publicity, the author is recommended to take the earliest opportunity to send a copy to the Zoological Records.

Recent Inclusions : The Fourth Edition of the International Code of Zoological Nomenclature was published at the end of 1999, and guide zoologists in the handling of scientific names and types of animals. The Code still preserves taxonomic freedom and leaves it to systematists to be responsible for the stability in grass-root nomenclature. This

was mainly because there were several instances of abuse of this freedom in North American and European aquarium press. Certain individuals, some apparently without systematic training, published new taxa that were incompetently described in the view of ICZN and apparently in at least one case, based on illegally collected and exported specimens. It was suggested that aquarists attempting to publish systematic papers without the proper training in systematics and taxonomy are doing themselves, the scientific community, and the aquarium hobby a disservice and that systematic science usually suffers from this activity. A word of caution was also given to the global museums which are supposed to be resources for biodiversity research, and not facilitators of illegal trade in animals. The ICZN felt that scientific communication should not be published in aquarium literature which is difficult to obtain, and which is sometimes in a local language difficult to understand for the majority of interested researchers. Statements affecting nomenclature sometimes are published unintentionally in any text mentioning names, synonyms or types. With the wealth of aquarium literature now available, such statements are a potential source of nomenclatural problems because they may be discovered only after a long time and then upset established usage. This document can be down loaded at http://www.nrm.se/ve/pisces/policy.pdf.

CONCLUSION

The tremendous development in the last century on the nature and definition of species, speciation, application and practice of the rules of nomenclature, has necessitated the establishment of ethics and codes in taxonomic research. This also resulted in the formation of *International Code of Zoological Nomenclature*, as the guiding principle for the present day taxonomists all over the world. The entire subject of nomenclature can be divided into the following types viz., nomenclature type, the rule of priority, new names, legitamacy of the names, correctness of the names, retention and choice of the names, rejection of names as well as change of names.

CHAPTER–3

SPECIES CONCEPT

Taxonomists are mainly concerned with the comparison of the species rather than individuals or parts of individuals. Therefore, it is very essential to define and delimit a species first. The species and process of speciation and the conclusions drawn by several systematists have acquired immense importance in view of the vastness of available literature. In the beginning, it was believed that the species was supposed to be created as separate entities as static and monotypic. At this stage, there was neither confusion nor any serious species problem. Subsequently, a species was considered as a "Polymorph variant or morphologically different population or geographically isolated population" It was therefore, with the advancement of knowledge on the species, a well defined and acceptable definition was essential to avoid confusion.

The origin of the concept of species can be traced back to Aristotle's *Scala Naturae,* (Scale of nature) with its root in "Phylogenetic scale" describing primitive and advanced groups, based on evolutionary arrangement. Linnaeus's *Philosophica Botanica* (1751) has laid the foundation to the constancy of the species or the doctrine of individual organisms within a species. Illiger (1800) spoke of species as a community of individuals, which produce fertile offspring. The first to recognise the biological variation and the application of the term "Kind" (for species) was Voigt (1817); Oken (1830) and Gloger (1833), the latter gave the definition, species is what belongs together either by descent or for the sake of reproduction. Baer (1828) defined the species as "sum of the individuals that are united by common descent" Cuvier (1829) defined it as the assemblage descended from one another or from common parents and of those who resemble each other.

Darwin's "*The Origin of Species*" (1859), looked at the species from a viewpoint almost directly opposite to that of Linnaeus. Accordingly, the species concept was purely arbitrary and subjective. The theory of evolution presupposes that species are mutable, but mutability itself doesn't imply evolution. Species must be able not only to change but also to change in an orderly manner and with reasonable systematic limits, before they can be organised into an evolutionary sequence. Darwin in a letter to Hooker (Oct. 22. 1864) wrote that "The power of remaining constant for a good long period, I look at as the essence of species", thus recognising the morphological species concept.

Plate (1914) was the first to state that the "members of a species are tied together by the fact that *they recognise each other as belonging together* and reproduce only with each other" Mayr (1940) defines species as "group of actually or potentially interbreeding population, which are reproductively isolated from each other " Simpson (1943) gave the definition of a genetic species as a "group of organisms so constituted and so situated in nature that a hereditary character of any one of these organisms may be transmitted to a descendent of any other"

Dobzhansky defined the species in various ways "there is a single systematic category which, in contrast to others, withstood all changes in nomenclature with an amazing tenacity and that is the category of species (1937)"; "as the largest and most inclusive... reproductive community of sexual and cross fertilising individuals which share a common gene pool" (1950), and in 1951 he redefined the species as " the group of populations, the gene exchange between which is limited or prevented in nature by one or by a combination of several reproductive isolating mechanisms" Borgmeir (1963) describes species as "natural phenomenon and biological unit based on objective facts" Wilmoth (1967) is of the opinion that a species is "a well defined autonomous and persistent organic unit, living in a free state of nature, not grading freely into any other unit, and generally of less perfect fecundity outside than inside its limits" Recently, a species is defined as the unit or element of the biodiversity spectrum - from genes to large-scale ecosystems. On the one hand, species are the most recognisable expression of genetic diversity, at the same time; the species are the building blocks of ecosystems (Mc Neely *et al.*, 1990).

CHARACTERS OF A SPECIES

According to Mayr (1976), the species should have the following characteristics :

1. Species characters are adaptive
2. Species are evolved and evolving
3. Species differ genetically
4. Species differ ecologically

According to Slobodchikoff (1976), the species should have the following :

1. All organisms to be sorted into discrete groups (i.e., should have operational component)
2. Account for morphological, behavioural, ecological, physiological and genetic differences among populations included within a species.
3. Account for differences between population groups of different species
4. Apply to all forms of genetic continuity and types of reproduction
5. Consistent with the theoretical framework of evolution

But today, greater emphasis on the dynamic concept of species is given. Various attempts have been made to define a species, and different species concepts are recognised. Grant (1981) identified five different types of species *viz* : 1. Taxonomic species (Morphological species or Phenetic species); 2. Biological species (Genetic species); 3. Micro species (Agamospecies); 4. Successional species (Palaeospecies or Chronospecies) and 5. Biosystematic species (Ecospecies, Coenospecies). However, presently, the following well recognized species concept has been adopted in the following discussion, based on the literature available from different sources.

1. Nominalistic species concept

The dogmatic belief is that the "nature produces individuals and nothing more" or the spontaneous generation of many highly organised animals, a pre-evolutionary theory of order, that of *the scala naturae*, usually assumed that all species formed a continuum and were inherited arbitarily and non delimitable (Simpson, 1961). The theory met with lot of critisism, as it believes in "nature produces individuals and nothing more, species have no actual existance in nature"

2. Typological species, (taxonomic species, morphological species or phenetic species)

The concept mainly based on the work of Aristotle, accordingly to which each species has an intrinsic nature that make up the species, i.e. has essential properties with defined characteristics and accidental properties that individual vary from one another. The taxonomists describe a given species based on the morphological properties, by designating a Type specimen, according to the *International Code of Zoological Nomenclature*. Thus a type specimen provides pragmatic starting point for all subsequent studies of species. A species name provides a convenient method of communicating information about a group of organisms. It is therefore, recognised as the morphological species concept. The main criticism comes from the fact that there are morphological differences due to sexual dimorphism, polymorphism, difference due to age and other form of individual variations.

The basic unit of Linnaean hierarchy is the species, of course composed of populations, a group of organisms defined in certain ways. All other groups above the level of species are themselves composed of one or more species. These groups, including species, are collectively known as taxa and each of them is a taxon. Taxon is defined as *"group of real organisms recognised as a formal unit at any level of hierarchic classification."* A taxonomic category or simply a category *is a class the members of which are all the taxa placed at a given level in a hierarchic classification. The rank of a category is either its absolute position in a given hierarchic sequence of categories or its position relative to other categories. The rank of taxon is that of the category of which it is a member.*

An outgrowth of typological species concept is the phenetic species concept (Sneath and Sokal, 1973), which is mainly based on the morphological characters, but the relationships between characters and between organisms are analysed by computer algorithms to produce meaningful groupings of organisms. Hence, it is defined by Sneath and Sokal (1973), as "smallest cluster that can be recognized on some given criteria as being distinct from other clusters" The operational definition is " A species is a group of organisms not itself divisible with the phenetic gaps resulting from concordant differences in character (except morphs, such as those resulting from sex, caste or age differences) but separated by such phenetic gaps from other such groups" (Michener, 1970).

Linnaeus System of Classification

The Linnean hierarchy developed in the *Systema Naturae* is based on the grouping of organisms into classes owing to their shared characteristics. It is the arrangement of

individuals into groups based on the similarities among them. It has a sequence of seven levels *i.e.,*

Kingdom
Phylum
Class
Order
Family
Genus
Species

Since the method adopted by Linnaeus was not of very practical use in the case of larger fauna and difficulties were felt in classifying the animals. As a result, it was replaced by post-Linnaean taxonomists by another method known as upward classification. In this method, taxa are assembled into groups of similar species (or related species) forming a hierarchy of higher taxa by again grouping similar taxa of the next lower rank (Blackwelder, 1967). In recent times, the deficiency noticed in this practice has been rectified, by adding *super-* (above), *sub* - and *infra* (below) to them. A complete hierarchy used in classification of a large group of animals (Simpson, 1945) commonly known as "Hierarchical System of Classification" is given below. It has 20 levels. Use of all possible *super-*, *sub-* and *infra-* levels between kingdom and subspecies would give thirty-four levels, probably more than needed in practice. Therefore, the use of any particular number of levels is a completely arbitrary convention.

Kingdom
Phylum
Subphylum
Super class
Class
Subclass
Infraclass
Super order
Order
Suborder
Infra order
Super family
Family
Subfamily
Tribe
Sub tribe
Genus
Subgenus
Species
Subspecies

Thus, it can be seen that the functional objective of any classification is the power of organisation or grouping of things or concepts for storage and retrieval of information. As can also be seen from the above listing of heirarchies, the various catagories (Kingdom to subspecies) are arranged in heirarchial manner. This means, each level of classification embraces all of the features characteristic of the level below it. It also means that the features which characterise each level of the classification include not only those which define that level but also each of its higher levels. This system allows the quick diagnosis of an animal and sorting a newly discovered one into existing.

Use of seven basic Linnaen levels is required by convention, that is, no animal is considered to be satisfactorily classified unless, it has been placed implicitly or explicitly in some definite groups at each of the seven levels, i.e., use of any levels other than the seven mentioned above is optional and depends on the nature of the requirement by the author. One should carefully understand, that an individual never is and cannot be classified. Classification involves groups, i.e., what is classified is always a group or population, defined in the broadest sense as any group of organisms systematically related to each other.

The concept of Linnaen species led to the mathematical formula by Ginsburg (1938) "a given population is to be considered a species with respect to another closely related population when the degree of intergradation (overlap of the observed samples) is not more than 10 per cent" The revival of this concept is taken up recently in "numerical taxonomy" Since numerical taxonomy is mainly based on the principles propounded by Adanson (1727-1806) it is often called Neo-Adansonian principle. Van valen (1988) defines species thus "a population is a species to the extent that most of its members share a set of criteria such as single origin and single extinction with reproductive continuity between these events, capacity to evolve, a mechanism to recognise other individuals or the gamates of the same species, and reproductive islolation from other species"

CLASSIFICATION AND NAMING

A taxonomist forms classifications employing a variety of methodologies. However, in all these methodologies, the basic tools of the taxonomist's job are attributes of the organism that he studies such as its structural features, external and internal morphology etc. For instance, birds are characterised by the presence of feathers, mammals by hair or fur, reptiles as well as fishes by scales (but fishes with fins and reptiles without fins) and amphibians by their skin lacking feathers, fur and scales. But all these animals are vertebrates because, of the possession of a backbone quite contrary to insects, spiders and worms, which lack a back bone (invertebrates). Yet, all these are animals. Therefore, all of them can be placed under a single kingdom called Animalia. Further, they can be segregated as vertebrates and invertebrates. All the vertebrates since they possess a backbone (a common character) can be grouped under one phylum, the phylum : Chordata. However, since, invertebrates donot possess such a common character, different groups of animals are placed under different phyla. Each phylum is further split into various categories, all based on character of animals, into class, order, family, genus and species.

To illustrate, how this is done, classification of Amphibians is considered here. Amphibians comprise of tailed salamanders and newts, limbless snake-like forms and quadruped frogs and toads. Since, salamanders and newts retain tail even in their adult stage, they are grouped under the order named Caudata. Since frogs and toads do not retain tail in adult stage, they form a different order namely, Anura. The snake-like amphibians that donot have legs are grouped under the order Gymnophiona (Apoda). Each of these orders can further be divided into families. In this context, for convenience in explaining, we will confine our discussion to the Anuran amphibains of the Western India in identification key to its families, as shown below :

1. Upper jaw toothed, tongue bifid 2

– Jaws toothless, tongue entire 3

2. Digits with an intercalary cartilage between penultimate

– Phalanges ..... Family RHACOPHORIDAE

– Digits without intercalary cartilage ..... Family RANIDAE

3. Pupil horizontal, tongue pyriform, skin tubercular ..... Family BUFONIDAE

– Pupil circular, tongue oval, skin smooth or granular ..... Family MICROHYLDAE

Each of the above families can be further split into genera. We will for convenience consider here the family Bufonidae alone as shown in the key to the genera of Family Bufonidae of Western India, as shown below :

1. Parotid glands absent ..... Genus ***Ansonia***

– Parotid glands present 2

2. Fingers webbed, discs present ..... Genus ***Pedostibes***

– Fingers free, no discs ..... Genus ***Bufo***

Members of each of the above genera can again be categorised into distinct species as shown below in the key to the speies of the Genus *Bufo* of Western India.

1. Head without bony ridges 2

– Head with bony ridges 4

2. Tymphanum very small or indistinct, toes fully webbed ..... Species *beddomeii*

– Tymphanum larger 3

3. Tymphanum nearly as large as eye, toes webbed at base ..... Species *holiolus*

– Tymphanum 2/3 diameter of eye, toes $^2/_3$ or ½ webbed ..... Species *stomaticus*

4. Parietal ridges present 5

– Parietal ridges absent 7

5. Size large, first finger longer than the second 6

– Size small, first finger equal to second ..... Species *fergusonii*

6. Dorsum of skin genrally smooth but with a few tubercles behind angle of jaws, limbs and flanks ..... Species *silentvaleyensis*

– Dorsum of skin warty ..... Species *parietalis*

7. Tymphanum 2/3 diameter of eye ..... Species *melanostrictus*

– Tymphanum small less than ½ diameter of eye ..... Species *microtymphanum*

The identification key (as shown above) divided into two parts (couplets) at each stage is known as the dichotomous key. The species key presented above covers all the species of the genus *Bufo* known from the Western India. If the character of the species of *Bufo* collected from Western India does not fit into the above key, the identification key of *Bufo* from other regions should be consulted and yet, if it does not fit into any of the keys pertaining to *Bufo*, it is a pointer that the species in question is likely to be new and hitherto unknown species. In such a case, a detailed study of the specimen is required to ascertain its own species specific characters and once ascertained, it can be described as a new species and the existing key to the identification further modified appropriately to accomodate the new species.

Having come this fact, let us now examine how a particular species fit into a classification. We will take *Bufo melanosticus*, as a typical case.

Kingdom	ANIMALIA
Phylum	CHORDATA
Subphylum	VERTEBRATA
Class	AMPHIBIA
Order	ANURA
Family	BUFONIDAE
Genus	***Bufo***
Species	*melanostictus*

Depending on the groups and individual cases dealt with, it may be sometimes necessary to bifurcate the above taxonomic categories further. Taxonomists use different kinds of keys to separate and segregate characters in such a way as to provide a series of alternative choices. This includes dichotomous key, bracket key, indented key, serial key, branching key, circular or the box key, depending on their convenience of arrangement.

3. Biological species (Genetic species)

The definition that stress on the reproductive isolation and community of gene pools are usually considered as the biological species. Mayr (1969) stresses that the biological species concept should have the following three criteria viz.,

1. Species are defined by distinctness rather than by difference.
2. Species consists of population rather than unconnected individuals.
3. Species are more unequivocally defined by their relation rather to non conspecific population (isolation) than by the relation of conspecific individuals to each other. The decisive criteria is not the fertility of individuals but the reproductive isolation of the population.

The term biological species existed as early as 1828 (Von Baer), accordingly the species is "the sum of individuals that are united by a common descent" Plate (1914) defines "the members of a species are tied together by the fact that they recognise each other as belonging together and reproduce only with each other" Dobzhansky (1950) defines the species as the largest and most inclusive reproductive community of sexual and cross fertilising individuals which share a common genepool. Mayr (1963) defines species *as "groups of actually or potentially interbreeding natural populations which are reproductively isolated from other groups"*, and further in 1976, redefines biological species based on the non dimensional (reproductive gap) and multidimensional (gene flow) species concept. Florkin (1964) gave the biochemical definition for the species as "groups of individuals with more or less similar combinations of sequences of purines and pyramidine bases in their macromolecules of DNA, and with a system of operators and repressors leading to the biosynthesis of similar amino acid sequences. This was later modified by Dobzhansky (1970), thus "a biological species is an inclusive Mendelian population, integrated by the bonds of sexual reproduction and parentage" Barton (1989) defines species as "a group of population possessing inherited differences and prevent gene exchange with each other such groups" In contrast to the Mayr's isolation concept, Patterson (1988), Patterson and Lambert (1984) recognises *"Species Mating Recognition System"* (SMRS), which are specific morphological and behavioural traits that allow an individual of a sexual species to differentiate between potential partners and organisms belonging to every other reproductive community.

The isolation concept of Mayr and recognition concept of Patterson are regarded as complementary, instead of alternative (Templeton, 1989). He further presents his own concept regarding the species. According to Templeton (*ibid*), species is "the most inclusive group of organisms having the potential for genetic and/or demographic exchangability"

The Biological species concept has created more confusion in plant taxonomy than in animals, for eg., in the genus *Epilobium* with about 160 species, interspecific hybridisation is very common, therefore, according to biological species concept the whole group is to be placed under a complex species. It should be noted that all populations tend to vary

and no two populations are alike, variations observed are adaptive and has survival value, variations shown by the individuals within a population must be heriditary if successive generations are to be modified from ancestral types, the forces of nature results in extinction and survival, and lastly the environment of the individuals must not be static. Biological species concept solely depends on the population studies which involves fertility tests and such tests are not applicable to all groups. Further to this, there are certain interspecific and intergeneric crosses, which pose several problems to the evolutionary biologists. For this reason, Sokal and Crovello (1970) concluded that the biological species concept is "neither operational nor heuristic nor of practical value" They are of the opinion that the phenetic species concept is the most appropriate one to be associated with the taxonomic category "species" It should be noted that the genetic species concept of Hugo de Vries, Lotsy, Shull, Bateson and other Mendelian followers is only a typological species concept that had nothing to do with the biological species concept (Mayr, 1963).

The biological species concept is not perfect, as Wilson (1992) notes, "the concept has been corroded by exceptions and ambiguities." According to Nelson (1995), the species (or the populations of a species) at some point in its evolutionary history may not be reproductively isolated. Hybridisation between species does occur, and in some cases especially in plants population may partially interbreed enough to produce a good many hybrids (*semi -species*) on a persistant basis.

4. Agamospecies or microspecies

Agamospecies are species of uniparental organisms (Ghiselin, 1974). Normally, ordinary mutations, or micromutations cannot produce new species in sexually reproducing organisms. The situation is different in uniparental condition, this is well established in botany by Mayr, (1969) [as in Hawkweed (*Hieracium*) and Hawthorn, (*Crataegus*)] who considers morphologically distinct clones as microspecies. In case of animals, Genermont (1980) recognises five modes of uniparental reproduction *viz.*, 1) Asexual (rotifers, cladocerans and nematodes) 2) Self fertilisaton as in parasitic hymenopterans (*Telenomus fariai*) and trematodes (*Didimozoon, Wedlia bipartita*) 3) Thelitoky (i.e. Meiotic and ameiotic parthenogenesis) 4) Gynogenesis as in *Dugesia* (Planaria), *Lumbricillus* (Oligochaete), *Poecila formosa* (fish), *Ambystoma* (newt) and 5). Hybridogenesis (*Poecillopsis*, a freshwater fish). Mayr (1987) considers these uniparentally reproducing organisms as a separate type of taxon and suggests the name Paraspecies, which fall within Simpson's concept of evolutionary species Minelli (1993).

5. Biosystematic species (Ecospecies, Coenospecies)

Turesson (1922) was the first person to recognise differences between Linnaen species, (the species based on the natural population, which he calls ecospecies) and the species based on the experimental studies on the population as biosystematic species or coenospecies. He later in 1936 contended that most species are mosaics of "discontinuous

adaptational" ecotypes and this was mainly based on the field experiments with plants in strikingly different habitats. He further believes in the ecospecies concept that the phenotype responds as a unit to the environment. Van valen (1976) while supporting the Turesson (1922) held that species are maintained for the most part ecologically and not reproductively and according to him the assumptions are 1) The genes are of minor importance in evolution 2) The control of evolution is largely governed by ecology and the constraints of individual development and 3) Selection acts primarily on phenotypes, which are the building blocks of the community.

Hiesey (1945) redefined the coenospecies as "all the ecospecies so related that they may exchange genes among themselves to a limited extent by hybridization" However, these two differences are not accompanied by satisfactory definitions and hence these are also called "species in *statu nascendi* " or intermediate entities. Bernardi (1980) and Stace (1989) considers these as biosystematic categories or taxonomic categories of evolutionary systematics.

Plant taxonomists believe that the ecotype or ecospecies represent more precisely the biological description of geographic variation rather than the division of species into subspecies. Ecotypes according to Mayr (1969) are rarely discontinuous, rarely well defined and often polyphyletic and always full of intraecotype variablity. The ecotype concept, thus, suffers from the same weakness as that of the subspecies concept.

In animal taxonomy, the term ecotype is rarely used and prefer to use the term "ecological race", which is defined as the adaptation of local population to the local habitat. These in recent terminology, are recognised as sibling species (Mayr, 1963; Stebbins,1981) or ecophenotypes (i.e.,the nongenetic modifications of phenotypes). Mayr (1963) defines sibling species as "morphologically similar or identical natural population that are reproductively isolated" Thus sibling species can be recognised by biological differences, such as host specificity, habitat specificity, fecundity, voltinism, diapause, longivity, temperature tolerance etc. Taxonomists, thus are unable to recognise sibling species in comparison to field biologists or ecologists. For this reason, those who adhere to purely morphological species concept usually refer to sibling species as "biological races" Savanna sparrow (*Passerculus sandwichensis*), Redwing (*Agelaius phoeniceus*) and the Swainson's Warbler (*Limnothlypis swainsoni*) are some of the examples of ecological races cited by Mayr (1969).

TAXONOMIC DIVERSITY WITHIN THE SPECIES

Due to the absence of a clear definition on the species and the difficulty in drawing conclusion on the closely related species (species in *statu nascendi*), Bernardi (1980) and Stace (1989) considers these as biosystematic categories in animals and include the following types :

(A) Good species - forming a monophyletic group, the mutual relationship of which offers some peculiarities but speciated from the same stock.

(B) Sibling species - also known as microspecies (Gates, 1951), biospecies (Scheel, 1968) showing the absence of any morphological differences between the species. Mayr (1963) defines sibling species as morphologically similar or identical natural populations that are reproductively isolated.

(C) Semi species also known as allo species (Amadon, 1976) having closely related allopatric species. Mayr(1963) applies the term semispecies to conspecific population which are partially reproductively isolated, perhaps to the extent of being thought of as incipient species.

(D) Coenospecies or coenogamodeme (Gilmour and Heslop-Harrison, 1954) – wherein the genetic isolation between closely related species is not complete and irreversible.

Accoring to Minelli (1993) members of two comparia cannot be crossed, because they are separated by genetic incompatability barriers. This comparia consists of two or more coenospecies. Coenospecies belonging to same comparium can be artificially crossed, which produce sterile F_1 hybrids. Similarly, at the subspecific level, ecospecies can be subdivided into several ecotypes. Members of a subspecies share a unique geographical range or habitat, a group of recognizable genetically controlled characteristics, morphological or molecular, and a unique natural history as compared to other subspecies. Since subspecies are not distinct species, they are reproductively compatible and will periodically interbreed with adjacent subspecies. All subspecies have the potential to acquire suitable adaptations to their specific ecological habitat and the longer they are separated the more cumulative adaptation we might expect. All subspecies also have the potential to one day evolve into new species as suggested by Charles Darwin in "On the Origin of Species" in 1886. Avise and Ball (1991) suggested that valid criteria for subspecies include concordant distribution of multiple independent genetic traits. These can be morphological or molecular or both.

In contrast to the above, certain other categories are errected in taxonomic levels between the species and the subspecies. These include quasi species (partial infertility whereever two forms live in sympatry); vice species having sterility barriers in some areas of sympatry but no barriers in other areas; citra species (Dujardin, 1965) or mega subspecies (Amadon and Short, 1976). These are monophyletic groups of subspecies of the same species, morphologically and geographically isolated from other species within the species.

Subspecies, Races and Varieties

Progress in science has led to an increasing appreciation of diversity within species, as well as understanding of the complex patterns of distribution. Species vary in space and time i.e., variation of animal species occur in non isolated, incompletely isolated, temporarily isolated or isolated local populations and in the course of their evolution. The geographical distribution and variation was well understood after Darwin's Theory of Natural Selection. The term "variety" was first used by Linnaeus (1751) in his *Philosophia*

botanica and stated that there are as many varieties as there are different plants produced from the seed of the same species. The variety is thus defined as "nongenetic modification of the phenotype" Linnaeus included the nongenetic variety for "races" of domestic and intra population genetic variants in animal kingdom. Race is thus synonymous with the subspecies, however, "race" is also colloquially used to designate populations or aggregates of populations within formally recognised subspecies (Mayr, 1969). Local populations that are conspeciously adapted to a local habitat are often referred as "ecological races" Contrary to this, morphological, ecological as well as physiological characterstics of adaptation of infraspecific units are known as "geographic races"

Ornithologists in the later part of the nineteenth century began to recognise geographic races as taxa in classification and began to use them as trinomials (Schlegel, 1844) and the subspecies concept was first defined in ornithological circles (Allen, 1877). According to Mayr (1985) subspecies "is an aggregate of local populations of a species, inhabiting a geographical subdivision of the range of the species, and differing taxonomically from other populations of the species" Bohme (1978) states that subspecies are those cases where "intra-specific evolutionary divergence can potentially give rise to new species " Grant (1981) considers subspecies as groups of interbreeding populations with strong morphological differences, combined with geographical, ecological, edaphic or physiological distinctions which give such groups a species like distinctiveness.

The definitions of ecological races and geographic races which are local populations of intraspecific units show possible phylogenetic trend in a polytypic species (Grant, 1960). It should be noted that the characters expressing infraspecific divergences should be adaptive characters necessary for evolutionary process. Few taxonomists are also of the opinion to avoid the usage of subspecies (La greca, 1987; Minelli, 1993). Therefore, there is great deal of confusion at the level of infraspecific taxonomic hierarchy and whether subspecies or varities are to be recognised or not. As far as the plant taxonomists are concerned there is a great deal of usage of infraspecific level as can be seen in the works of Hamilton and Richards (1992), who found nearly 8% of the plant species discussed in 26 major journals published between 1987 - 1990 subdivided into subspecific entities. Of these subdivided species, 42% were divided into subspecies, 52% into varieties, 3% into formae and 3% into infraspecific taxa of two or more levels.

Minelli (1993), the Australian systematist observes that infraspecific taxa are more commonly recognised in developing countrires, using European classic reference as source and adds "given that, experimental evidence shows monotypic variation in response to environmental variables such as predators, pH, temperature, and naming of infraspecific taxa is neither justified nor useful" He prefers to call them ecotypes rather than subspecies. At the same time, there are certain defenders for the retention of the infraspecific level in groups like odonata, orthoptera, lepidoptera, hymenoptera, a few families of coleoptera, birds and mammals.

In animal taxonomy, according to Internatonal Code of Zoological Nomenclature, the Article 16 and Article 45 relates to species groups, which include taxa at the rank of

species and subspecies. The application of names, formation, treatment and infrasubspecific names are all in accordance with the provisions of various articles of the code. The zoological code does not recognise the names of the taxa of infrasubspecific rank *i.e*, a scientific name proposed expressly as the name of a "variety" or "form" after 1960, is excluded from Zoological Nomenclature (Article 1b (5); Article - 16, but those designated before 1961, to be regarded as subspecific names (Article 45 g).

Hybrids

The term hybrid is normally applied to the individuals that are the offsprings of a cross between two good biololgical species (e.g., horse and donkey resulting in the sterile mule or hinnie). Plant hybrids are common and many stable hybrids are known in nature. Knobloch (1972) lists nearly 3,000 intergeneric crosses among a list of 23,675 intergeneric and interspecific hybrids. Hunt (1986) describes nearly 70,000 hybrids derived from 1100 natural species in orchids. In animal kingdom Grant (1992) reports that 9.5% of the bird species are known to have bred in nature with another species and produced hybrid offspring. Bullini (1985) observed exensive hybrid species in grasshoppers, stick insects, weevils, plant hoppers, freshwater snails, planarians, fishes, newts, frogs, and lizards. The question now arises about the topology of the phylogenetic tree in these hybrids.

6. Phylogenetic species

Lamarckian theory (1809) elucidates that all taxa have arisen by evolution and are in phylogenetic continuum. Darwin's theory of evoution (1859) recognised that the taxa originated by evolution and evolutionary phylogeny could explain the order that had already found among organisms. The concept is based on the direct geological evidence and indirect deductions based on geographical distribution. It is now possible to estimate the time taken for one species to split into two "good" ones or for a species to change sufficiently for systematics to regard it as having become a different one. The concept includes the origin and linkage based on monophyly or polyphyletic lineages. Monophyly includes members arising from the common ancestor, but not all lineages arising from that ancestor must be members of the designated category. Polyphyletic lineages include species that arise from two or more immediate ancestors, but which does not include the ultimate ancestor of these multiple immediate ancestors (Ross, 1974).

Recently, biologists (Maddison and Maddison, 1992; Wiley *et al.*, 1991) reconstruct the pattern of events that have led to the distribution and diversity of life; this is known as cladistics or *phylogenetic systematics*. The basic idea behind cladistics is that members of a group share a common evolutionary history, and are "closely related," more so to members of the same group than to other organisms. These groups are recognized by sharing unique features which were not present in distant ancestors. These *shared derived* characteristics are called *synapomorphie*. There are three basic assumptions in cladistics :

1. All groups of organisms are *related by descent* from a common ancestor. It essentially means that life arose on earth only once, and therefore all organisms are related in some way or other.

2. There is a *bifurcating pattern* of cladogenesis. The most controversial assumption that, new kinds of organisms may arise when existing species or populations divide into exactly two groups.

3. *Change* in characteristics occurs in lineages over time. The convention is to call the "original" state of the characteristic *plesiomorphic* and the "changed" state *apomorphic.*

CONCLUSION

The key feature of the species based approach is their emphasis on analysing population sizes and geographic distribution of individual species to identify conservation priorities. The species based approach emphasizes biological individualism (i.e., stressing the value of individual species), where as ecosystem based approach emphasizes the importance of interaction between genes, species and biophysical processes (Nelson, 1995).

In reality, there are only two recognised systems of species concept currently in use viz., typological and biolgical species, the former relies more on type designation recognised by the *International Code of Zoological Nomenclature* and the latter on the reproductive isolation between groups of organisms. Since both the concept have their inherant advantages and disadvantages, the species concepts should have to be dynamic, allowing organisms to be sorted into discrete groups; accounting for morphological, physiological, behavioural, ecological and genetic similarities among populations included within a species as well as account for differences between population groups of different species. It should also apply to all forms of genetic continuity and types of reproduction, yet be consistant with the theoratical framework of evolution. With this view in mind, Slobodchikoff (1976) introduced the terminology "Selection Species Concept" Accordingly, a species is a system of genetically similar individuals and populations maintained as a cohesive unit by a set of selection pressures that balance the disruptive forces imposed by environmental factors, mutation or genetic recombination.

CHAPTER–4

NATURAL HISTORY MUSEUMS

Natural History Museums have long been recognised as the centres of systematics and biological research. Museum collections are also an important reference system of diversity of living organisms, to be used as material for new evolutionary ideas (Minelli, 1993). Arnet and Samuelson (1986) estimates nearly 500 million insect specimens stored in public collections worldwide, he further estimates the total number of specimens is around three billion. Such an enormous number of specimens are stored in the global museums. The following are some of the major Natural History Museum present all over the world, having permanent voucher specimens corresponding to the published names of new taxa (types), as well as the general zoological specimens. The functions and utility of zoological museums are as follows :

1. Storehouse of zoological collections including type specimens.
2. Type specimens maintained is a link between the original description of a taxon and a real object so that the observation of the author can always be checked and revised for taxonomic research.
3. Serves as the fundamental resource for the identification of zoological specimens collected by way of comparison with the known taxa. Voucher and reference purposes (taxonomic identification by comparison, nomenclatural types, and research vouchers ensuring the replicability of research results).
4. The global biodiversity information is mostly based on the museum specimens, which form the baseline data on the diversity, distribution, abundance and variation. Supply of ecological data (label and ledger data, as well as site sampling can provide synecological information, water samples provide pollution data, *etc.*).
5. The variation noticed in the voucher specimens form the basis for further research in population biology studies.
6. Assists in teaching, research as well as advisory services.
7. Museums aid in dipicting the past, present and gives guidelines for future research in the bio-geographical distribution.
8. Old museum collections are becoming increasingly useful for molecular studies [*e.g.*, mitochondrial DNA (Diamond, 1990)] *i.e.*, the extraction of natural substances, DNA, as educational materials for university courses).
9. Museum specimens are also used to compare the lineage of several taxa.

10. Conservation of any group is not only based on the population studies but also on the past history of the organism in question; museum specimens add valuable tool in this direction.
11. Serves as a source for search for new genetic material for improvement of our cultivated stock.
12. Biopotential and bioprospecting are the areas of research, mainly based on the museum material and field studies
13. Serves as the source material for investigation on anatomy, morphology, molecular biology, pharmacology and environmental impact assessments. Also forms research material for taxonomic investigations, molecular and genetic research, global change measurements in preserved materials, *etc.*
14. Seed bank, gene bank and sperm banks are used in recent days to resurrect the extinct species in wild by using modern technology
15. Museum offers excellent facility for comparison of material with artefacts percolating in our lives as curios.
16. Exchange of information is possible based on the museum collections and catalogues thus prepared.

The institutes of biodiversity provide a highly valuable source of knowledge of the functions and evolutionary history of organisms, as variation and interaction of species constitute the basis for the ecosystem. The following are the list of a few Natural History Museums of the World, wherein the Type materials and other zoological reference collections are maintained.

1. Auckland Institute and Museum, New Zealand
2. American Museum of Natural History, New York, USA
3. Australian Museum, Sidney, Australia
4. Division of Entomology, CSIRO, Canberra, Australia
5. Academy of Natural Sciences of Philadelphia, Pensylvania, USA
6. Bernice p. Bishop Museum of Natural History, Honolulu, Hawai, USA
7. British Museum of Natural History, Cromwel road, London
8. Californian Academy of Sciences, San Fransisco, California, USA
9. Charles Darwin Research Station, Puerto Ayora, Ecuador
10. Canterbury Museum, Chrischurch, New Zealand
11. Cambridge University Museum of Zoology, London

12. Centro de Zoologia do Instituto de Investigacao Cientifica Tropical de Lisbon, Portugal
12. Departmento de Biologia, Universidad Autonoma, Madrid, Spain
13. Delaware Museum of Natural History, Wilmington, Delaware, USA
14. The Field Museum of Natural History, Chicago, Illinois, USA
15. Florida Museum of Natural History, Gainesville, Florida, USA
16. Houston Museum of Natural Science, Houston, Texas, USA
17. Humboldt State University, Arcata, California, USA
18. Hebrew University of Jerusalem, Israel
19. Instituto de Ecologia y Systematica de la Habana, Havana, Cuba
20. Instituto de Investigacao Cientfica Tropical de Lisbon
21. Instituto de Investigacao Tropical (Centre de Zoologia) Lisbon, Portugal
22. Institute of Malacology of Tokyo, Japan
23. Illinois Natual History Suvey, Champaign, Illinois, USA
24. Institute Royal de Sciences Turelles, Brussels, Belgium
25. Museum of Natural Sciences, Royal Belgian Institute of Natural Science, Brussels.
26. Natural History Museum of Los Angeles, Los Angeles County, USA
27. Museum of Comparative Zoology, Harward University, Cambridge, Massachusetts, USA
28. Museum d'historie Naturelle, Geneva, Switzerland
29. Muséum National D'Histoire Naturelle, Paris
30. Museo Nacional de Historia Natural de Montevideo, Uruguay
31. Manchester Museum, Manchester, England
32. Museo Nacional, Universidade Federal do Rio Janeiro, Brazil
33. Museo Nacional de Ciencias Naturales, Madrid, Spain
34. Museum of Natural History, Piacenza, Italy
35. Museum of New Zealand, Wellington, New Zealand
36. Oman Natural History Museum, Oman

37. National Naturhistorische Museum, Leiden, Netherlands
38. National Museum of Natural History, Smithsonian Institution, Washington,
39. South Australian Museum, Adelaide, Australia
40. South African Museum, Cape Town, South Africa
41. San Diego Natural History Museum, Sand Diego, California, USA
42. Spenser Museum, University of British Columbia, Canada
43. Forschungsinstut und Naturmuseum Senckenberg, Frankfurt, Germany
44. Tulane University Museum of Natural History, Lousiana, USA
45. Universidade Agostonho Neto, Luanda, Angola
46. University of California, Museum of Palaeontology, Berkeley, California
47. University Museum of Zoology, Cambridge, England
48. Western Australian Museum, Perth, Australia
49. Russian Academy of Sciences, St. Petersburg, Russia
50. Zoologische Museum Amsterdam, Netherlands
51. Zoological Museum of the University of Copenhagen, Denmark
52. Zoological Survey of India, Calcutta, India.

Nearly 90,000 animal species are described so far from the Indian subcontinent and it is estimated that through further survey and inventorisation, about nine times that number of species still remains to be discovered in India alone. In the light of Biodiversity Convention, India holds a unique position with the priority of conservation of natural resources and sustainable development. The Zoological Survey of India, since its inception (1916), as a Government of India's department by bodily converting the Natural History section of the Indian Museum, Calcutta, has in its custody and care over 200 years old collections as well as subsequent collections. The Zoological Survey of India was established on 1st July 1916 to promote survey, exploration and research leading to the advancement of knowledge on the faunal resources of the country. The National Zoological Collections present in the different sections of Zoological Survey of India, the National Heritage of the country was acquired from the former Museum (1814-1875) of the Asiatic Society of Bengal and the Zoological Section of the Indian Museum (1875-1916). At present, the department holds more than 40 lakh specimens of all groups (protozoa to mammalia), collected through intensive field explorations. Mention may be made of the zoological collections acquired from the Expeditions to Yunan (China) 1868, Persian Boundary Commission (1870-72), Second Yarkand Mission (1873-74), Dafla expedition (1874-75); Royal Indian Marine Survey Expedition by ***Investigator;*** Afghan Delimitation Commission,

1885; The Palmir Boundary Commission, 1896; The Tibet Frontier Commission, 1903-04; Abhor Expedition, 1911-12; Dr. Annandale's expedition to Lake Biwa in Japan, Alcock's collection from R.I.M.S. ***Investigator*** and several others. Besides the above, the Survey has in its possession the valuable collections of Francis Day of Indian Fishes, Lionel Neville's collection on butterflies, Dudgeon's collections of moth; collections made by Blanford, Stoliczka, Theobald, Geoffery Neville, H.H. Godwin-Austen, and several others.

Since independence, the survey got impetus through successive Five Year Plans and with the tempo of activities in the field of animal systematics and zoogeography, besides studying the environmental impact assessments and behavioural and ecological studies. The present activities are in tune with the guidelines given by the Ministry of Environment & Forests in inventorising the faunal resources in the protected areas, ecosystems and conservation areas. It generates data on threatened animals, state fauna and provide identification, advisory and referral services. It participates in exhibitions and develop regional musea. All the above lead to the collection, storage, maintenance of faunal components including the "TYPE SPECIMENS", besides giving their geographical distribution.

The National Zoological Collection housed at Zoological Survey of India, now contain more than 30,00,000 authentically identified specimens comprising over 90,000 known species of different groups of animals. The major groups of animals in this vast assemblage are protozoa, sponges, cnidarians (corals & coelenterates), helminthes, molluscs, annelids, crustaceans (prawns, lobsters, crabs), insects, echinoderms, proto and hemichordates, fishes, amphibians, reptiles, birds and mammals. The collection contain >15,000 Type Specimens. These Type Specimens and other authentically identified specimens serve as "Standards" for comparison. The department is also engaged in taxonomic publication in the form of Fauna of India, Fauna of States, Records of Zoological Survey of India, publication related to conservation areas, hand books, manuals, catalogues and checklists on various faunal groups, besides above reviews, revisions and technical monographs.

Besides the head quarters situated at Calcutta, sixteen regional offices have been established in various parts of the country to carryout intensive field survey's, to ensure National Zoological Collection and field observations, to undertake environmental impact assessment of the areas under their jurisdiction, to develop regional faunal museums for scientific and educational purposes and to attend to all queries from the state, central and non governmental organisations under their area. The sixteen regional offices are as detailed below :

1. Eastern Regional Station, Zoological Survey of India, Shillong, Meghalaya
2. Western Regional Station, Zoological Survey of India , Pune, Maharastra
3. Northern Regional Station, Zoological Survey of India, Dehradun, Uttaranchal
4. Southern Regional Station, Zoological Survey of India, Chennai, Tamil Nadu

5. Central Regional Station, Zoological Survey of India, Jabalpur, Madhya Pradesh
6. Desert Regional Station, Zoological Survey of India, Jodhpur, Rajasthan
7. Gangetic Plain Regional Station, Zoological Survey of India, Patna, Bihar
8. High Altitude Field Zoology Station, Zoological Survey of India, Solan, Himachal Pradesh
9. Marine Biological Station, Zoological Survey of India, Chennai, Tamil Nadu
10. Andaman & Nicobar Regional Station, Zoological Survey of India, Port Blair
11. Freshwater Biological Station, Zoological Survey of India, Hyderabad, Andhra Pradesh
12. Western Ghats Field Research Station, Zoological Survey of India, Calicut, Kerala
13. Arunachal Pradesh Filed Station, Zoological Survey of India, Itanagar
14. Estuarine Biological Station, Zoological Survey of India, Berhampur, Orissa
15. Sunderbans Field Station, Zoological Survey of India, Canning, West Bengal
16. Marine Aquarium & Research Centre, Zoological Survey of India, Digha, West Bengal.

By the act of Parliament, Zoological Survey of India, is recognised as the centre for Zoological Research in the country and the Zoological specimens present in the Institute as National Zoological Collections. Besides, Zoological Survey of India, a number of institutions, carry out research in taxonomy and maintain zoological collections in the country such as

1. Indian Agricultural and Research Institute, New Delhi
2. Forest Research Institute, Dehra Dun
3. Fishery Survey of India, Mumbai
4. Fisheries Research Institute, Barrackpore
5. Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
6. Salim Ali Institute of Ornithology and Natural History, Coimbatore
7. Bombay Natural History Society, Mumbai
8. Universities in the country

CHAPTER–5

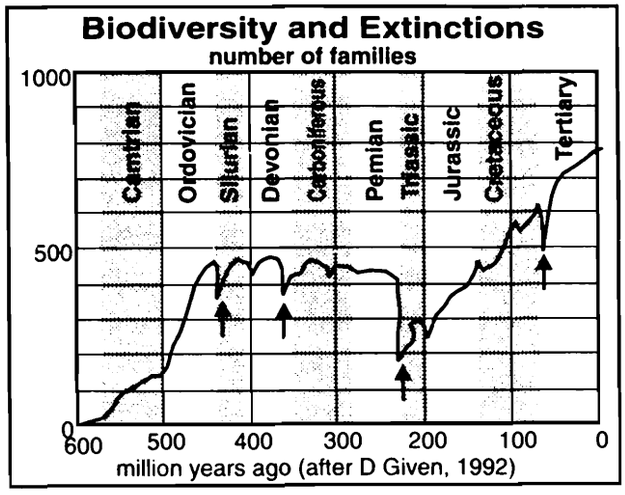
FAUNAL RESOURCE

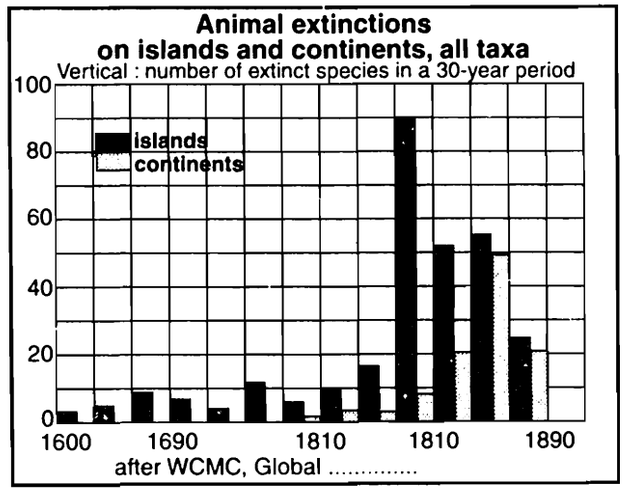
Biodiversity is the variety and variability of life and its many processes. It includes all life forms from bacteria, fungi and protozoa to higher plants, insects, fishes, birds and mammals. Biodiversity also includes countless millions of races, subspecies, and local variants of species and the ecological processes and cycles that link organisms into populations, communities, ecosystems, and ultimately the entire biosphere. Genetic variation affects a species physical characteristics, productivity, resilience to stress and long-term evolutionary potential. Genetic diversity means that species contain characteristic levels of genetic variation within and among their populations, including that of extreme populations. The foundation of biodiversity is genetic conservation.

A more easily recognized element of biological diversity is the distinct species associations in an area. We refer to these associations as biological communities and usually recognize them as distinct strands, patches or sites such as forests, meadows, fencerows, ponds, wetlands etc. Communities form the biotic parts of ecosystems. The species composition in an ecosystem is intertwined with its structural and functional aspects and hence with the diversity of its ecological processes. At the geographic scale of regional landscape, diversity includes variety in the kinds of biological communities and a biogeography (that is patterns, sizes, shapes, juxtapositions and interconnectedness) that provides for free, natural interchange of individuals throughout the area. Biologically diverse communities contain sufficient compositional, structural and functional variety that they are assured a high prospect of continued presence and ecological influence in an area.

The history of this planet goes back about 5 billion years. Life evidently first appeared on Earth more than 3 billion years ago, and for the next 1.5 billion years, only the bacteria and blue-green algae, or centrotrophic prokaryotes existed. Human beings arose as a species out of the web of life a mere 200,000 years ago. We are made up of the same basic atoms in the same proportion, the same macromolecules, and the same cellular plan as all other living things because we share common ancestors. The genetic blueprint written in nucleic acids is a universal genetic code. The first fossils, organisms with cells, a nucleus and chromosomes (eukaryotes) are from rocks preserved about 1.4 million years ago. These are thought to have arisen from prokaryotes through symbiotic associations (Marylis, 1970). About 640 million years ago, there was a sudden appearance of a diverse assemblage of multicellular eukaryotic organisms. Since the Cambrian, there has been continuous evolution and extinction of life. Over a half billion species may have existed over the past 600 million years. Calculations show that for organisms inhabiting shallow marine waters, the longevity of species is usually less than 10 million years (6 million in echinoids, 1.9 million in graptolites, 1.2 to 2 million in ammonites). If the average survival

of a species is about 5 million years and eukaryotic life has been around for over 600 million years, then there could have been at least 120 complete changes of species during the time of metazoan existence. Since the Cambrian began, the average species extinctions rate has been 9% per million years. The earliest known mass extinction occurred about 650 million years ago, when a worldwide event eliminated as much as 70% of the plankton diversity on earth.





One out of four mammals, one out of eight birds, one amphibious animal out of three and nearly half of all freshwater turtles are threatened, according to the World Conservation Union. At least 15,589 species face extinction, according to 2004 IUCN list, includes 7266 animal species and 8323 species of plants and lichens. The current rate of species becoming extinct is estimated to be up to 1000 times the normal figure, *ie.*, in evolutionary terms including the normal renewal of ecosystems. Since 1500, a total of 784 known animal and plant species are considered to have become extinct. Another 60 only survive in captivity or through cultivation. This is because the distinctive survival strategy evolved by one species – the *Homo sapiens* – was the highly developed brain. From that brain emerged self awareness, memory, curiosity, imagination, and creativity. The human brain had an unprecedented capacity for abstraction, to create ideas that existed only in a mind that became as real to that mind as a rock or tree. It was this capacity for abstraction that enabled us to conceive notions of tribes, loyalty, nations justice, peace, war, equality, god, heaven and hell. And it was also responsible for creating economies, an idea that value in human activity and natural "resources" that we can exploit and which symbolize that value in currency. When biological diversity is depleted, all the money in the world won't substitute it.

PURPOSE

Documentation of faunal resource of a country therefore focuses on developing 'indicators' to be used in the assessment which are reflected in a combination of ecological fundamentals, such as biodiversity, critical habitat and key ecological relationships; site-specific considerations, environmental stress and potential impacts. Assessments and

documentations also provide biodiversity values that are recognized and taken into consideration in the planning and decision making process. It is for this reason the documentation of faunal resources will enhance the effective performance of planning and management and also assists in competencies or compensable factors found in evaluating the diversity of the country, has been taken up in the present instance.

INDIAN SCENARIO

India's immense biological diversity encompasses ecosystems, populations, species and their genetic make-up. This diversity can be attributed to the vast variety in physiography and climatic situations resulting in a diversity of ecological habitats ranging from tropical, sub-tropical, temperature, alpine to desert. As a result, according to world biogeographic classification, India represents two of the major realms (the Palaearctic and Indo-Malayan) and three biomes (Tropical Humid Forests, Tropical Dry/Deciduous Forests and Warm Deserts/Semi-Deserts). These include 12 biogeographic regions. However, the Wildlife Institute of India has proposed a modified classification–which divides the country into 10 biogeographic regions : Trans-Himalayan, Himalayan , Indian Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic Plain, North East India, Islands and Coasts.

India's major biogeographic habitats

No.	Biogeographic Zone	Biotic Provinces
1.	Trans-Himalaya	Upper reaches of Himalaya
2.	Himalaya	North-west Himalaya, West Himalaya, Central Himalaya, East Himalaya
3.	Desert	Kutchh, Thar, Ladak
4.	Semi-arid	Central India, Gujarat Rajwara
5.	Western Ghats	Malabar Coast, Western Ghats Mountains
6.	Deccan Peninsula	Deccan Plateau, South Central Plateau, Eastern Plateau, Chhota Nagpur, Central High Lands
7.	Gangetic Plain	Upper Gangetic Plain, Lower Gangetic Plain
8.	North-East India	Brahmaputra Valley, North-Eastern Hills
9.	Islands	Andaman Islands, Nicobar Islands, Lakshadweep Islands
10	Coasts	West Coast, East Coast

The rich vegetation wealth and diversity in the country is enormous due to the variety of climatic and altitudinal variations coupled with diverse ecological habitats. Champion and Seth (1968) recognized 16 major forest types comprising 221 minor types, of this tropical moist deciduous forms the major percentage (37%), followed by tropical dry deciduous (28.6%), tropical wet evergreen (8%), tropical thorn forest (2.6%) and others of minor values. Recent Forest Cover Assessment by Forest Survey of India (2001) indicates

a dense forest cover of 416,809 km² (12.68%), open forest of 258,729 km2 (7.87%), thus totaling 20.55%; while the non forest cover constitute a major portion (79.45%) with Scrub forest depicting only 1.44% of the total area. Among the states, Madhya Pradesh has the maximum area of 77,265 km² followed by Arunachal Pradesh (68,045 km²), Chattisgarh (56,448 km²). In terms of percentage of forest cover, Lakshadweep has the maximum (85.91%) (because of the inclusion of Coconut plantations) followed by Andaman & Nicobar Islands (84.01%), Mizoram (82.98%), Arunachal Pradesh (81.25%) and Nagaland (80.49%).

VEGETATIVE COVERAGE IN INDIA

No.	Vegetation Type	Location
01.	Tropical wet evergreen	West of the Western Ghats, Orissa coast, east of Indo-Gangetic plain, Assam and the Andamans
02.	Tropical semi-evergreen	Assam, West Bengal, Orissa, Maharashtra, Karnataka and Kerala
03.	Tropical dry evergreen	Coast of Tamil Nadu
04.	Tropical moist deciduous	Assam, West Bengal, Bihar, Orissa, eastern Uttar Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu, Karnataka and Kerala.
05.	Tropical dry deciduous	Indo-Gangetic plain from Bihar to Punjab, Maharashtra, Madhya Pradesh, Orissa, Andhra Pradesh, Tamil Nadu and Karnataka.
06.	Tropical Thorn	Western Ghats,west of Uttar Pradesh & Rajasthan
07.	Littoral & swamp	Ganga-Brahmaputra delta, the Mahanadi the Godavari, the Krishna & the Cauveri.
08.	Sub-tropical wet hill	Eastern Himalaya and Assam hills
09.	Sub-tropical moist hill	Western and central Himalaya, Meghalaya, Manipur & Nagaland
10.	Sub-tropical dry Evergreen	Western Himalaya and Kashmir hills.
11.	Montane wet temperate	Eastern Himalaya, Assam & Assam hills.
12.	Himalayan moist Temperate	Himalaya of Punjab, Kashmir, Uttar Pradesh, Sikkim & West Bengal
13.	Himalayan dry temperate	Kashmir, Garhwal, Uttar Pradesh, Sikkim & inner Himalaya.
14.	Alpine	Higher reaches of Himalaya
15.	Savanna	Strip of grassland from Karnataka to Rajasthan through Maharashtra and Madhya Pradesh.

Class-wise forest cover in the country

Class	Area in sq.km.	% of Geographic area
Dense forest	416809	12.68
Open forest	258729	7.87
Mangrove	4871	0.15
Sub-total	680409	20.15
Scrub	51896	1.58
Non-Forest	2598074	78.27
Total	3330379	100.00

RESOURCE AREAS

Forests are an important reservoir of biodiversity. Ancient and frontier forests, because of their long standing and relatively lower levels of human disturbance, are typically richer in biodiversity than other natural or semi-natural forests. An illustration of the conservation importance of forests relative to biodiversity is found in the recent analysis of biodiversity hotspots (Myers *et al.*, 2000). Loss of forest will inevitably result in reduction of biodiversity as a direct result of loss of habitat. There are many anthropocentric reasons to preserve biodiversity (direct use value, option value, etc.) but the principal such reason considered here is the indirect use value in the form of ecosystem services. A loss in biodiversity affects the stability of an ecosystem resulting in a reduction of its resistance to disruption of the food web (by loss of the weak interaction effect), resistance to species invasion and resilience to global environmental change (McCann, 2000; Chapin *et al.*, 2000). Therefore, the argument for conserving biodiversity is two-fold:

(1) Biodiversity is essential for maintaining ecosystem services and

(2) Biodiversity increases the stability and resilience of an ecosystem to a disturbance.

Protected Area Network : Protected areas are recognized as the most important core 'units' for its resource and *in-situ* conservation. It is also a geographically defined area which is designated or regulated and managed to achieve specific resource conservation objectives. Protected area coverage was endorsed by the seventh Conference of the Parties (CoP_7) of the Convention on Biological Diversity (CBD) as an indicator for immediate testing in relation to the adopted target of significantly reducing the rate of biodiversity loss by 2010. However, the concept of protection is not new to this country. The concept of Sacred Groves, operation of closed period for fishing hunting and the establishment of wildlife reserves were known during the Mauryan kings in India in the second and third centuries (Grove, 1995). It is therefore, *"Protected areas are a cultural response to the perceived threats to nature"* (McNeely, 1998). But, the establishment of Yellowstone National Park in US in1872 is often cited as the starting point of the modern era of protected areas.

Definitions of the IUCN protected area management categories (IUCN 1994)

Category Ia

Strict nature reserve : protected area managed mainly for science

Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

Category Ib

Wilderness area : protected area managed mainly for wilderness protection

Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

Category II

National park : protected area managed mainly for ecosystem protection and recreation

Natural area of land and/or sea, designated to (i) protect the ecological integrity of one or more ecosystems for present and future generations, (ii) exclude exploitation or occupation inimical to the purposes of designation of the area and (iii) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III

Natural monument: protected area managed mainly for conservation of specific natural features

Area containing one or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

Category IV

Habitat/species management area : protected area managed mainly for conservation through management intervention

Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/ or to meet the requirements of specific species.

Category V

Protected landscape/seascape : protected area managed mainly for landscape/seascape conservation and recreation

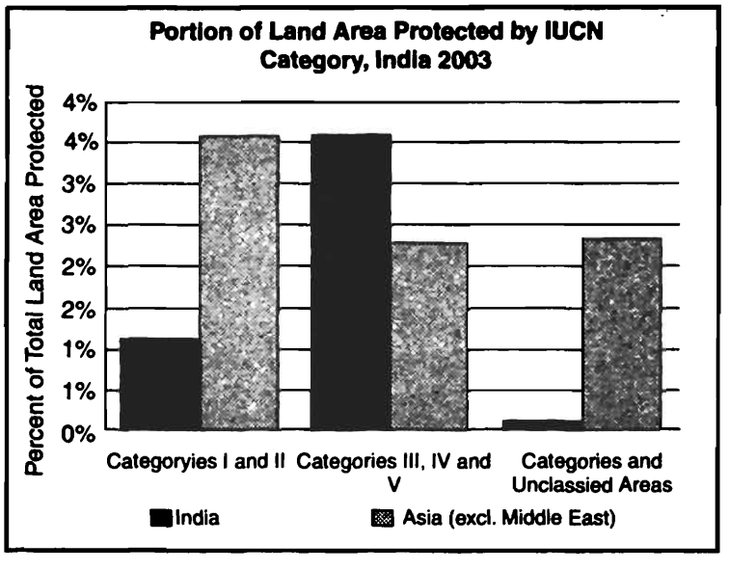
Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic,

ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

Category VI

Managed resource protected area: protected area managed mainly for the sustainable use of natural ecosystems

Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs



STATUS OF PROTECTED AREA NETWORK

Ministry of Environment & Forests, through various programmes assist and contribute to the development of a sound programme for the conservation and sustainable and equitable utilisation of biodiversity in the Protected Area Management Systems that will assure enduring ecological, economic and social benefits. The declarations of these are based on the following facts. The State Government may, by notification, declare its intention to constitute any area other than an area comprising within any reserve forest or the territorial waters as a sanctuary if it considers that such an area is of adequate ecological, faunal, floral, geomorphologic, natural or zoological significance, for the purpose of protecting, propagating or developing wildlife or its environment. The declaration of a National Park by the state government also falls with the same principle of protection, propagation and developing wildlife in an area, whether within a sanctuary or not.

The three-pronged approaches of the protected area are :

1. Securing the integrity of nearly a total of 87 National Parks with an area of 37,648.57 km or 1.15% of the country's geographic area and 485 Wildlife Sanctuaries with an area of 115,351.77 km or 3.51% have been established. This gives a total of 572 Protected

Areas, with an area of 153,000.34 km or 4.66% of the country's geographic area, within the forest ecosystem to preserve, mainly through the preparation of management plans and also through provision of support for surveillance and monitoring activities (Table). The conservation strategies adopted by the government are the initiation Project Tiger a programme that was launched in 1973 in order to ensure the maintenance of available population of tigers in India and to increase the species numbers. At present, there are about 3,800 tigers found in India in 27 Tiger Reserves. Project Crocodile is the second breeding programme initially started in Orissa was then extended to several other States in 1975. The major objective of the project is to protect the three endangered species of crocodiles, *Gavialis gangeticus, Crocodylus palustris and Crocodylus porosus.* The third programme, Project Rhino was launched in 1987 in Kaziranga Wildlife Sanctuary in Assam to save the Lesser One-horned Rhinoceros from extinction. Lastly in 1991-92 the Project Elephant was initiated to ensure long-term survival of identified population of elephants in their natural habitats.

2. Institutionalise the basic biological inventory work that has been progressing satisfactorily for several years, giving emphasis to the efficient data collection, storage and analysis and innovative information management. In this regard the ENVIS programme was initiated at various levels to disseminate information on the biological resources of the country.

3. Bioprospecting - an activity concerned with the search for new forest or marine products and other natural faunal and floral resources or their products with market potential. Culture of species of biomedical importance like horseshoe crabs, beetles etc.

National Parks and Wildlife Sanctuaries in India

No.	State	National Parks		Wildlife sanctuaries		Total Area
		No.	Area	No.	Area	Km^2
1.	Andhra Pradesh	4	3314.50	21	12530.09	15844.59
2.	Arunachal Pradesh	2	2468.23	10	7114.45	9582.68
3.	Assam	3	1173.71	13	939.88	2113.59
4.	Bihar	1	335.65	11	2068.25	2403.90
5.	Chattisgarh	2	1458.00	10	3419.41	4877.41
6.	Delhi	0	—	1	27.60	27.60
7.	Goa	1	107.00	6	647.96	754.96
8.	Gujarat	4	479.67	21	16422.71	16902.38
9.	Haryana	1	1.43	9	278.32	279.25
10.	Himachal Pradesh	2	1429.40	32	5736.85	7166.25
11.	Jammu & Kashmir	4	4650.07	16	10172.15	14822.22
12.	Jharkand	1	231.67	10	1822.00	2053.67

No.	State	National Parks		Wildlife sanctuaries		Total Area
		No.	Area	No.	Area	Km^2
13.	Karnataka	5	2472.18	20	3930.61	6402.79
14.	Kerala	3	536.52	12	2143.36	2679.88
15.	Madhya Pradesh	9	5016.69	25	7284.64	12301.33
16.	Maharashtra	5	955.93	33	14387.78	15343.71
17.	Manipur	2	81.80	1	184.85	266.65
18.	Meghalaya	2	267.48	3	34.20	301.68
19.	Mizoram	2	250.00	4	634.00	884.00
20.	Nagaland	1	202.02	3	24.41	226.43
21.	Orissa	2	990.70	18	6971.15	7961.85
22.	Punjab	—	—	11	317.79	317.79
23.	Rajasthan	4	3856.53	24	5712.83	8569.36
24.	Sikkim	1	1784.00	5	265.10	2049.10
25.	Tamil Nadu	5	307.85	20	2602.07	2909.92
26.	Tripura	—	—	4	603.62	603.62
27.	Uttaranchal	6	4920.82	5	2166.39	7087.21
28.	Uttar Pradesh	1	490.00	24	5428.15	5918.15
29.	West Bengal	5	1692.65	16	1103.48	2796.13
30.	Andaman & Nicobar	9	1157.14	94	327.13	1484.27
31.	Chandigarh	—	—	2	26.01	26.01
32.	Dadra & Nagar Haveli	—	—	—	—	—
33.	Daman & Diu	—	—	1	2.18	2.18
34.	Lakshadweep	—	—	—	—	—
35.	Pondicherry	—	—	—	—	—
	TOTAL	**87**	**40631.64**	**485**	**115329.42**	**155961.06**

BIOSPHERE RESERVES

A biosphere reserve is a specific type of conservation area, which accommodates and benefits both the natural environment and the communities living in and around it. This is possible because, a biosphere reserve consists of three different but associated zones *viz.*, Core, Buffer and Transition. Core zone, a most ecologically sensitive and pristine area where nature conservation is a priority with allowed low-impact activities. Buffer zone, a less ecologically sensitive but mostly natural area where recreation and sustainable utilisation of natural products can be accommodated and finally, the Transition zone, a less ecologically sensitive area where a great variety of land uses occur. All zones are

interdependent and are managed and protected according to the definitions above. By linking conservation, development and the sustainable use of natural resources, a harmony and balance between nature and people can be achieved. Following are the list of biosphere reserves in India, wherein conservation and management action plans are initiated. Several new ones are being in the process of addition to the existing ones.

No.	Name	Area Km^2	Date of Notification	Location & Type
1.	Nilgiri	5520.00	01.08.1986	Part of Wynad, Nagarhole, Bandipur, Mudumalai, Nilambur, Silent Valley, Siruvani Hills [Western Ghats of Karnataka, Kerala & Tamil Nadu]
2.	Nanda Devi	5860.69	18.01.1988	Part of Chamoli, Pithorgarh, Almora Dist. [Western Himalaya]
3.	Nokrek	820.00	01.09.1988	Part of Garo hills, Meghalaya [Eastern Himalaya]
4.	Great Nicobar	885.00	06.01.1989	Southern Islands of Andaman [A&N Islands]
5.	Gulf of Mannar	10500.00	18.02.1989	Indian part of Gulf of Mannar (Between Sri Lanka & India)-coasts
6.	Manas	2837.00	14.03.1989	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamrup & Darang Dists. [Assam-Eastern Himalaya]
7.	Sunderbans	9630.00	29.03.1989	Part of Delta of Ganges & Brahmaputra River–Gangetic Plain
8.	Simlipal	4374.00	21.06.1994	Part of Mayurbhanj Dist, Orissa [Deccan Peninsula]
9.	Dibru Saikhowa	765.00	28.07.1997	Part of Dibrugarh & Tinsukhia Dists, Assam–Eastern Himalaya
10.	Dehang-Debang	5112.00	02.09.1998	Part of Siang & Debang Valley in Arunachal Pradesh, Eastern Himalaya
11.	Pachmarhi	4926.28	03.03.1999	Part of Hoshangabad, Betul Chindwara Dist. of MP–Semi Arid Gujarat Rajputana
12.	Kanchendjonka	2619,92	07.02.2000	Part of Kanchendjonka in Sikkim–Eastern Himalya
13.	Agasthamalai	1701.00	12.11.2001	Neyyar, Peppara, Shendurani WLS of Kerala–Western Ghats

METHODS OF FAUNAL ASSESSMENT

Using the diversity index, Erwin (1982) estimated 30,000,000 arthropod species live in the tropical forests of the world, on the basis of canopy sampling of arthropods in Costa Rica, based on his calculation :

$$n = \frac{(a \times b \times c)}{(d \times c)}$$

Where *a* is the number of beetle species living on a given species of tree, *b* is the probability that a beetle species live exclusively on that tree, *c* is the number of different tree species growing in the tropics, *d* is the probability for a forest arthropod species to the animal communities of the canopy. Stork (1988) based on the assumption of Erwin (1982), found more than 2800 species from 24,000 arthropod collected from the 10 Bornean trees. In the same way, May (1992) estimates some 500,000 species on the sea floor only. Wilson (1988) estimates a total number of globally described species of plants and animals at 1,392,485. Minelli (1993) estimated 18,00,000 as the total number of living species, almost corresponding to the earlier estimate of 18,20,000 species by Stork (1981). To this, an estimated nearly 300,000 (Stern, 1981) or 2,50,000 (Raupp, 1988) fossil species are to be added. Global species diversity is estimated by Steyskal (1976), White (1975) and others. Nearly 1.5–1.7 million species of plants, animals and microbes have been named and described so far (Wilson, 1985; Groombridge, 1992). Assuming the global biodiversity to be 30 million species, the present knowledge of 1.75 million species amounts to a mere 5.67% of the total, IUCN (2004).

Currently documented rates of species introductions to different regions of the world are greater than documented rates of extinction. Thus, while the total number of species on the planet is decreasing due to extinctions, the total number of species on each individual continent is actually increasing and the distribution of species on earth is becoming more homogenous, *i.e.* suites of species are becoming more similar across the planet. (Duraiappah *et al.*, 2005). Consequence of this, the documentation of the biological resource of the country is becoming more important in recent years.

The value of the diversity of genes, species, or ecosystems *per se*, is too often confused with the value of a particular component of that diversity. Species diversity in of itself, for example, is valuable because the presence of a variety of species helps to increase the capability of an ecosystem to be resilient in the face of a changing environment. At the same time, an individual component of that diversity, such as a particular food plant or animal species, may be valuable as a biological resource. The consequences of changes in biodiversity for people can stem both from a change in the diversity *per se* and a change in a particular component of biodiversity or often resulting in the loss of biodiversity. Given the complexity of what constitutes biodiversity, it is clear that actual changes to biodiversity cannot be measured in full in any natural environment, and given logistical considerations. What is more important is that good metrics are used to measure

biodiversity "loss" UNEP (DEC)/MED WG.268/Inf.14 2 May 2005. The Convention on Biodiversity defines biodiversity loss to be "the long-term or permanent qualitative or quantitative reduction in components of biodiversity and their potential to provide goods and services, to be measured at global, regional and national levels" (CBD COP VII/30). Under this definition, biodiversity can be lost either if the diversity *per se* is reduced (such as through the extinction of some species) or if the potential of the components of diversity to provide a particular service is diminished (such as through unsustainable harvest).

The assessment of biological diversity depends on the distribution and diversity of species in different areas, habitats or ecosystems. Conservation efforts can be usefully assigned only on the basis of species richness, species abundance, geographic distribution and comparison in different areas, species/area relationships. Further the criteria for assigning the priorities for conservation of biological diversity depends on the richness in a given area, the number of occurrences of a genotype, species or ecosystem (Rarity), degree of separation of population, species or ecosystem from its comparable analog (Distinctiveness), degree of occurrence (Representation), imminent danger or harm (Threat) and the presence or absence of key stone resources (Function). An understanding of the biological diversity and ecosystem function rests on the identification of the biota in their habitats. The biodiversity assessment on the estimates of number of vertebrate and invertebrate species is the major task owing to the complexity related to their abundance, diversity and interactions in the varied habitats/ecosystems. Often only reasonable predictions on broad estimates of number of living species can be made depending on the available data pertaining to reference collection and literature and also on evaluations made on their ecological preferences. The process is also complex and challenging, invariably testing the competence and knowledge of taxonomists involved.

In order to handle the extinction crisis, the conservation scientists have to agree on an explicit mission and strategy aiming complete inventorying of the world's biota as quickly as possible at several levels or scales in time and space, from hot spot identification to global survey audited and readjusted at ten years intervals as suggested by Wilson (1992). The levels or scales of assay envisaged in recent years are the *Rapid Assessment Programme* (RAP) created by Conservation International, aiming mostly at the local hotspots; secondly by BIOTROP approach envisaging systematic exploration of broad areas including major and multiple hotspots. BIOTROP method also includes areas such as Wildlife Sanctuaries, National Parks, Biosphere Reserves and Ecologically Sensitive Areas. The third area of systematic inventorisation of the bioresources is the estimation of population and species concentration (species packing), either at individual, community or at ecosystem level employing Geographic Information System (GIS) technology. This includes collection of data on topography, vegetation, soil, hydrology and species distribution and is registered electronically on a common coordinate system. When applied to biodiversity and endangered species, the cartography is called gap analysis. Yet another way of analysis is the Statistical Analysis System (SAS), with a set of computer aided programmes, recording taxonomic identifications and localities of individual specimens, integrating the

data in catalogues and maps with an unbiased measure of similarity (phenetics) or deducing the family tree of species (cladistics).

Biological diversity is identified as the number of taxa within an area, as the number of different life-history stages, the different species interactions within an area, or simply the number of individuals of a selected species or group of species and the geographic distribution of those individuals. The different ecological roles that species may play at different stages in their lifecycles can be considered or the level of endemism and/or biodisparity (range of morphologies and reproductive styles in a community, determined by heterogeneity and unpredictability of habitats) (RAMSAR, 1999, Derous, 2004). The simplest method for target areas for conservation action is to identify countries with the highest number of species (greatest species richness, for e.g., the concept of Mega diversity countries based on the species of vertebrates, swallowtails, butterflies and higher plants). Various methodologies are adopted to estimate the faunal resources of the area, among them the following are important.

Species / Area relationships : The global distribution of biological diversity is that the tropics at lower latitudes harbour relatively more species per unit area than the temperate zones at higher latitudes and even within tropics the biological diversity does not exhibit any distinctly recognizable patterns. The number of species in an area increases with the size of the area and this increase follows a predictable pattern known as Arrhenius Relationship, $\mathbf{Log\ S = C + Z\ Log\ A}$, Where S = No. of species, A = Area and C & Z are constants. According to this *Species/Area* relationship more species occur in tropical communities than in the temperate and arctic communities, e.g., a small region at 60° latitude may have 10 species of ants, at 40° there may be 50–100 species and within 20° of the equator 100–200 species. Within the latitudinal limits (belts) the number of species varies widely among the habitats according to the productivity of the area and degree of structural heterogeneity. Therefore, tropics show higher diversity and rate of speciation, as they are older and more stable (Non equilibrium hypothesis), and less stringent competition due to greater productivity, more resources, increased spatial heterogeneity and increased control over competing populations exercised by predators (Equilibrium hypothesis). The differences between habitats are referred as beta (β) diversity while diversity within a site or habitat is known as alpha (α). Differences in the site diversity over large areas, such as continents, are sometimes to as gamma (γ) diversity.

The simplest measure of species diversity is the number of species or the species richness, which is calculated after Margalef (1968) as modified by Brower and Zar (1977) : $\mathbf{Da = (s\text{-}1)/log\ N}$, Where, Da = Margalef's index; s = no. of species and N = total number of individuals. Usually, Shannon – Weiner Diversity Index and Simpson diversity indices are used to describe the species diversity. This measure of species diversity, based on the information theory or related to the concept of "uncertainty" was calculated after Shanon and Weiner (1949) : $\mathbf{H' = \Sigma sP_i log\ P_i = 1}$. Where, H' = measure of Shannon–Weiner diversity, s = number of species and P_i = proportion of the total number of individuals occuring in

species i. However, in the present context, H' was calculated, using its algebraic manipulation as the equivalent equation after Brower and Zar (1977) : H' = (N log N - $\Sigma n_i \log n_i$)/N; Where, n_i = total number of individuals occurring in species, i = abundance of species. The maximum possible diversity H' or H_{max} was calculated using the following formula : $\mathbf{H_{max} = \log s}$ where *s* is the number of species or category. The most common indicator of trends in species abundance is species richness within a prescribed area. But monitoring the number of species in an area can be misleading, because it is generally the assemblage of organisms in an area that is important, rather than simply the number of species present (Derous, 2004). The species richness is valued as the common currency of the diversity of life, the "face" of biodiversity–the problem with this emphasis on using species for quantifying biodiversity is that such a focus on species may provide patterns that mask many important patterns and trends for other properties of biodiversity beyond taxonomy (Norse, 1994). For example, when the sizes of the areas chosen are substantially smaller than biogeographic regions, this will result in a high degree of species replication and will fail to protect those species most at risk (rare species), which mostly have unique habitat preferences (Derous, 2004). It is for this reason, a combined index of species richness, rarity and vulnerability was proposed by Rey Benayas and de la Montaña (2003) as a measure of the diversity of an area with species. Applying this index had a much better performance to reveal the areas of high diversity than when the constituting criteria were used. It should be noted that this index was developed for terrestrial ecosystems and that it has not been tested on its applicability in the marine environment (Derous, 2004). In marine ecosystems, intensification of fishing beyond sustainable levels has lead to ecological extinction of some species in some regions, and major imbalances in the entire marine food web (Watson *et al.*, 2003) and it is for this reason Marine Trophic Index is adopted to measures the change in mean trophic level of fisheries landings.

As an example, the usefulness on the application of various diversity indices on the faunal assemblage, based on the survey and inventorisation of Nalban Sanctuary, a protected area situated in the Chilka lake, Orissa has revealed the following relationships among the sampling sites and faunal groups. The Shannon-Wiener index, varied considerably from 2.05 to 0.99 at station 1, 6.17 to 1.4, 1.9 to 1.5, 1.5 to 1.3, 1.1 to 0 .72, 1.0 to 0.1, 1.6 to 1.1 and 2.07 to 1.6 at stations 2, 3, 4, 5, 6, 7 and 8, respectively. The maximum value of H recorded was 6.17, 2.07, 2.05 and 1.9 (Table) indicating a site of higher diversity. Higher diversity signifies longer food chain and more cases of symbiosis (mutualism, commensalisms *etc.*) and also more stable community (Margalef, 1968). Sampling sites 2, 7 and 8 with high species diversity are generally considered to have high conservation value. Evenness index measures of the uniformity of different species in a community and the value increases as the environment becomes favourable. The Evenness index values computed were found to vary between 0.91 to 1.1 at station-1, 1.02 to 3.44, 0.95 to 1.2, 0.8 to 1.1, 0.8 to 1.04, 0 to 1.4, 0.6 to 0.94, 1.0 to 1.1 in stations 2, 3, 4, 5, 6, 7, and 8 respectively (Table).

Table –Showing range of values of Shannon Wiener index (H), Simpsons index (D) and Evenness index (e) at the different sampling stations, during different seasons

Sampling Sites	*SW Monsoons*			Winters			Summers		
	H	*D*	*e*	*H*	*D*	*e*	*H*	*D*	*e*
N1	1.63	2.15	0.91	0.99	2.04	1.43	2.05	2.17	1.14
N2	1.83	2.68	1.02	1.44	2.36	1.32	6.17	13.20	3.44
N3	1.64	2.77	1.18	1.53	2.31	0.95	1.92	2.43	1.2
N4	1.30	2.04	1.19	1.59	2.65	0.99	1.49	2.31	0.83
N5	0.72	1.38	1.04	1.11	1.65	0.80	0.89	1.26	0.81
N6	0.32	1.00	0.00	1.00	1.94	1.45	0.14	1.00	0.00
N7	1.64	1.86	0.91	1.30	2.24	0.94	1.18	1.60	0.60
N8	1.88	2.71	1.17	1.61	2.65	1.00	2.07	2.43	1.06

In order to study the relation between the molluscan species, coefficient of correlation was calculated. Among gastropod a significant correlation between *Nassarius sp.* and *Thira tuberculata* ($r = 0.0.563$; $P<0.05$) *Cerithidia cingulata and Thira tuberculata* ($r = 0.798$; $P<0.01$) conforms their coincidence of abundant pattern. Similarly, among bivalves, a significant correlation between *Modiolus undulatus and Macoma birmanica* ($r = 0.430$; $P< 0.05$); *Macoma birmanica and Clementia* sp. ($r = 0.615$, $P<0.001$) was recorded while a negative correlation between *Modiolus undulatus and Clementia sp.* ($r = -0.622$, $P<0.01$) suggest an inverse relation due to the nature of substratum and feeding of other organism in island. Further, the ANOVA test conforms that there is significant variation within the molluscan species and no significant variation within stations.

FAUNAL RESOURCE

India is very rich in terms of biological diversity due to its unique biogeographical location, diversified climatic conditions and enormous ecodiversity and geodiversity. In fact, within only about 2% of world's total land surface, India is known to have over 7.43% of the species of animals that the world holds and this percentage accounts nearly for 206 species so far known, of which insects alone include 61,151 species. Indeed, those groups that are known to occur in India have not received adequate attention, while some other invertebrates (like Nemertinea, Nematomorpha, Priapulida, Pogonophora and Pentastomida) are not known at all in India. Further studies will not only reveal many more species but also certainly enhance the information on endemic species.

Table : Showing estimated number of described species

Taxonomic group	No. of species		% in India
	World	India	
PROTISTA (Protozoa)	**31250**	**2577**	**8.24**
ANIMALIA			
Mesozoa	71	10	14.08
Porifera	4562	500	10.70
Cnidaria	9916	842	8.49
Ctenophora	100	12	12.00
Platyhelminthes	17500	1622	9.22
Nemertinea	600	-	-
Rotifera	2500	330	13.20
Gastrotricha	3000	100	3.33
Kinorhyncha	100	10	10.00
Nematoda	30000	2850	9.50
Nematomorpha	250	-	-
Acanthocephala	800	229	28.62
Sipuncula	145	35	24.14
Mollusca	66535	5072	7.62
Echiura	127	43	33.86
Annelida	12700	840	6.61
Onychophora	100	1	1.00
Arthropoda	**987949**	**68389**	**6.90**
Crustacea	35534	2934	8.26
Insecta	867351	61151	6.90
Arachnida	73440	5818	7.90
Pycnogonida	600	16	2.67
Pauropoda	360	-	-
Chilopoda	3000	100	3.33
Diplopoda	7500	162	2.16
Symphyla	120	4	3.33
Merostomata	4	2	50.00
Phoronida	11	3	27.27
Bryozoa (Ectoprocta)	4000	200	5.00
Entoprocta	60	10	16.66
Brachiopoda	300	3	1.00

Table : *Contd*

Taxonomic group	No. of species		% in India
	World	India	
Pogonophora	80	-	-
Priapulida	8	-	-
Pentastomida	70	-	-
Chaetognatha	111	30	27.02
Tardigrada	514	30	5.83
Echinodermata	6223	765	12.29
Hemichordata	120	12	10.00
Chordata	**48451**	**4994**	**10.40**
Protochordata	2106	119	5.65
Pisces	21723	2546	11.72
Amphibia	5150	240	4.66
Reptilia	5817	460	7.91
Aves	9026	1232	13.66
Mammalia	4629	397	8.58
Total (Animalia)	1196853	88391	7.25
Grand Total			
(Protista+ Animalia)	1228103	91206*	7.43

(*Updated list Jan. 2006)

Estimated number of Endemic species

Group	No. of species		Percentage
	Total	Endemic	
Protozoa			
Free living	1247	90	7.21
Parasitic	1330	550	41.33
Mesozoa	10	10	100.00
Porifera			
Freshwater	31	13	41.93
Cnidaria	842	**10	-
Platyhelminthes	1622	1160	71.88
Rotifera	330	23	7.00
Gastrotricha	100	64	64.00
Kinorhyncha	10	7	70.00

Table : *Contd*

Group	No. of species		Percentage
	Total	Endemic	
Nematoda	2850	**400	-
Acanthocephala	229	203	88.64
Mollusca			
Terrestrial	1487	498	33.50
Freshwater	183	77	41.80
Echiura	43	12	28.00
Annelida			
Oligochaeta	473	368	77.80
Hirudinea	59	25	42.37
Arthropoda			
Crustacea	2934	501	17.07
Insecta	61151	20765	34.86
Arachnida	5818	2623	45.08
Phoronida	11	1	1.00
Bryozoa	4000	**12	-
Entoprocta	10	1	1
Chaetognatha	111	3	2.70
Chordata			
Pisces	2546	223	8.75
Amphibia*	240	138	58.33
Reptilia*	460	214	46.52
Aves	1232	176	14.28
Mammalia*	397	44	11.30

**Incomplete data and hence % not given, *Dta updated 2004

CONSERVATION

India has a rich tradition of respect for conservation of diversity of life. These traditions are responsible for the presence; through the length and breadth of the country; of hundreds of thousands of trees such as banyan and peepal, now recognized by ecologists as a significant keystone resource. They have permitted the persistence of macaque and langur monkeys and peafowl in the midst of villages and towns. Such traditions have also protected entire biological communities in sacred groves and sacred ponds. For instance, a few years ago, scientists of the Botanical Survey of India discovered a new species of

a leguminous climber, ***Kunsterlia keralensis*** in a sacred grove in the densely inhabited plains of Kerala. What is further encouraging is that these practices are today being adopted to the modern secular context. Thus many shifting cultivator communities from the northeastern states of Manipur and Mizoram have revived protection to sacred groves as safety forests. They serve as large belts of firebreaks exclusively to the villages (Gadgil, 1997).

The culture of conservation is well seen among the Ladakhis. Ladakh is mainly a Buddhist region in the north Indian states of Jammu & Kashmir with rugged elevations of 3,500 meters and more, poor soil conditions, less than 10 centimeters of rainfall per annum, temperatures of–40°C and very brief growing periods. And yet the Ladakhis have developed a diversity of crops, animals, agricultural land, social practices that allow them to survive in these harsh conditions. A key feature of their success is that they have selected and planted suitable crops in particular niches. Barley is grown everywhere except in the highest villages while apricots, apples and potatoes are grown in the lower valleys. Peas are harvested by hand with nitrogen-rich nodules left in the soil. Fields are irrigated with glacier run off and enriched with human night soil. In this diversified setting, many barley plants have more grains per stalk than most European varieties and cereal yields average about 10 metric tons per hectare compared to yields of 1 ton per hectare in India and Africa, 2.2 tons per hectare in North America and 1.5 tons in the former Soviet Union. The Ladakhis also raise a variety of animals for dairy products, meat, wool and transport. Stray social cooperation also enables the Ladakhis to use these methods successfully (Natiers-Hedge *et al.*, 1991).

Convention on biological diversity stipulates that the sovereign rights of countries of origin over their genetic/ biological diversity resources, and the acceptance of the need to share benefits flowing from commercial utilization of biological diversity resources with holders of traditional knowledge and practices of conservation and sustainable utilization of these resources. In view of this, Conservation of biological diversity is a protective measure to prevent the loss of genetic diversity of a species, save the species from extinction, and to protect ecosystems from damage so as to promote it's sustained utilisation. The "World Conservation Strategy" aims at resource conservation and sustainable utilization, as these two objectives will maintain the essential ecological process and the life-support systems, preserve genetic diversities besides sustainable utilisation of the genes, species and the ecosystems. These strategies *inter alia* will have the following usefulness to the community as a whole *viz.*,

- The inter-generational equity,
- Use and conservation of natural resources,
- Economic growth,
- Environmental protection,
- Precautionary principles,
- Obligation and assistance for cooperation.

The conservation paradigm of Redford *et al.* (2003), *"that we know more about what to conserve than how to conserve"* is true in case of temperate countries, but the situation is different in tropical countries where three fourths of biodiversity resides in small areas of the world. Conservation Programme is a useful tool to identify and to conserve the components of biodiversity in defined habitats and geographical areas for sustainable use. Besides the above, promoting *in situ* and *ex situ* conservation through an integrated scientific research by studying and formulating the intrinsic and extrinsic factors causing the depletion of species/populations will identify Biodiversity Conservation Regions and 'hotspot' areas (that require urgent measures) in the country for concentrated research and protection.

Biodiversity Information System forms an integral part of the data acquisition and retrieval system of National Biodiversity Authority, State Biodiversity Boards and Biodiversity Management Committees. It compiles information on a variety of issues, namely, status of country's ecological habitats, and the natural as well as anthropogenic processes impacting the habitats, population measures and conservation measures of resource base. These are well achieved by maintaining the database system on important groups of animal species with additional knowledge on traditional and ethnic ideas on wild relatives, land races and breeds of domesticated species to encourage equitable sharing of benefits arising out of utilisation of such knowledge systems. Dissemination of information on the importance of conservation and sustainable utilisation of biodiversity through popular and scientific publications and other educational programmes are the other methods employed to achieve the goal of conservation. Ministry of Environment & Forests has already initiated methods to achieve these goals through :

1. Emphasis on the basic role of natural ecological processes, bio-diversity and sustainable utilisation at all levels of decision-making.
2. Identify conservation priorities with attainable goals.
3. Implementation of sound conservation methods by promoting establishment of protected area network, biosphere reserves, management plans and conservation initiatives to preserve the natural habitat.
4. Promote a conservation consciousness with the public and community participation in conservation decisions providing facilities for conservation education and community development programmes.
5. Promote and regulate the use of natural resources in trade of endangered species and wild life products by enactment of Wildlife (Protection) Act, 1972, with suitable amendments from time to time, signing International treaties such as Wetland conservation, IUCN, CITES, CBD etc.
6. Establish an efficient scientific information and decision support system that includes needs-driven research and conservation planning by Botanical and Zoological Survey organizations, Wildlife Institute and several autonomous institutes under the Ministry

of Environment and Forests dealing with environmental priorities and discriminating information

7. Community based Programmes has been incorporated into the conservation strategy by giving importance to the ***sacred groves***. Sacred groves are defined as the species rich habitats that were consecrated to a deity or spirit, where extraction of any living material is forbidden. These sacred groves serve as prey refugia, where prey populations could maintain a minimal population. Such sacred groves investigated recently in Andhra Pradesh, Kerala, Karnataka, Madhya Pradesh, Bihar, and some Northeastern states are identified as the species rich area of the primary forests as in Western Ghats (Gadgil, 1993), or area with rare species (*Kunstleria keralensis*) Mohanan and Nair, 1981), endemic frog (*Philaetus sanctisilvaticus*) as in Amarkantak, M.P. (Das and Chanda, 1997), sacred ponds having a *refuge* of the black turtle (*Chelonys nigricans*) in Chittagong, Bangladesh (Reza Khan, 1980). The conservation idiom of the tribals is also seen in their hunting practices. The Jenu Kurubas in Southern India never extract honey completely from the honeycomb in order to ensure that the bees do not suffer and the production does not come to an abrupt end. Similarly, the tubers and other roots on which tribes sustain are never uprooted fully and are used ensuring that the mother plants survive and reproduce.

8. Forest based programmes by conservation of forests through the Forest Act; guarantee economically, ecologically, socially and culturally sustainable utilisation of the forests. It aims at promoting a rational use of forest resources. A key element of the Forest Act, with regards to safeguarding biodiversity, is defining certain habitats of special importance and giving guidelines as to how these habitats may be managed. Joint Forest (Protected Area) Management an Act under Participatory Management under Wildlife Act, Silvicultural practices, Co-operation between forest dwellers and forest authorities are added to the Forest Protection & Conservation. Use of remote sensing for data gathering, allied to the introduction of Geographic Information System (GIS) as a powerful tool to process that data in conjunction with information collected using traditional field techniques. This has been further substantiated by Peter Raven (2004) that locally driven indigenous efforts incorporating participatory approach, conflict resolution, and mutual learning are more likely to garner the relatively broad support and participation of local communities and strengthening of the local institutions for conservation.

9. Human oriented programmes such as development of Safari Park, ranching of some game animals, identification of agriculture and forests pests and propagation of species, effective control of pests (Biological Control), culture of edible frogs, oysters, clams and other food animals.

10. Taxonomy is the science of identification, classification and naming of organisms. Taxonomic work involves study of morphological characteristics and phylogenetic relationship of organisms, which is essential for applied biological sciences including medicine, agriculture, forestry and fisheries. A sound taxonomic knowledge base is

a pre-requisite for environmental assessment; ecological research, effective conservation, management and sustainable use of biological resources. At this crucial juncture, when the need for a taxonomic stock taking of the earth's biodiversity is becoming increasingly important and urgent, taxonomic experts are ageing and declining in number, both nationally and globally. This decline of taxonomic expertise is a critical problem that needs to be addressed urgently. Current requirements of taxonomic work and available expertise and studies indicate a dire need to encourage excellence and motivate experts to do work on hitherto neglected groups of organisms e.g., microbes, lower groups of plants, animals etc. The challenges are quite serious because while on the one hand the existing experts are ageing and retiring, on the other not many young scholars are opting for studies in taxonomy.

Hence, the Ministry of Environment and Forests set up a Technical Group to develop the All India Project and after inter-ministerial consultations, the project was approved. The project envisaged establishment of centres for research in identified priority gap areas (e.g. virus, bacteria, micro-lepidoptera, molusca, diptera etc.) in the field of taxonomy, education and training (fellowships, scholarships, chairs, career awards etc.) and strengthening of National Taxonomic Institutions such as Botanical Survey of India and Zoological Survey of India as the ***coordinating units.*** The modalities of implementing the All India Coordinating Project and prioritising activities under the project was decided after detailed consultations with experts. The Ministry launched the All India Coordinated Project on Capacity Building in Taxonomy (AICOPTAX) in the financial year 1999-2000. Nine centres for research and two centres for training and coordinators for these centres were identified in the first phase. Subsequently, one centre was added and during the financial year 2001-2002, two more centres have been added bringing the total to fourteen.

11. **Regulations through Laws :** Conservation of biological diversity is taken up through the introduction of various legal procedures especially the Wildlife Protection Act, 1972, Environmental Protection Act, 1991 and declaration of *Ecologically Sensitive Areas* in the country. The Indian Wildlife (Protection) Act, 1972 intended to provide a comprehensive National legal framework for wildlife protection, with conservation of species as the main criteria. The strategy includes total environmental protection and conservation with the assumption that all such areas should be free from human activities. The act prohibits hunting of wildlife, protects their habitats, and restrains trade in wild animals, trophies etc. The scope of this act was slightly ambiguous in the initial stages, as the definition of wildlife included only selected wild animals and birds. However, the scope was broadened in Wildlife Protection Amendment Act 1991 to include flora as well as fauna. The two-pronged approaches of this act are :

    ★ Specified endangered species are protected regardless of its location and

    ★ All species are protected in specified areas

The threat category implies a higher expectation of extinction, and over the time-frames specified more taxa listed in a higher category are expected to go extinct than those in a lower one (without effective conservation action). However, the persistence of some taxa in high-risk categories does not necessarily mean their initial assessment was inaccurate. The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. The IUCN Council adopted the new Red List system in 1994. The latest version is 3.1 of 2001 published in 2003. According to IUCN all taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable. Together these categories are described as 'threatened' The threatened categories form a part of the overall scheme. It will be possible to place all taxa into one of the categories

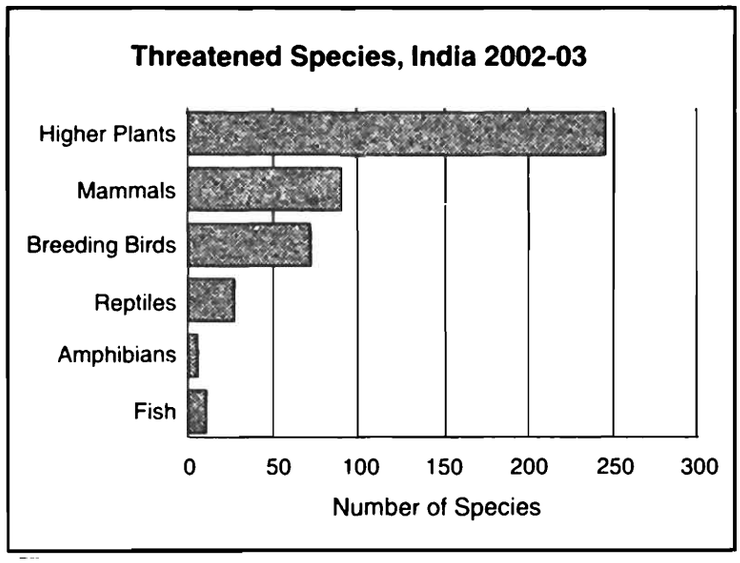
For listing as Critically Endangered, Endangered or Vulnerable there is a range of quantitative criteria; meeting any one of these criteria qualifies a taxon for listing at that level of threat. Each taxon should be evaluated against all the criteria. Even though some criteria will be inappropriate for certain taxa (some taxa will never qualify under these however close to extinction they come), there should be criteria appropriate for assessing threat levels for any taxon. The relevant factor is whether *any one* criterion is met, not whether all are appropriate or all are met. Because it will never be clear in advance which criteria are appropriate for a particular taxon, each taxon should be evaluated against all the criteria, and *all* criteria met at the highest threat category must be listed.

India contains 552 species of animals considered threatened by IUCN 2004, or 7.20% of the world's total number of threatened species. These include 85 species of mammals, 79 birds, 25 reptiles and 66 amphibians, 28 species of fishes, 2 species of molluscs and 21 species of other invertebrates. Out of the species identified by IUCN (2004) as Red list categories, 1 species extinct, 35 species are critically endangered, 91species are endangered, 180 species are vulnerable, 7 species are at lower risk/conservation dependant and 143 species are at lower risk- near threatened, while for 1400 species, the data is deficient. India contains globally important populations of some of Asia's rarest animals, such as the Bengal Fox, Asiatic Cheetah (now extinct in Indian limits), Marbled Cat, Asiatic Lion, Indian Elephant, Asiatic Wild Ass, Indian Rhinoceros, Markhor, Gaur, Wild Asiatic Water Buffalo etc. The number of species of various taxa found in India that are listed under the different categories of endangerment are shown :

Globally Threatened Animals Occurring in India by Status Category

Groups	Threatened	Extinct	Cr	En	Vu	LRnt	NT	LRcd	DD	Total
Mammals	213	2	12	47	63	39	13	6	31	213
Birds	149		10	13	64	3	56		3	149
Reptiles	033		4	12	10	4			3	33
Amphibia	148	1	14	30	22		9		72	148
Pisces	75		2	5	20	14	13		21	75

Groups	Threatened	Extinct	Cr	En	Vu	LRnt	NT	LRcd	DD	Total
Crustacea	12				09				3	12
Mollusca	5			2				3		5
Hymenpotera	5				5					5
Lepidoptera	4					3			1	4
Odonata	3		1		2					3
Anoplura	1		1							1
Total	**648**	**3**	**44**	**109**	**195**	**63**	**91**	**9**	**134**	**648**



IUCN RED LIST CATEGORIES AND CRITERIA

Prepared by the IUCN Species Survival Commission. As approved by the 51st meeting of the IUCN Council Gland, Switzerland, 9 February 2000, IUCN - The World Conservation Union, 2001.

EXTINCT (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected

habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a period appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it is not Extinct and it is considered to be facing an extremely high risk of extinction in the wild. Survey should be over a time appropriate to the taxon's life cycle and life form.

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it is not Critically Endangered but is considered to be facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria.

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it is not Critically Endangered or Endangered but is considered to be facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria.

NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

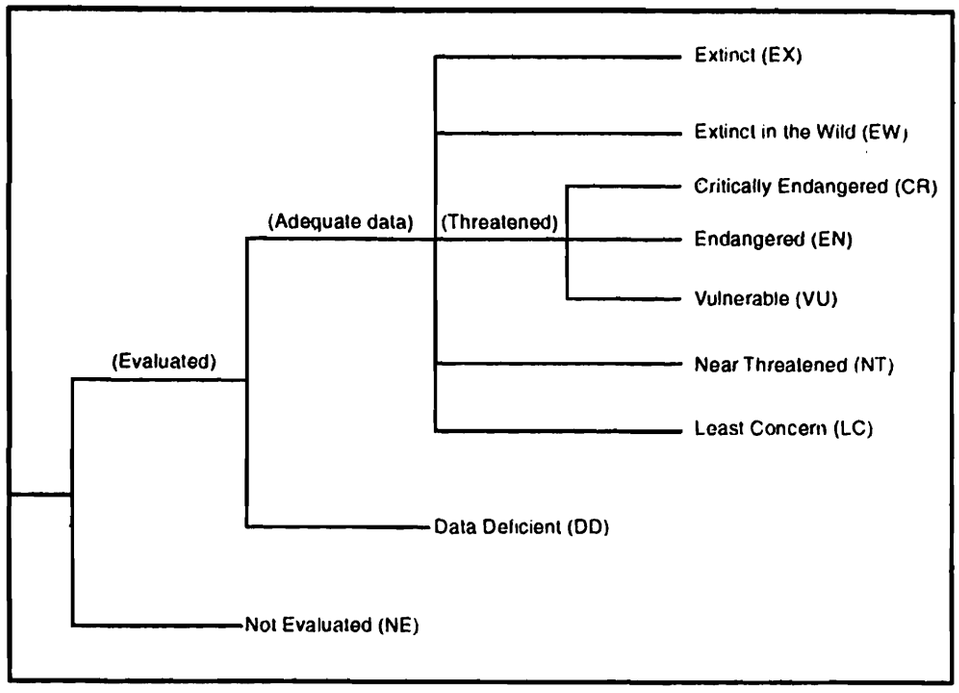
LEAST CONCERN (LC)

A taxon is of Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened categories. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available.

In many cases great care should be exercised in assigning a Data Deficient or a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.



Structure of IUCN categories

NOT EVALUATED (NE)

A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Another important criterion for conservation is the endemic status of the fauna. India has many endemic plants and vertebrate and invertebrate species. Among plants, species endemism is estimated at 33% with *c.* 140 endemic genera but no endemic families (Botanical Survey of India, 1983). Areas rich in endemism are northeast India, the Western Ghats and the northwestern and eastern Himalaya. A small pocket of local endemism also occurs in the Eastern Ghats (MacKinnon and MacKinnon, 1986). The Gangetic plains are generally poor in endemics, while the Andaman and Nicobar Islands contribute at least 220 species to the endemic flora of India (Botanical Survey of India, 1983). Threatened Plants Unit (TPU) is in the preliminary stages of cataloguing the world's centres of plant diversity; approximately 150 botanical sites worldwide are so far recognised important for conservation action, but others are constantly being identified (IUCN, 1987). Five locations have so far been issued for India: the Agastyamalai Hills, Silent Valley, New Amarambalam Reserve, Periyar National Park (all in the Western Ghats), and the Eastern and Western Himalaya.

Among various faunal groups, 396 higher endemic vertebrate species have been identified by WCMC from source references. Endemism among mammals and birds is relatively low. Only 44 species of Indian mammals have a range that is confined entirely to within Indian territorial limits. Four endemic species of conservation significance occur in the Western Ghats. They are the Lion-tailed macaque *Macaca silenus*, Nilgiri leaf monkey *Trachypithecus johni* (locally better known as Nilgiri langur *Presbytis johnii*), Brown palm civet *Paradoxurus jerdoni* and Nilgiri tahr *Hemitragus hylocrius*.

Only 55 bird species are endemic to India, with distributions concentrated in areas of high rainfall. The areas have been mapped by Bird Life International (formerly the International Council for Bird Preservation). They are located mainly in eastern India along the mountain chains where the monsoon shadow occurs, southwest India (the Western Ghats), and Andaman and Nicobar Islands (ICBP, 1992). In contrast, endemism in the Indian reptilian and amphibian fauna is high. There are around 187 endemic reptiles, and 138 endemic amphibian species. Eight amphibian genera are not found outside India. They include, among the caecilians, *Indotyphlus, Gegeneophis* and *Uraeotyphlus;* and among the anurans, the toad Bufoides, and the microhylid *Melanobatrachus,* and the frogs *Ranixalus, Nannobatrachus* and *Nyctibatrachus.* Perhaps most notable among the endemic amphibian genera is the monotypic *Melanobatrachus* which has a single species known only from a few specimens collected from the Anaimalai Hills in the 1870s. It is possibly most closely related to two relict genera found in the mountains of eastern Tanzania (Groombridge, 1983).

Further, the 'Washington' Convention on International Trade in Endangered Species of Wild Fauna and Flora, more commonly known as CITES, aims to protect certain plants and animals by regulating and monitoring their international trade to prevent it reaching unsustainable levels. The Convention entered into force in 1975. There are more than 150 Parties to the Convention. The CITES Secretariat is administered by the United Nations Environment Programme (UNEP) (Refer : checklist of CITES species and annotated cites appendices and reservations, Published by : CITES Secretariat/UNEP World Conservation Monitoring Centre).

Threatened Endemic Indian Species by groups and categories

Groups	Threatened	Endemic	Percentage	Extinct	Cr	En	Vu	LRnt	NT	LRcd	DD
Mammals	213	63	29.10	1	8	21	19	4	2		7
Birds	149	43	28.85		5	3	20		13		2
Reptiles	033	1	3.03			1					
Amphibia	148	72	48.64	1	2	15	13		5		36
Pisces	075	2	2.66			2					
Crustacea	012	2	16.66				2				
Total	**630**	**183**	**29.01**	**2**	**15**	**42**	**54**	**4**	**20**		**45**

SUSTAINABLE DEVELOPMENT

The "World Conservation Strategy" of 1980, emphasized three objectives of resources conservation, viz., i. Maintenance of the essential ecological process and the life-support systems, ii. Preservation of the genetic diversities, iii. Sustainable utilisation of the genes, species and the ecosystems. However, the strategy did not prescribe any social, political or organisational framework to realise these objectives. Norwegian Prime Minister. G.H. Burtland (Dec.1983), chairing the World Commission on Environment & Development of UN General Assembly made it clear that the existing pattern of development are not

sustainable and the commission defined "Sustainable Development" as the development, which meets the needs and the aspirations of the present without compromising the ability of the future generations to meet their needs. From then onwards, the concept of sustainable development has acquired a new dimension in terms of economic growth and environmental protection. It is this convention that gave the inter-generational equity, use and conservation of natural resources, environmental protection, precautionary principles, obligation and assistance to cooperate, eradication of poverty and financial assistance in the developing countries.

In 1987 the definition of the phrase "Sustainable Development" was modified, and redefined as that which lasts, durable and dynamic enough to meet the emerging needs of the people. It means taking the development processes in such a manner as to "preserve" or "conserve" the life-supporting systems and the resources-capital base of the Earth like air, water, soil, forests, fauna, flora, minerals, non-renewable resources, etc. It also means meeting the needs of the present generations without impairing the needs of the future generations. It is now defined as the "Social and structural economic transformation which optimises the social and economic benefits available in the present without jeopardising the likely potential for similar benefits in the future"

Ecologically the sustainable development is "using, conserving and enhancing the community resources so that the ecological processes, on which the life depends, are maintained and the total quality of life, now and in the future can be increased" Therefore the guiding principles of sustainable development in the broad sense are :

- Respect and care for the community of life
- Improve the quality of human life
- Conserve the earth's vitality and diversity
- Conserve life support system
- Conserve biodiversity
- Ensure that the use of renewable resources are sustainable
- Minimise the depletion of non-renewable resources
- Enable communities to care for their own environments
- Provide a national framework for integrating the development and conservation

India's Environmental policy, including International Agreements and implementation is principally made by the Ministry of Environment & Forests (MoEF), Government of India. The Convention of Biological Diversity (1992) to which the Government of India is a signatory, dwell a great deal on the need to document the biological diversity existing with in the Indian territory. Being conscious of the intrinsic value of the biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values, especially Article – 7 of the Convention proposes the member country for the ***"Identification and Monitoring"*** It also calls for the signatories to monitor through

sampling and other techniques, besides identifying the process and categories of activities, which are likely to have significant adverse impact on the conservation and sustainable use of resources. This involves a combination of collection and collating the existing data, generation of new data accessible easily for the conservation of resources.

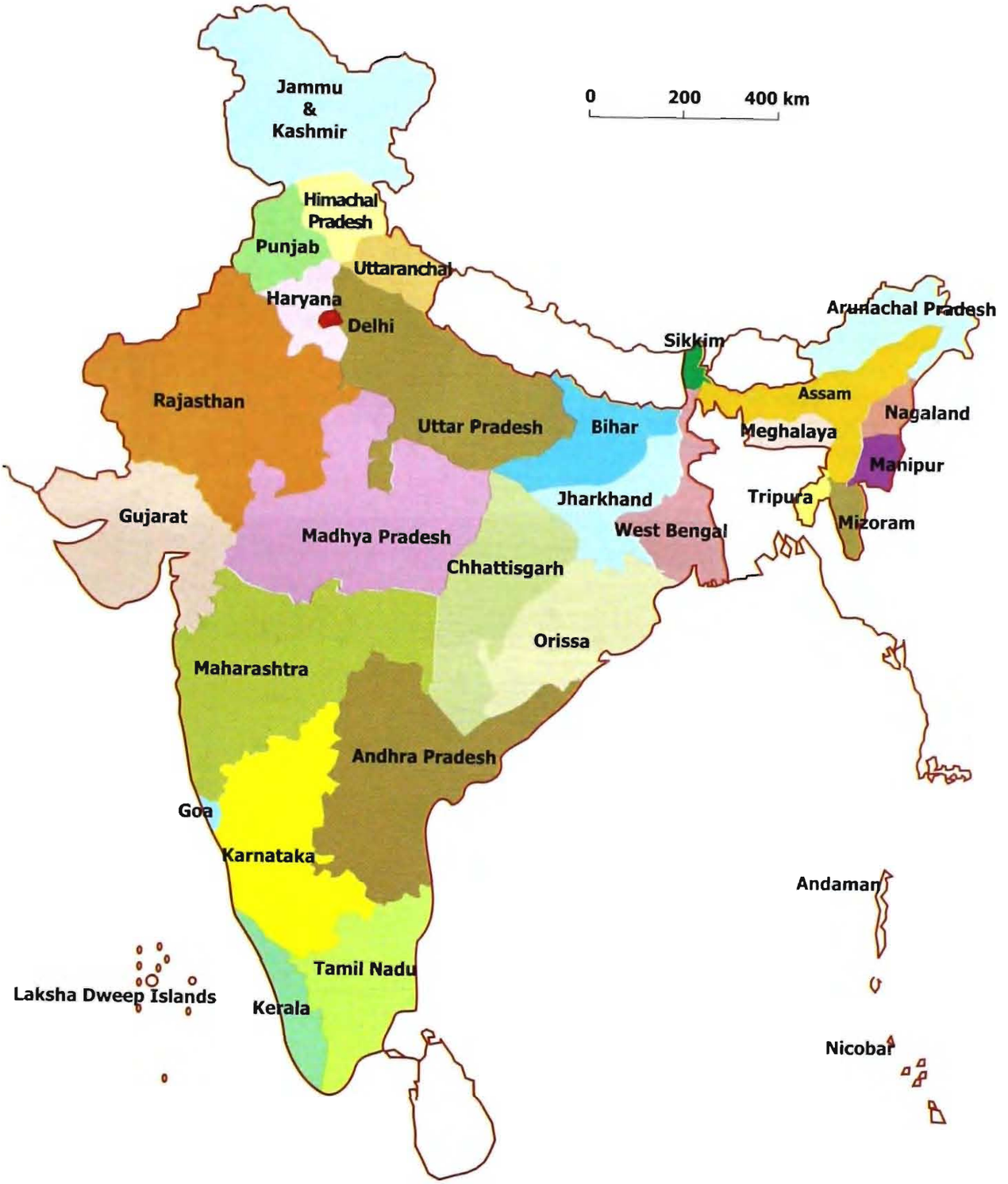
Inventorisations provide and develop data on natural resources and help to develop biological bases, reference collections, gene banks, technologies and services required by Government in the execution of its regulatory, developmental and protection functions. These inventories are the benchmarks of databases of reference collections of fauna from different geographic areas and provide density and volumes of different classes of natural resources of the country. The inventorisation will aid in timely warning of impending threats to natural resource base and the impact of human activities thereon in the maintenance of biological diversity in all ecosystems and areas such as :

- States and union territories
- Natural ecosystems & habitats
- Landscapes where forestry, fisheries and grazing are dominant land use factors
- Threatened and Endangered population of wild species
- Agriculture and other economically important species and their wild relatives
- Species or habitats having significant social and cultural importance (e.g., Sacred groves)
- Habitats or ecosystems associated with the key evolutionary (e.g., *"refugia"*) or biological processes (migratory habitats or corridors)

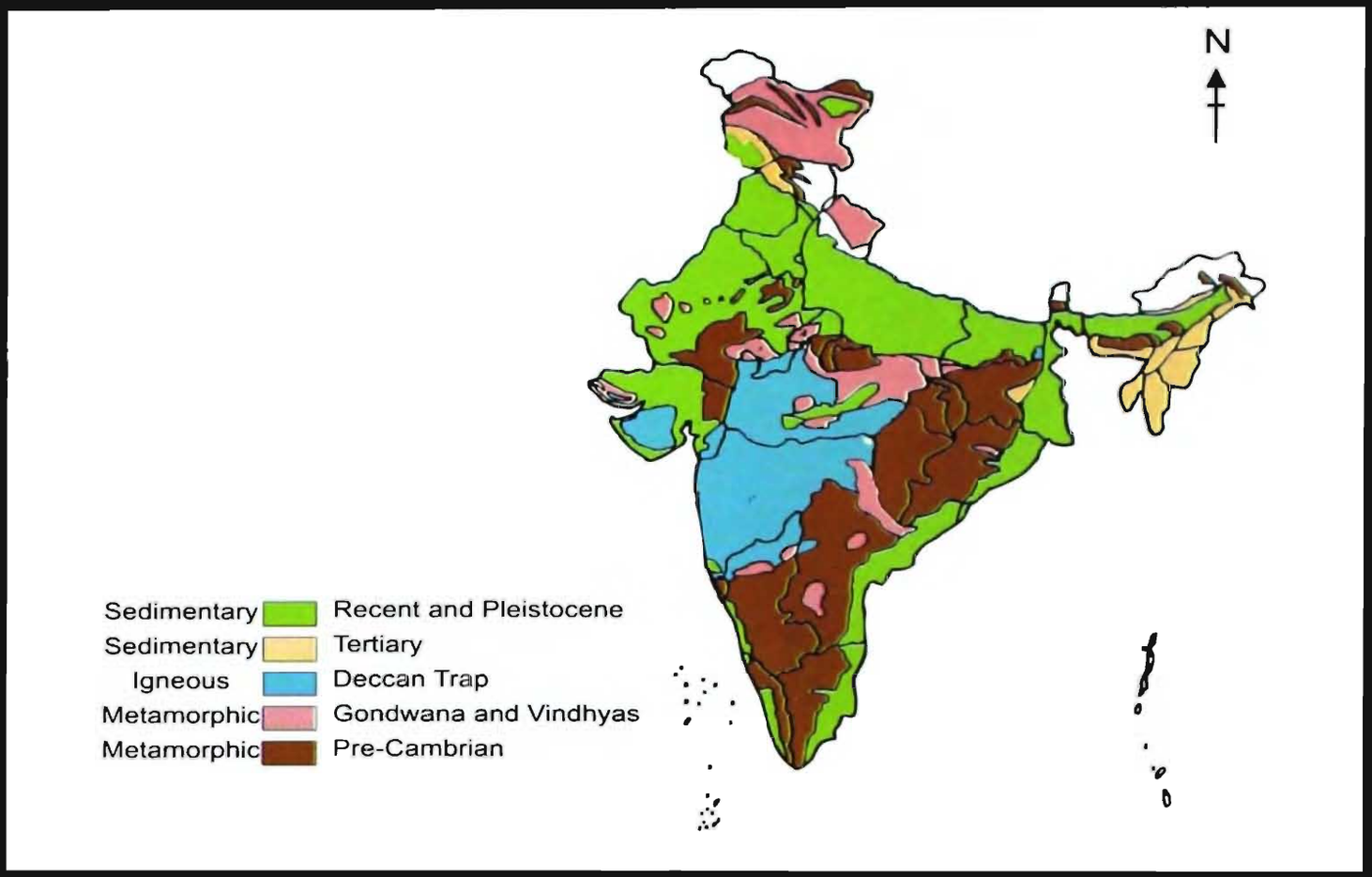
PRECAUTIONARY PRINCIPLE

In recent years a concept called the 'precautionary principle' or 'precautionary approach', which has become an important principle of international environmental law, reflected in global agreements such as the Convention on Biological Diversity (CBD), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The use of precautionary approach resulted from increasing recognition that ecological systems cannot be comprehensively observed and that impacts cannot, therefore, be fully regulated and controlled. In essence, the precautionary approach identifies scientific and other limitations and promotes regulatory action in the absence of full evidence of a cause – effect relationship. It allows incomplete data, uncertainty and indeterminacy to be taken into account in a meaningful way in the decision making process (Stirling, 1999). In other words, if there is a threat, which is uncertain, then some kind of action is mandatory.

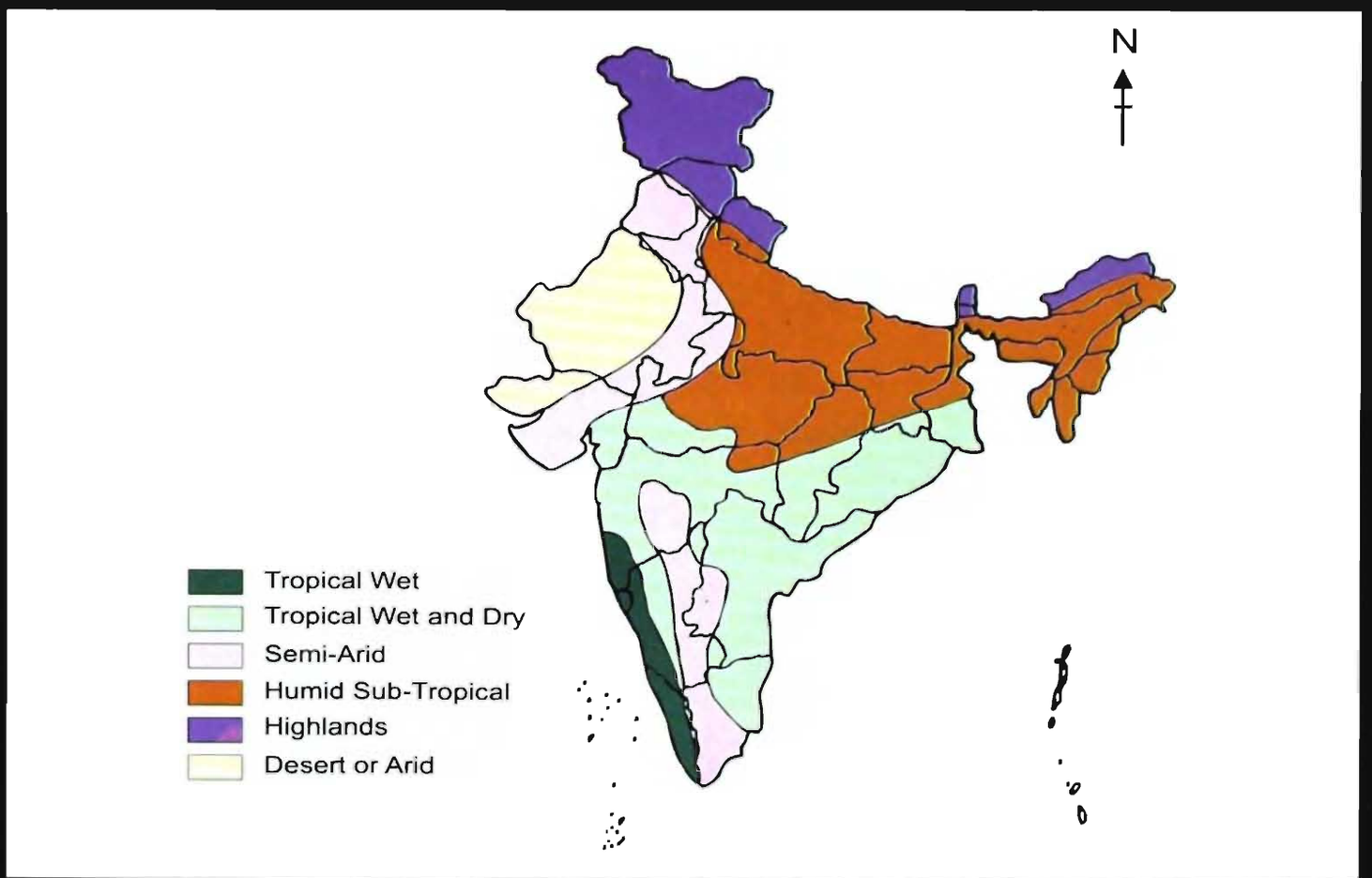
Stability in terms of population and the ecosystem is commonly known as Homeostasis. During the process, several factors such as biotic and abiotic, acts in the system maintaining a balance of nature. Any deviation from this natural phenomenon results in an abnormal



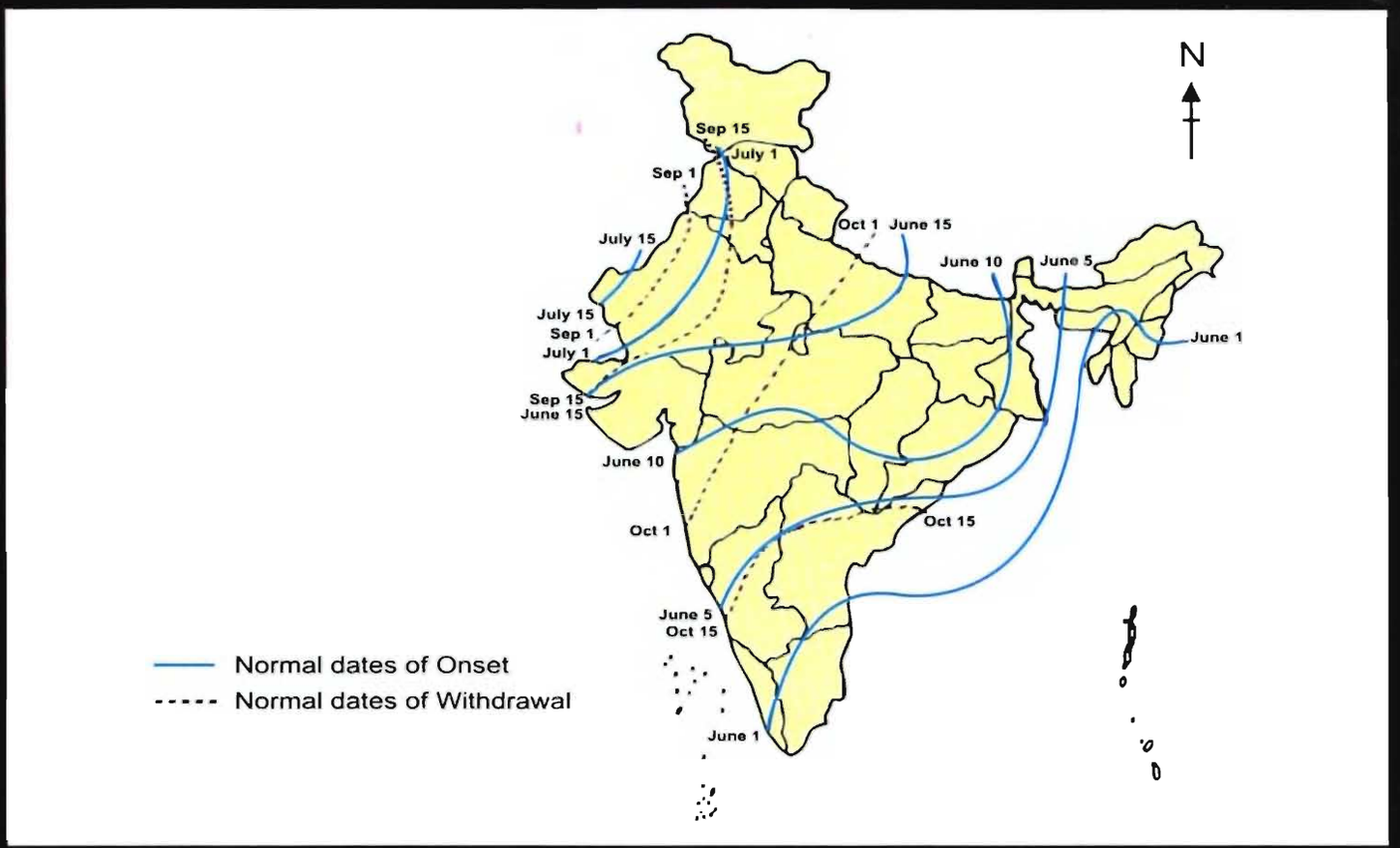
Map 1. Political map of India (*Source* : Kumar *et al.*, 2005)



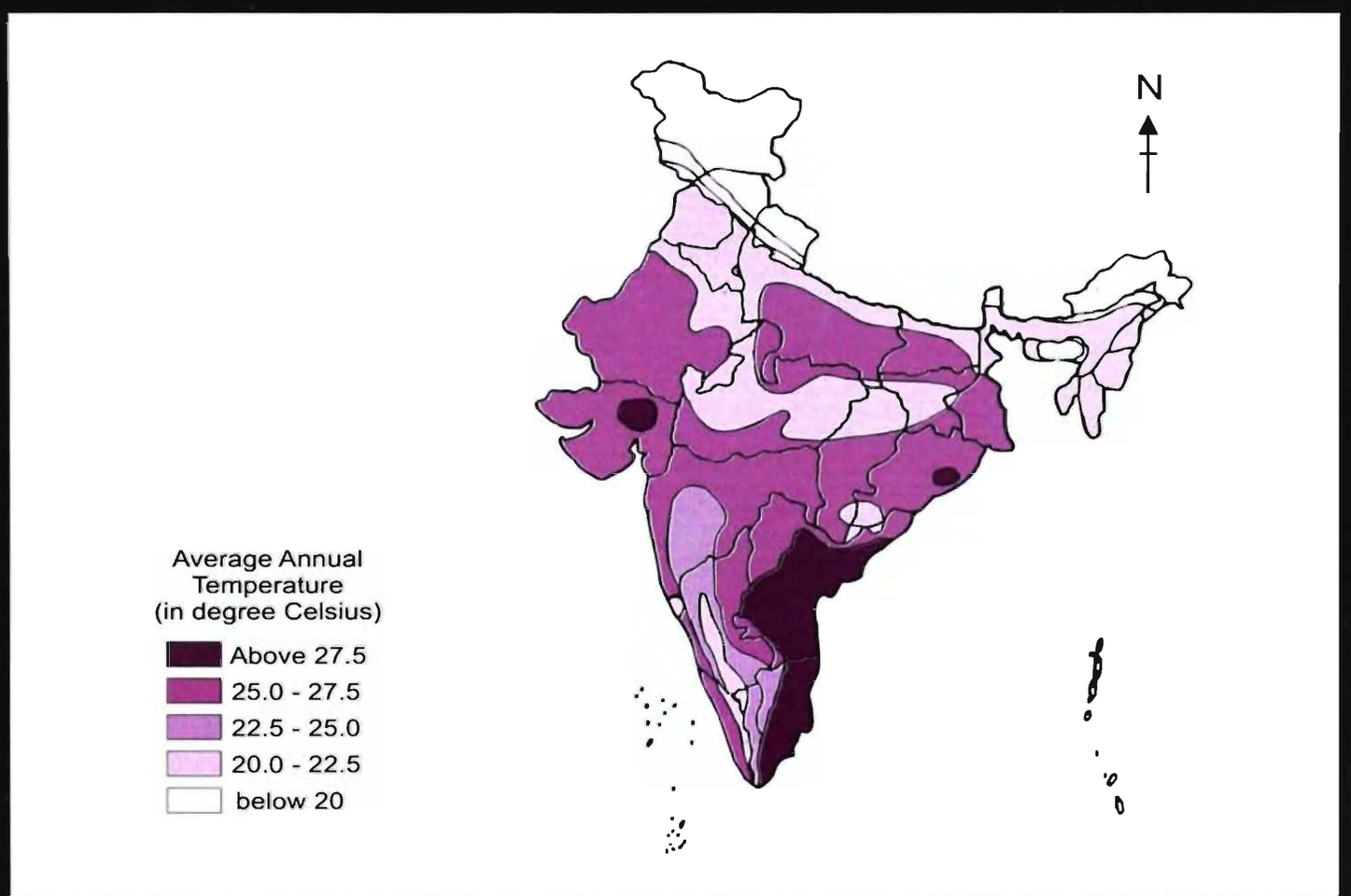
Map 2. Geological map of India (*Source* : Kumar *et al.*, 2005)



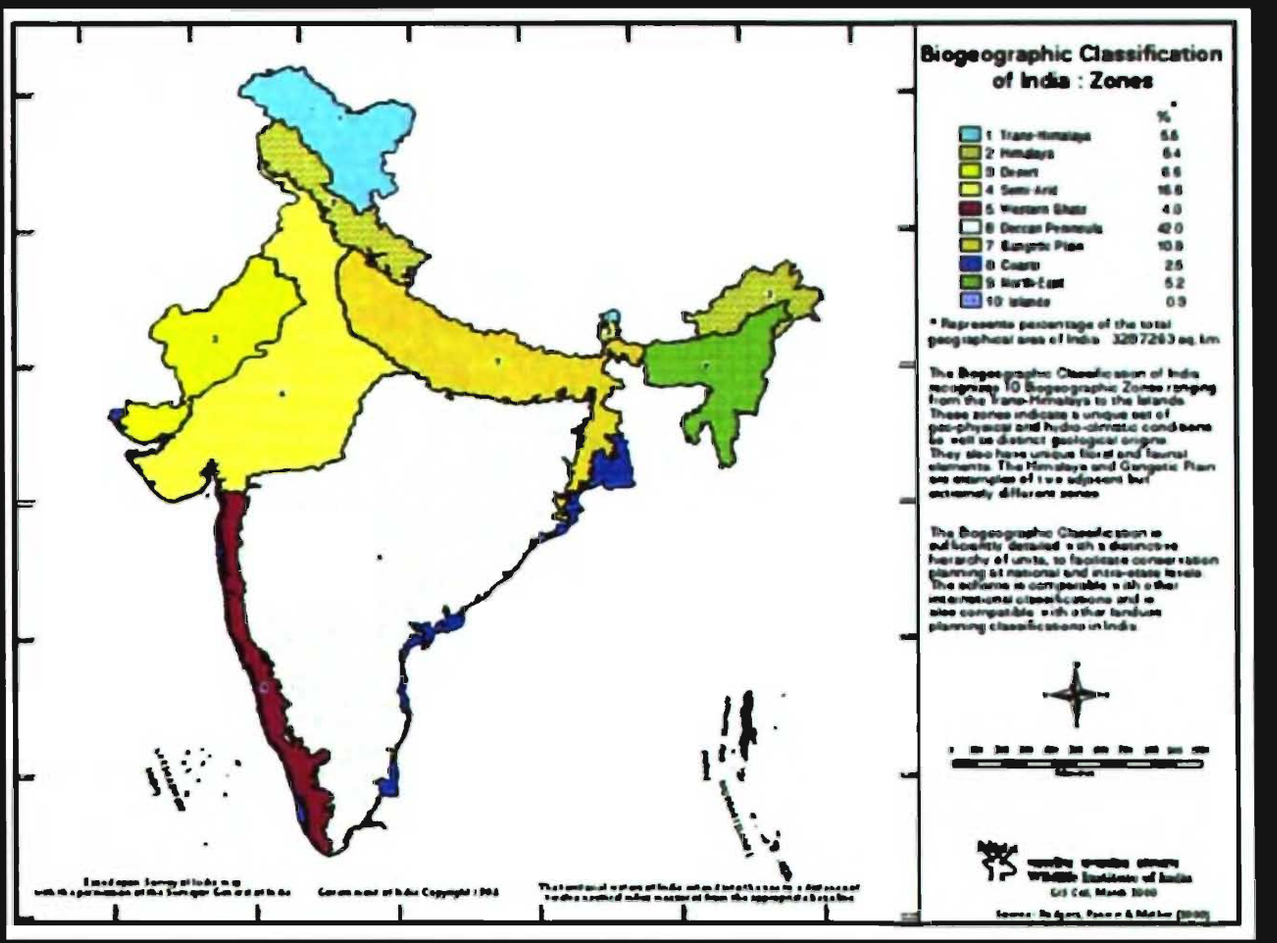
Map 3. Climatic Regions of India (*Source* : Kumar *et al.*, 2005)



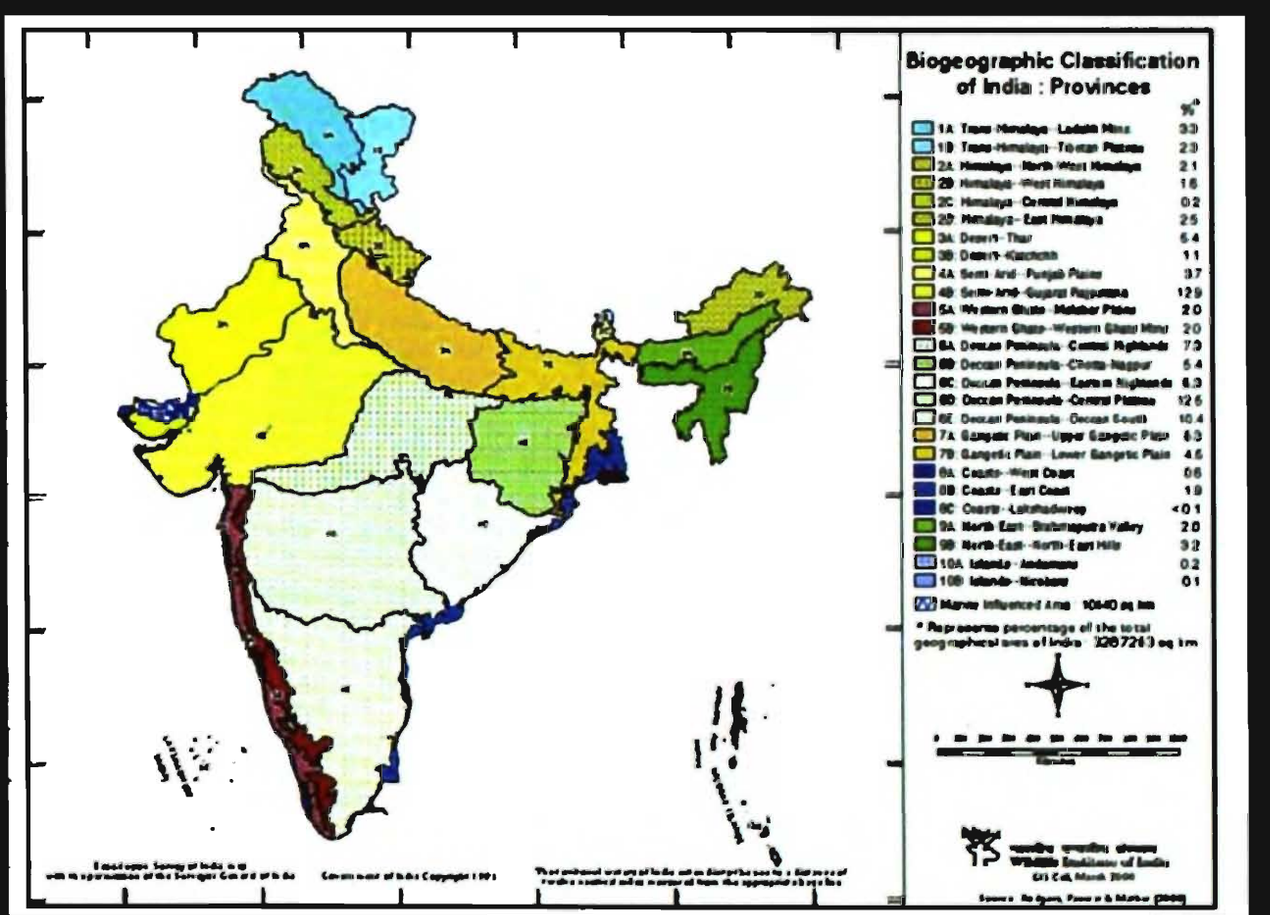
Map 4. South-West Monsoon pattern in India (*Source* : Kumar *et al.*, 2005)



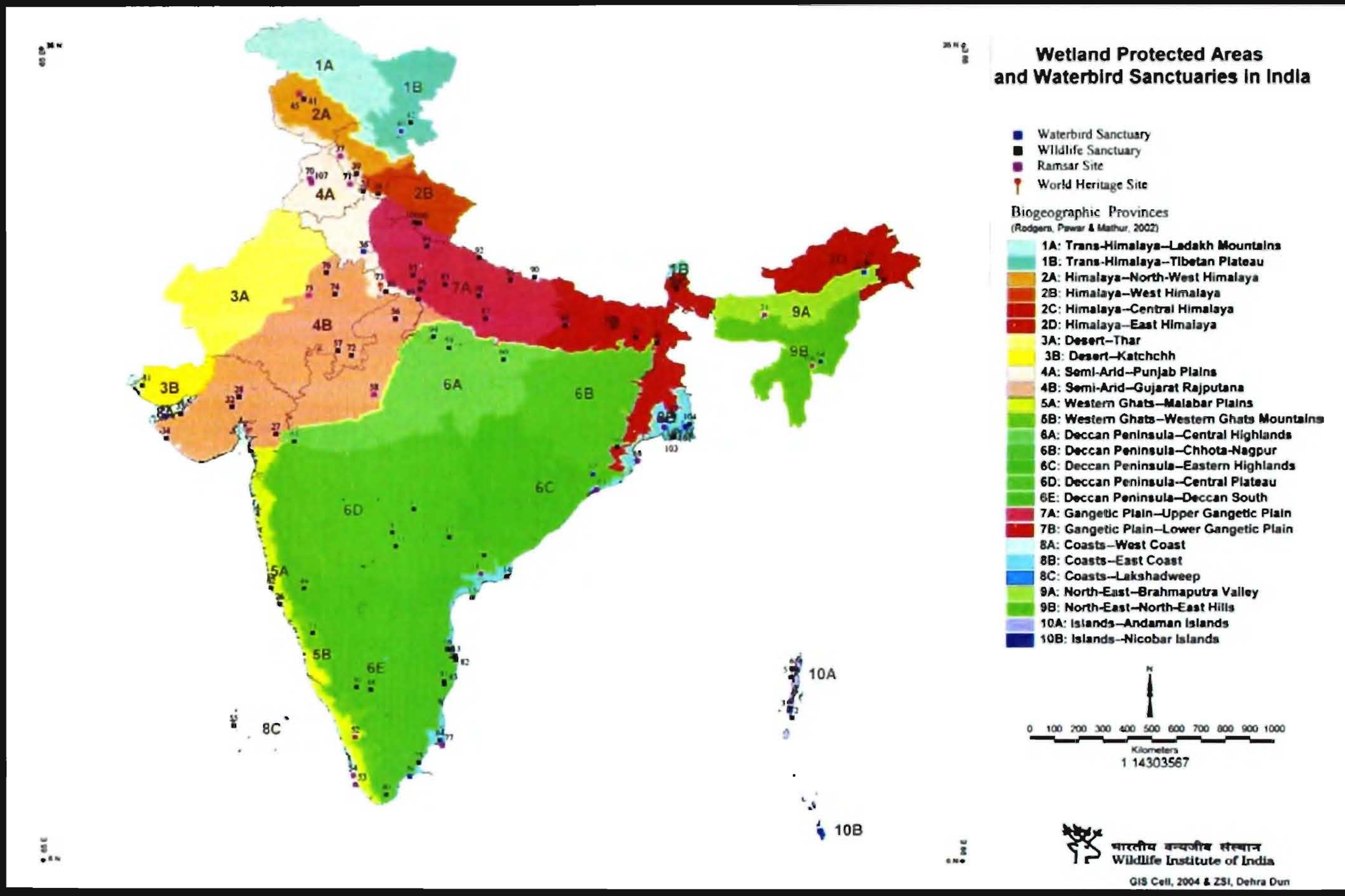
Map 5. Mean Annual Temperature of range in India (*Source* : Kumar *et al.*, 2005)



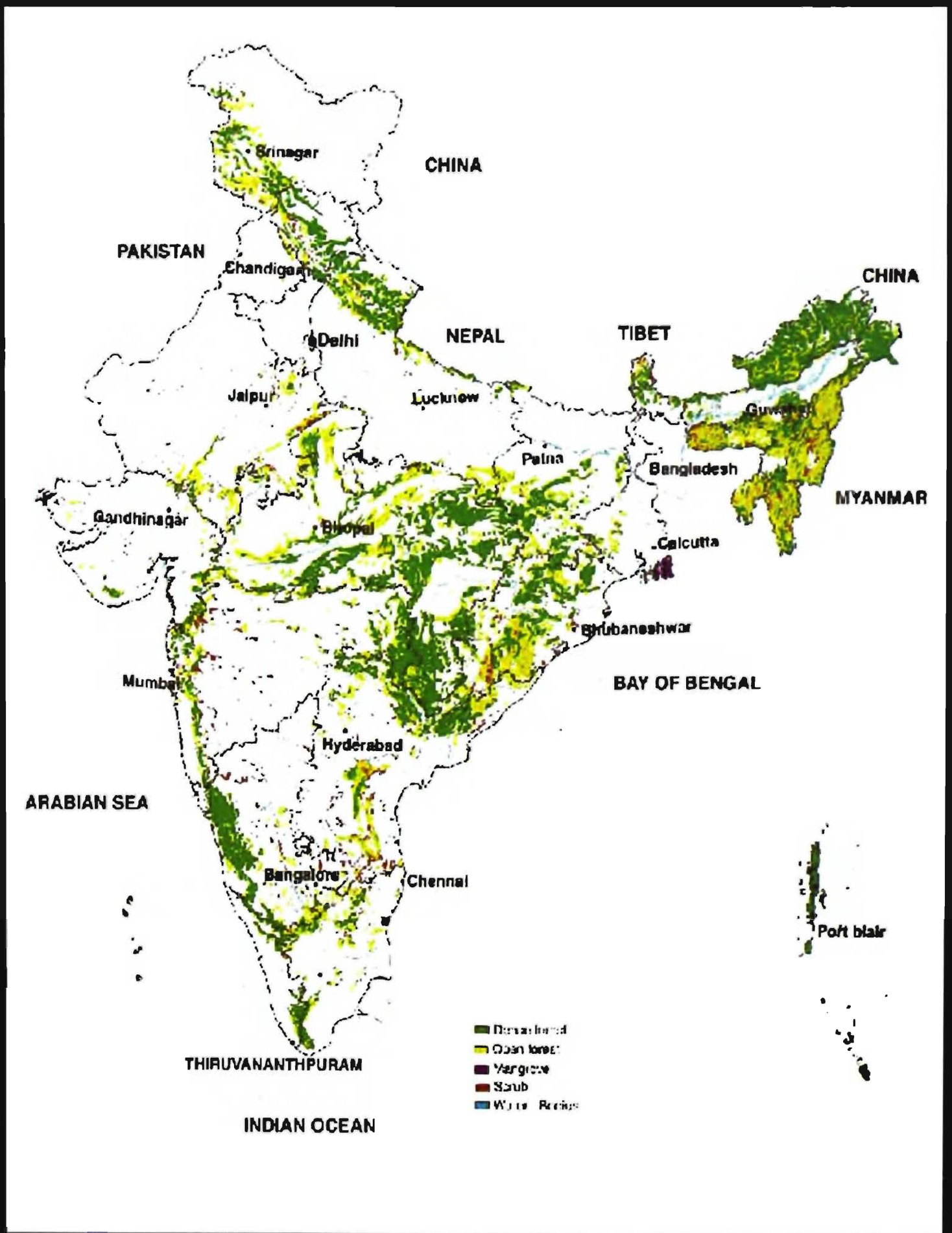
Map 6. Biogeographic Classification of India : Zones (*Source* : Rodgers, Panwar & Mathur, 2002)



Map 7. Biogeographic Classification of India : Provinces (*Source* : Rodgers, Panwar & Mathur, 2002)



Map 8. Wetland Protected Area Network in India (*Source* : WII, Dehra Dun)



Map 9. Forest cover map of India (*Source* : FSI, Dehra Dun)

Deciduous Forest

Moist Deciduous Forest—Mettupalayam, Coimbatore District

Dry Deciduous Forest—Donubai, Srikakulam District

Indira Gandhi Wildlife Santuary—Evergreen Forests

Coastal Vegetation

Mixed forest Guerans at the top Kaflani area

Sub Alpine Forest at Dhakuri

A view of vegetation in high altitude

increase in the population of insect species and turns them pests. This is caused due to the habitat destruction. According to Gess and Gess (1993), loss and reduction of insect species will result from the loss and reduction of plant species, which are direct source of food or habitat. Species most valuable to localised loss are clearly those which are most specialised with respect to their habitat requirements. Clearly, loss of habitat diversity will result in the loss of alpha diversity. The second cause for the loss of species diversity in insects is overgrazing and deforestation. Introduction of an unproductive South American Weed, *Chromolaena odorata* in the forests of Nilambur, Kerala resulted in the loss of phytophagous insects and flower visiting insects and caused immeasurable damage as the pollinating insects and predatory insects have become rare in the area. Based on these examples, the role of precautionary principles in the introduction of alien species has become important in recent years.

KEYSTONE SPECIES

Species, which have disproportionately large influence on the structure of the ecosystem, are called Keystone Species, and when such species are removed, there is profound detrimental effect on the system, i.e., Cascading effect (Reid and Miller, 1989). Solbring (1991) divided the keystone species impacting insects into three categories viz., predators, parasitoids, herbivores and pathogens forming the first group; they maintain the diversity of insects by reducing the abundance of dominant competition and thus prevent competitive exclusion. Second group includes Mutualists; the loss of one species may cause the loss of a second species. For *e.g.*, loss of pollinators (e.g., bees & fig wasps) will result in the loss of ability of fertilisation in several trees. The last includes species which provide resources for the survival of the dependent population (many species of ants acts as key stone species for e.g. survival of Pangolin (*Manis crassicaudata*) depends on the availability of ants.

BIODIVERSITY AND ECONOMICS

The major problem, involved in the application of the methods to assess the value of biodiversity is defining exactly what is meant by biodiversity, a notoriously intractable question. In this regard, the distinction between valuing biological resources and valuing biological diversity (i.e. the range of variation in biological resources, whether measured quantitatively or qualitatively) is an important one and leads to two different types of questions: in the first instance, a gross estimate of the value of biological resources in a particular geographic locate is sought; in the second, attempts are made to trace the impact of changes in diversity on economic values. The economic values are regarded a useful tool for addressing threats as it enables conservationists to compare issues and problems and devise appropriate responses. It provide new ways of thinking, analyses problems, identifies how some solutions may give perverse or inappropriate incentives to act and gives new perspectives enabling conservationists to capture total values. Basic training in economic approaches to biodiversity conservation is achieved by developing skills to :

- Identify economic causes of biodiversity loss in their respective eco-regions
- Describe economic tools and instruments for assessing and for correcting the causes
- Identify pilot projects to test and implement economic tools and instruments

The total economic value of an environmental resource may be broken down into a range of use and non-use values. The direct use of ecosystem outputs in non-consumptive, consumptive or productive activities is the impact that is most commonly measured in valuation exercises. Included as direct uses would be the harvesting of wild species for use as food, fuel, shelter or medicine. Other activities such as eco-tourism involve a direct "transaction" between people and biological resources and fall in the category of direct use values. Some direct uses of biological resources such as commercial logging, agriculture or fisheries generate products which are exchanged in the market place, while the products of others such as subsistence hunting and gathering go largely un-marketed. In the latter case, although these non-marketed resources have no financial value (cash price in exchange) they do have economic value as they are of importance to society.

Biological resources may also make indirect contributions to the welfare of society. Environmental functions support economic activity by recycling important elements such as carbon, oxygen and nitrogen and by acting as a buffer against excessive variations in weather, climate and other natural events outside the control of human beings. Economists are increasingly attempting to place values on these indirect uses. Since indirect use values do not enter directly into human preferences and are often widely available, their value is not often recognised and incorporated into development decisions.

In addition to direct and indirect use values, biological resources may have option and existence (non-use) values. Option values are associated with the future use of a resource and future flows of information regarding the use of resources. Risk-aversion dictates that societies should be willing to pay an additional sum above and beyond what a future use value of a biological resource is worth in order to guarantee future access. If this is the case, there is an 'extra' value that can be placed alongside the use values of the resource.

Finally, there may be non-use or existence values associated with a resource. These are benefits derived by an individual from the mere knowledge that the resource exists. For example, people who donate money to a conservation organization with no expectation of ever visiting the habitats or hunting the species which the organization aims to conserve must be deriving some satisfaction that is simply a result of the continued survival of the species or habitat. The Objective (Article 1) of the convention is "to conserve the maximum possible biological diversity for the benefit of present and future generations and for its intrinsic value"

CHAPTER–6

FAUNAL RESOURCE ANALYSIS INVERTEBRATE DIVERSITY IN INDIA

Protozoa live under all natural conditions and have been reported from freshwater, brackish and marine, soil and moss as free-living forms. Parasitic protozoans occur in epizoic, luminicolous, coelozoic, histozoic and coprozoic environs. Protista (Protozoa) are represented by 1330 parasitic species (52%) and 1247 free-living (48%) totaling 2577 species in India as against 32% parasitic and 68% free-living species known so far from the world. It may be mentioned that the parasitic species especially trypanosomes are well studied because many of them are associated with certain dreaded diseases of man and animals. Non-trypanosome flagellate parasites such as *Retortomonas*, *Monocercomonas*, and *Chilomastox* have also been studied among vertebrate hosts. Several workers deal haemosporidians, which include malaria and related parasites; the occurrence of this group is reported from fishes (Ray and Choudhury, 1981), amphibia (*Rana limnocharis* by Singh *et al.*, 1951-56), birds (Nandi and Mondal, 1976), bats (Sinha and Das Gupta, 1989), and crab eating monkeys of Great Nicobar (Das Gupta *et al.*, 1965). It is estimated that the number of species in the protozoa so far known is only one-fourth of the species expected to occur in India. Therefore, much more attention is required to know the Protozoan fauna in India.

Taxonomic details of the phylum Protozoa

Phylum	Family		Genera		Species	
	World	India	World	India	World	India
Sarcomstigophora Subphylum :						
Mastigophora	90	28	800	60	6900	400
Sarcodina	100	35	950	85	11300	6500
Opalinata	1	1	5	4	250	30
Ciliophora	197	70	1135	150	7200	600
Apicomplexa	71	20	1135	150	7200	600
Microspora	5	2	18	4	550	20
Myxozoa	15	4	40	12	500	125
Labyrinthomorpha	1	-	2	-	*	-
Ascetophora	3	1	5	1	*	2

* Few species

Parasitic and freeliving protozoans from India

Phylum	Parasitic	Freeliving	Total
Sarcomstigophora			
Subphylum :			
Mastigophora	198	202	397
Sarcodina	5	645	650
Opalinata	30	-	30
Ciliophora	200	400	600
Apicomplexa	750	-	750
Microspora	20	-	20
Myxozoa	125	-	125
Ascetophora	2	-	2
Total	**1330**	**1247**	**2577**

The Mesozoa known in India by 10 endemic species as against 71 species in the world (approx. 14%) remain a subject for further research to reveal the real diversity and endemicity. The porifera are represented by 486 species, of which 455 are marine and 31 freshwater accounting for nearly 11% of the species known in the world. The present species diversity of the group exceeds 500 species, as a large number of marine sponges have been added to the list from the recent explorations. However, marine Porifera are estimated to be much more than what are known till date. It maybe mentioned that the marine sponge fauna known in India shows close relationship with those of the Australian region, the Pacific Ocean and Red sea.

Marine and freshwater sponges in India

Class	Genera	Species	Percent
Calcispongiae (Calcareous)	11	14	2.70
Hyalospongiae (Hexactenelids)	19	44	8.48
Sclerospongiae (Coralline)	-	_	-
Demospongiae (Silicious)		428	82.46
Order :			
Keratosida	15	27	
Haplosclerida	19	64	
Poecilioscleride	52	114	
Halichondria	20	53	
Hadromerida	23	63	
Epipolasida	12	23	
Choristida	18	58	
Carnosida	14	26	
Total	173	428	
Subtotal	**203**	**486**	
Freshwater sponges	3	33	6.36
TOTAL	**206**	**519**	**100**

Bioactive and biomedical compound of sponges are extracted and used extensively in immunological studies. Besides the above, certain chemicals extracted from this group exhibit antifertility, antimicrobial and antifouling properties. The wonder drug Arabinose nucleoside extracted from *Tetya crypta* is now used in the treatment of blood cancer and certain malignant tumours. Recently, as a matter of conservation of the sponges, Government of India wide their notification No. 1-4/95/WL-1, dated 11.07.2001 included all calcareous sponges under Schedule–III of the Wildlife (Protection) Act, 1972.

There are 842 species of the Cnidaria known in India as against 9916 species in the world (8.49%). Among them, the ctenophores register only 12 in number (12% of the world fauna) and are distributed in marine environs. These play an importat role in the food web as small and large fishes in the coastal ecosystem feed them. The lysosomal property exhibited by the lasso cells of ctenophores is having biomedical value. The siphonophores are abundant as tropical marine planktonic forms represented by 15 families, 45 genera and 120 species known from the Indian Ocean. Of these, Daniel (1986) studied 39 genera, 90 species from Indian seas (25°N to 1°S Lat. and 60°E to 100°E Long.). The monotypic family Physalidae is represented by a single species *Physalia physalis* (*Portuguese man of war*) with two dimorphic forms common throughout the tropical seas and inflicts injuries to humans. A few of the siphonophores reach several meters in length and are known only from the fragments of its polymorphic forms in the cold deep sea (*e.g.*, *Halistemma rubrum*). Nearly six species of the genus *Forskalia* are known from Indian Ocean are found during the upwelling of deeper waters and occur near the sub-antartic convergence belt. The members of Siphonophora not only indicate the movement of water mass in the ocean but also show the diversity of plankton species in the area, that is acts as "indicator species" of fisheries (e.g., *Dimophyes arctica*). Nearly 18 species of siphonophores are known from the Antartic Ocean, and these are considered as indicator species of cold-water masses.

Scleractenia constitute a class of the phylum includes corals which are exclusively marine with calcareous exoskeleton and are grouped into four major orders. The coral reefs abound with a rich biodiversity and are often compared with the "Tropical Rain Forests" of the terrestrial region in respect of biodiversity as well as productivity. Their role is similar to mangroves in protecting the hinterland and building up the coastline. The coral reef area are the habitat for a number of ornamental fishes (several families particularly Muraenidae, Balistidae, Scorpaenidae, Tetraodontidae, Syngnathidae, Chaetodontidae, Pomacanthidae, Pomacentridae), food fishes (families particularly, Clupeidae, Lutjanidae, Serranidae, Lathrinidae, Siganidae, Caesionidae, Haemulidae), shells, worms, echinoderms, *etc.*

The most important associates of the corals are the zooxanthellae, which are symbionts - sometimes even obligatory. These play an important role in the carbon cycle of the sea by absorbing the carbon dioxide and releasing oxygen through photosynthesis. These contribute the major share of the primary productivity of the system. Their presence gives the corals beautiful colourations. During adverse conditions (siltation, high temperatures,

etc.) the zooxanthellae leave or expelled by the corals and the latter loose their colors. These bleached corals may regain their healthy condition once the ambient parameters are restored to normalcy. In addition to the biodiversity, economic, medicinal values directly discernible, the totality of values of corals can be summarized as shown below :

VALUES OF CORAL REEFS (after Dixon, 1997)

A. **Use Values**

1. Direct Use Values
   a. Consumptive Use : Shell Collection, Fish Collection, Pharmaceutical
   b. Non-Consumptive Use: Tourism, Recreation
2. Indirect Use Values : Storm Surge, Fish Nursery, Food Chain, Sand for Beach Nourishment

B. **Non-use Values**

1. Option Value, Viewing, Recreational Use
2. Bequest Value, Recreational Amenities
3. Existence Value, Biodiversity Value

Anthozoa is the most primitive of the four groups and includes true corals, which build giant reefs in tropical waters as well as sea anemones, sea fans and sea pens. Cubozoa consists of deadly box jellies with complex eyes. Hydrozoa is the most diverse group with hydroids, Siphanophores, fire corals and many medusae. Scyphozoa are the big jellyfishes, all numbering nearly 830 species. Obviously, there is a large gap in our knowledge on the Cnidaria in India. Importance of corals and coral ecosystem have been well understood recently, and looking at its biological, aesthetic, scientific and geopositional significance and values, the entire hard corals have been included under Schedule–I of the Wildlife (Protection) Act 1972.

Distribution of Corals in India

Reef Area	No. of Families	No. of Genera	No. of Species
Gulf of Kutchh	9	23	37
Lakshadweep	13	37	105
Gulf of Mannar	13	36	96
Andaman Islands	16	31	82
Nicobar Islands	18	43	103

The platyhelminthes or flat worms are mostly parasitic; this phenomenon has greatly influenced the character of the group and constitutes only 9.27% of the world-fauna. The free-living Turbellarians with only 47 species (approx.1%) of the world fauna have received very little attention. Among the Trematodes, most of the Monogenea numbering 295 are

ectoparasites known from freshwater fishes and other vertebrates but there is a big lacuna with regard to marine fishes. The other groups like Trematoda and Cestoda with 750 and 530 species, respectively need further exploration due to the multiplicity of hosts available in our country. Nearly 1160 species exhibit endemism in India. The value of this group is well understood by the estimates of Peters (1978) with 4–5 billion people suffering from helminth infection.

Rotifers constitute a dominant planktonic group, with 330 species, a little over 13% of the world fauna. A critical analysis of the Indian freshwater rotifera indicates that various planktonic and semi-planktonic taxa are fairly known from this country but periphytic, benthic, colonial, sesile and bdelloid rotifers are still to be much studied.

The marine meiofauna includes Gastrotricha and Kinorhyncha and are represented by 100 and 10 species respectively which account for 3.33% and 10% of the species known from the world. It is interesting to note that there is high degree of endemicity in these groups i.e., 64 out of 100 species in Gatrotricha and 7 out of 10 in Kinorhyncha are endemics. There is ample scope for studying these marine groups. The groups like Sipuncula and Echiura with 35 and 43 species respectively in India account for about 24% and 34% of the world-fauna. All these groups exhibit very high biological diversity in Andaman & Nicobar group of islands, as they are oceanic in their distribution.

The nematodes constitute about 50% of all metazoa in the world and occur in every possible type of habitat, free-living or predaceous or parasitic in plants and animals. Animal parasitic nematodes numbering 1,000, and plant, soil and other nematodes 1850 account for 9.5% of the world fauna. Our knowledge on the nematode parasites in vertebrate animals is satisfactory but plant, soil and aquatic (both freshwater and marine) nematodes are poorly known; their endemicity is more than 400 species. Nematodes cause significant loss and damage to the humans, livestock, and crops. Mention may be made of filariasis, ascariasis, trichuriasis, onchocerciasis etc. Loss caused by plant parasitic nematodes is equally immense, as they damage nearly 15 % of the crops. Among plant parasitic nematodes causing extensive damage of nearly 40 million Rupees to wheat is by *Anguina tritici*, nearly. 12 million Rupees loss in coffee by *Pratylenchus* spp. and potato disease by *Globodera rostochinensis*. Nematodes have also been found very useful as good model experimental animals or the basic research in nutrition, physiology, genetics, ageing etc. A few species are beneficial as biological agents; some help in maintenance of natural balance of soil and serve as indicator species.

Number of families, genera and species known from India

Order	Families	Genera	Species
Tylenchida	17	85	560
Dorylamida	16	110	480
Mononchida	7	15	60
Miscellaneous orders	40	90	250
Total	**80**	**300**	**1350**

Phylum Acanthocephala, forming nearly 29% (229 species, 54 genera, 20 families) of the world fauna (800 species) are known to occur in India. Systematic survey based on host species and their distribution is desirable. Among other minor phyla, the Phoronida and the Brachiopoda represented by 3 species each are the least known groups in India. However, the Bryozoa with 200 species is known better than the Entoprocta (10 species) or even the Chaetognatha (30 species) and the Tardigrada (30 species).

The Annelida in India constitute (840 species out of 12,700 species) about 6% of the world-fauna under 312 genera, 80 families and 3 classes. Polychaeta constitute a major group with 400 species (200 genera, 61 families) followed by Oligochaeta with 381 species (87 genera and 14 families) and Hirudinea with 59 species (25 genera and 5 families). Nearly 49 peregrine earthworm species are introduced from other geographical realms on the mainland. 42% of the leaches and 77.80% of the oligochaetes are endemic to the country, while the percentage of endemism in polychaetes is very low. Although polychaetes are comparatively well studied, knowledge of brackish water fauna is far from satisfactory. The value of annelids in soil fertility is immense and the aquatic oligochaetes retrive organic matter from sediments. Compounds extracted from leaches are from time immemorial used as remedies for throat and inflammatory swellings. Anticoagulant secretion (*hirudin*) is used in blood clotting experiments.

Molluscs are very ancient organisms believed to have evolved from a flatworm like ancestor during the Precambrium about 650 million years ago. Because many species secrete a shell of some sort, the fossil record is good. Different classes of molluscs have been predominant in the past and the Ammonites represent a group of Cephalopods which were extremely abundant for millions of years before they became extinct. Their close relatives the Nautiloid cephalopods were also once very successful but are now only represented in the world by one species, *Nautilus*.

The molluscs are of great diversity with 5072 species that account for about 8% of the world fauna. At the family level, 62.8% of the families known from the world are represented in India. The richness of the species is due to the diverse ecosystems and habitats and the table shows the species diversity at different levels.

Forms	**Families**	**Genera**	**Species**
Land forms	26	140	1499
Freshwater	22	53	193
Marine	242	591	3380
Total	290	784	5072
Class	**India**	**World**	**% in India**
Aplacophora	Nil	130	Nil
Monoplacophora	Nil	5	Nil
Polylplacophora	40	500	8

Class	India	World	% in India
Gastropoda	3620	50,000	7.24
Bivalvia	1182	15,000	7.87
Scaphopoda	20	300	6.67
Cephalopoda	210	600	35.0
Total	**5072**	**66,535**	**7.62**

The landforms are exclusively confined to the class Gastropoda falling under two subclasses Prosobranchia and Pulmonata. The land operculates of India include a number of geographically significant genera such as Cyclo*phorous, Diplommatina* and *Alycaeus,* which are typical of the Oriental region and have a number of endemic species, majority of them, are distributed in peninsular plains and Western Ghats. It is interesting to note that both the land and freshwater molluscs have a number of endemic genera and species. Our knowledge on the endemic marine molluscs as compared to the land and freshwater ones is far from satisfactory. 575 species of freshwater and terrestrial molluscan species are endemic to the country. The table represents the distribution of endemic forms in various zoogeographical regions of the country.

Region	Species	Genera
Andaman & Nicobar	87	33
Western Ghats & Peninsular plains	221	51
North eastern states	237	38
Himalaya (Including Arunachal Pradesh & Darjeeling)	246	54
Gangetic plains of U P, Bihar, West Bengal	24	10
Madhya Pradesh	4	3
Occurring in more than one region	65	35

Source : Ramakrishna and Mitra, 2002

Among the molluscs, several species are of ornamental value and support a viable shell-craft industry. Several others such as giant clams (*Tridacna* spp.), oysters etc. are of food value. Windowpane oysters are a source material of aesthetic value. Out of six species of pearl oysters available in India, *Pictada fucata* is used for pearl production. The intial production on experimental basis was initiated in 1973 and hatchery production of pearl oyster seed in 1982 at CMFRI, Kochin.

Commercially important species of squids are *Loligo uyii* (Little squid), *L. duvauceli* (Indian squid), *Doryteuthis sibogae* (Siboga squid), *D. singhalensis* (Needle squid), *Loliolus investigatoris, Sepioteuthis lessoniana* (Palk-bay squid), *Sepia pharaonis* (Pharaoh cuttlefish), *S. aculeata* (Needle cuttlefish), *S. elliptica* (Golden cuttlefish), *S. prashadi* (Hooded cuttlefish), *S. brevimana* (Shotclub cuttlefish), *Sepiella inermis* (Spineless cuttlefish), *Octopus dollfusi* (Marbled octopus), *O. membranaceous* (Webfoot octopus), *O. lobensis* (Lobed octopus), *O.*

vulgaris (Common octopus) and *Cistopus indicus* (Old woman octopus). Accordiing to Appukuttan *et al.* (2000); Kripa and Appukuttan (2003), the most important shells and marine bivalves of commercial value are *Terbinella pyrum* (Sacred chank), *Turbo marmoratus* (Turban shell), *T intercostals* (Ribbed turban), *Trochus niloticus, T. radiatus* (Top shells), *Umbonium vestiarium* (Button shell), *Lambis chiragra* (Spider shell), *L. lambis* (Scorpion shells), *Cypraena monita* (Cowries), *Cellana radiate, Strombus canarium* (Winged shells), *Thais rudolphi, T bufo, Oliva gibbosa, Babylonia spirata, B. zeylanica, Cassis cornuta* (Helmet shells), *Chicoreus ramosus, Pleuroploca trapezium* (Murex shells), *Villorita cyprinoides* (Black clam), *Paphia malabarica* (Short neck clam), *Meretrix casta, M. meretrix* (Yellow clams), *Marcia opima* (Baby clam), *Mesodesma glabaratum, Sunetta scripta* (Marine clam), *Donax* spp. (Wedge clam), *Geloina bengalensis* (Big black clam), *Anandra granosa* (Cockle), *Placenta placenta* (Windowpane oyster), *Hippopus hippopus, Perna viridis* (Green mussel), *P. indica* (Brown mussel), *Pinctada fucata* (Indian pearl oyster), *P. margaritifera* (Black lip pearl oyster), *Crassostrea madrasensis* (Indian backwater oyster) and *Saccostrea cucullata* (Rock oyster).

Recent inclusion of marine molluscs under schedule animals (Part II Section - 3 sub sections (ii) I, in the Extraordinary Gazette of India, dated 5th December, 2001) is one such step to protect and conserve several key species, which are under threat due to overexploitation, for commercial purposes.

Systematic list of Molluscs included in the Schedule

Schedule-I	Schedule–IV
Cassis cornuta (Linnaeus) Part IVB, 1	*Trochus niloticus* Linnaeus Part 19, XIV
Cypraecassis rufa (Linnaeus) Part IVB, 4	*Turbo marmoratus* Linnaeus Part 19, XV
Charonia tritonis (Linnaeus) Part IVB, 2	*Lambis* (*Harpago*) *chiragra chiragra* (L) Part 19,VI
Tudicla spirillus (Linnaeus) Part IVB, 9	*L.* (*H.*) *chiragra arthitica* Roeding Part 19,VII
Conus milne-edwardsi Jousseaume Part IVB, 3	*L.* (*Lambis*) *crocata crocata* (Link) Part 19,VIII
Nautilus pompilius Linnaeus Part IVB, 6	*L.* (*M.*) *millepeda* (Linnaeus) Part 19, IX
Tridacna maxima (Roeding) Part IVB, 7	*L.* (*Millepes*) *scorpio scorpio* (Linnaeus) Part 19, X
T squamosa Lamarck Part IVB, 8	*L.* (*Lambis*) *truncata truncata* (Humphrey) Part 19, XI
Hippopus hippopus (Linnaeus) Part IVB, 5	*Strombus* (*Doxander*) *plicatus sibbaldi* Sowerby Part 19, XIII
	Cypraea limacina Lamarck Part 19(i)
	Cypraea mappa Linnaeus Part 19 (ii)
	C. talpa Linnaeus Part 19 (iii)
	Fasciolaria trapezium Linnae [= *Pleuroploca trapezium* (Linnaeus)] Part 19(iv)
	Harpulina arausiaca (Light foot) Part 19 (v)
	Placuna placenta Linnaeus Part 19 (xii)

The Echinodermata represented in India by 765 species (nearly 12.5% of the world fauna) give a good picture of the fauna in India, except for the deep-water echinoderms of the Indian region. 765 species are recorded of which Crinoidea with 95 species, Asteroidea with 180 species, Ophiroidea 150 species, Echinoidea with 150 species and Holothuroidea with 160 species are represented in Indian waters. Nearly 12 species of Holothuroidea are commercially very important. *Beche-de-mer* is the delicacy prepared from holothurians especially from *Holothuria scabra, Holothuria spinifera* and *Bohadschia marmorata*. The holothurians till recently supported a good *bêche-de-mer* industry in the Gulf of Mannar of Tamil Nadu and used to earn considerable foreign exchange. Though there are prospects of the industry at Lakshadweep and Andaman and Nicobar Islands, the holothurians are included in Schedule- I of the Wildlife (Protection) Act, 1972 in the interest of conservation of the ecosystem. Although the Onychophora as a group is extremely rare, it is known by a single species discovered at the foothills of the eastern Himalaya in the northeastern frontier of India.

The phylum Arthropoda is remarkable in having the largest number of classes, order, families, genera and species in India. The crustaceans group comprised mainly of penaeid prawns, non-penaeid prawns, lobsters, crabs and stomatopods (mantis shrimp, *Oratosquilla nepa*). India is one of the major contributors of marine crustaceans in the world market (Anon, 1982). Crustaceans also fetch a very high price of Rs. 200 or US$ 4.3 per kg in the domestic market (Sathiadas and Hassan, 2002). The penaeid prawn fishery constitutes the backbone of the seafood export industry, being the major foreign exchange earner as well as source of livelihood for millions of fish workers. Frozen shrimp contributes about 70% (Rs. 448 crores corresponding to US$ 978,807) of India's total seafood export value and the share of capture fisheries is 59% by volume (Nandakumar and Maheswarudu, 2003). Commercial species of prawns include *Penaeus indicus* (Indian white prawn), *P. semisulcatus* (Green tiger prawn), *P. monodon* (Giant tiger prawn), *P. merguiensis* (Banana prawn), *P. japonicus* (Kuruma prawn), *P. penicillatus* (Redtail prawn), *Penaeopsis jerryi, Metapenaeus dobsoni* (Flowertail prawn), *M. monoceros* (Speckled prawn), *M. affinis* (Jinga prawn), *M. kutchensis* (Ginger shrimp), *M. brevicornis* (Yellow prawn), *Metapenaeopsis stridulans* (Fiddler shrimp), *M. andamanensis* (Rice velvet shrimp), *Parapenaeopsis stylifera* (Kiddi prawn), *P. hardwickii* (Spear prawn), *P. sculptilis* (Rainbow prawn), *P. maxillipedo* (Torpedo prawn), *P. uncta* (Uncta prawn), *Parapenaeus longiceps* (Flaming prawn), *Trachypenaeus curvirostris* (Rough prawn), *Solenocera crassicornis* (Coastal mud prawn), *S. choprai* (Coastal mud prawn), *S. hextii* (deep sea mud shrimp), and *Aristeus alcocki* (Arabian red shrimp) (Kurian *et al.*, 1976b; Nandakumar *et al.*, 2003, N B F G R I, 2005). According to Radhakrishnan and Manisseri (2003), lobster species exported from India are *Panulirus polyphagus* (Mud spiny lobster), *P. homarus* (Scalloped spiny lobster), *P.ornatus* (Ornate spiny lobster) *P. versicolor* (Tropical rock lobster), *Thenus orientalis* (Shovelnosed lobster), *Puerulus sewelli* (Indian Ocean lobster), and *Linupurus somniosus*. Besides above, *Portunus sanguinolentus* (Spotted crab), *P. pelagicus* (Reticulate crab), *Charybdis feriatus* (Cross crab), *C. annulata* and *C. natator*, out of these, *Portunus sanguinolentus, P. pelagicus* and *Charybdis feriatus* are the dominant species of edible marine crabs.

Crustacea is one of the major classes of the phylum with 2934 species, which is over 8% of those in the world, of which 501 species show endemicity. Crustaceans have adapted themselves to live in a variety of ecological conditions; more abundant in marine environment than in freshwater or land. Diversity is more in the rocky intertidal zone along the coastal and coral reef ecosystems. Most of the burrowing forms live in sandy substratum, as they support a variety of interstitial fauna. The major habitats of crustacea are as given below :

Group	Habitat
BRANCHIOPODA	
Notostraca	Freshwater
Cladocera	Freshwater (95%)
	Brackishwater (3%)
	Marine (2%)
Conchostraca	Freshwater
Anostraca	Freshwater and Inland Saltwater
Copepoda	Marine & Freshwater
Cirripedia	Marine & Brackishwater
Ostracoda	Marine & Freshwater
MALACOSTRACA	
Stomatopoda	Marine
Amphipoda	Marine, Freshwater & Terrestrial
Isopoda	Marine, Freshwater & Terrestrial
Decapoda	Marine, Freshwater & Terrestrial
Cumacea	Marine

The Arachnida, another major class is known by 5818 species (2623 endemic species), being nearly 8% of the world fauna. Soil mites occur abundantly in any soil rich with litter and organic debris and hence common in forest soil, agricultural land. The Chilopoda and the Diplopoda with 100 and 162 species are only over 3% and 2%, respectively of the fauna in the world. The other groups under the Arthropoda except the Insecta are poorly known in our country. The Xiphosurans is of special interest with 2 species known from India. All these groups need special attention because much remains to be known about them. There is high degree of endemism among them but our knowledge is limited to the Crustacea, the Insecta and the Arachnida only despite incomplete knowledge about their total fauna. IUCN has identified 7 species of diaptomous copepods (Among Crustacea), a species of coconut crab (*Birgus latro*) and two species of Arachnida (*Carcinoscorpius rotundicauda* and *Tachypleus gigas*) as threatened animals.

Crustaceans identified in respect of the medicinal properties in Ayurveda, Unani and Sidda are the *Scylla serrata* with two formulations (*'Arq-e-Sartan'* and *'Safuf-e-Sartan'*) used in curing constipation, Rakta Pitta, headache, T.B., chronic cough, anaemia, sexual debility, obstructed micturition, general debility, neurological disorders. Even the

freshwater prawns is used in unani and has the property for curing constipation and also possesses nutrient, blood purifying, anti-anthelmintic, aphrodisiac, cardiotonic and uterotonic properties. Dried prawn is used as Surma for the treatment of night blindness. It is mixed with oil to form a useful application in inflammation, rheumatism, gout, anti-inflammatory, anthelmintic, aphrodisiac, haematinic and uterotonic diseases.

The scorpion (*Hedrurus hirsutus*) acts as anti-poisoning, stimulant, anti-tussive and anti-leprotic agent in unani. Dried scorpions are pulverised and mixed with vinegar for application on vitiligo, leucoderma and alopecia. Scorpion ash is useful in curing chronic cough, renal and cystic calculi, healing necrotic wounds and piles. Spiders also have a very significant role to play in the ecology by being exclusively predatory (Wise, 1993) and thereby regulate insect populations. All spiders are venomous but only a few species are venomous enough to harm humans. However, the venom of some spiders is useful in study of neuromuscular and cardiac pharmacology. It is likely that spider silk will be the material of the future as its silk is the toughest material (Tensile strength) known. The gene for the silk of *Nephila maculata* has been cloned and the spinning technology needs to be perfected. The spider (*Lactrodectus mactans mactans*) acts as styptic and healing agent. It is anti-pyretic and analgesic. *Julus terrestris* (Millipede) the whole body is used in unani and acts as analgesic and anti-leprotic.

INSECT RESOURCE

Insects as a group of animals are the largest of all in the world. They out number not only as species but also as individuals of the species. They occur almost everywhere from high mountains to the sea, and from the hot desert to the cold ice-water at the extreme, and all these cause them to flourish extremely well with 8,67,391 species that account nearly for 80% of the total animal species in the world. This high biodiversity among insects lies in their characteristics like size, presence of chitinous exoskeleton, high fecundity, proficiency to feed on variety of materials, capability of water retention, capacity for flight and dispersal, etc., that help them to survive in different ecosystems with success. Researchers find more than 5,000 new species every year, mainly insects and above all Coleoptera, an order of insect that comprises the beetles, forming the largest order of animals on the earth, and which makes up almost one fourth of all known species.

Insects so far known in India are grouped in 27 orders, of which 4 are apterygotes and the remaining 23 are pterygotes. Recently, a new order has been erected, thus making the number 28. Among apterygotes in India, the Collembola is known better than the other 3 groups. It is represented by 210 species (above 4.0% of the world fauna) under 86 genera as against 451 genera in the world. The other 3 groups, viz., Thysanura, Diplura and Protura are known by 31 species (nearly 2.5%) under 16 genera, 16 species (4.5%) under 7 genera and 20 species (nearly 7.7%) under 8 genera, respectively. It may be mentioned that the endemism is quite remarkable in the groups with 22 genera and 45 species in the Collembola, 12 genera and 23 species in the Thysanura, 3 genera and 12 species in the Diplura, and 4 genera and 16 species in the Protura. Indeed, our knowledge

on the Indian apterygote groups is poor and therefore, much more attention requires to be paid in order to reveal the tremendous biodiversity among them. Odonata is an economically and ecologically important group of insects, as they act as predators of flies, mosquitoes and moths besides being a consumer link in the aquatic food chain. The diversity of the group being comparatively enormous with nearly 449 species (8.96% of the total fauna of the world), and equally 23% of the fauna (115 species) are endemic to the country.

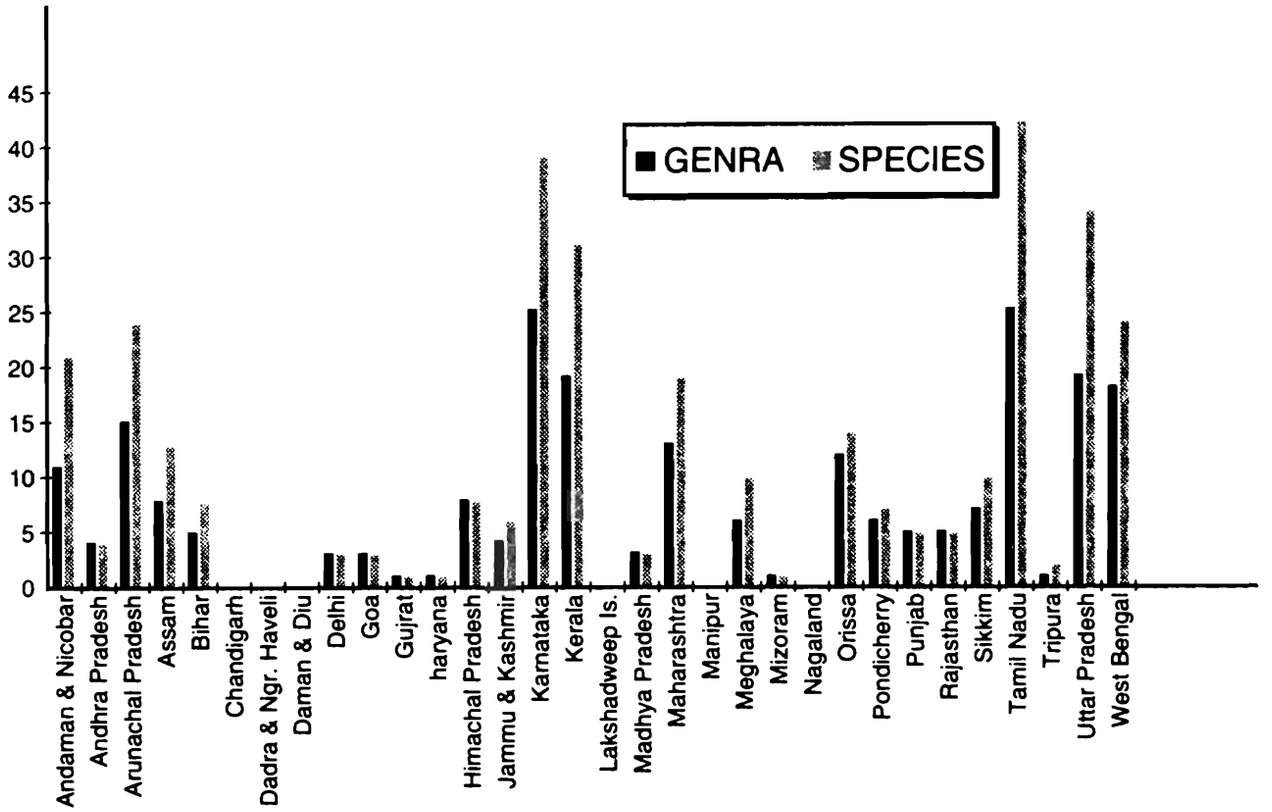
The groups' *viz.*, collembola, diplura, protura and thysanura form the soil micro arthropods. Soil is a finite and nonrenewable resource. Soil degradation is caused by adverse changes in the soil's physical, chemical and biological processes. Similarly, the dead wood or a fallen tree in a forest ecosystem is an important aspect in the forest ecology, as they influence the carbon cycle, forest soil fertility, and water holding capacity, water runoff, besides being a home for a variety of life forms. Species richness, succession of insect fauna and fungal-insect mutualism are some of the areas that need to be looked into. Among the soil fauna, mention may be made of collembola, dermaptera, embioptera, orthoptera (especially gryllotalpidae, tetrigidae), blattaria, isoptera, hymenoptera (formicidae), coleoptera (carabidae, staphylinidae) and a few others. Collembola appear to show a trend of higher diversity in temperate regions than in the tropics. Concentration of dermaptera in the subcontinent is higher than in many other tropical countries. Literature on the soil dwelling orthoptera is partial and fragmented. Gryllotalpidae attain the status of pest in root crops. Many species are phenotypically similar, but many may be genetically isolated crypto species awaiting recognition. Similarly, the taxonomy of the tetrigidae is a subject of discussion, as it requires determination of many closely related species. Many of the soil dwelling isoptera provide extensive cohabiting fauna in their nests ranging from commensals to symbionts, parasites and specialist predators. Carabidae, a potential and valuable group for analysing the soil faunal distribution however lacks a definite record of speciation in tiger beetles in the country (e.g., subfamily: Cicendilinae).

The biological diversity of coleopteran is enormous represented by nearly 15,500 species so far known (nearly 4. 42 % of the world), representing nearly one tenth of those existing today. The beetles are known for their useful and harmful values, besides being the environmental indicators monitoring the health of the ecosystem. It is a well-established fact that the luminocity of the fireflies (Lampyridae), poisonous properties of the Chrysomelidae and Carabidae and the brilliant colouration of Bupestridae have attracted the attention of the primitive people. Besides known for their diversity, coleopterans are equally known for their plasticity from the point of dispersal efficiency. A few genera belonging to Carabidae, Cebrionidae, Drilidae, Cantharidae, Tenebrionidae, and Curculionidae exhibit flightless female forms. However, certain other genera belonging to Chrysomelidae, Curculionidae and Carabidae exhibit longlived but flightless forms and their larva donot develop in the dead timber. A third category known in the coleopterans are those, short lived but exhibits wide dispersal capacity due to their frequent flying adult forms (Scarabaeidae, Cantharidae, Cicindelidae, Melyridae, Mordellidae, Oedermeridae, Cererabicidae). Yet another category of coleopterans represented by the

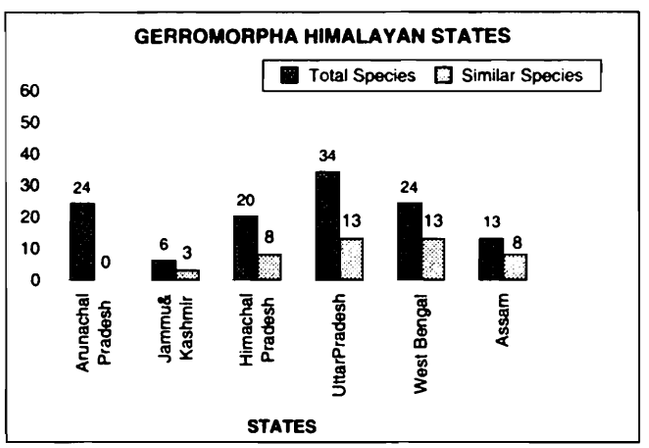
members belonging to Cerculionidae and Cerambicidae both adults and larvae live on dead timber and have the capacity to live on the logs drifted on high seas. The last category of copleopteran insects are known as 'Aerial plankton" as they are small and disperses over a long distance through aerial currents. In terms of value of the taxon, more than 300 species are noted pests of the field crops, forest timbers and stored products. Many species belonging to Silphidae, Trogidae, Scarabaeidae, Dermestidae acts as scavengers feeding on dead tissues of animals.

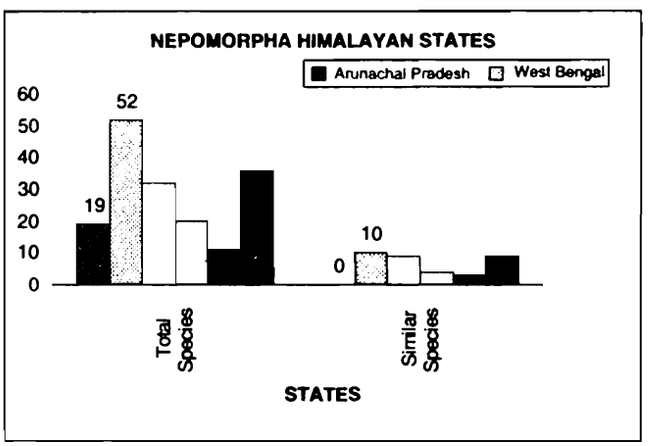
Of the pterygotes, Coleoptera is the largest of all the orders and is known by 15,500 species (nearly 4.5% of the world fauna), followed by the Lepidoptera with 15,000 species (over 10.5%), the Hymenoptera with 10,000 species (over 8%), the Hemiptera with 6,556 species (over 8.20%) and the Diptera with 6,093 species (over 6.0%). As regards the endemic species of these groups in India, it is estimated that the Hymenoptera contains 9,000 species and 516 genera in 65 families, the Coleoptera 3,100 species and 923 genera in 104 families, the Hemiptera 2,421 species and 579 genera in 77 families, the Diptera 2,135 species and 107 genera in 87 families and the Lepidoptera 1,500 species and 100 genera in 84 families.

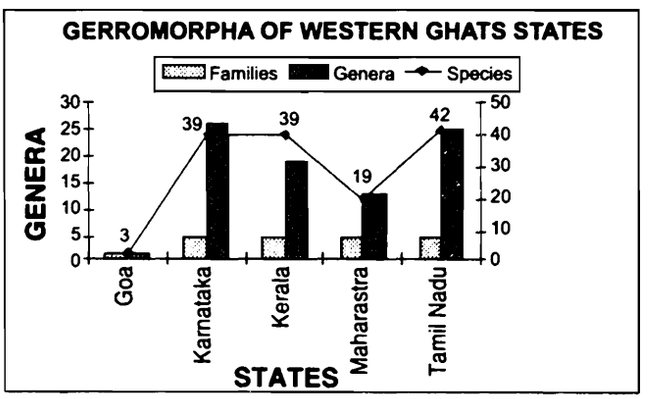
Out of 285 genera and about 3677 species distributed all over the world, aquatic hemipteran fauna in India is represented by 80 genera and about 279 species under 17 major families (Thirumalai, 1999, 2003). The water bugs that are associated with water are divided into Gerromorpha or semi-aquatic bugs, Nepomorpha or truly aquatic bugs and Leptopodomorpha or shore bugs. The Infraorder Gerromorpha comprises of semi-aquatic bugs characterised by long conspicuous antennae, longer than head and inserted in front of eyes. They are distributed in all kinds of climatic zones, except the coldest and driest parts. This infraorder contains 8 families namely, Gerridae, Veliidae, Hydrometridae, Mesoveliidae, Hebridae, Macroveliidae, Paraphrynoveliidae and Hermatobatidae of which the last three families are not represented in India. So far 131 species under 45 genera or 8.7% of the world fauna of Gerromorpha are known from the country. The infraorder Nepomorpha includes the truly aquatic bugs, as well as two littoral families, Gelastocoridae and Ochteridae all characterizes by short antenna that are usually hidden. They are essentially predaceous, although many corixids are omnivorous. There are 134 genera and about 1884 species distributed all over the world except in Antarctica (Polhemus *et al.*, 1995). 33 genera and 140 species assigned to 10 families of Nepomorpha are known from India, which equals to 7.2% of the world fauna. Out of these 5 major families, Belostomatidae, Corixidae, Naucoridae, Nepidae and Notonectidae are totally aquatic, leaving water during their migratory phase. The Infraorder Leptopodomorpha contains bugs that are ground dwelling and predacious that are characterised by long antennae. They are distributed in boreal, temperate, subtropical zones and associated with littoral habitats, including marine intertidal zones where they regularly undergo submergence, while a few are partial or truly terrestrial and xerothermic habitats are may even occur in caves. Globally 310 species and 36 genera are known accommodated in 4 families, out of which 10 species and 3 genera in 2 families are so far recorded from India.

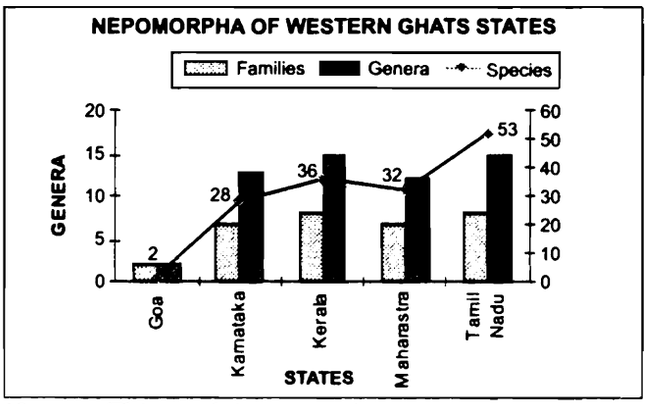


Statewise distribution of Genera & Species of Gerromorph in India









(*Source* : Thirumalai per. com)

Out of 32 political divisions, no authentic report of the group Nepomorpha from 4 divisions are known. Among the north-eastern states, there is no record of this group from Tripura, irrespective of report 2 species of semi aquatic bugs. All the known 9 families occur in West Bengal, followed by Kerala, Tamilnadu and Maharashtra (8 families each). The states of Gujarat, Haryana, Nagaland have 1 family each The highest number of species namely, 53 species accommodated in 15 genera is from Tamilnadu followed by West Bengal which harbours 52 species under 18 genera. Further, more than 55% of Nepomorpha are found in the states where Western Ghats run through. Studies on the distribution of Nepomorpha from Indian part Himalaya indicate that more than 65% of Indian species are represented in this area (Thirumalai, 2002b). The distribution of the bugs in the Himalayan states is given in Fig. The similar 9 species in Arunachal Pradesh out of 36 from Assam, suggests the two-way movements and admixture of fauna between Indian peninsula, Indo-Chinese and Malayan elements there.

Out of the 32 political divisions recognised in the Indian Union, 5 families (Hebridae, Hydrometridae, Gerridae, Mesoveliidae and Velidae) occur in Himachal Pradesh, Karnataka, Kerala, Maharashtra, Punjab, Tamilnadu, Uttar Pradesh and West Bengal; 4 families (Hydrometridae, Gerridae, Mesoveliidae and Veliidae) in Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Bihar, Chandigarh, Manipur Orissa and Rajasthan; 3 families in Assam (Hydrometridae, Gerridae and Veliidae), Meghalaya, Punjab, Sikkim (Hebridae, Gerridae and Veliidae) and Pondicherry (Hydrometridae, Gerridae and Mesoveliidae); 2 families in Delhi, Goa, Jammu & Kashmir, Madhya Pradesh, Tripura (Gerridae and Veliidae) and Rajasthan (Hydrometridae and Gerridae); and 1 family in, Haryana (Gerridae), Gujarat (Hydrometridae) and Mizoram (Veliidae). There is no authentic record of Gerromorpha from the remaining 4 political divisions (Thirumalai 2002a, 2004; Thirumalai *et al.*, 2002 a & b). The distribution of Gerromorpha species so far known from India is presented in the Fig. Out of 131 species so far recorded, the highest number of species namely 42, accommodated in 25 genera occurs in Tamilnadu followed by Karnataka which harbours 39 species under 26 genera. Further, it is interesting to note that more than 50% of Gerromorpha are found in the states where Western Ghats run through. This is perhaps due to the complex assemblage of ecosystems that harbour diverse faunal constituents (Thirumalai and Krishnan, 2000).

The butterflies, besides their aesthetic value, form an important object of display in natural history museums. The ecological significance of this group need not be underestimated, as their immature stages or caterpillars are largely herbivorous and form the primary consumer in the ecosystem. Butterflies are in turn fed upon by higher groups of organism such as amphibians, birds, lizards and other groups and thus form a link in the food web, besides being excellent pollinators.

The Government of India has already extended legal protection to the group Lopidoptera under Wildlife (Protection) Act, 1972 by including nearly 120 species and subspecies of butterflies and moths in Schedule-I and nearly 292 species and subspecies under Schedule – II. As butterflies perform the dual role in generating public awareness

on nature conservation and the need for *in-situ* conservation of endangered and threatened species, butterfly farming/breeding programmes have become important recently. Besides conservation, butterfly farming is an alternative source to replenish the depleted population and to provide material for scientific study. In this regard, nutrition, larval food plants, nectar plants, breeding, oviposition, egg care, larval rearing, pupation etc., are important while maintaining the captive population.

List of Lepidoptera included under Wildlife Protection Act, 1972

Schedule–I Part : IV

Family AMATHUSILIDAE	
1. *Discophora deo deo*	Duffer, Banded
2. *Discophora sondaica muscina*	Duffer, Common
3. *Faunis faunula faunuloides*	Pallid fauna
Family DANIDAE	
4. *Daunus gautama gautamoides*	Tigers
5. *Euploea crameri nicevillei*	Crow, Spotted Black
6. *Euploea midamus roepstorfti*	Crow, Blue spotted
Family LYCAENIDAE	
7. *Allotinus drumila*	Darkie, Crenulate/Great
8. *Allotinus fabius penormis*	Angled Darkie
9. *Amblopala avidiena*	Hairstreak/Chinese
10. *Amblypodia ace arata*	Leaf blue
11. *Amblypodia alea constanceae*	Rosy Oakblue
12. *Amblypodia ammonariel*	Malayan Bushblue
13. *Amblypodia arvina ardea*	Purple brown tailless Oakblue
14. *Amblypodia comica*	Comic Oakblue
15. *Amblypodia opalina*	Opal Oakblue
15. *Amblypodia zeta*	Andaman tailless Oakblue
17. *Biduanda melis cyana*	Blue Posy
18. *Callophrys leechii*	Hairstreak, Ferruginosus
19. *Castalius rosimon alarbus*	Pierrot, Common
20. *Charana cephies*	Mandar in Blue, Cachar
21. *Chlioria othona*	Tit/ Orchid
22. *Deudoryx epijarbus amatius*	Cornelian Scarce
23. *Everes moorei*	Cupid, Moore's
24. *Gerydus biggsii*	Bigg's Brownie

25. *Gerydus symethus diopeithes*	Great Brownie
26. *Heliophorus hybrida*	Sapphires
27. *Horaga albimacula*	Onyxes
28. *Jamides Ferrari*	Caeruleans
29. *Liphyra brassiolis*	Buterfly,moth
30. *Listeria dudgenni*	Lister's hairstreak
31. *Logania watsoniana subfasciata*	Mottle, Wasten's
32. *Lycaenopsis binghami*	Hedges Blue
33. *Lycaenopsis haraldus ananga*	Hedge Blue, Felder's
34. *Lycaenopsis puspa prominens*	Common Hedgeblue
35. *Lycaenopsis quadriplaga dohertiya*	Naga Hedgeblue
36. *Nacadubadoreia hampsoni*	Lineblue, White-tipped
37. *Polyommatus oritulus leela*	Greenish mountain Blue
38. *Pratapa icetas mishmia*	Royal, dark-blue
39. *Simiskina phalena harterti*	Brilliant, Broadlanded
40. *Sinthusa virgo*	Spark, pale
41. *Spindasis elwesi*	Silverline, Elwes's
42. *Spindasis rukmini*	Silverline, Khaki
43. *Strymoni mackwoodi*	Hairstreak, Mackwood's
44. *Tajuria ister*	Royal, uncertain
45. *Tajuria laculentus nela*	Royal, Chinese
46. *Tajuria yajna yajna*	Royal Chestnut and Black
47. *Thecla ataxus zulla*	Wonderful Hairstreak
48. *Thecla bleti mendera*	Indian Purple hairstreak
49. *Thecla paona*	Paona Hairstreak
50. *Thecla pavo*	Peacock Hairstreak
51. *Virchola smiles*	Guava Blues
Family NYMPHALIDAE	
52. *Apatura ulupi ulupi*	Emperor, Tawny
53. *Argynnis hegemone*	Silver-washed fritillary
54. *Callnaga Buddha*	Freak
55. *Charases dunfordi nicholi*	Rajah, Chestnut
56. *Cirrochroa fasciata*	Yeoman
57. *Diagora nicevillei*	Siren, Scarce

58.	*Dillpa morgiana*	Emperor, Golden
59.	*Doleschallia bisaltidae andamana*	Autumn leaf
60.	*Eribloea morel sandakanus*	Malayan Nawab
61.	*Eulaceura manipurensis*	Emperor, Tytler's
62.	*Euthalia durga splendens*	Barons/ Connis/Duchesses
63.	*Euthalia iva*	Duke, Grand
64.	*Euthalia khama curvifascia*	Duke, Naga
65.	*Euthalia tellihinia*	Baron, Blue
66.	*Helcyra hemina*	Emperor white
67.	*Hypolimnas missipus*	Eggfly, Danaid
68.	*Limenitis austenia puppurascens*	Commodore, Grey
69.	*Limenitis zulema*	Admirals
70.	*Melitaea shandura*	Fritillaries/Silverstripes
71.	*Neptis antilope*	Sailer, variegated
72.	*Neptis aspasia*	Sailer/ Great Hockeystic
73.	*Neptis columella kankena*	Sailer. Shortbanded
74.	*Neptis cydippe kirbariensis*	Sailer, Chinese yellow
75.	*Neptis ebusa ebusa*	Sailer/ lascar
76.	*Neptis jumbah binghami*	Sailer, Chestnut-streaked
77.	*Neptis manasa*	Sailer, Pale Hockeystic
78.	*Neptis nycteus*	Sailer, Hockeystic
79.	*Neptis poona*	Lascar, Tytler's
80.	*Neptis sankara nar*	Sailer, Broadbanded
81.	*Panthoporia jina jina*	Bhutan Sergeant
82.	*Panthoporia reta moorei*	Malay staff Sergeant
83.	*Prothoc franckii regalis*	Begum Blue
84.	*Sasakia funebris*	Empress
85.	*Sophisa chandra*	Courtier, Eastern
86.	*Symbrenthia silana*	Jester, Scarce
87.	*Venessa antiopa yedunula*	Admirables
	Family PAPILIONIDAE	
88.	*Chilasa clytea clytea of commixtus*	Common mime
89.	*Papilio elephenor*	Spangle yellow crested
90.	*Papilio liomedon*	Swallotail, Malabar banded

91.	*Parnassius aeco geminifer*	Apollo
92.	*Parnassius delphius*	Banded Apollo
93.	*Parnassius hannyngtoni*	Hannyngton's Apollo
94.	*Parnassius skolitskanus*	Ladakh banded Apollo
95.	*Polydorus coon sambilana*	Common clubtail
96.	*Polydorus crassipes*	Black windmill
97.	*Polydorus nevilli*	Nevill's windmill
98.	*Polydorus plutonius pebertoni*	Chines windmill
99.	*Polydorus polla*	Deniceylle's windmill
	Family PIERIDAE	
100.	*Aporia harrietae harrietae*	Black veins
101.	*Baltia butleri sikkima*	White butterfly
102.	*Colias colias thrasibulus*	Clouded yellow
103.	*Colias dubi*	Dwarf clouded yellow
104.	*Delias samaca*	Jezebel, pale
105.	*Pieris kruperi devta*	Butterfly cabbage/White II
	Family SATURNIDAE	
106.	*Coelitis mothis adamsoni*	Cat's eye, scarce
107.	*Cyllogens janetae*	Evening brown, Scarce
108.	*Elymnias peali*	Palmfly, Peal's
109.	*Elymnias penanga chiliensis*	Palmfly painted
110.	*Erebia ananda ananda*	Argus, ringed
111.	*Erebia nara singha narasingha*	Argus, mottled
112.	*Lethe distans*	Forester, scarce red
113.	*Lethe dura gammiel*	Lilacfork, scarce
114.	*Lethe europa tamuna*	Bamboo tree brown
115.	*Lethe gemina gafuri*	Tayler's tree brown
116.	*Lethe guluihal guluihal*	Forester, dull
117.	*Lethe margaritae*	Tree brown, Bhutan
118.	*Lethe ocellata lyncus*	Mystic, dismal
119.	*Lethe ramadeva*	Silverstripe, single
120.	*Lethe satyabati*	Forester pallid
121.	*Mycalesis oreseis nautilus*	Bushbrown, purple
122.	*Pararge menava maeroides*	Wall dark
123.	*Ypthima dohertyi persimilis*	Five ring, great

Wildlife (Protection) Act, 1972 : Schedule–II Part–II

Family DANAIDAE	Family NYMPHALIDAE	Family SATYRIDAE
1. *Euploea melanoleuca*	*Adolias cyanipardus*	*Anlocera brahminus*
2. *Euploea midamus rogenhofer*	*Adolias dirtea*	*Cyllogenes suradeva*
Family ERYCINIDAE	*Adolias khasiana*	*Elymnias malelas milamba*
3. *Abisara kausambi*	*Apatura chevana*	*Elymnias vasudeva*
4. *Dodona adonira*	*Apatura parvata*	*Erebia ananda suroia*
5. *Dodona dipoea*	*Apatura sordida*	*Erebia hygriva*
6. *Dodona egeon*	*Apatura ulupi florenciae*	*Erebia kalinda kalinda*
7. *Libythea lepita*	*Argynnis adippe pallida*	*Erebia mani mani*
Family HESPERIDAE	*Argynnis altissima*	*Erebia seanda opima*
8. *Baoris phidippina*	*Argynnis clara clara*	*Erites falcipennis*
9. *Bebasa sena*	*Argynnis pales horla*	*Hipparchis hoydenreichi shandura*
10. *Halpe homolea*	*Atella alciope*	*Lethe atkinsoni*
Family INOPEPLIDAE	*Calinaga budha Brahman*	*Lethe baladeva*
11. *Inopeplus albonatus*	*Charaxes aristogiton*	*Lethe brisanda*
Family LYCAENIDAE	*Charaxes karruba*	*Lethe goalpara goalpara*
12. *Allotinus subviolaceous manychus*	*Charaxes marmax*	*Lethe insana insane*
13. *Amblypodia aenea*	*Charaxes fabius sulphureus*	*Lethe jalaurida*
14. *Amblypodia agaba Aurelia*	*Charaxes polyxena heman*	*Lethe karuba*
15. *Amblypodia agrata*	*Cheroonesia rahria rahroides*	*Lethe latiaris latiaris*
16. *Amblypodia alesia*	*Cyristes cloces*	*Lethe moelleri moelleri*
17. *Amblypodia apidanus ahamus*	*Diagora persimilis*	*Lethe naga naga*
18. *Amblypodia areste areste*	*Dolischallia bisaltidae malabarica*	*Lethe nicetella*
19. *Amblypodia bazaloides*	*Eriboea athames andamanicus*	*Lethe pulaha*
20. *Amblypodia camdeo*	*Eriboea delphis*	*Lethe scandal*
21. *Amblypodia ellisi*	*Eriboea dolen*	*Lethe serbonis*
22. *Amblypodia fulla ignara*	*Eriboea harcoea lissainei*	*Lethe siderca*
23. *Amblypodia genesa watsoni*	*Eripus consimilis*	*Lethe sincrix*
24. *Amblypodia paraganesa zephyreeta*	*Equipus halitherses*	*Lethe tristigmata*

25. *Amblypodia paralea*	*Euthalia anosia*	*Lethe violaceoticta kanjupkula*
26. *Amblypodia silhetensis*	*Euthalia cocytus*	*Lethe visrava*
27. *Amblypodia suffuse suffuse*	*Euthalia duda*	*Lethe yama*
28. *Amblypodia yendava*	*Euthalia durga durga*	*Lethe yama*
29. *Apharitis lilacinus*	*Euthalia evalina landabilis*	*Maniola davendra davendra*
30. *Araotes lapithis*	*Euthalia franciae*	*Melanites ziteneus*
31. *Artipe eryx*	*Euthalia garuda acontius*	*Mycalesis adamsoni*
32. *Bindahara phocides*	*Euthalia lepidea*	*Mycalesis anaxias*
33. *Bothrinia chennellia*	*Euthalia merta eriphyla*	*Mycalesis quotama chakma*
34. *Castalius roxus manluena*	*Euthalia nara nara*	*Mycalesis heri*
35. *Catapocilma elegans myostina*	*Euthalia patala taooana*	*Mycalesis lepcha bethami*
36. *Charana jalindra*	*Euthalia teuta*	*Mycalesis malsarida*
37. *Chetirella truncipennis*	*Horona marathus andamana*	*Mycalesis mestra*
38. *Chliaria kina*	*Hypolimnas missippus*	*Mycalesis misenus*
39. *Deudoryx hypargyria gaetulia*	*Hypolimnas polynice birmana*	*Mycalesis mystes*
40. *Enchrysops cnejus*	*Kallima albofasciata*	*Mycalesis suavolens*
41. *Everes kala*	*Kallima philarchus horsefieldi*	*Neorina hilda*
42. *Helipphorus androcles moorei*	*Limenitis austenia austenia*	*Oeneis budha quaurhwalica*
43. *Horage onyx*	*Limenites damava*	*Parantirhoea marshali*
44. *Horage viola cashmirensis*	*Limenites dudu*	*Pararge eversmanni*
45. *Hypolycaena nilgirica*	*Melitaea robertsi lukto*	*Pararge maerula maerula*
46. *Hypolycaena theclodies nicobarica*	*Neptis aurelia*	*Ragadia crislda crito*
47. *Iraota rochana boswelliana*	*Neptis anjana nashona*	*Rhapicera sttriens kabrua*
48. *Jamides alectokandulana*	*Neptis magadh khasiana*	*Ypthima bolanica*
49. *Jamides celeodus pura*	*Neptis nandina hamsoni*	*Ypthima lycus lycus*
50. *Jamides coeruler*	*Neptis narayana*	*Ypthima mathora mathora*
51. *Jamides kankena*	*Neptis radha radha*	*Ypthima similes affectata*
52. *Lampides boeticus*	*Neptis soma*	*Zipotis saitis*
53. *Lilacea albocaerulea*	*Neptis zaida*	
54. *Lilacea atroguttata*	*Neurosigma doublodayi doublodayi*	**Schedule – III**

55. *Lilacea lilacea*	*Pantoporia kanwa phorkys*	**NIL**
56. *Lilacea melanea*	*Pantoporia ksura ksura*	
57. *Lilacea minima*	*Pantoporia larymna siamensis*	**Schedule – IV**
58. *Logania massalia*	*Pantoporia pravara acutipennis*	
59. *Lycaenesthes lycaenina*	*Pantoporia ranga*	Family DANAIDAE
60. *Mhathala atkinsoni*	*Parthenos Sylvia*	*Euploca core simulatrix*
61. *Magisba malaya prsbyter*	*Penthema lisarda*	*Euploca crassa*
62. *Nacaduba aluta coelestis*	*Symbrenthia niphanda*	*Euploca dioclctianus ramsayi*
63. *Nacaduba dubiosa fulva*	*Vanesa egea agnicula*	*Euploca muleiber*
64. *Nacaduba helicon*	*Vanesa lalbum*	Family HESPERILIDAE
65. *Nacaduba hermus major*	*Vanesa polychloros fervida*	*Baoris farri*
66. *Nacaduba pactolus*	*Venesa parasoides dohertyi*	*Hasora vitta*
67. *Neucheritra febronia*	*Venesa urticoe rizama*	*Hyarotis adrastus*
68. *Nephanda cymbia*	Family PAILIONIDAE	*Oriens concinna*
69. *Orthomeiella pontis*	*Bhutanitis liderdalei liderdalei*	*Pelopidas assamensis*
70. *Pithcops fulgens*	*Chilasa epycides epycides*	*Pelopidas sinensis*
71. *Polymmatus devanica devanica*	*Chilasa paradoxa telearchus*	*Polytrema discreta*
72. *Polymmatus metallica metallica*	*Chilasa slateri slateri*	*Polytrema rubicans*
73. *Polymmatus orbitulus jaloka*	*Graphium aristeus anticrates*	*Thoressa horiorei*
74. *Polymmatus yeonghusbandi*	*Graphium arycles arycles*	
75. *Porita erycinoides elsiei*	*Graphium eurypylus macronius*	Family LYCAENIDAE
76. *Porita hewitsoni*	*Graphium evemon albociliates*	*Tarucus ananda*
77. *Porita plsurata geta*	*Graphium gyas gyas*	
78. *Pratapa bhetes*	*Graphium megarus megarus*	Family NYMPHALIDAE
79. *Pratapa blanka*	*Papilio bootes*	*Euthalia lubentina*
80. *Pratapa deva*	*Papilio budha*	
81. *Pratapa icetas*	*Papilio fuscus andamanicus*	Family PIERIDAE

82. *Rapala buxaria*	*Papilio machaon vertityi*	*Aporia agathon ariaca*
83. *Rapala chandrana chandrana*	*Papilio mayo*	*Appias lbythea*
84. *Rapala nasaka*	*Parnassius charltonius charltonius*	*Appias nero galba*
85. *Rapala refulgens*	*Parnassius epaphus hillensis*	*Prioneris sita*
86. *Rapala rubida*	*Parnassius jacquemonti jacquemonti*	
87. *Rapala scintilla*	*Polydorus latreillei kabrua*	
88. *Rapala sphinx sphinx*	*Polydorus plutonius tytleri*	
89. *Rapala varuna*	*Teinopalpus imperialis imperialis*	
90. *Spindasis elima elima*	Family PIERIDAE	
91. *Spindasis lohita*	*Aporia nebellica*	
92. *Spindasis nipalicus*	*Appias albina darada*	
93. *Sausa lisides*	*Appias indra shiva*	
94. *Surendra todara*	*Appias lycinda latifasciata*	
95. *Tajuria albipalga*	*Appias wardi*	
96. *Tajuria cippus cippus*	*Baltia butleri butleri*	
97. *Tajuria culta*	*Cepora nadian remba*	
98. *Tajuria diaeus*	*Cepora nerissa dapha*	
99. *Tajuria illurgiodes*	*Colias ecocandiae hinducucica*	
100. *Tajuria illurgis*	*Colias eogene*	
101. *Tajuria jungala andamanica*	*Colias ladakensis*	
102. *Tajuria melastigma*	*Colias stoliczkana Miranda*	
103. *Tajuria sebonga*	*Delias lativitta*	
104. *Tajuria thyuia*	*Dercas lycorias*	
105. *Tajuria yajna istroides*	*Euchloe charlonia lucilla*	
106. *Tarucus callinara*	*Eurema andersoni ormistoni*	
107. *Tarucus dharta*	*Metaporia agathon*	
108. *Thaduka multicaudata kanara*	*Pieris deota*	
109. *Thecla ataxus ataxus*	*Pontia chloridice alipina*	
110. *Thecla bitel*	*Saletara panda chrysea*	
111. *Thecla icana*	*Valeria avatar avatar*	
112. *Thecla jakamensis*		
113. *Thecla kabreea*		
114. *Thecla khasia*		
115. *Thecla kirberiensis*		

116. *Thecla suroia*
117. *Thecla syla assamica*
118. *Thecla vittata*
119. *Thecla zeba*
120. *Thecla zsta*
121. *Una usta*
122. *Yasoda tripunctata*

The family Tipulidae is the largest of all the families in the order Diptera and is represented by 1,330 species under 60 genera, of which over 1,200 species were described during 1918-1976. The tipulid fauna is quite significant in India since it accounts for about 50% of the nematocerans and nearly 22% of the entire diptera fauna known so far from the country. *Exorista bombycis:* The uzi fly (Diptera : Tachinidae) is a serious endo- larval parasitoid of the silkworm, *Bombyx mori* and is estimated to cause around 10-20% crop loss. Though it occurs throughout the year, maximum incidence is from August to November. Black scar on the body of parasitized silkworm is the main symptom.

Besides the above major groups, the Orthoptera is ranked below with over 1750 species that account for over 10% of the fauna in the world. There are 77 endemic genera and over 200 species in this order. It is mentionable that maximum diversity of these insects is encountered in the Terai and Dooars areas of the Himalaya, tropical rain forest areas of northeastern India, and Nilgiri, Wynad and Silent Valley areas of south India. It is a matter of concern that the encroachment by man into the grassland habitats of these insects for agricultural and industrial purposes leads to a considerable reduction in the populations and species.

There are 2 orders, viz., the Trichoptera and the Thysanoptera that register the number of species below 1,000 but over 500 in that, the former comprises 812 species under 112 genera and the latter 693 species under 249 genera. However, the number of endemic species is quite high in comparison to the total species number. The endemism in case of the Trichoptera with 650 species and of the Thysanoptera with 520 species is a matter of satisfaction. It is extremely difficult at this stage to estimate the actual diversity unless systematic exploration is undertaken all over the country.

The following 5 orders, viz., the Odonata with 499 species under 139 genera, the Phthiraptera with 400 species under 85 genera, the Neuroptera with 335 species under 125 genera, the Dermaptera with 320 species under 74 genera and the Isoptera with 253 species under 54 genera exhibit the number of species below 500 but above 200. Indeed, a good endemicity is on record as the Odonata with 115 species, the Phthiraptera with 16 species, the Neuroptera with 262 species, the Dermaptera with 117 species and the Isoptera with 170 species despite impoverished species population size of these groups of insects as opined by the leading workers.

There are 5 other groups of insects that are known by the species below 200 but above

100. The Blattaria are represented by 186 (nearly 4.0% of the world fauna), followed by the Mantodea with 162 species (a little over 7.0%), the Phasmida with 146 species (nearly 6.5%), the Plecoptera with 113 species (nearly 5.5%) and the Ephemeroptera with only 106 species (nearly 5.0%) that includes 60, 86, 70, 66 and 72 species, respectively as endemic elements of these groups in India. The fauna of each of the 5 remaining orders, i.e., the Psocoptera, the Siphonaptera, the Embioptera, the Mecoptera and the Strepsiptera are insignificantly known by the species below 100 numbering 90 species (over 3.0%), 52 species (over 2.5%), 33 species (16.5%), 15 species (over 4.0%) and 18 species (over 3.0%), respectively.

India by virtue of her very rich evergreen and subtropical vegetation in the Himalaya up to Assam hills, Eastern and Western Ghats, and the adjoining areas has a highly rich fauna of coleoptera, which is not adequately explored. Perhaps the number of species known would be much less than half of the existing at present. It is evident that the lepidopterous fauna is much more concentrated in the eastern Himalaya as far as the Myanmar border than in the other parts of the country, such as, the western Himalaya, southern India, the plateau, and the oceanic islands. Indeed, the microlepidopterous fauna as well as several families of moths like Castniidae, Neopseustidae, etc. are poorly known. On the basis of available information it may be presumed that about 20-60% lepidopterans still await discovery. Major concentration of hymenopterous species is in the hilly and densely forested areas of the country and it is estimated that nearly 80 - 85% of the species remain to be explored from these areas. A great diversity of hemipterous insects is found both in the eastern and the western Himalaya, and the Assam hills but the fauna is much less in the Indian peninsula, and the Gangetic and Indus plains. In fact, aphids attracted much more attention than several other groups. Likewise the Himalayan belt and the Assam hills exhibit maximum concentration of the dipterous insects both qualitatively and quantitatively despite their overwhelming occurrence in other hilly areas also along side plains with variegated vegetation. It is true that the known fauna is far from satisfactory and it is estimated that a number of species still remain undiscovered.

In reality, India is quite rich in her vast faunal wealth and this richness largely depends upon the splendid floral diversity of the country. With the change of vegetation under the influence of physico-chemical factors prevaling in different zones of the country, the fauna has taken a shape of integrity with all kinds of innate characteristics of their own. Nature has been taking care and maintaining the equilibrium both in the plant and animal kingdoms in her own way. Man being a supreme creation of Nature must obey her by looking after her wonderful artistic creation on the earth. Soil and water quality, types of vegetation, humidity and rainfall, variations of temperature, etc., are the major parameters that influence the distribution of Insects in India. The eastern Himalayas and the Assam hills in the northeast India with tropical evergreen forests form a paradise of maximum number of species and populations of species. The western Himalaya extending from Kashmir to Uttar Pradesh through Himachal Pradesh is rich in insects. In these areas, the fauna is varied, colourful and plentiful as well as preponderant with rare species. It may be mentioned that some localities in the areas, such as Khasi Hills, Sikkim,

Darjeeling, Simla and Mussoorie are the well-known type localities of a good number of species including, some unique ones. Likewise, the hills of south India *viz.*, Nilgiri, Anamalai, Palni and Cardamon hills, Malabar and Coorg etc. along with the rest of Western Ghats have provided suitable habitats for many insects of immense interest. On the other hand, the Great Indian Desert exhibits minimum number of species with little population size because of adverse vital conditions for certain groups of insects. Although the insect fauna in the above areas are fairly known, there are still areas like Pangi valley of Himachal Pradesh, valley of Flowers in Uttar Pradesh, Neora Valley of West Bengal, selected pockets of Western Ghats and the border states in the northeastern India where the fauna remains to be adequately explored.

No. of families and species of insects in India

Insect Order	No. of families in India	No. of species in India	No. of species in World	% of species in India
APTERYGOTA				
Thysanura	5	31	1250	2.48
Diplura	3	16	355	4.50
Protura	3	20	260	7.69
Collembola	8	210	5500	3.81
PTERYGOTA				
Exopterygota				
Ephemeroptera	12	106	2200	4.81
Odonata	17	499	6000	8.31
Plecoptera	7	113	2100	5.38
Orthoptera	30	1750+	17250	10.14
Phasmida	8	146	2262	6.45
Dermaptera	7	320	2000	16.00
Embioptera	2	33	200	16.50
Blattariae	12	186	5000	3.72
Mantodea	6	162	2310	7.04
Isoptera	7	253	2000	12.65
Psocoptera	16	90	2500	3.60
Phthiraptera	8	400	3000	13.33
Hemiptera	77	6556	80000	8.22
Thysanoptera	5	693	6000	11.55
ENDOPTERYGOTA				
Neuroptera	13	335	5000	6.70
Coleoptera	114	17036	344105	4.82

Insect Order	No. of families in India	No. of species in India	No. of species in World	% of species in India
Strepsiptera	4	18	554	3.25
Mecoptera	2	15	350	4.28
Siphonaptera	8	52	2000	2.60
Diptera	87	6255	100000+	6.21
Lepidoptera	84	15000	142500	10.52
Trichoptera	19	812	7000	11.60
Hymenoptera	65	10000	120000	8.33
Total	**629**	**61,151**	**861696**	**6.90**

Updated : January, 2006

Insects are a large group among the animal kingdom, includes highest number of orders, families, genera, and species. The table shown below is indicative of the enormity of the family, genera and species in a single order such as Coleoptera and Diptera. Coleoptera represent the largest group of organisms at the order, family and species level. Equally true that they exhibit habitat diversity under bark, stone tunnel, soil, flowers, fruits, fresh and estuarine waterbodies as well as even on other animals such as nests of mammals, birds, ants and termites.

Status of Indian Coleoptera vis-a-vis world

Sl. No.	Family	Number of species	
		World	India
1.	Rhysodidae	150	14
2.	Paussidae	350	27
3.	Cicindelidae	1500	151
4.	Carabidae	30,000	2,500
5.	Halipcidae	200	7
6.	Amphizoidae	5	1
7.	Noteridae	175	10
8.	Dyticidae	3,000	380
9.	Gyrinidae	700	56
10.	Hydraennidae	400	8
11.	Spercheidae	300	3
12.	Hydrochidae	350	4
13.	Groryssidae	25	5
14.	Hydrophilidae	2,000	140
15.	Syntelidae	4	1

Sl. No.	Family	Number of species	
		World	India
16.	Histeridae	3,000	170
17.	Ptilidae	10	430
18.	Liodidae	2,000	40
19.	Scydmaenidae	2,000	40
20.	Silphidae	175	30
21.	Staphylindiae	30,000	3,000
22.	Pselaphidae	5,000	100
23.	Clambidae	50	5
24.	Helodidae	600	30
25.	Dascillidae	70	12
26.	Rhipiceridae	50	10
27.	Lucanidae	1,200	102
28.	Trogidae	300	10
29.	Acanthoceridae	200	2
30.	Passalidae	500	20
31.	Geotrupidae	600	50
32.	Scarabeidae	25,000	1,200
33.	Byrrhidae	300	30
34.	Ptilodatilidae	300	2
35.	Psephenidae	100	1
36.	Elmidae	700	2
37.	Dryophidae	200	16
38.	Heteroceridae	300	13
39.	Bupestridae	15,000	430
40.	Calliriphidae	150	2
41.	Brachypsectridae	3	1
42.	Cebrionidae	170	2
43.	Elateridae	9,000	170
44.	Throscidae	190	7
45.	Eucnemidae	1,200	60
46.	Lysidae	3,500	180
47.	Drilidae	80	17
48.	Phengodidae	200	2

Sl. No.	Family	Number of species	
		World	India
49.	Lampyridae	2,000	50
50.	Cantharidae	5,000	150
51.	Nosodendridae	50	1
52.	Dermestidae	850	20
53.	Jacobsoniidae	12	2
54.	Bostrichidae	600	70
55.	Lyctidae	100	2
56.	Anobiidae	1,600	12
57.	Ptinidae	450	10
58.	Trogossidtidae	600	17
59.	Cleridae	4,000	155
60.	Melyridae	5,000	89
61.	Lymexilidae	50	3
62.	Nitidulidae	3,000	175
63.	Rhizophagidae	250	25
64.	Phalacridae	600	30
65.	Sphindidae	35	7
66.	Cucujidae	800	50
67.	Passandridae	40	8
68.	Silvanidae	450	72
69.	Cryptophagidae	600	35
70.	Helotidae	100	11
71.	Byturidae	25	2
72.	Biphellidae	200	8
73.	Languriidae	900	95
74.	Erotylidae	2,500	60
75.	Propalticidae	35	1
76.	Corylophidae	400	4
77.	Endomychidae	1,300	55
78.	Coccinellidae	4,500	280
79.	Discolomidae	400	6
80.	Merophysiidae	150	10
81.	Lathridiidae	500	25

Sl. No.	Family	Number of species	
		World	India
82.	Archeocryptidae	22	2
83.	Colydiidae	1,300	40
84.	Prostomidae	20	1
85.	Mycetophagidae	200	10
86.	Tetratomidae	25	1
87.	Melandryidae	450	7
88.	Mordellidae	1,200	10
89.	Rhipiphoridae	400	11
90.	Oedeeridae	1,000	5
91.	Pythidae	50	5
92.	Trictenotomidae	15	5
93.	Pyrochoridae	100	11
94.	Anthicidae	3,000	115
95.	Aderidae	1,100	7
96.	Meloidae	3,000	108
97.	Scraptiidae	400	4
98.	Othniidae	20	1
99.	Inopeplidae	60	8
100.	Monmmidae	225	1
101.	Lagriidae	600	13
102.	Tenebrionidae	14,000	450
103.	Alleculidae	1,200	30
104.	Cerambycidae	35,000	800
105.	Bruchidae	1,500	60
106.	Chrysomelidae	35,000	1,600
107.	Anthribidae	2,600	30
108.	Attelabidae	2,100	80
109.	Apionidae	2,200	80
110.	Brenthidae	2,300	103
111.	Curculionidae	45,000	2,500
112.	Scolytidae	7,000	280
113.	Platypodiidae	1,000	20
	TOTAL	**3,40,491**	**17,431**

Source : Pal, 2003

No. of families, genera and species of Diptera in India

Sl. No.	Families	Genera	Species
	Nematocera	**(245)**	**(2759)**
1.	Trichoceridae	2	20
2.	Tipulidae	60	1330
3.	Tanyderidae	1	3
4.	Psychodidae	8	41
5.	Pblebotomidae	2	38
6.	Ptychopteridae	1	4
7.	Nymphomyudae	1	1
8.	Blephariceridae	6	23
9.	Deuterophlebiidae	1	2
10.	Dixidae	1	11
11.	Choboridae	1	2
12.	Culicidae	15	3000
13.	Thaumaleidae	1	14
14.	Ceralopogonidae	21	220
15.	Chironomidae	25	185
16.	Similiidae	1	57
17.	Anisopodidae	1	8
18.	Bibionidae	4	39
19.	Mycetophilidae	22	77
20.	Sciaridae	8	71
21.	Scatopridae	3	3
22.	Cecidomyiidae	113	380
	Brachycera	(198)	(1,156)
23.	Coenomyiidae	1	2
24.	Rachiceridae	1	4
25.	Solvidae	2	13
26.	Stratiomyidae	34	73
27.	Tabanidae	12	200
28.	Rhagionidae	5	30
29.	Therevidae	3	16
30.	Scenopinidae	2	2

Sl. No.	Families	Genera	Species
31.	Mydidae	3	5
32.	Asilidae	55	482
33.	Nemestrinidae	2	6
34.	Acroceridae	8	14
35.	Bombyliidae	24	118
36.	Empididae	19	57
37.	Dolichopodidae	27	134
	Cyclorrhapha	(632)	(2,178)
38.	Lonchopteridae	1	3
39.	Phovidae	18	64
40.	Platypezidae	1	3
41.	Pepunculidae	4	25
42.	Syrphidae	62	256
43.	Microdontidae	4	16
44.	Conopidae	11	48
45.	Neriidae	2	4
46.	Micropozidae	3	10
47.	Pilidae	1	1
48.	Megamerinidae	1	1
49.	Nothybidae	1	1
50.	Diopsidae	5	8
51.	Pyrgotidae	6	15
52.	Tephritidae	77	241
53.	Platystomatidae	10	36
54.	Otitidae	1	2
55.	Sciomyzidae	4	10
56.	Dryomyzidae	1	1
57.	Sepsidae	8	17
58.	Lauxaniidae	12	30
59.	Celyphidae	2	12
60.	Chamaemyiidae	1	7
61.	Lonchaeidae	3	8
62.	Piophilidae	1	2

Sl. No.	Families	Genera	Species
63.	Aulacigastridae	2	4
64.	Asteiidae	3	3
65.	Agromyzidae	22	157
66.	Milichiidae	3	6
67.	Carnidae	1	1
68.	Chloropidae	70	225
69.	Ephydridae	26	65
70.	Drosophilidae	13	112
71.	Heliomyzidae	1	2
72.	Canaceidae	1	1
73.	Sphaeroceridae	17	46
74.	Hippoboscidae	7	33
75.	Nycteribiidae	7	59
76.	Streblidae	4	10
77.	Scathophagidae	1	2
78.	Anthomyiidae	11	19
79.	Fanniidae	1	5
80.	Muscidae	39	263
81.	Eginiidae	2	2
82.	Calliphonidae	26	107
83.	Sarcophagidae	26	85
84.	Rhinophoridae	1	1
85.	Tachinidae	111	227
86.	Gasterophilidae	3	6
87.	Oestridae	7	8
Grand Total		**1,141**	**6,255**

Source : P.T. Cherian, C. Radhakrishnan, R.M. Sharma, G. Thirumalai (pers. Comn.)

Dipteran vectors

The genus *Culicoides* Latreille, of tribe Culicoidini of subfamily Ceratopogoninae, is by far the largest genus of 1210 extant and 37 extinct species globally and those species have been accommodated in more than 40 species groups of 29 subgenera. The species normally encountered are *Culicoides distinctus; C. brevitarsis; C certus; C. definitus; C. fulvus; C. himalayae; C. imicola; C. inexploratus; C. jacobsoni; C. odious* and several other species. Through their

painful bites that may cause serious type of allergic dermatitis, Culicoides may retard the importance of tourist spots or residential areas or reduce the output of poultry and farm animals. Species of biting midges are found to be actual or potential vectors of disease pathogens in man and other animals, including poultry and wild birds of which transmission of Bluetongue Virus (BTV) in domestic and wild ruminants is of prime importance even in India.

Aedes aegypti causes Dengue fever; *A. albopictus* causes Dengue and Yellow fever; *Anopheles subpictus, A. stephensi* transmits malaria; viral disease is transmitted by both nymphs and adults of *Bemisia tabaci; Circulifer tenellus* is a vector of curly top virus. *Culex quinquefasciatus* adults are generally active only during the warmer months; they usually attack both indoors and outdoors humans towards the middle of the night, but are often more attracted to birds (e.g. poultry) and causes encephalitis. *Frankliniella schultzei* causes viral disease by premature dropping of flowers. Apical parts of shoots show retarded growth; flattening and crinkling of leaves and leaves become dark by *Maconellicoccus hirsutus*. Both nymphs and adults desap the mulbery plant. *Myzus persicae* commonly known as Potato leaf rolls causes viral disease in older leaves as they turn yellow and wilt and die prematurely. *Nephotettix virescens* is a Rice Tango virus. Vector of *Sesame phyllody*, caused by MLO; it also attacks Bengal-gram, sunhemp and turnip (*Orosius albicinctus*).

Dipetran Pollinators : *Ischiodon scuterllaris* (*Cassia tora* plant); *Apis mellifera* and *Apis dorsata (Brassica oleoracea, Litchi chinensis, Mangifera indica); Apis floria (Emblica officinalis); Apis cerana (Almond, Cherrys); Petrorosea nigrofemorata (Coriandrum sativum); Exoprosopa insulata* and *Petrorosea albofulva (Solanum melongina, Lycopersicom esculentum); Chrysomya megacephala (Tectona grandis)* are some of the dipteran pollinators.

Agricultural pests : Diptera : *Abgrallaspi cyanophylli* infects leaves and fruits; *Acritochaeta excisa* on tomato and mango plant; the lepidoptera viz., *Acanthopsyche bipars* attacks cardamom. Among Acarina, *Acaphylla theae* causes damage to tea leaves; *Aceria lycopersici* on tomato; *A. janata* on grapevine, rose, mango, pomegranate and castor. *A. styx* damages gingely, grapevine, mango, *Acherontia lachesis* affects teak and *Aconurella indica* damages groundnut.

Dipteran Research : By the end of 1984, 62 genera and 2,822 described species of this family Drosophilidae were known worldwide, and at least 4,000 species were predicted to exist (Wheeler, 1986). Indian diversity of the family accounts to 112 species of 13 genera. The *Drosophila melanogaster* (the so-called fruit fly), a dipteran insect became a favourite "model" organism for genetics research. The giant ("polytene") chromosomes in the salivary (and other) glands of the mature larvae, the chromosomes showing far more structural detail than any normal chromosomes, and are present during interphase when chromosomes are normally invisible, are some of major facts being used as an experimental animal in research. Besides these, the circadian rhythms, foraging behavior, and genetic controls over the building of wings, legs, and eyes are the major factors. The *Drosophila* genome sequence was published in the issue of *Science* (March 24, 2000). The researchers report that they have sequenced 97 to 98 percent of the genome and the size of the

genome is about 165 million bases and contains and estimated 14,000 genes (by comparison, the human genome has 3,300 million bases and may have about 30,000 genes; yeast has about 5800 genes in 13.5 million bases). The genetic sequence database is accessible to scientists worldwide through Genebank, the National Institutes of Health, USA. In recent years, a variety of genome projects have successfully employed high throughput methods to rapidly and reliably generate large numbers of sequences. As a result, wealth of characters is now readily available to the molecular systematist. Many systematists have begun to take a "phylogenomic" approach by using genomic information to infer phylogenetic relationships. This family is an excellent model system for genomic studies because the entire sequence of *Drosophila melanogaster* is now completed and that of a second drosophilid, *D. pseudoobscura*, is nearing completion.

ENDEMICITY IN INSECTS

In view of several unexplored or under explored areas of the country and not well worked out orders of insects, the picture of endemism is far from complete. Many of the earlier records are from literature, which need to be confirmed through faunistic surveys.

No. of endemic genera and species of insects in India

Order	Endemic genera	Endemic species
Thysanura	12	23
Diplura	3	12
Prolura	4	16
Collembola	22	45
Ephemeroptera	-	72
Odonata	6	115
Plecoptera	-	66
Orthoptera	77	200
Phasmida	-	70
Dermaptera	3	117
Embioptera	-	14
Blattariae	14	60
Mantodea	24	86
Isoptera	-	170
Psocoptera	-	15
Phthiraptera	-	16
Hemiptera	579	2,421
Thysanoptera	92	520
Neuroptera	13	262

Order	Endemic genera	Endemic species
Coleoptera	923	3,100
Strepsiptera	-	15
Mecoptera	-	2
Siphonaptera	-	15
Diptera	110	2,183
Lepidoptera	100	1,500
Trichoptera	5	650
Hymenoptera	516	9,000
Total	**2,503**	**20,765**

Note : (-) indicates lack of knowledge. (*Source* : ZSI publications)

THREAT

Some insects groups in India now included in the revised list of Schedules to the Wildlife (Protection) Act 1972, which have come into force from 2.10.1980, are shown below. This is due to the fact many groups exhibit rarity due to environmental degradation, deforestation and application of agrochemicals. In contrast to the Wildlife (Protection) Act 1972, IUCN (2002) identified 12 species of insects as threatened, among them, 2 species as critical viz., *Haematopinus oliveri* (Pygmyhog sucking lice) and *Burmagomphus benghalensis.*

No.	Schedule	Insect Group	No. of Species included
1	Schedule–I : Part IV	Butterflies Dragonfly	126 1
2	Schedule–II : Part II	Beetles Butterflies	37 304
3	Schedule IV	Butterflies	19

Species of Coleoptera under Wildlife (Protection) Act, 1972

Schedule–II Part–II

Family AMATHUEIDAE	Family CHRYSOMELIDAE
Aemona amathusia amathusia	*Acrocrypta rotundata*
Amathusia phidippus andamanicus	*Bimala indica*
Amathuxida amythaon amythaon	*Clitea indica*
Discophora deo deodoides	*Gopala pita*
Discophora lepida lepida	*Griva cyanipennis*
Discophora timora andamanesi	*Nistora cardoni*

Enispe cycnus	*Nistora madurensis*
Faunis sumeus assama	*Nistora nigripennis*
Sticopthalma nourmahal	*Nistora semicorelulea*
Thauria aliris amplifascia	*Nonartha patkia*
Family CARABIDAE	*Psylloides plana*
Agonotrechus andrewesi	*Psylloides shira*
Amara burcei	*Sebaethe cervina*
Amara eleganfula	*Sebaethe patkia*
Brachinus atripennis	*Sphaeroderma brevicorne*
Brocosoma gracile	Family CUCUJIDAE
Brosous bipillifer	*Carinophlocus raffrayi*
Broter ovicollis	*Cucujus bicolor*
Calathus amaroides	*Cucujus grouvelle*
Callistominus belli	*Cucujus imperialis*
Chalenius championi	*Heterojinus semilaetaneus*
Chalenius kanarae	*Laemoploeus incertus*
Chalenius masoni	*Peiaus refipes*
Chalenius nigricius	

INTRODUCED SPECIES

A number of insect species have been introduced in the country knowingly or unknowingly; some insects have been imported for the biological control of some other insect pests and weeds. The lantana bug, *Telionenia scrupulosa* (Hemiptera) is one of the early examples of import of insects in India. This species was introduced about 60 years ago for the control of lantana bushes. However, the insect was found to be a threat to the teak plants as well, hence, its culture was stopped but with in the next few decades it has spread over a major part of country. The erstwhile Indian station of the Commonwealth Institute of Biological Control (Now known as Project Directorate of Biological Control, Bangalore) introduced a number of parasitic Hymenopteran species and some ladybird beetles for the control of several coccid and aphid pests. Introduced hymenopteran species belong to the families Trichogrammatidae, Aphelinidae, Entophidae and Pteromalidae. Encyrtid hymenopterans also reached different parts of the country as coccid and mealy bug parasites.

There were considerable introductions of cockroaches in India. Several species including some well known pests' species, *e.g., Blatta orientalis, Periplaneta americana, Blattella germanica* and *B. humbertiana* were introduced through human agency and have established in different parts of India. Of the 50 introduced species of termites in the globe, only two species viz., *Cryptotermes dudleyi,* a species which originated in the Oriental Region, has

been introduced in lower Bengal and Orissa and *Cryptotermus bengalensis*, native to Africa, has been introduced in the Sunderbans. On the other hand, *Coptotermus heimi* predominantly found in India and Pakistan probably has established in Java (Maiti and Saha, 1998).

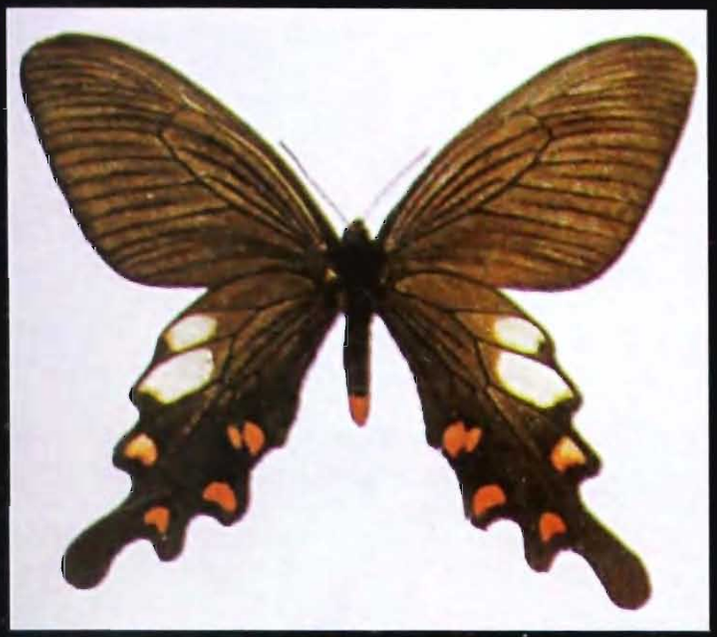
Amongst the 6145 species of dipterous fauna in India, about 25% have introduced and have established themselves in India from abroad. As for example, all species of the Gasterophilidae and Oestridae have been imported with their hosts. Likewise, several pest and parasitic species of animals belonging to the families Culicidae, Ceratopogonidae, Simuliidae, Phlebatomidae, Ippoboscidae, Nycteribiidae, Streblidae, etc., and those of plants from among dipteran families Tephritidae, Drosophilidae, Agromyzidae, etc. have made their way to India mainly by carriages, by birds and other animals or through imported fruits and vegetables. Among Tephritidae (Diptera), *Procecidochares utilis* belonging to the Neotropical Region was released in the Darjeeling district of West Bengal, Assam, Tamil Nadu and Uttar Pradesh in 1963 for the control of the obnoxious weed *Eupatorium trapezoiduon*. The larvae of the fly form galls on the stems, particularly destroying the terminal portion of the weed thereby preventing the weed from growing and spreading further. Though introductions of the fly in Hawaii has resulted in a grand success in the eradication of the weed, in India the fly in spite of establishing itself sufficiently well has not been effective in the control of the weed. Mexican Beetle (*Zygogramma bicolorata)* introduced to control Congress Grass in Jammu, has caused considerable damage to the ecology of the area.

Insect interrelationship is the most important aspect in the insect ecology. Usually a perfect homeostatic mechanism exists in crowding of beetles, aphids, butterflies and dragonflies during feeding, hibernating or other activities thus exhibiting perfect intraspecific associations. The interspecific variations found in insects especially in the groups that exhibits predatism, parasitism, and insects as vectors of diseases and insects as food for other animals is most important in terms of taxonomic research. This is true especially in insects (e.g., parasitic hymenoptera; blood sucking parasites such as mosquitoes, tabanids; vectors of diseases viz., *Siphunculina funicola* (Diptera : Chloropidae) causing Conjuctivitis in eyes; symbionts such as insects in the nests of ants).

Silkworm bioresource

India has the unique distinction of producing all the five known varieties of silk *viz.*, mulberry, oak tasar, tropical tasar, eri and muga. Among five types of silkworms reared in India, mulberry silkworm *(Bombyx mori)* is reared on large scale through out the country and contributes to over 90% of total silk produced in the country.

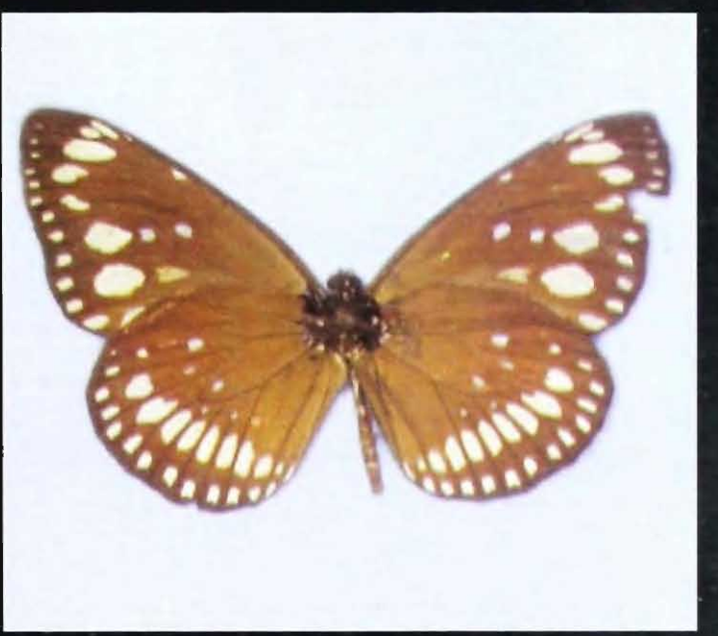
The mulberry silkworm, *Bombyx mori*, an economically important insect and a sole source of mulberry silk, finds its commercial origin in China, which is traced back to more than 5000 years. It is believed that two wild silkworms namely *Bombyx mandarina* and *Theophila religiosae* are the closest relatives of the domesticated silkworm. *Bombyx*, though is single genus, has three broad types of geographical identities, namely i) Japanese (Peanut shaped cocoons), ii) Chinese (Elliptical or spherical cocoons) and iii) European (Large



Atrophaneura neville (Wood-Mason), female (Upperside)

Papilio liomedon (Moore), female (Upperside)

Callerebia annada annada (Moore), (Upperside)



Euploea crameri nicevillei (Moore), (Underside)

Bassarona durga splendens (Tytler) (Upperside)

Bassarona khama curvifascia (Tytler) (Upperside)

Neptis aspasia Leech (Upperside)

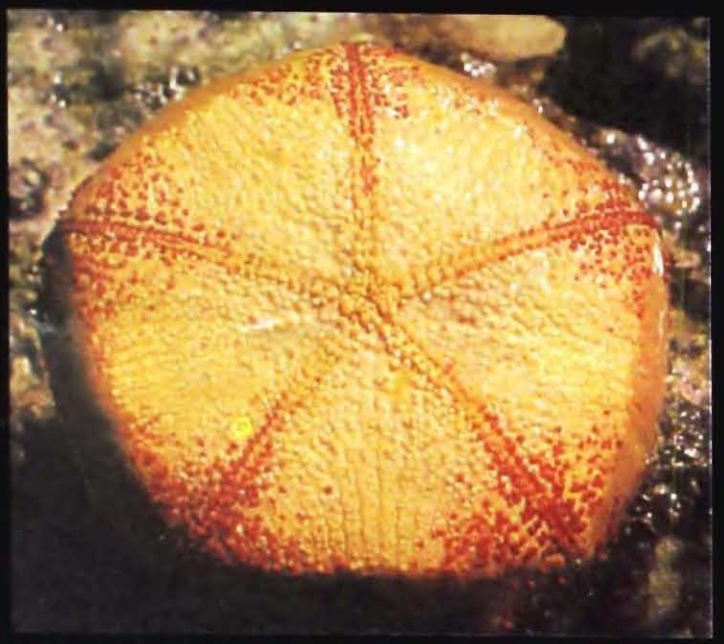
Parnassius imperator augustus Fruhstorfer

Narathura asinarus tounguva zulla (Grose-Smith), male (upperside)

Chrysozephyrus atasux zulla (Tytler), female

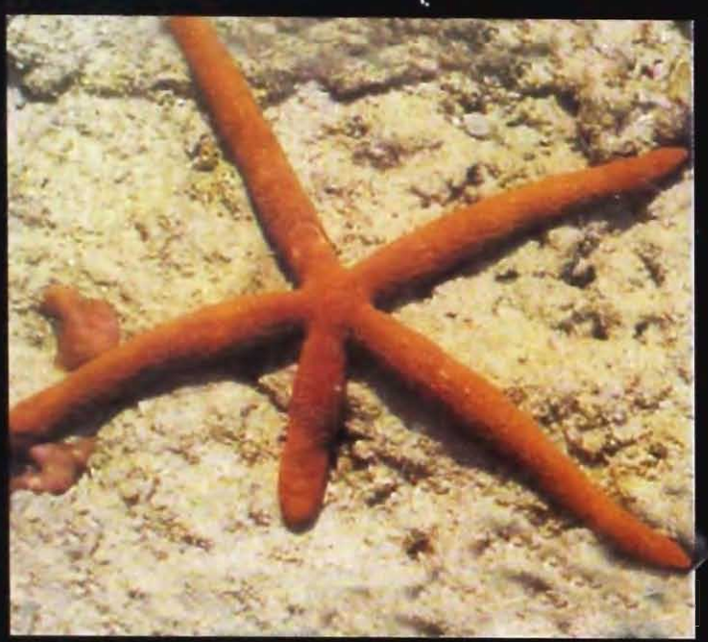
Tajuria yajna yajna (Doherty), female (upperside)

Pieris krueperi devta (de Niceville) Upperside)

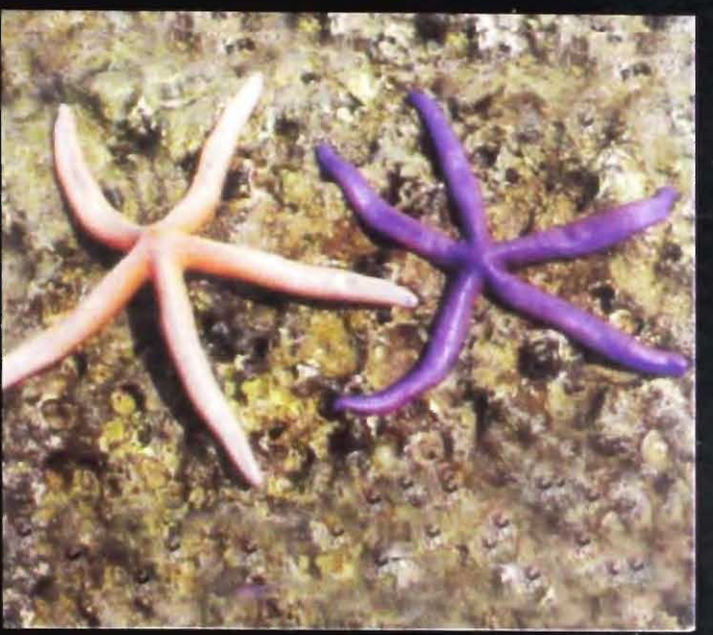


Culcita schmideliana (Retzius)

Asterina sarasini (deLorid)



Linckia guildingi Gray



Linckia laevigata (Linnaeus)

Actinopyga mauritiana (Quoy and Gaimard)

Phyllacanthus imperialis (Lamarck)

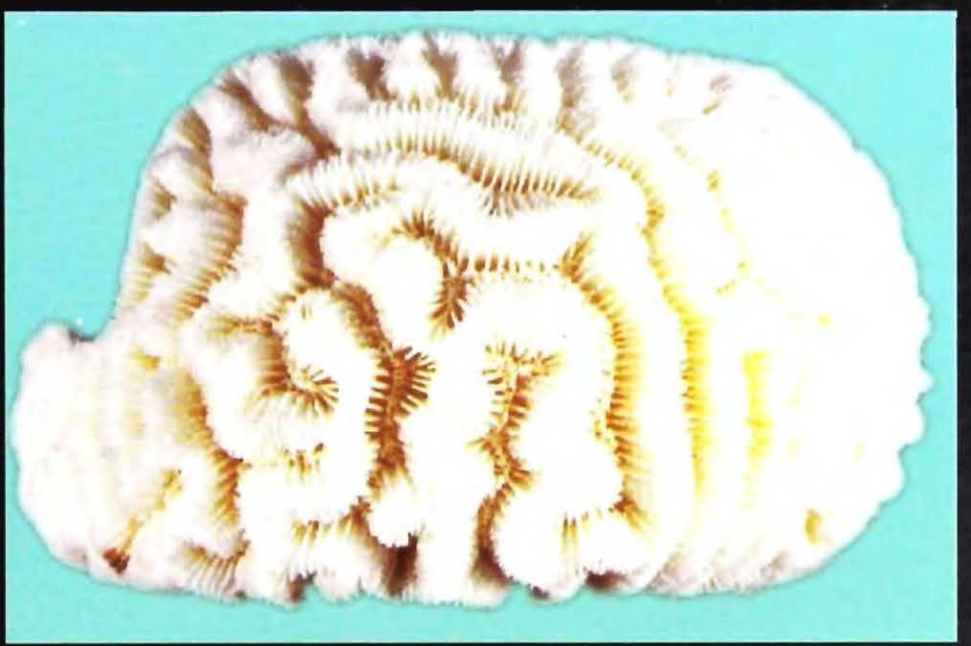
Acropora grandis

Montipora verruccsa

Pocillopora damicornis

Euphyllia glabrescens

Platygyra lamellina



Oulophyllia crispa

Cyclophorus khasiensis Nevill–lateral view

Cyclophorus khasiensis Nevill–lateral view

Cyclophorus nilagiricus (Benson)–lateral view

Cyclophorus nilagiricus (Benson)–lateral view

Ariophanta interrupta (Benson)–lateral view

Ariophanta interrupta (Benson)–lateral view

Cryptozona sisparica (Blanford)–lateral view

Cryptozona sisparica (Blanford)–lateral view

Bensonies monticola (Hutton)–dorsal view

Bensonies monticola (Hutton)–lateral view

Cypraecassis rufa (Linnaeus)

Cypraecassis rufa (Linnaeus)

Lambis (Harpago) chiragra arthitica Roeding

Lambis (Harpago) chiragra arthitica Roeding

Trochus niloticus Linnaeus

Trochus niloticus Linnaeus

Pleuroploca trapezium (Linnaeus)

Pleuroploca trapezium (Linnaeus)

Lambis (Millepes) millepeda (Linnaeus)

Lambis (Millepes) millepeda (Linnaeus)

Cassis cornuta (Linnaeus)

Cassis cornuta (Linnaeus)

with little constriction in the cocoons). Due to continuous breeding, few promising silkworm breeds have been bred in all the three types of silkworms. Based on voltinism, silkworms are classified into univoltine, bivoltine and multivoltine :

Univoltine silkworms : They have one generation in a year and are characterized by large body size, good quality cocoon filament, but are susceptible to environmental conditions as they are temperate in origin.

Bivoltine silkworms : They have two generations in a year and are characterized by shorter larval duration. Cocoon quality is comparatively inferior to that of univoltine, robust larvae and can be reared during spring and autumn seasons.

Multivoltine silkworms : They have more than three generations in a year and are characterised by non-diapause eggs, small cocoons, less cocoon filament, robust larvae and can be reared even during summer and autumn seasons.

Muga silkworm

Antheraea assamensis, (Helfer) (syn. *Antheraea assama* Westwood, a junior synonym) Type locality: Assam is unique for its golden yellow silk, which is endemic to this region. It is an integral part of the socio economic life of the people in northeast, besides ethnical values are involved in muga culture. Traditionally, since time immemorial and all the skills related to rearing, seed production, silk production as well as weaving is part and parcel of the farmers of the region. Rearers refer to three types of eco-races available in the wild environment. These are *Harujukia* (Harubhagia), *Barjukia* (Barbhagia) and *Lebang* (Lebong) (Chowdhury, 1968).

Geographical distribution : Himachal Pradesh, Sikkim, Assam, Meghalaya, Pondicherry in India and Bangalesh (in Sylhet), Srilanka and Indonesia (Arora and Gupta, 1979). Later workers assumed that the natural distribution of this insect is mainly confined to the Brahmaputra valley of Assam and its surrounding hills (Thangavalu *et al.*, 1988 and Chaudhuri, 1981).

Samia ricini (Donovan) [syn. *Philosamia ricini* (Hutton)]; Type locality : Assam, a state of the North Eastern India is believed to be the natural abode. Number of eco races/ varieties recognised with preferred host plant :

Sl. No.	Name of the Eco-races	Host plants
1.	Borduar	Castor, Kesseru, Payam
2.	Titabar	Castor, Kesseru
3.	Khanapara	Castor, Kesseru
4.	Dhanubhanga	Castor, Kesseru
5.	Mendipathar	Castor, Kesseru
6.	Sille	Castor, Kesseru
7.	Nongpoh	Castor, Kesseru
8.	Kokrajhar (red)	Castor

Geographic distribution : The tribal inhabited areas of the North Eastern India, particularly the Brahmaputra Valley of Assam and its neighbouring states.

Tasar, Tussore or Tussah is the silk produced by some wild species of silkworm belonging to the family Saturniidae (Arora and Gupta, 1979). Some of the important species of Tasar silkworm which belong to the genus *Antheraea* are *A. pernyi* (China) (Hua-Sin, 1987), *A. yamamai* (Japan), *A. proylei* (India), *A. roylei* (India), *A. frithii* (India) (Jolly *et. al.*, 1974) and *A. mylitta* (India). Tasar silk is divided into temperate tasar and tropical tasar. The tasar silkworm species available in China, Japan and sub-himalayan oak belt of India are temperate in nature while traditional Indian tasar is tropical in nature.

Geographical Distribution : Oak tasar silkworms are distributed in Sub-Himalayan oak belt of India (Assam, Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Mizoram, Himachal Pradesh, Jammu & Kashmir and Uttaranchal).

Commercial Silkworm species

A. *Antheraea proylei* Jolly : *Antheraea proylei* is a hybrid evolved by the Scientists of Central Silk Board, India through the interspecific hybridization between indigenous species *Antheraea roylei* Moore (n = 30) and exogenous Chinese species *Antheraea pernyi* GM (n = 49) (Bhagirath *et. al.*, 1987). This hybrid spins a reelable cocoon thereby introducing a temperate tasar culture in the sub-himalayan oak belt of India in 1970. The chromosome number of *A. proylei* is now stabilized at n = 49.

B. *Antheraea frithii* Mr : *Antheraea frithii* Mr (n = 31) is found distributed in the hilly regions of North-eastern India, at an altitude between 780 m to 1800 m AMSL. This species feeds primarily on *Lithocarpus dealbata* and *Quercus serrata.* In Manipur this species is found distributed in different districts *viz.* Senapati (Phybung Khullen, Luwang Sangol, Tumuyon Khullen), Ukhrul (Silent village, Hundung village), Imphal East (Pukhao, Dolansabi, Yumnam Khunou, Andro etc.). The species multiplies in two generations under *in situ* conditions in the natural habitats of Manipur (23.80°N to 25.68°N Latitude and 93.3°E to 94.78°E Longitude). Under *ex situ* condition the species is maintained in germplasm to study the behaviour of this wild silkworm.

C. *Antheraea roylei* Moore : *Antheraea roylei* (n= 30,31) is an endemic species found in the North-eastern and North-western sub-himalayan oak belt of India at an altitude of 1100 m to 1800 m AMSL. It forms a white coloured double-layered cocoon. This silkworm feeds on different *Quercus species* like *Q. serrata, Q. incana, Q. dealbata, Castanopsis sp.* etc. and apple leaves.

D. *Antheraea pernyi* GM : *Antheraea pernyi* is an exogenous (Chinese) species (n=49) and distributed from Amur to southern China. This species was introduced to Korea, Soviet Russia, Japan and India just a few decades back. The naturally grown food plants of *A. pernyi* are *Quercus serrata, Q. griffithii, Q. semecarpifolia, Q. incana, Q. himalayana and Q. dealbata,* etc. Presently it is commercially exploited for production of oak tasar silk in North eastern and western states of sub-Himalayan oak belt.

E. PRP_{12} : It is an important breed of oak tasar silkworm, *A. proylei* developed by the Regional Tasar Research Station, Central Silk Board, Imphal through selection from the segregating progenies of the cross *A. proylei* (*A. roylei* × *A. proylei*). PRP_{12} has shown improvement of 20.62% in larval weight, 81.46% in cocoon yield per dfl and 24.87% in cocoon weight over *A. proylei.* Commercial exploitation of this breed has been initiated through the extension centres of Regional Tasar Research Station, Central Silk Board, Imphal.

F. PRP_5: It is also an important breed of oak tasar silkworm *A. proylei* developed by the Regional Tasar Research Station, Central Silk Board, Imphal through selection from the segregating progenies of the cross *A. proylei* (*A. roylei* × *A. proylei*). PRP_5 has shown improvement of 18.60% in fecundity and 29.79% in filament length over *A. proylei.* Commercial exploitation of this breed has been initiated through the extension centres of Regional Tasar Research Station, Central Silk Board, Imphal.

No. of ecoraces/varieties of Tasar silkworm recognized : So far, 44 ecoraces of tropical tasar silkworm are reported. Geographical distribution of the ecoraces is depicted below :

No.	Name of ecorace	State	No.	Name of ecorace	State
1.	Sivalica	J & K	23.	Simlipal	Orissa
2.	Sultanpur	U. P.	24.	Modal	Orissa
3.	Monga	U. P.	25.	Nalia	Orissa
4.	Mirzapur	U. P.	26.	Sukinda	Orissa
5.	Nowgong	Assam	27.	Boadh	Orissa
6.	NE_1-95	Assam	28.	Omarkote	Orissa
7.	NG-94	Nagaland	29.	Sukly	Chattisgarh
8.	NE_2-95	Meghalaya	30.	Korbi	Chattisgarh
9.	Jiribam	Manipur	31.	Mandalla	Chattisgarh
10.	Japla	Jharkhand	32.	Kurudh	Chattisgarh
11.	Modia	Jharkhand	33.	Raily	Chattisgarh
12.	Kowa	Jharkhand	34.	Bhopalpatnam	Chattisgarh
13.	Laria	Jharkhand	35.	Janghbhir	Chattisgarh
14.	Barharwa	Jharkhand	36.	Jhabua	M. P.
15.	Munga	Jharkhand	37.	Piprai	M. P.
16.	Sarihan	Jharkhand	38.	Seoni	M. P.
17.	Palma	Jharkhand	39.	Multai	M. P.
18.	Daba	Jharkhand	40.	Dadar & Nagar Haveli	Maharastra
19.	Lodhma	Jharkhand	41.	Bhandara	Maharastra
20.	Tira	W. B.	42.	Andhra local	A. P.
21.	Bankura	W. B.	43.	Belgaum	Karnataka
22.	Tesera	Rajasthan	44.	KE-02	Kerala

(*Source* : S. Dandin, CSRTI, Mysore, 2005)

Sources of Silkworm Germplasm

The major sources of silkworm germplasm in India are Research Institutes and Regional Research Stations of Central Silk Board. Central Sericultural Germplasm Resources Centre, Hosur (Tamil Nadu) is involved in collection, characterization, evaluation and preservation of silkworm germplasm. Presently, 394 silkworm accessions (311 bivoltines, 19 mutants and 64 multivoltines) are being maintained at CSGRC, Hosur. Working germplasm stocks to facilitate the silkworm breeders are being maintained at Central Sericultural Research & Training Institutes at Mysore (Karnataka), Berhampore (West Bengal) and Pampore (Jammu & Kashmir) and at Regional Sericultural Research Stations located in Jammu (J & K), Sahaspur (Uttaranchal), Kalimpong (West Bengal) and Coonoor (Tamil Nadir). In addition, silkworm germplasm stocks are also maintained by state owned sericultural institutes like KSSRDI, Bangalore (Karnataka) and APSSRDI, Hindupur (A.P.). A few Universities like University of Mysore, Mysore and Bangalore University, Bangalore are also maintaining a small quantity of germplasm stock, mainly for breeding purposes.

Lac bioresource

Lac, *Kerria lacca* (Kerr.) is a unique natural, renewable, non toxic and ecofriendly bioresource of this country and needs to be preserved and fostered for its prosperity, as it yields three useful materials i.e., resin, dye and wax. Presently lac and lac based products are contributing to the national exchequer as it offers local employment and earns foreign exchange for the country, being exported to more than 100 countries all over the world. Predation and parasitism upon lac insects are common due to their sedentary and gregarious habits. Biological control of the insect predators (*Eublemma amabilis* Moore, *Pseudohypatopa (Holcocera) pulverea* Meyr, *Chrysopa modesties* Banks and *Chrysopa lacciperda* Kimmins) attacking the lac insects has been very scanty. Egg parasitoids such as *Trichogramma brasiliense, T. chilonis* were found to be quite potent against *P. pulverea* and *E. amabilis.* Similar work in this direction may further benefit mankind. The second area of research that needs to be looked into is the effect of infestation, host plant metabolism and inter and intra specific variation in the host plants (*Butea monosperma, Zizyphus maurutiana, Schleichera oleosa, Albizia lucida, Flemingia macrophylla, Acacia auriculaeformis*), used for lac culture. This will have a pronounced effect on the biological characteristics of lac insects which ultimately affect the quality and quantity of the lac produced. Medicinally lac is used in curing haemorrhage, fracture, wound, hiccup, cough and other upper respiratory diseases, diarrhoea, fever, skin diseases. Its use cures backache, premature ejaculation and leprosy. The above have a direct bearing on the socio-economic conditions of the tribal population of Madhya Pradesh, Jharkand, Bihar, West Bengal, Orissa and other areas that predominantly utilize this resource for their livelyhood as well as for the enhancement of the country's resource base.

MEDICINAL RESOURCES OF INSECTS

Ants (*Niger umbratus*) are used as a whole organism in Unani system of medicine as they have analgesic and aphrodisiac action. Black ants are extracted in olive oil and used for the treatment of earache and believed to have aphrodisiac power. *Vespa orientalis* (Vespidae) acts as nervine stumulant, analgesic and other nutrient actions. Live wasps are

made to sting the subjects suffering from vitiligo, paralysis and other nervous disorders for beneficial effect. Wasps ground with honey and salt form a useful paste for application in rheumatism and leucoderma. Black variety is fried in olive oil and applied externally for the treatment of Leucoderma. Young ones of wasps in combination with other drugs are said to be nutrient and fattening.

Cimex lectularis (Bed bugs) is also used in unani system of medicine as the whole organism has detoxicant and depilatory actions. In Unani System of Medicine, application of dried bedbug in and around nostrils or their gargles with urine facilitates expulsion of leech from throat. Instillation of the extract of bugs through urethral opening relieves urinary obstruction. Fumigation is good for epilepsy. Application in the form of paste promotes hair growth. In snakebite cases, ingestion of one bug acts as detoxicant. Ingestion of 6 bedbugs with ripe banana cures piles. *Pediculus humanus* (Hippoboscidae) the whole organism is used in unani system of medicine as it has anti-febrile action.

Anthrenus scrophulariae (Myrmeleonidae), the buffalo carpet beetle used as a whole organism in Unani System of Medicine has antibillious, anti-poisoning and depilatory actions. It is also good for eyes. Its khisandah in very small doses removes bilious tumours of stomach and liver. It is useful in dropsy and scorpion sting. Insects fried in olive oil alleviate earache and give relief in piles. Tail of an insect is cut; a fluid exudes from the body. This is instilled in eyes for the treatment of eye diseases. The beetle if tied on the thighs of parturient women believed to facilitate delivery. *Mutella occidentalis* (Coccidae), the cochineal insect is used in Ayurveda, Unani and Homoeopathy system of medicine. The dried bodies of the fecundated female insect containing eggs and larvae are used in medicine. The insects are collected from the branches and leaves of the cacti, crushed and immersed in boiling water, spread out and dried ready for use. When dry they can be easily reduced to powder. It contains carmine (the colouring matter) or carminic acid 10%, wax coccerin, fatty matter consisting of myrestin, liquid fat and fatty acids 18, moisture 6, salts and ash 3 to 5%. The carmine prepared from the insect is a brilliant red powder with a faint odour and bitterish and warm taste; it tinges the saliva violet –red. It is soluble in water and alcohol, entirely soluble in ammonia water. It has acid properties and hence called carminic acid. It is given in many of the Vatavyadhis (Vatic diseases) and in Dhvaja Bhanga. In Dhvaja Bhanga, it is applied both externally and given internally. It is given for eruptions of measles pustules. It is also used as a colouring agent, as an adjunct to expectorant mixtures. It is useful in whooping cough, neuralgia, etc. The insects are taken in betel for improving complextion and for the treatment of paralysis and facial paralysis. Inhalation with lemon juice is good for amenorrhoea. In Homeopathy, the dried insects are mixed with alcohol and used in whooping cough with the symptoms, paroxysms of cough, ending with vomiting of clear, ropy mucus, extending in great long strings even to the feet.

Periplaneta americana (Blattidae), the whole organism is used in Unani system of medicine. The cockroaches are dried and pulverized for use in earache. They are ashed and given with honey for relief in dyspnoea, urinary obstruction, uterine colic and for emmenagogoue and abortifacient actions. The ash is administered with lemon juice for detoxicating action.

Gryllus domestica (Gryllidae), the whole organism is used in Unani system of medicine as an analgesic. Roasted insect is useful in colic, particularly of cystic origin. The insect is fried in olive oil and instilled in ear for alleviating earache. *Poecilocerus pictus* (Locustidae), the whole organism is used in Unani system of medicine as has aphrodisiac, anti-poisoning and depilatory actions. It is useful in Leprosy, lung diseases and sexual debility. *Chlamydolycus trabeatus* (Lampyridae), the whole organism is used in Unani system of medicine as an analgesic, depilatory and good for eye diseases. If one fly is dried and taken with asfaoetida for three days, it is useful in renal and cystic calculi. It is believed to cure night blindness. Externally it is used with egg albumen for the treatment of piles. Instillation with rose oil is depurative and beneficial in earache and deafness. Ingestion of more than three flies is found to be fatal.

Musca domestica (Muscidae), the excreta and the whole organism is used in Ayurveda system of medicine as it acts as an emetic. *Tinea pellionella* (Pellionelliadae), the whole organism is used in Unani system as it acts as an aphrodisiac. The tincture is made of one part of dried Spanish flies (*Lytta vesicatoria*), and five parts of alcohol. *Mylabris chicorii* (Coleoptera), the insect is used in aurveda and unani as the dried part contains a fatty acid "Cantharidin" 1 to 2 per cent. Cantharidin is an internal stimulant and diuretic. When applied externally, a powerful and valuable counter irritant and vesicant. As a vesicant it is a very powerful and acts without pain and without irritation of the urinary organs. *Apis mellifica* (Apidae) the wax, honey and whole organism is used in Ayurveda, Siddha, Homoeopathy and Unani systems of medicine. Grape-sugar or dextrose which becomes crystalline, fruit-sugar or levulose which remain liquid, wax, volatile oil, proteins, mucilage, colouring matter, formic acid and ash (rich in carbohydrates). Some of the substances contained are pollen dust, ethereal oil, various phosphates, lime (calcium) and iron. Most of the elements found in the human body are in small proportion present in the honey. The dextrose and levulose present in saccharine are absorbed easily by the digestive system and therefore acts as nutrient. Regarding the presence of vitamin content it is stated that honey contains both the fat-soluble and water-soluble principles. Honey contains a special protein secreted by the bee; in addition it contains a diastolic ferment similar to that of saliva and having the power to convert starch into sugar. In short, chemically honey is mainly a mixture of dextrose and livulose. New honey is considered demulcent and laxative. Honey more than a year old is astringent, demulcent, detergent, pectoral, emollient and laxative. It also possesses nutritive properties. The fatty acids present in honey stimulate peristalsis and digestion. Honey in moderate doses has a beneficial effect on digestion, an appetite of those with weak stomachs and loose bowels. Its value lies in providing a readily absorbable food. It is the most potent fuel to provide energy for muscle and consequently most valuable for that all-important, most vital muscle the heart that knows no complete physical rest. Lime in honey is useful in regulating the secretion of internal glandular organs. Again it has hypnotic action in bringing sound sleep if taken with cold water, before going to bed in doses of 2 tea spoons full in a big cup full of water. It decreases flatulence and increases general metabolism and also the quantity of the urine among children. Locally applied it stimulates the mucus surfaces when in an atonic condition. It also acts as styptic. A special protein secreted by the bees contain in honey when inoculated into rabbits causes the formation of anti bodies in the

serum. *Bhramara* type of honey is beneficial for phlegm, cough, fever and epitaxis. It is used as tincture. *Kshudra* honey is useful in eye diseases. *Chhatra* is beneficial in haematemsis, worms, leucoderma, gonorrhoea and alleviative of giddiness, hysteria and poisoning. *Argha* or wild honey is beneficial in eye diseases, piles, cholera, cough, pthysis, jaundice and ulcers. *Dala* or unprepared honey is productive of digestive fire, generative of bile and beneficial in phlegm, gonorrhoea and vomiting.

In Homoeopathy, honey is used in curing rapid swellings with redness, burning and stinging pains, and oedema of any part of the body. This remedy meets oedematous infiltrations and inflammations. In addition to the above, honey is used in curing mental symptoms, head symptoms (Meningitis), eye symptoms (Asthenopia and chemosis, a puffiness of the conjunctiva showing oedma. Oedematous swelling of the eyelids and especially under eyes), in glossitis or inflammation of the tongue, in diptheria, in laryngeal symptoms, in diarrhoea, in urinary symptoms, in external genital organs (oedematous swellings of the scrotum, testicles or labiae) and in ovarian troubles. It is also used in curing respiratory symptoms, in general symptoms of extremities and in curing the skin infection. It is also used in curing dropsy and in febrile symptoms.

Wax contains hydrocarbons (12-15%), cerolein, cerinor, cerotic acid which crystallizes from boiling alcohol, myricin as myricyl and melissyl palmitate, ceryl alcohol etc. Wax is an emollient and demulcent chiefly used externally as basis, in the preparation of ointments, clusters. It acts as analgesic, demulcent and anti-poisoning.

CHAPTER–7

CHORDATE DIVERSITY IN INDIA

Protochordates include two sub phyla viz., Cephalochordata and Tunicata exclusively distributed in marine environment. The total number of species from the Indian marine waters is 119, which forms 5.65 percent of the estimated taxa of the world. Cephalochordates are represented by two families, Belostomatidae represented by a single genus (*Branchiostoma* with three species) and Epigonythidae represented by the genus *Epigonycyhys* (with two species) which includes the larval form of the genus viz., *Amphioxys* (previously thought to be a different genus). The Urochordates are represented three classes (Ascidacea, Thaliacea and Larvacea) are usually the burrowing forms and many of them act as biofoulers. The distribution of this group is indicative of fishery resource in the marine environment.

Table–Verebrate diversity in India

No.	Category	No. of Species		Indias Share in World %
		World	India	
1	Protochordata	2106	119	5.65
2	Pisces	21723	2546	11.72
3	Amphibia	5150	240	4.66
4	Reptilia	5817	460	7.91
5	Aves	9026	1232	13.63
6	Mammalia	4629	397	8.58
	Total	**48,451**	**4994**	**10.41**

PISCES

Record of primitive fishes date back to the Cambrian period, about 550 million years ago. These jawless fishes lived relatively unchanged over the following 100 million years. The Devonian period, about 360 to 400 million years ago, is known as the "Age of Fishes," because of the abundance and diversity of fishes that appeared during this period. Fishing is one of the oldest human activities, and it developed gradually, when our ancestors moved from the collection of plants and animals to hunting by using tools and weapons. The oldest fishing implements so far identified are harpoons, found in the territory of Congo, and dated about 90,000 years (Stringer and McKie, 1996). In India too, it is believed that the development of fishing must have been parallel. There are reports that fishes were grown in reservoirs as early as 320 BC.

In India, during pre-independence, regulations regarding the fisheries were essentially

revenue-oriented, and expressed little interest in the development of the fisheries. The first fisheries department explicitly aimed at developing the fisheries was the Madras Presidency, organized in 1907 by Sir F. Nicholson, also called the "Father of Indian Fisheries Development" (Bensam, 1999c; Devanesen, *et al.*, 1953). During the close of 19th century and starting of 20th century, officials of the Marine Survey of India and the Zoological Survey of India undertook numerous studies on fishes and other aquatic fauna (BOBP, 1982). In the 1930s, Dr. Stanley Kemp, Director of the Marine Biological Laboratory, Plymouth, U.K. and the former Director of the Zoological Survey of India, also emphasized the need to improve knowledge on Indian fishes (Bensam, 1999b). Inspite of these, marine fisheries in India was neglected until the 1940s. The Second World War (1939-1945) changed this situation. During the war, India provided bases for American and other allied army personnel and this brought the problem of supplying adequate amounts of good quality fish. This scarcity of food led to interest in expansion of marine fisheries. As a result, Dr. Beni Prasad, the then director of the Zoological Survey of India, was asked to inquire and write a report on Indian fisheries (Bensam, 1999a).

The world's fish diversity is estimated to be 21,723 extant species under 4,044 genera, 445 families and 50 orders (Nelson, 1984), of which 8411 are freshwater (excluding common diadromous fishes that may have landlocked population) and 11,650 marine species. Russell made the first systematic study of the Indian fish fauna from 1785 to 1789 AD. There were evidences to indicate over-fishing in the Ganga river as early as 1785. Sir Francis Day studied the systematics of Indian fishes for over 20 years and listed 351 genera and 1418 species of marine, brackishwater and freshwater fishes in 1868. Later, Alcock added 86 new genera and 200 species to the list. The Indian fish diversity represents 11.72 % of the world, comprising of 2546 species under 969 genera (24%), 254 families (57%) and 40 orders (80%). Jayaram (1999) listed 852 freshwater species under 272 genera, 71 families, and 16 orders, including the primary and secondary freshwater fishes from India and adjacent countries. The checklist of freshwater fishes by Menon (1999) indicates 446 primary freshwater species under 33 families and 11 orders. Recent analysis by the National Bureau of Fish Genetic Resources, Lucknow (Kapoor and Dayal, 2004), identified about 1400 marine & estuarine and 800 freshwater species are known to occur in India but the data is still incomplete.

The class Chondrichthyes comprises 131 species under 67 genera, 28 families and 10 orders and the class Osteichthyes is represented by 2415 species belonging to 902 genera, 226 families and 30 orders. Of the 131 species of chondrichthyes , Day (1878; 1879) reported a total of 67 species consisting of 41 sharks (including saw fishes), 19 rays and 7 skates. According to Misra (1952) 78 species of elasmobranchs are known including 51 sharks (including saw fishes), 20 rays and 7 skates in the Indian seas of which 76 are commercially important. Talwar and Kacker (1984) reported 76 species of commercially important elasmobranchs. Compagno (1984) listed 55 species of sharks from the Indian Ocean. According to Sivasubramaniam (1992) there are about 40 species of pelagic sharks belonging to five families in the Indian Ocean. Nearly 75% of these belong to the family–Carcharhinidae (Requiem sharks). While 25% of the species are found in small pockets,

another 30% are wide spread in the Indian Ocean. The remaining are insular inhabiting the inshore and off shore waters of the Indian Ocean. Haneef, (1996a) has enlisted nearly 68 species of sharks occurring in the Indian Coast. Pillai and Parakal (2000) prepared a list of 49 species of pelagic sharks occurring in the Indian Coast. Raje *et al.* (2002) have reported 66 species of sharks in the Indian waters. 73 species of sharks enlisted in the work of Venkataraman *et al.* (2003), include the compilation of lists given by previous workers.

A Check List of Sharks in the Indian Waters

Shark Species	Common Name	Habitat
Class : CHONDRICHTHYES		
Order : HEXANCHIFORMES		
Family : HEXANCHIDAE		
1. *Heptranchias perlo* Bonnaterre, 1788	Bramble shark	O, DW
Order : SQUALIFORMES		
Family : ECHINORHINIDAE		
2. *Echinorhinus brucus* Bonnaterre, 1788 *	Bramble shark	C, O, DW
Family : SQUALIDAE		
3. *Centroscyllium ornatum* Alcock, 1889	Ornate dogfish	DW
4. *Centrophorus granulosus* Bloch and Schneider, 1801	Gulper shark	DW
5. *Centrophorus moluccensis* Bleeker, 1860	Arrow spine dogfish	DW
6. *Centrophorus uyato* Rafinesque, 1810	Little Gulper shark	DW
7. *Centroscymus crepidator* Bocage & Capello, 1864	Long nose velvet dogfish	O, DW
8. *Squalus mitsukurri* Jordan & Snyder, 1903	Short spine spur dog	O, P
9. *Squalus blainvillei* Risso, 1826	Big eye dogfish	DW
Order : ORECTOLOBIFORMES		
Family : HEMISCYLLIIDAE		
10. *Chiloscyllium plagiosum* Bennett, 1830	White spotted bamboo shark	BD
11. *Chiloscyllium griseum* Muller and Henle, 1838*	Black banded cat shark	BD
12. *Chiloscyllium indicum* Gmelin, 1789*	Indian cat shark	BD
13. *Chiloscyllium punctatum* Muller and Henle, 1838	Brown banded bamboo shark	BD

Shark Species	Common Name	Habitat
Family : STEGOSTOMATIDAE		
14. *Stegostoma fasciatum* Hermann, 1783*	Zebra shark	C, P
Family : GINGLYMOSTOMATIDAE		
15. *Nebrius ferrugineus* Lesson, 1830	Giant sleepy shark	BD
Family : RHINIODONTIDAE		
16. *Rhiniodon typus* Smith, 1828*	Whale Shark	C, O, P
Order : LAMNIFORMES		
Family : ODONTASPIDIDAE		
17. *Eugomphodus taurus* Rafinesque, 1810	Blue nurse sand tiger	P
18. *Eugomphodus tricuspidatus* Day, 1878	Indian sand tiger	P
Family : PSEUDOCARCHARIDAE		
19. *Pseudocarcharias kamoharai* Matsubara, 1936	Crocodile shark	O, P
Family : ALOPIIDAE		
20. *Alopias superciliosus* Lowe, 1839	Big eye thresher shark	O, DW
21. *Alopias pelagicus* Nakamura, 1935	Pelagic thresher shark	O, P
22. *Alopias vulpinus* Bonnaterre, 1788	Thresher shark	C, O, P
Family : LAMNIDAE		
23. *Carcharadon carcharias* Linnaeus, 1758*	Great white shark	C, O, P
24. *Isurus oxyrinchus* Rafinesque, 1809*	Shartfin mako	C, O, P
Order : CARCHARHINIFORMES		
Family : SCYLIORHINIDAE		
25. *Apisturus investigatoris* Misra, 1962	Broad nose Cat shark	DW
26. *Cephaloscyllium silasi* Talwar, 1974	Indian Swell shark	BD
27. *Scyliorhinus capensis* Smith, 1838	Yellow spotted cat shark	P, C
28. *Atelomycterus marmoratus* Bennett, 1830	Marbled catfish	O, BD
29. *Halaelurus hispidus* Alcock, 1891	Bristly cat shark	O, BD
30. *Halaelurus quagga* Alcock, 1899	Quagga cat shark	C, BD
Family : PROSCYLLIDAE		
31. *Eridacnis radcliffei* Smith, 1913*	Pygmy ribbon tail cat shark	O, BD
Family : TRIAKIDAE		
32. *Lago omanensis* Norman, 1939*	Big eye hound shark	O, DW
33. *Mustelus mosis* Hemprich & Ehrenberg, 1899	Gummy smooth hound	O, DW

Shark Species	Common Name	Habitat
Family : HEMIGALEIDAE		
34. *Hemipristis elongatus* Klunzinger, 1871*	Fossil shark	C, O, P
35. *Hemigaleus microstoma* Bleeker, 1852	Sickle fin Weasel shark	C, P
36. *Chaenogaleus macrostoma* Bleeker, 1852	Balfour's shark	C, P
Family : CARCHARHINIDAE		
37. *Carcharhinus albimarginatus* Ruppell, 1837*	Silver tip shark	C, P
38. *Carcharhinus altimus* Springer, 1950*	Big nose shark	O, P
39. *Carcharhinus amblyrhynchoides* Whitely, 1934*	Graceful shark	C, P
40. *Carcharhinus amblyrhynchos* Bleeker, 1856*	Grey reef shark	C, P
41. *Carcharhinus amboinensis* Muller & Henle, 1839*	Pig eye shark	C, O, P
42. *Carcharhinus falciformis* Bibron, 1839	Silky shark	C, O, P
43. *Carcharhinus leucas* Valenciennes, 1839*	Bull shark	C, P
44. *Carcharhinus melonopterus* Quoy & Gaimard, 1824*	Black tip reef shark	C, P
45. *Carcharhinus sealei* Pietschmann, 1916*	Black spot shark	C, P
46. *Carcharhinus brevipinna* Muller and Henle, 1839*	Spinner shark	C, O, P
47. *Carcharhinus dussumieri* Valenciennes, 1839*	White cheeked shark	C, O, P
48. *Carcharhinus hemiodon* Valenciennes, 1839*	Long nosed shark	C, P
49. *Carcharhinus limbatus* Valenciennes, 1841*	Black tip shark	C, O, P
50. *Carcharhinus longimanus* Poey, 1861	Oceanic white tip shark	O, P
51. *Carcharhinus macloti* Muller and Henle, 1839*	Maclot's shark	C, P
52. *Carcharhinus sorrah* Valenciennes, 1839*	Sorrah shark	C, P
53. *Carcharhinus brachyurus* Gunther,1870	Copper shark	P, C
54. *Carcharhinus cautus* Whitely, 1945	Nervous shark	P, O

Shark Species	Common Name	Habitat
55. *Carcharhinus obscurus* Peron & Le Sueur, 1822	Dusky shark	C, P
56. *Carcharhinus plumbeus* Nardo, 1827	Sandbar shark	C, P
57. *Carcharhinus wheeleri* Garrick, 1982	Black tail reef shark	C, P
58. *Galeocerdo cuvier* Le Sueur, 1822*	Tiger shark	C, P
59. *Lamiopsis temminckii* Muller and Henle, 1839*	Fawn shark	C, P
60. *Loxodon macrorhinus* Muller and Henle, 1839*	Slit eye shark	C, O, P
61. *Negaprion acutidens* Ruppell, 1837	Indian lemon shark	C, O, P
62. *Rhizoprionodon acutus* Ruppell, 1837*	Milk dog shark	C, P
63. *Rhizoprionodon oligolinx* Springer, 1964*	Grey dog shark	C, P
64. *Scoliodon laticaudus* Muller and Henle, 1839*	Indian dog shark	C, P
65. *Triaenodon obesus* Ruppell, 1837*	White tip reef shark	C, P
66. *Glyphis gangeticus* Muller & Henle, 1839	Ganges shark	C, P
67. *Glyphis glyphis* Muller and Henle, 1839	Spear tooth shark	C,P
68. *Prionace glauca* Linnaeus, 1758	Blue shark	O, P
Family : SPHYRNIDAE		
69. *Sphyrna blochii* Cuvier, 1817	Arrow headed/hammer head	C, O, P
70. *Sphyrna lewini* Cuvier, Griffith and Smith, 1834*	Scalloped hammerhead	C, O, P
71. *Sphyrna mokarran* Ruppell, 1837*	Great hammerhead	C, O, P
72. *Sphyrna zygaena* Linnaeus, 1758*	Round headed hammerhead	C, P
73. *Eusphyra blochii*, Cuvier 1817*	Wingehead shark	C, P

Source : Sharks of Indian Waters by Venkataraman *et al.* (2003).

*Economically Important, C- Coastal, O- Oceanic, DW- Deep Water, P- Pelagic, BD- Bottom Dwelling

Exploratory surveys by the Government of India indicate that the sharks constitute 42% of the total long line catch in the Arabian Sea, 32% in Bay of Bengal, 43% in the Andaman Sea and 31% in equatorial areas. The species that occur in the long line catches are *Carcharhinus albimarginatus, Carcharhinus dussumieri, Carcharhinus limbatus, Carcharhinus longimanus, Carcharhinus macloti, Carcharhinus melanopterus, Carcharhinus sorrah, Galeocerdo cuvieri, Prionace glauca, Rhizopriodon acutus, Scoliodon laticaudus, Stegostoma fasciatum, Alopias*

spp., Isurus oxyrincus and *Sphyrna spp.,* The catches of tuna long line vessels from the offshore and oceanic waters include *Carcharhinus melanopterus, Carcharhinus limbatus, Carcharhinus plumbeus, Alopias vulpinus, Alopias pelagicus, Isurus oxyrhincus* and *Sphyna zygaena* (Hanfee, 1996a). Although catch composition data is not readily available, the multi species nature of these fisheries is evident from the published works. Among the 20 most common species harvested are the *Carcharhinus* spp. and *Sphyrnids* spp., (Appukuttan and Nair, 1988). Their data also show that *Rhizoprionodon acutus, Rhizoprionodon oligolinx, Carcharhinus limbatus, Carcharhinus sorrah, Carcharhinus hemiodon, Sphyrna lewini and Eusphyra blochi* are the other important species. Among the remaining important species reported from catches are *Carcharhinus melonopterus* and *Scoliodon laticaudus* (Devadoss, 1983).

Indian Commercial Sea fishes (other than elasmobranches)

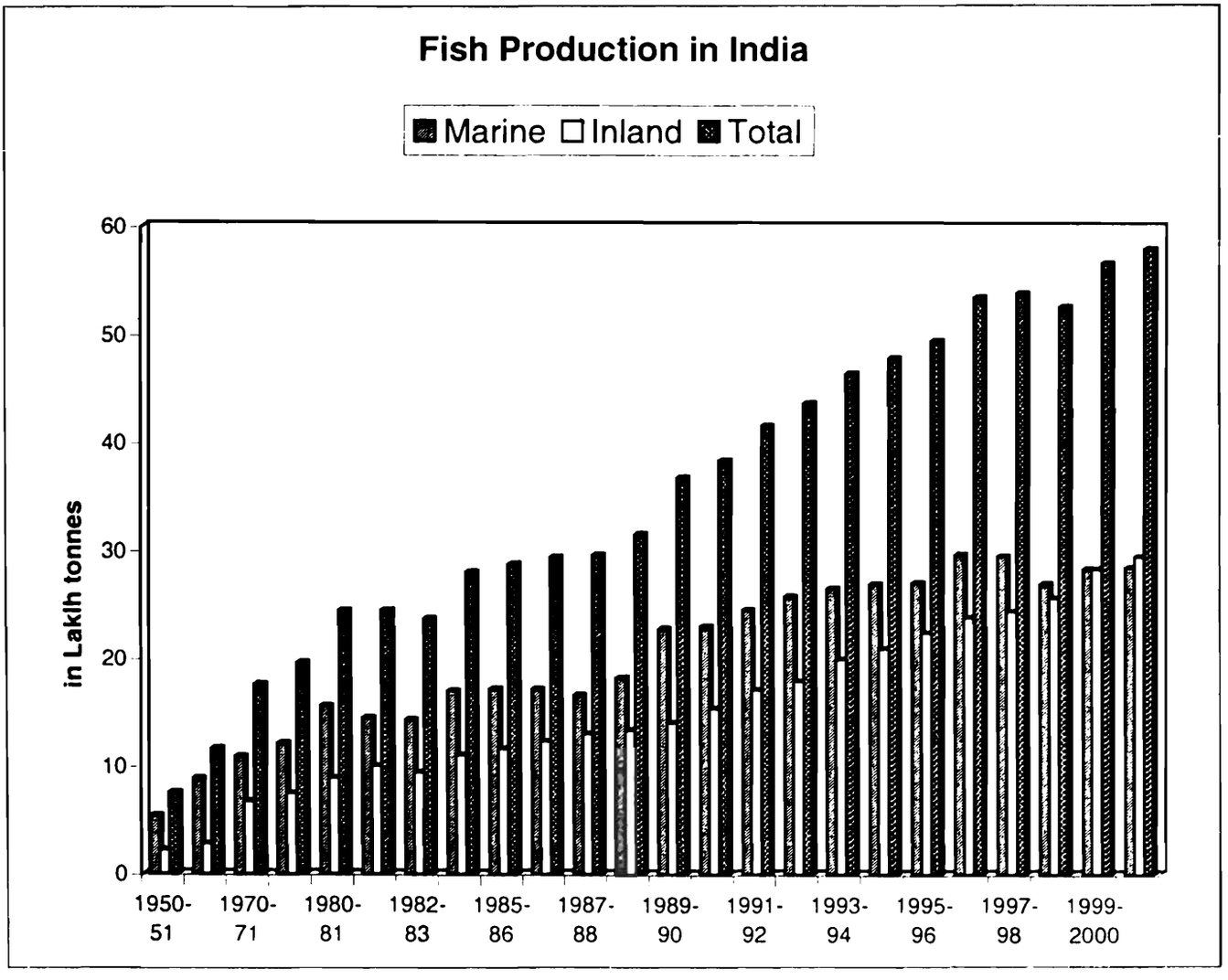
Eels	*Gymnothorax pseudothyrsoideus (Black eels); Congresox talabonoides* (Wam); *Muraenosox bagio* (Golden eel), *M. cinereus* (Dagger tooth pike conger); *Conger cinereus* (Indian conger eel); *Anguilla bengalensis* (Indian mottled eel)
Catfishes	*Batrachocephalus mino* (Frogheaded catfish); *Arius sona* (Dusky catfish), *A. jella* (Smalleye catfish), *A. dussumieri* (Marine catfish), *A. tenuispinis* (Thinspine sea catfish), *A. caelatus* (Engraved catfish), *A. thalassinus* (Giant seacatfish), *A. sagor* (Sagor catfish), *A. subrostratus* (Sona sea catfish), *A. sumatranus* (Shovelnose sea catfish), *A. crossocheilos* (Roughback sea catfish); *Osteogeneiosus militaris* (Soldier catfish); *Plotosus canius* (Gray eel catfish) *P. lineatus* (Striped eel catfish)
Clupeoids (Wolf herring)	*Chirocentrus dorab,* Wolf herring
Clupeoid (Sardines)	*Sardinella longiceps , Sardinella jussieui, Sardinella gibbosa* (Goldstripe sardinella), *S. jussieui* (Mauritian sardinella), *S. fimbriata* (Fringescale sardinella), *S. albella* (White sardinella), *S. sindensis* (Sind sardinella), *S.melanura* (Blacktip sardinella), *S. brachysoma* (Deepbody sardinella); *Amblygaster sirm* (Spotted sardinella), *A. clupeoides* (Bleeker smoothbelly sardinella); *Clupeoid* (Shads) *Anodontostoma chacunda, Ilisha elongate* (Elongate ilisha), *I. megaloptera* (Bigeye ilisha), *Tenualosa ilisha* (Indian or Hilsa shad); *Tenualosa toli* (Toli shad); *Anodontostoma chacunda* (Chacunda gizzard shad); *Nematalosa nasus* (Bloch's gizzard shad); *Hilsa kelee* (Kelee shad)
Clupeoid (Anchovies)	*Stolephorus baganensis, Setipinna brevifili, Coilia dussumieri* (Golden anchovy), *C. ramcarati* (Ramcarat grenadier

	anchovy), *C. reynaldi* (Reynald's grenadier anchovy), *Setipinna brevifilis* (Shorthead hairfin anchovy), *S. tenuifilis* (Common hairfin anchovy), *Stolephorus waitei* (Spotted anchovy), *S. commersonii* (Commerson's anchovy), *S. indicus* (Indian anchovy), *S. baganensis* (Estuarine anchovy), *Encrasicholina devisi* (Devil's anchovy), *E. punctifer* (Buccaneer anchovy), *Thryssa mystax* (Mustached thyrssa), *T malabarica* (Malabar thryssa), *T. gautamiensis* (Gautama thryssa) and *T. purava* (Oblique-jaw thryssa)
Bombay duck	*Harpadon nehereus* Lizard fishes *Saurida longimanus* (Longfin lizardfish), *S. tumbil* (Greater lizard fish), *S. undosquamis* (Brush toothed lizardfish) *S. micropectoralis* (Shortfin lizardfish), *Trachinocephalus myops* (Blunt nose lizardfish), *Synodus englemani* (Engleman's lizard fish)
Halfbeaks and full beaks	*Rhynchorhamphus malabaricus, Strongylura strongylura. Rhynchorhamphus georgii* (Halfbeak garfish), *R. malabaricus* (Malabar halfbeak), *Zenarchopterus dispar* (Feathered river garfish), *Strongylura strongylura* (Fullbeak garfish
Flying fishes	*Hirundichthys oxycephalus* (Bony flyingfish), *Hirundichthys coromandelensis* (Coromandel flyingfish), *Exocoetus volitans* (Two-winged flyingfish), *Cypselurus comatus* (Clearwing flyingfish),
Perches (Groupers)	*Epinephelus tauvina* (Greasy grouper), *E. malabaricus* (Speckled grouper), *E. bleekeri* (Dusky tail grouper), *E. areolatus* (Areolate grouper), *E. diacanthus* (Six banded reef cod), *E. epistictus* (Broken line grouper), *E. fasciatus* (Red banded grouper), *E. flavocaeruleus* (Blue and yellow reef cod), *E. morrhua* (Banded cheek reef cod), *E. undulosus* (Brown lined reef cod), *E. merra* (Wire netting reef cod), *E. fuscoguttatus* (Brown marbled grouper), *E. chlorostigma* (Brown spotted grouper), *E. longispinis* (Spotted grouper), *E. lanceolatus* (Giant grouper), *Cephalopholis sonnerati* (Red coral cod), *Cephalopholis boenack* (Blue lined seabass)
Snappers	*Lutjanus johni* (John's snapper), *L. argentimaculatus* (Red snapper), *L. gibbus* (Hunced snapper), *L. bohar* (Two spot snapper), *L. rivulatus* (Blue-lined snapper), *L. bengalensis* (Bengal snapper), *L. lutjanus* (Bigeye snapper), *L. fulviflammus* (Black snapper), *L. kasmira* (Blue and yellow snapper), *L. sebae* (Emperor snapper), *L. sanguineus* (Red snapper), *L. russelli* (Russel's snapper), *L. malabaricus* (Malabar snapper); *Pristipomoides typus* (Sharp tooth snapper)

Pigface breams	*Lethrinus nebulosus* (Starry emperor bream), *L. obsoletus* (Yellow banded emperor bream), *L. microdon* (Long face pigface bream), *L. miniatus* (Long nosed emperor bream), *L. nebulosus* (Bridle pig-face-bream), *L. mahsena* (Sky emperor), *Lethrinus ornatus* (Ornate emperor), *L. semicinctus* (Black blotch emperor) and *L. variegatus* (Slender emperor)
Threadfin breams	*Nemipterus japonicus* (Japanese threadfin bream) and *N. mesoprion* (Red filament threadfin bream)
Other perches	*Argyrops spinifer* (Long spined redbream), *Acanthopagrus latus* (Yellowfin seabream), *A. berda* (Black seabream), *Crenidens crenidens* (Karenteen seabream), *Drepane punctata* (Moon fish), *Ephippus orbis* (Spade fish), *Lates calcarifer* (Giant Sea perch), *Lobotes surinamensis* (Triple tail), *Pomadasys maculatus* (Spotted grunter), *P. hasta* (Lined silver grunter), *Scatophagus argus* (Spotted butter fish)
Goat fishes	*Upeneus sulphureus* (Yellow goat fish), *U. sundaicus* (Ochrebanded goatfish), *U. vittatus* (Yellowstriped goatfish), *U. tragula* (Freckled goatfish), *U. moluccensis* (Goldband goatfish), *U. taeniopterus* (Finstripe goatfish) and *U. bensasi* (Bensasi goatfish)
Thread fins Sciaenids	*E. tetradactylum* (Indian salmon), *Leptomelanosoma indicum* (Gianthreadfin), *Johnieops dussumieri* (Sharptooth hammer croaker), *Johnius macrorhynus* (Big-snout croaker), *J. amblycephalus* (Bearded croaker), *J. glaucus* (Pale spotfin croaker), *J. coitor* (Coitor croaker), *J. belangrii* (Belanger's croaker), *J. carutta* (Karut croaker), *J. borneensis* (Sharpnose hammer croaker), *Pseudotolithus elongatus* (Bobo croaker),, *Otolithes cuvieri* (Lesser tiger toothed croaker), *Otolithoides biauritus* (Bronze croaker), *O. pama* (Pama croaker), *Protonibea diacanthus* (Spotted croaker), *Nibea maculata* (Blotched croaker), *Kathala axillaris* (Kathala croaker), *Pennahia anea* (Greyfin croaker), *Daysciaena albida* (Bengalcorvine), *Dendrophysa russelii* (Goatee croaker)
Ribbonfishes	*Trichiurus lepturus* (Grey ribbonfish), *T russelli* (Short-tailed hairtail), *T. gangeticus* (Ganges hairtail), *Euplurogrammus muticus* (Smallhead hairtail), *E. glossodon* (Longtooth hairtail), *Lepturacanthus savala* (Silver ribbonfish) and *L. pantului* (Coromandel hairtail)
Jacks	*Caranx sexfasciatus* (Six banded trevally), *C. hippos* (Black tailed trevally), *C. ignobilis* (Yellowfin trevally), *C. melampygus* (Bluefin trevally), *Megalaspis cordyla* (Horse

	mackerel), *Alepes kleinii* (Golden scad), *A. djedaba* (Shrimp scad), *Decapterus ruselli* (Roundscad), *D. kurroides* (Redtail scad); *Scomberoides lysan* (Port hole fish), *S. commersonianus* (Talang queenfish), *S. tala* (Deep queenfish), *S. tol* (Slender queenfish), *Trachinotus blochii* (Subnose pompano), *T. baillonii* (Bailon's pompano), *T. botla* (Russel's pompano), *Atropus atropus* (Kuweh trevally), *Selar crumenopthalmus* (Bigeye scad), *S. boops* (Banded scad), *Carangoides armatus* (Longfin trevally), *C. malabaricus* (Malabar trevally), *C. oblongus* (Coach-whip trevally), *C. chrysophrys* (Longnose trevally), *C. ferdau* (Ferdau's cavalla), *Atule mate* (One finlet scad), *Seriolina nigrofasciata* (Black banded kingfish), *Elagatis bipinnulata* (Rainbow runner), *Alectis indicus* (Indian threadfin trevally), *A. ciliaris* (Redfin trevally), *Rachycentron canadum* (Cobia); *Coryphaena hippurus* (Dolphin fish)
Silverbellies	*Leiognathus splendens* (Splendid ponyfish), *L. dussumieri* (Dussumier's ponyfish), *L. brevirostris* (Shortnose ponyfish), *L. equulus* (Common ponyfish), *L. bindus* (Orangefin ponyfish), *Gazza minuta* (Toothpony), *Secutor insidiator* (Pugnose ponyfish)
Pomfrets	*Apolectus niger* (Black pomfret), *Pampus argenteus* (Silver pomfret) and *Pampus chinensis* (Chinese pomfret)
Mackerels	*Rastrelliger kanagurta* (Indian mackerel), *R. faughni* (Island mackerel) and *R. brachysoma* (Short mackerel)
Seerfishes	*Scomberomorus commerson* (King seer), *S. guttatus* (Spotted seer), *S. lineolatus* (Streaked seer), *Acanthocybium solandri* (Wahoo)
Tunas	*Euthynnus affinis* (Little tuna/ Kawakawa), *Katsuwonus pelamis* (Skipjack tuna), *Thunnus tonggol* (Longtail tuna), *Auxis* species such as, *A. thazard* (Frigate tuna) and *A. rochei* (Bullet tuna), *Thunnus albacares* (Yellowfin tuna), *Sarda orientalis* (Striped bonito)
Billfishes	*Istiophorus gladius* (Indian sail fish) and *Xiphias gladius* (Swordfish).
Barracudas	*Sphyraena jello* (Banded Barracuda), *S. obtusata* (Great barracuda), *S. barracuda* (Great barracuda) and *S. forsteri* (Bigeye barracuda)
Mullets	*Mugil cephalus* (Flathead mullet), *Chelon macrolepis* (Largescale mullet), *Valamugil seheli* (Bluespot mullet), *V. cunnesius* (Longarm mullet), *Lizaparsia* (Goldspot mullet), *L. tade* (Tade mullet) and *L. vaigiensis* (Squaretail mullet)

Halibut	*Psettodes erumei* (Indian halibut); *Synaptura commersonnii* (Commerson's sole)
Flounders	*Pseudorhombus arsius* (Large tooth flounder), *P. elevatus* (Deep flounder), *P. javanicus* (Javan flounder), *P. malayanus* (Malayan flounder), *P. natalensis* (Natal flounders), *P. triocellatus* (Three spotted flounder); *Bothus pantherinus* (Leopard flounder), *B. myriaster* (Indo-Pacific oval flounder); *Chascanopsetta lugubris* (Pelican flounder)
Soles	*Cynoglossus dubius* (Tongue sole), *C. bilineatus* (Malabar tongue sole), *C. arel* (Largescale tonguesole), *C. pucticeps* (Speckled tonguesole), *C. carpenteri* (Hooked tonguesole), *C. dispar* (Roundhead toungesole), *C. macrolepidotus*, *C. macrostomus* (Malabar tonguesole), *Paraplagusia bilineata* (Doublelined tonguesole), *Brachirus orientalis* (Oriental sole), *Solea elongata* (Elongate sole), *Zebrias quagga* (Zebra sole) and *Z. synapturoides* (Indian zebra sole)



Production and export of marine products from India

Year	Fish production (million tonnes)			Export of marine products	
	Marine	Inland	Total	Quantity ('000 tones)	Value Rs. (in Crore)
1950-51	0.5	0.2	0.7	20	2
1960-71	0.9	0.3	1.2	20	4
1970-71	1.1	0.7	1.8	40	35
1980-81	1.5	0.9	2.4	80	235
1990-91	2.3	1.5	3.8	140	893
2000-01	2.8	2.8	5.6	503	6296
2001-02	2.8	3.1	5.9	458	5815
2002-03	3.0	3.2	6.2	521	6793
2003-04(P)	3.0	3.4	6.4	412 (P)	5739

Source : Department of Animal Husbandry (P. part).

Our knowledge of sharks and other elasmobranch groups is based on the species caught within the narrow belt of coastal zone upto 70 m or so. Beyond this there may be many more species about which we have no knowledge. Till 1996 elasmobranchs accounted for an annual average catch of 55 thousand tones of which sharks share 35 thousand tonnes (65%). The projected potential yield of this group is about 0.18 million tones, leaving a large gap. The group is very much over exploitated (Devadoss, 1996). A critical analysis and evaluation of the results of frequent exploratory surveys would provide a clear picture of the productive areas, seasons and species composition of sharks in the Indian waters.

Trade in sharks and shark products gained importance in the late 80's due to the increased utilization of shark meat for domestic consumption along with the reduction of tariff rates on the import of shark fins *etc.* The shark fishery has become more lucrative one in view of the great demand for their fins and flesh. The major products of sharks are such as fins; meat; liver oil; stearin; liver meal; cartilage; skin; teeth. Dried shark fin is a valuable export product in India. A major portion of export takes place from Bombay and Chennai. The fins of certain sharks like *Alopias spp.*, *Centrophorus spp.* and *Echinorhinus spp.*, are of no economic value, but its flesh or liver oil, and in some cases both, are made use of. Fins of whale shark are also of not much value but still it is traded mainly from Gujarat. According to Marine Products Export Development Authority (MPEDA), fins of the following shark species are exported from India :

1. *Shyrna zygaena*
2. *Rhizoprionodon acutus*
3. *Scoliodon laticaudatus*

4. *Carcharhinus melanopterus*
5. *Rhincibatus djeddensis*
6. *Negaprion acutidans*
7. *Rhiniodon typus*

India, Sri Lanka, Bangladesh and Maldives are the main producers of the fins. The main consumer countries are Thailand, Malaysia and Singapore. From 1995-1999, India has exported 543.48 tonnes of dried shark fins worth of 1234.2 lakhs to Hong Kong alone. The other countries which imported dried shark fins from India were China, Germany, Japan, Malaysia, Spain, Srilanka, Taiwan, UAE and USA. The total export of dried shark fin from India to countries other than Hong Kong was 91.93 tonnes worth of 150.49 lakhs (MPEDA, 1999). India has exported 784.63 tonnes of frozen shark meat worth of 282.49 lakhs to Taiwan from 1995-1999. The second largest export of frozen shark meat from India was to China (408.88 tonnes worth of 160.59 lakhs). The total amount of frozen shark meat imported from India by countries like Austria, Germany, Hong Kong, Japan, Malaysia, Singapore, Spain, Srilanka, Switzerland, Thailand, UK and USA was 491.68 tonnes worth of 198.81 lakhs (MPEDA, 1999). A very important use to which the elasmobranch fishes are put to is for the extraction of liver oils having a medicinal value. The livers of most of the species have a high percentage of oil with high vitamin-A content. Indigenous production of shark liver oil has replaced the imports of cod liver oil for medicinal purposes since the Second World War period (Bal and Virabhadra Rao, 1990). *Stearin* is separated by chilling the crude liver oil in a cooler temperature before centrifuging. Crude liver oil contains about 20–30 percent stearin, which is used in the manufacture of candles, soaps and paints. It is also used as an anti fouling agent for fishing craft (Pillai and Parakal, 2000). Liver meal obtained from fresh livers that are minced and vigorously boiled for two hours. On boiling, water and liver settle at the bottom and the oil floats on the surface. The oil is carefully separated using a filter cloth and the liver meal is dried and powdered for mixing in poultry feed (Hanfee, 1996b; Pillai and Parakal, 2000).

It is for these reasons of over exploitation, Ministry of Environment and Forests have introduced the conservation of the species by including several of them in the Wildlife Schedules. In exercise of the powers conferred by sub section (1) of section 61 of the Wild Life Protection Act, 1972 (53 of 1972), the Central Government included the following shark species under Schedule I of the said Act in 5.12.2001 :

Carcharhinus hemiodon
Glyphius gangeticus
Glyphis glyphis
Himantura fluviatilis
Anoxypristis cuspidata
Pristis microdon,

Pristis zijsron,

- *Rhyncobatus djiddensis*
- *Urogymnus asperrimus*

The class Osteichthyes is the largest group and includes fresh, brackish and marine water bony fishes and account for about 96% of all fish species. The class Osteichthyes includes the largest number of living species of all scientific classes of vertebrates, more than 23,500 species, the world over. Approximately 58% (about 13,630) of all species of bony fishes live in marine environments. Although only 0.01 % of the earth's water is fresh water, freshwater fishes make up approximately 42% (about 9,870) of fish species (Wootton, 1990). Analysis of Indian Fish fauna reveals the order osteoglossiformes are predominantly tropical freshwater fish with only one family (Notopteridae), four species under a single genera (*Notopterus*) known for considerable yield of freshwater fishes in the country. The order elopiformes includes three families, primarily a marine, but occasionally found in brackish and freshwater. Notable ones are *Megalops* with two species, a common one in the brackish waters of Andhra and Kerala state. The species is also known for migration, migrates nearly 400 km upstream of the coastal water. The members of the order notacanthiformes are distributed in deep sea between 125 to 4900 m. The members of the order anguilliformes are all marine, except one family of freshwater eel. The order clupeiformes are the primitive teleosts with a distinctive type of connection between the swim bladder and the ears which is unique among fishes. Members are pelagic, mainly inshore fishes, often forming large and densely packed shoals which are heavily preyed upon by fishes, birds and man. The clupeoid fishes are the most important group exploited world over and account half of the total catch. Notable ones are *Hilsa, Sardinella, Chirocentrus,* and Anchovies a coastal, marine and schooling fishes occuring in all seas. The order gonorhynchiformes include a small group and some of them are even monotypic (*Chanos chanos*). The order cypriniformes are exclusively freshwater, several of them are known for the aesthetic value as aquarium fishes. Notable food fish is the *Catla catla,* which was originally confined to the plains north of Krishna, but during the last four decades it has been introduced to practically all river systems and many of the tanks and reservoirs. Other notable ones are *Chela, Amblypharyngodon, Aspidoparia, Barilius, Cyprinus, Esomus* etc. These fishes are of no practical value but their chief value lies in the fact that they form food for the predatory fishes, and because of their beautiful colour, several of them are known as the aquarium fishes. The catfishes belong to the order siluriformes includes monotypic *Horabagrus, Rama (Chandamara)* and *Rita.* The other freshwater food fishes are *Mystus, Chandramara, Ompok, Wallago, Clupiosoma, Pangasius, Amblyceps, Bagarius, Hara, Clarias, Heteropneustes, Chaca, Plotosus* and the *Arius.* In India these catfishes constitute a striking and well marked group, and some of them are among the largest freshwater fishes of Asia.

The order salmoniformes includes marine deep sea fishes, but a poorly known family of alepocephalidae, an evolutionary interesting deep sea family of platytroctidae, coldwater fishes of the family galaxiidae and introduced arctic and northern sea fishes of salmonidae.

The order stomiiformes includes 9 families, 18 genera and 31 species are not of much commercial value. The order aulopiformes comprises of deep sea fishes i.e., meso to bathypelagic, the notable ones are the *Harpadon* a fish of commercial importance and Barracudinas, bycatch fishes of trawl fisheries. Members of the order myctophiformes includes fishes distributed in the continental shelf and slopes of the Andaman sea and south west coast of India. Members of the order cyprinodontiformes includes epipelagic fishes such as Exocoetidae, Hemirapmhidae, Belonidae, Oryziidae, Horaichthyidae, Aplocheilidae, Cyprinodontidae and Poecilide, the last one includes introduced members such as *Gambusia* and *Poecilla* for controlling mosquitoes in India.

According to Fish Base, 2004 Commercially important eels and catfishes includes *Congresox talabonoides* (Wam), *Gymnothorax pseudothyrsoidea* (Black eel), *Muraenosox bagio* (Golden eel), *M. cinereus* (Daggertooth pike conger), *Conger cinereus* (Indian conger eel) and *Anguilla bengalensis* (Indian mottled eel) and (Families Ariidae and Plotosidae), *Batrachocephalus mino, Arius thalassinus, Batrachocephalus mino* (Frogheaded catfish), *Arius sona* (Dusky catfish), *A. jella* (Small eye catfish), *A. dussumieri* (Marine catfish), *A. tenuispinis* (Thin spine sea catfish), *A. caelatus* (Engraved catfish), *A. thalassinus* (Giant sea catfish), *A. sagor* (Sagor catfish), *A. subrostratus* (Sona sea catfish), *A. sumatranus* (Shovelnose sea catfish), *A. crossocheilos* (Roughback sea catfish), *Osteogeneiosus militaris* (Soldier catfish), *Plotosus canius* (Gray eel catfish) and *P. lineatus* (Striped eel catfish).

The order perciformes is the largest of all the group includes a heterogeneous and diversified assemblage of 98 families, 388 genera and 1011 species and dominate in vertebrate ocean life. Several of them are colourful and are associated with the coral reefs of Andaman & Nicobar Islands, Lakshdweep, Gulf of Katchchh and Gulf of Mannar and hence they are highly priced as ornamental fishes in aquarium industry.

Fishery resources in India

Order	India			No. of species in the world
	No. of Families	No. of Genera	No. of Species	
Chimaeriformes	2	4	4	30
Hexanchiformes	1	1	1	4
Echinorhinidae	2	5	5	69
Orectolobiformes	4	4	7	16
Lamniformes	4	4	6	13
Carchariniformes	6	22	42	189
Pristiformes	1	2	4	7
Torpediniformes	3	6	13	39
Rajiformes	2	7	15	252
Myliobatiformes	2	5	8	37

Order	India			No. of species in the world
	No. of Families	No. of Genera	No. of Species	
Osteoglossiformes	1	1	2	6
Elopiformes	3	3	3	13
Notacanthiformes	2	3	6	25
Anguilliformes	11	49	98	625
Clupeiformes	4	24	83	354
Gonorhynchiformes	1	1	1	1
Cypriniformes	4	67	380	2482
Siluriformes	12	50	164	650
Salmoniformes	5	11	17	147
Stomiformes	9	18	31	368
Aulopiformes	7	15	39	167
Myctophiformes	2	15	41	241
Gadiformes	2	2	3	67
Ophidiformes	4	25	34	385
Batrachoidiformes	1	2	2	64
Lophiformes	6	15	32	196
Cyprinodontiformes	8	21	50	658
Atheriniformes	2	4	7	126
Lampriformes	4	4	5	18
Bericyformes	6	11	28	137
Zeiformes	3	5	6	25
Indostomiformes	1	1	1	1
Pegasiformes	2	2	4	5
Sygnathiformes	6	23	44	231
Dactylopteriformes	1	2	5	7
Synbranchiformes	1	2	6	15
Scorpaeniformes	8	46	93	569
Perciformes	98	388	1011	6799
Pleuronectiformes	7	30	89	543
Tetraodontiformes	9	46	74	341
Total	**157**	**969**	**2546**	

Extract from : Animal Resources of India, ZSI

ENDEMICITY

The Indian fish fauna includes 2 endemic families Viz., Parapsilorhynchidae (Hill stream fishes with one genus and three species) distributed in Western Ghats, Satpura Mountains and Bailadila range of Madhya Pradesh. The class Horaichthydae includes a monotypic species *Horaichthyes setnai* distributed in the west coast of India. The fishes of India (Faunal Resources, Alfred *et al.*, 1998) contain 223 endemic species representing 8.75 % of the fishes known from India (while the Fish database records 213 species of endemic forms whose detailed account is given below) and 127 monotypic genera (13.10% of the Indian genera). Most of these endemics, numbering 116 species are exclusive to the Western Ghats, found mostly in the upper reaches and isolated river stretches (Remadevi, 2003), the details are as shown in the table.

Order	Family	Genera	Species
Anguilliformes	Ophichthidae	1	1
Clupeiformes	Clupeidae	2	2
Cypriniformes	Cyprinidae	22	97
	Parapsilorhynchidae	1	3
	Balioridae	6	46
	Cobitidae	4	8
Siluriformes	Bagridae	5	10
	Siluridae	3	3
	Schilbeidae	6	6
	Sisoridae	7	21
	Clariidae	2	3
	Olyridae	1	1
Cyprinodontiformes	Hemiramphidae	2	2
	Horaichthydae	1	1
	Synbranchidae	1	2
	Chandidae	1	1
	Nandidae	1	1
	Cichlidae	1	1
	Gobiidae	7	9
	Eleotrididae	1	1
	Mastacembelidae	1	1
	Chaudhuriidae	1	2
Tetraodontiformes	Tetraodontidae	1	1
Total — 6	**23**	**78**	**223**

List of Endemic Fishes for India n = 213

Scientific Name	FB Name	Name
Aborichthys elongatus		
Aborichthys garoensis		
Acentrogobius griseus	Grey goby	Phursandi
Aplocheilus kirchmayeri		
Balitora mysorensis	Slender stone loach	Kalla
Barbodes bovanicus	Bowany barb	Bovani
Barbodes carnaticus	Carnatic carp	
Barbodes wynaadensis		
Barilius bakeri		Malabar baril
Barilius canarensis		Jerdon's baril
Barilius dimorphicus		
Barilius dogarsinghi		Manipur baril
Barilius evezardi		Day's baril
Barilius gatensis		River-carp baril
Barilius radiolatus		Günther's baril
Batasio travancoria		Malabar batasio
Bathygobius ostreicola		
Bhavania australis	Western Ghat loach	
Botia striata	Zebra loach	Handi
Callogobius seshaiyai		
Carinotetraodon imitator		
Carinotetraodon travancoricus	Malabar pufferfish	
Chela dadiburjori	Dadio	
Chela fasciata		Malabar hatchet chela
Cirrhinus fulungee	Deccan white carp	Arja
Cirrhinus macrops	Hora white carp	Hora white carp
Clarias dayi		Malabar clariid
Clarias dussumieri		Valenciennes clariid
Clupisoma bastari		Bastar garua
Crossocheilus periyarensis		
Dayella malabarica	Day's round herring	Nil
Devario acuticephala		Manipur danio
Devario fraseri		Fraser danio

Scientific Name	FB Name	Name
Devario naganensis		Naga danio
Devario neilgherriensis		Peninsular danio
Enobarbichthys maculatus	Whitley loach	Whitley loach
Erethistoides montana montana		
Erethistoides montana pipri		
Esomus barbatus	South Indian flying barb	
Etroplus canarensis	Canara pearlspot	Elimeenu
Eutropiichthys goongwaree		Goongwaree vacha
Gagata sexualis		
Garo khajuriai	Garo spineless eel	Garo spineless eel
Garra bicornuta		Tunga garra
Garra gotyla stenorhynchus		Nilgiris garra
Garra hughi		Cardamon garra
Garra kalakadensis		
Garra lissorhynchus		Khasi garra
Garra mcclellandi		Cauvery garra
Garra menoni		
Garra naganensis		Naga garra
Garra rupecula		Mishmi garra
Glyptothorax anamalaiensis		
Glyptothorax coheni		
Glyptothorax dakpathari		
Glyptothorax garhwali		
Glyptothorax housei		
Glyptothorax kapuri		
Glyptothorax lonah		
Glyptothorax madraspatanum		
Glyptothorax nelsoni		
Glyptothorax poonaensis		Pathar chata
Glyptothorax saisii		
Glyptothorax striatus		
Glyptothorax trewavasae		
Gymnocypris biswasi	Ladakh snowtrout	Ladakh snowtrout
Hara horai		Terai hara

Scientific Name	FB Name	Name
Hemibagrus maydelli		Krishna mystus
Hemibagrus punctatus	Nilgiri mystus	
Homaloptera manipurensis		
Homaloptera menoni		
Homaloptera montana	Anamalai loach	
Homaloptera pillaii		
Horabagrus brachysoma	Günther's catfish	
Horabagrus nigricollaris		
Horaglanis krishnai	Indian blind catfish	
Horaichthys setnai	Malabar ricefish	
Hyporhamphus xanthopterus	Red-tipped halfbeak	
Hypselobarbus curmuca	Curmuca barb	
Hypselobarbus dobsoni	Krishna carp	
Hypselobarbus dubius	Nilgiris barb	
Hypselobarbus jerdoni	Jerdon's carp	
Hypselobarbus kolus	Kolus	
Hypselobarbus kurali		
Hypselobarbus lithopidos	Canara barb	Canara barb
Hypselobarbus micropogon	Korhi barb	
Hypselobarbus pulchellus		Haragi
Hypselobarbus thomassi	Red Canarese barb	Thomassi
Indoreonectes evezardi		
Johnius gangeticus		Gangetic bola
Kraemericus smithi		
Labeo kawrus		Deccan labeo
Labeo kontius	Pigmouth carp	
Labeo nigrescens		Karnataka labeo
Labeo potail		Deccan labeo
Labeo rajasthanicus		
Labeo udaipurensis		
Lepidopygopsis typus	Peninsular hilltrout	
Longischistura bhimachari		Murangi
Longischistura striata		Chikli

Scientific Name	FB Name	Name
Macrognathus guentheri	Malabar spinyeel	
Mesonoemacheilus guentheri		
Mesonoemacheilus pambarensis		
Mesonoemacheilus pulchellus		
Mesonoemacheilus triangularis		
Monopterus eapeni		Malabar swamp eel
Monopterus fossorius	Malabar swampeel	Malabar swampeel
Monopterus hodgarti	Indian spaghetti-eel	Indian spaghetti-eel
Monopterus indicus	Bombay swampeel	
Mystus malabaricus		Jerdon's mystus
Mystus montanus		Wynaad mystus
Mystus oculatus		Malabar mystus
Nemacheilus anguilla		Chikli
Nemacheilus carletoni		
Nemacheilus devdevi		
Nemacheilus doonensis		
Nemacheilus gangeticus		
Nemacheilus himachalensis		
Nemacheilus keralensis		
Nemacheilus kodaguensis		Murangi
Nemacheilus monilis		
Nemacheilus mooreh		Murangi
Nemacheilus nilgiriensis		
Nemacheilus pavonaceus		
Nemacheilus petrubanarescui		
Nemacheilus reticulofasciatus		
Nemacheilus rueppelli		
Nemacheilus singhi		
Nemacheilus tikaderi		
Neolissochilus spinulosus		
Neotropius khavalchor	Khavalchor catfish	
Ompok malabaricus	Goan catfish	
Osteobrama bakeri		Malabar osteobrama
Osteobrama bhimensis		Bhongi

Source : Fish database 2005

Scientific Name	FB Name	Name
Osteobrama cotio peninsularis		Peninsular osteobrama
Osteobrama neilli		Nilgiri osteobrama
Osteobrama vigorsii		Bheema osteobrama
Osteochilichthys brevidorsalis	Kantaka barb	
Osteochilus godavariensis	Chandkas barb	Chandkas barb
Osteochilus longidorsalis		
Osteochilus nashii	Nash's barb	
Osteochilus thomassi	Konti barb	
Pangio bashai		
Pangio goaensis	Indian coolie-loach	Indian coolie-loach
Parambassis dayi	Day's glassy perchlet	
Parambassis thomasi	Western Ghat glassy perchlet	
Parapsilorhynchus discophorus	Ratnagiri minnow	Ratnagiri minnow
Parapsilorhynchus prateri	Deolali minnow	Kallu-korava
Parapsilorhynchus tentaculatus	Khandalla minnow	Khandalla minnow
Parascolopsis boesemani	Redfin dwarf monocle bream	
Parluciosoma labiosa		Slender rasbora
Physoschistura elongata		
Pillaia indica	Hillstream spineless eel	Hillstream spineless eel
Pristolepis marginata	Malabar leaffish	
Proeutropiichthys taakree taakree		Indian taakree
Pseudeutropius mitchelli		Malabar patashi
Pseudosphromenus dayi		
Pterocryptis indicus		
Pterocryptis wynaadensis		Malabar silurus
Puntius arenatus		Arenatus barb
Puntius arulius	Arulius barb	
Puntius cauveriensis	Cauvery barb	Cauvery meenu
Puntius chalakkudiensis		
Puntius deccanensis	Deccan barb	Deccan barb
Puntius denisonii	Denison barb	
Puntius fasciatus	Melon barb	

Scientific Name	FB Name	Name
Puntius fraseri	Dharna barb	Kadwi
Puntius melanostigma	Wynaad barb	
Puntius narayani	Narayan barb	Narayani
Puntius ophicephalus	Channa barb	
Puntius parrah		Parrah barb
Puntius punctatus		
Puntius roseipinnis	Pondicherry barb	Pondicherry barb
Puntius sahyadriensis	Khavli barb	Gende
Puntius shalynius	Shalyni barb	Phabourga
Puntius sharmai		
Puntius tambraparniei		
Rasbora caverii	Cauvery rasbora	Saslu
Rita chrysea		Mahanadi rita
Rita gogra		Gogra rita
Rita kuturnee		Deccan rita
Rohtee ogilbii	Vatani rohtee	Bipsi
Salmostoma boopis	Boopis razorbelly minnow	Malli
Salmostoma horai	Hora razorbelly minnow	Malli
Salmostoma kardahiensis minnow		Reddiah razorbelly
Salmostoma novacula	Novacula razorbelly minnow	
Salmostoma orissaensis	Orissa razorbelly minnow	Orissa razorbelly minnow
Salmostoma untrahi	Mahanadi razorbelly minnow	Malli
Schismatorhynchos nukta	Nukta	Mukarti
Schistura chindwinica		
Schistura denisoni		
Schistura manipurensis		
Schistura montana		Chitai
Schistura nagaensis		
Schistura prashadi		
Schistura semiarmata		
Schistura sijuensis		
Schizothorax kumaonensis	Kumaon snowtrout	Kumaon snowtrout
Schizothorax niger	Chush snowtrout	Ale gad

Scientific Name	FB Name	Name
Setipinna brevifilis	Short-hairfin anchovy	Short-hairfin anchovy
Setipinna phasa	Gangetic hairfin anchovy	
Sillago indica	Indian sillago	
Sillago soringa	Soringa sillago	
Sillago vincenti	Vincent's sillago	Estuarine whiting
Silonia childreni		White catfish
Thynnichthys sandkhol	Sandkhol carp	Banga
Tor mussullah	High-backed mahseer	
Tor progeneius	Jungha mahseer	Jongapittia
Travancoria elongata		
Travancoria jonesi	Travancore loach	
Triplophysa kashmirensis		
Triplophysa marmorata		Kashmir triplophysa-loach
Triplophysa shehensis		Tilak triplophysa-loach

List of Introduced Fishes for India n = 20 (Fish database, 2005)

Scientific Name	FB Name	Name
Aristichthys nobilis	Bighead carp	Belli-gende
Barbonymus gonionotus	Java barb	Tawes
Carassius auratus auratus	Goldfish	
Carassius carassius	Crucian carp	Gang gad
Clarias gariepinus	North African catfish	
Ctenopharyngodon idella	Grass carp	Hullu
Cyprinus carpio carpio	Common carp	
Gambusia affinis	Mosquitofish	Gambusia
Gambusia holbrooki	Eastern mosquitofish	
Hypophthalmichthys molitrix	Silver carp	Belli-gende
Oncorhynchus mykiss	Rainbow trout	Rainbow trout
Oreochromis mossambicus	Mozambique tilapia	
Oreochromis niloticus niloticus	Nile tilapia	
Osphronemus goramy	Giant gourami	
Poecilia reticulata	Guppy	Barbados millions
Salmo trutta fario	Brown trout	Brown trout
Salmo trutta trutta	Sea trout	

Scientific Name	FB Name	Name
Salvelinus fontinalis	Brook trout	Brook trout
Tinca tinca	Tench	Tench
Xiphophorus hellerii		Green swordtail

Indigenous Freshwater Culture fishes

Catla catla (Ham)	*Etroplus suratensis (Blcoh)*
Labeo rohita (Ham)	*Anabas testudineus (Bloch)*
Labeo calabasu (Ham)	*Wallgo attu (Bloch)*
Labeo fimbriatus	*Aorichthyes seenegala (Sykes)*
Labeo bata (Ham)	*Channa striatus (Bloch)*
Cirrhinus mrigala (Ham)	*Channa batrachus (Linne)*
Cirrhinus reba (Ham)	*Heteropneustes fossilis (Bloch)*

Exotic Fish Species

Species	Place of Origin
Salmo trutta fario (Game fish)	British Islands
Salmo silvelinus	Arctic & Northern Seas
Onchorhycnhcus sp.	— do —
Carassius carassius	China. Japan, Tiwan Vietnam etc.
Tinca tinca	Europe & W Siberia
Hypopthalmichthys molitrix	S & Central China
Hypopthalmichthys nobilis	China
Ctenopharyngodon idella	Siberia & Manchuria
Oreochromis mossambica	East coast of Africa
Osphronemus gorami	Indonesia, Thailand & Vietnam
Cyprinus caprio caprio	China, Korea, Japan, Taiwan
Gambusia affinis patruelis (Larvicidal)	America
Poecilia reticulatus (Larvicidal)	America

Fish diversity

Total	2,546 species
Freshwater	930 species
In comparison to the World	
Percent	11.72% species
	24.00% genera
	57.00% families
	80.00% orders

Tamil Nadu	157 species
Karnataka	112 species
Kerala	165 species
Andhra Pradesh	158 species
Western Ghats	231 species
Northeast	205 species
Gangetic Plains	271 species
Cauveri	142 species
Godavari	122 species
Krishna	160 species

(*Source* : Remadevi, 2003)

Game Fishes : *Notopterus chitala* (Hamilton) which grows up to 120–150 cm and weighs nearly 30–35 kg is distributed in the tanks and rivers of Indo-Genetic plain. *Chela argentata* Day is distributed in peninsular India and the Indian trout *Raimas bola* (Hamilton), *Tor chilinoides* Mc Clelland, *Tor putitora* (Hamilton), *Tor tor, Acrossocheilus hexagonolepis* (Mc Clelland), *Schizothorax planifrons* Heckel are all distributed in the foothill of Himalaya. Among estuarine and sea game fishes *Megalops cyprinoides* (Broussonnet), *Lates calcarifer* (Bloch), *Eleutheronema tetradactylus* (Shaw), *Lutjanus argentimaculata, Scomberomorus commersoni* (Lacepede), *S commersoni, A guttatus, Sparus berda* and *Sparus datia* are important ones. Mahaseer – The Premier Sport Fish abound in the State of Arunachal Pradesh. This potential resource led to the holding of an International Angling Festival" consecutive for two years with the prospects for Tourism. Besides above, the Trout fishery, both Brown and Rainbow Trout variety being cultured for stocking the cold water resources has gained popularity for providing recreation to the Defence personal posted in the forward areas of Northeast Region as well as upper stretches of Himalaya.

Threats : The freshwater fishes in general and game fishes in particular are in danger, the decline is due to the indiscriminate fishing, habitat destruction due to dynamite operation in the rivers, checking the river flow, construction of dams, land and forest erosion, pollution and due to the introduction of exotic fishes. Dams & weirs have affected the spawning ground of the Indian Mahaseers. IUCN (2002) identified 17 species of fishes under various threatened categories, among them *Glyphis gangeticus* (Gangetic shark) is considered critical, *Pristis monodon* (Sawfish) endangered, 6 species vulnerable, one species under lower risk and in respect of 8 species there is data deficiency. Menon (1989–92) provided a comprehensive account of Endangered, Vulnerable and Rare species occurring in Peninsular India, comprising of 45 species, which needed immediate attention for conservation. Alien species invasions and the ecological imbalances they wreak, are the large problem for freshwater, coastal and marine biodiversity. The ecological consequences of the invasions include : habitat loss and alteration: altered water flow and food webs : the creation of novel and unnatural habitats subsequently colonized by other exotic species :

abnormally effective filtration of the water column; hybridization with native species; highly destructive predators; and introductions of pathogens and disease (MA, 2005).

Fish Germplasm Resources of India and their Threatened Status

Ecosystem	Total Species	Endangered	Vulnerable	Rare	Indeterminate	Total
Coldwater	73	01	04	-	12	17
Warm water	544	03	13	02	28	46
Brackish water	143	-	02	-	04	06
Marine	1440	04	21	02	52	79
TOTAL	2200	04	21	02	52	79

(*Source* : S. Ayyappan, 2003)

List of Threatened Fishes for India n = 34

Aetomylaeus nichofii	Banded eagle ray
Anoxypristis cuspidata	Knifetooth sawfish
Balistes vetula	Queen triggerfish
Carcharhinus hemiodon	Pondicherry shark
Carcharias taurus	Sand tiger shark
Cheilinus undulatus	Humphead wrasse
Epinephelus lanceolatus	Giant grouper
Epinephelus marginatus	Dusky grouper
Glyphis gangeticus	Ganges shark
Hemipristis elongata	Snaggletooth shark
Heteropneustes microps	
Himantura chaophraya	Freshwater whipray
Himantura fluviatilis	Ganges stingray
Hippocampus kuda	Spotted seahorse
Hippocampus trimaculatus	Longnose seahorse
Horaglanis krishnai	Indian blind catfish
Labeo porcellus	
Liza melinoptera	Otomebora mullet
Mobula mobular	Devil fish
Nebrius ferrugineus	Tawny nurse shark
Negaprion acutidens	Sicklefin lemon shark

Pegasus laternarius	
Pristis microdon	Largetooth sawfish
Pristis pectinata	Smalltooth sawfish
Pristis pristis	Common sawfish
Pristis zijsron	Longcomb sawfish
Rhina ancylostoma	Bowmouth guitarfish
Rhincodon typus	Whale shark
Rhinobatos typus	Giant shovelnose ray
Rhynchobatus djiddensis	Giant guitarfish
Schistura sijuensis	
Stegostoma fasciatum	Zebra shark
Thunnus obesus	Bigeye tuna
Urogymnus asperrimus	Porcupine ray

Source : Fish database, 2005

Sustainable Fisheries

Sustainable fisheries means maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations and mitigating any adverse effects of fishing on the aquatic environment. Utilisation means conserving, using, enhancing, and developing fisheries resource to enable people to provide for their social, economic and cultural well being. The objectives of sustainable fisheries are :

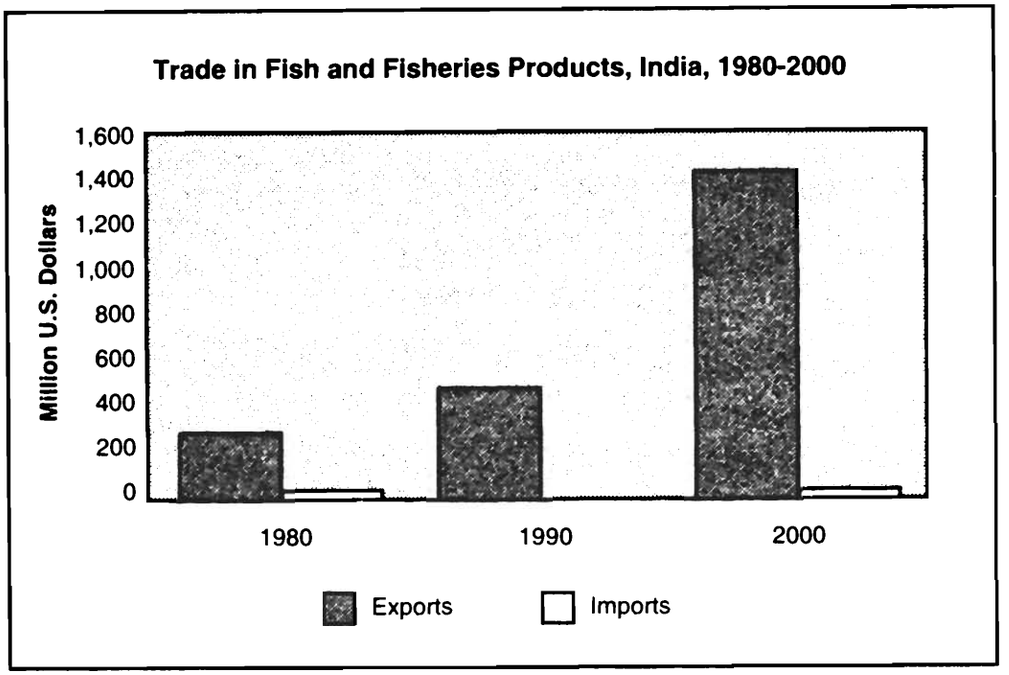
1. Sustainable exploitation of fish stocks-status and perspectives for improvement
2. Conservation of the environment
3. Efficient utilisation of input factors (bio-mass, energy, capital and manpower)
3. Maximising output of limited catch quotas
4. Integrated approaches to fisheries regulation
5. Environmental impacts of fisheries technology
6. Innovative approaches to technology development by improving the capture, processing and transportation of fish and fish products

The productive enhancement techniques suggested for freshwater aquaculture in the country are by 1. Fish stock assessment by way of hybridization, production of triploids and tetraploids and selective breeding 2. Fish nutrition and feed formulation by assessing the nutritional requirements of different stages of fish and formulation of feeds 3. Fish health management by prophylactics and therapeutics for various fish diseases and lastly 4. Aquatic environmental management by biofertilisation, use of processed organic material, biofilters, bioreefs etc.(Ayyappan, 2003). For fishery managers, tracking the changes in

genetic composition of stocks is critically important, as it is for aquaculture operators (Costello *et al.*, 2001). Genetic composition defines population assemblages, and is one of the key factors in determining stock delineations for management. There is longstanding evidence that heavy fishing pressure reduces the genetic diversity of stocks, possibly to the point where homogeneity puts organisms at a genetic disadvantage (Smith, 1994). In addition, intense fishing pressure can select for ever-smaller sizes of individuals (Dayton *et al.*, 2002). The major problem with the use of this indicator is cost and time for sampling and performing genetic analyses. Such investments can be significantly reduced if the choice of species for genetic analysis is a good indicator for wider genetic changes, and if sampling can be built into the fishery. In aquaculture operations, cost is less of a factor since the investment is regularly made by the private sector underwriting the farming operation UNEP (DEC)/MED WG.268/Inf. 14 2 May 2005.

Fishing Vessel Technology is an another area that needs to be upgraded by way of technology change and fleet restructuration; design methodology for sustainability; energy efficiency and innovations in fishing vessel design, gear and catch handling systems; refrigeration systems for reduced environmental impact (ozone depletion and global warming); preservation and improved utilisation of catch besides monitoring, control of gear and vessel performance. This is particularly important, as from the data available from Kungsuwan, 1999; Salgrama, 1999, that from 1972 to 2000 only 30% of the fishes caught by trawlers are retained and 70% are discarded.

Fish is now a commodity of the trade and export besides a source of income for poor people's subsistence. They contribute one third of the total agricultural export with many commercial firms engaged in aquaculture and processing. In this scenario, conservation



Source : Earth trends, country profile.

States	Shelf	Available area in ha; Inshore (0-50 m)				Available area in ha; Offshore (50-200 m)			
	10^2km^2	1961	1973-77	1980	1990	1961	1973-77	1980	1990
Gujarat	164	554 / 1453	288 / 1095	177 / 862	136 / 499	843 / 2214	439 / 1669	271 / 314	207 / 760
Maharashtra	112	125 / 257	62 / 251	54 / 205	37 / 108	415 / 852	207 / 833	181 / 680	124 / 359
Goa	10	120 / 3030	72 / 229	33 / 87	23 / 94	280 / 7070	172 / 534	78 / 204	55 / 220
Karnataka	25	89 / 114	36 / 109	31 / 89	37 / 51	189 / 224	78 / 433	67 / 190	79 / 109
Kerala	40	17 / 59	16 / 57	9 / 44	6 / 40	36 / 123	33 / 118	20 / 92	13 / 84
Tamil Nadu	41	42 / 78	33 / 74	24 / 52	31 / 53	30 / 55	23 / 53	17 / 36	22 / 38
Pondicherry	1		36 / 82	27 / 77	6 / 25		24 / 55	18 / 51	4 / 17
Andhra Pradesh	31	35 / 84	26 / 64	20 / 46	11 / 31	29 / 69	21 / 53	16 / 38	9 / 25
Orissa	32	169 / 528	165 / 317	48 / 147	13 / 96	192 / 599	187 / 359	55 / 166	15 / 109
West Bengal	17	359 / 1503	199 / 599	60 / 234	14 / 192	149 / 626	82 / 249	25 / 97	6 / 80

Continental shelf area of India's maritime states and union territories and, available area (in hectares) per fisher (top value) and per boat (mechanized and non-mechanized; bottom value) in inshore and offshore regions. (Sources : DAHD, 1993; 1994; Sathiadas *et al.*, 1995).

and management of fishery resources of the country depends on the protection offered to fishes by way of establishing closed and open seasons, usage of proper mesh size during fish catch, proper stocking methods, maintenance of the stable ground for spawning, restricted usage of insecticides and herbicides, reduction in the point and non point sources of pollution and proper and periodic impact assessments. The Government of India formulated a National Agricultural Policy–2000, which envisages to enhance the sustainability, strengthen rural infrastructure, promote value addition and promote mariculture including sea culture in an eco-friendly manner.

AMPHIBIA

One of the main problems of establishing the evolutionary lineage of this group is the sparse fossil record. However, the earliest frog fossil *Vieraella herbstii* is about 160 million years old and it came from Argentina. *Triadobatrachus masenotti* found in Madagascar and believed to be the ancestor of the modern day frog is 200 million years. The modern day frogs, toads and caecilians are anatomically highly modified; however, the frogs and toads have adapted for jumping while the caecilians have lost their limbs and adapted for fossorial life. The present day frogs evolved around 250–280 million years ago.

The Indian Amphibia comprises of 240 species under 38 genera, 9 families and 3 orders, the details of the diversity in comparison to the world is given as under. The amphibian species are not evenly distributed throughout India, the highest concentration is found in Western Peninsula followed by Northeast. Interestingly all the three living orders of Amphibia *viz.* Gymnophiana, Caudata and Anura are distributed in North-east India, the Western Peninsula has Gymnophiana and Anura while the rest of the geographical regions of the country harbours only Anura.

No. of families		Genera		Species	
World	**India**	**World**	**India**	**World**	**India**
31	9	330	38	5150	240
Percent (%)	29.03		11.51		4.66

The black narrow-mouthed frog, *Melanobatrachus indicus* was rediscovered in Kalakkad Mundunthorai Tiger Reserve, nearly 120 years after its first description (Vasudevan, K. 1997). *Nasikabatrachus sahyadrensis* Biju and Bossuyt (2003), is a new species of a new genus and even a new family, "Once in a century" kind of discovery from Idukki, Kerala which shows affinity to amphibians in the age of Dinosaurs; its closest relative now living in Seychelles is another piece of evidence supporting the theory of continental drift, which signifies the spurt in our knowledge on the amphibian diversity in recent years. Further to this, the spurt in amphibian discovery during the year (2003-04) can be seen from the description of five new five species of caecelians:

- ★ *Gegenophis seshachari* Ravichandran, Gower & Wilkinson 2003
- ★ *Gegenophis danieli* Giri, Gower, Wilkinson, 2003

★ *Gegenophis madhavi* Bhatta & Srinivas, 2004

★ *Gegenophis nadkarni* Bhatta & Prashanth 2004

★ *Indotyphlus maharastraensis* Giri, Gower, Wilkinson, 2004

ENDEMICITY

Of the 240 species of Amphibians in India, 60.26 percent i.e., 138 species are endemic to the country, 8 genera are exclusively endemic to India (genus *Indotyphlus* (Gymnophiana) and 5 genera belonging to Anura). The western Peninsula harbours highest number of endemic species (98) followed by northeast India (31), Andaman & Nicobar Islands have 5 species, north and Deccan plateau have 3 each. All the 20 species of Gymnophiana reported from India are endemic, while among Anurans 114 species out of 198 (57.5%).

Order	Family	Genera	Species
Gymnophiana	Ichthyophiidae	*Ichthyophis*	10
		Urotyphlus	5
	Caeciliidae	*Gegeneophis*	4
		*Indotyphlus**	1
Anura	Megophryidae	*Megophrys*	1
		Scutiger	2
	Bufonidae	*Ansonia*	3
		Bufo	7
		*Bufoides**	1
		Pedostibes	3
	Microhylidae	*Melanobatrachus**	1
		Microhyla	2
		Ramanella	5
	Ranidae	*Amolops*	3
		*Indirana**	9
		Limnonectus	13
		*Micrixalus**	7
		*Nyctibatrachus**	10
		Phrynoglossus	1
		Rana	5
		Tomopterna	3
	Rhacophoridae	*Chirixalus*	2
		Philautus	26
		Polypedates	4
		Rhacophorus	9
Total–2	**7**	**25**	**138**

Threats : The discharge of pesticides, fertilizers, synthetic detergents, domestic and industrial wastes account for the heavy toll to the larval stages of amphibians. The large scale export of frog legs (*Hoplobatrachus tigerinus, H. crassus* and *Euphlyctis hexadactylus*), a few years ago caused imbalance on the ecology, causing tremendous increase in agricultural pests (ban on export imposed since, April 1986).

Conservation : The status of Indian Amphibians was discussed in the CAMP Workshop (1997, Bubaneswar), out of 207 species of amphibians then known from India, 9 were considered critically endangered, 42 endangered, 39 vulnerable, and 74 of lower risk category. Only 4 species, *Pedostibes kempi* (Garo Hills Tree Toad), *P. tuberculosus* (Malabar Tree Toad), *Melanobatrachus indicus* (Malabar Black Narrow-mouthed Frog), *Tylototriton verrucosus* (Himlayan Salamander) are protected under Schedule–II of Indian Wildlife Protection Act of 1972 and frogs of the genus *Rana* under Schedule –IV of the Act. Recently, IUCN (2002) identified 3 species of amphibia (*Melanobatrachus indicus, Pedostibes kempi* and *Pedostibes tuberculosus*), the first being endangered and the other two under vulnerable category.

WORLD LIST

Amphibia	**Anura**
Classes : 1	Families : 29
Orders : 3	Subfamilies : 32
Families : 44	Genera : 352
Subfamilies : 36	Species : 4837
Genera : 446	Synonyms and New Combinations : 18005
Species : 5504	English Names : 6388
Synonyms and New Combinations : 21608	
English Names : 7785	
Caudata	**Gymnophiona**
Families : 10	Families : 5
Subfamilies : 2	Subfamilies : 2
Genera : 61	Genera: 33
Species : 502	Species : 165
Synonyms and New Combinations : 3058	Synonyms and New Combinations : 515
English Names : 1174	English Names : 223

INDIAN LIST

SALAMANDRIDAE

1. *Tylototriton verrucosus* Anderson,1871

MEGOPHRYIDAE

1. *Leptobrachium hasseltii* Tschudi, 1838
2. *Leptobrachium* smithii [*Leptobrachium hasseltii*]?

3. *Megophrys boettgeri* (Boulenger, 1889)
4. *Megophrys kempii* (Annandale,1912)
5. *Megophrys lateralis* (Anderson, 1871)
6. *Megophrys major* (Boulenger, 1908)
7. *Megophrys montana* Kuhl & van Hasselt, 1822
8. *Megophrys parva* (Boulenger, 1893)
9. *Megophrys robusta* (Boulenger, 1908)
10. *Scutiger mokokchungensis* Das & Chanda, 2000
11. *Scutiger nyingchiensis* Fei, 1977
12. *Scutiger occidentalis* Dubois, 1978
13. *Scutiger sikimmensis* (Blyth, 1854)

HYLIDAE

1. *Hyla annectens* (Jerdon, 1870)

BUFONIDAE & MICROHYLIDAE

1. *Ansonia kamblei* Ravichandran & Pillai, 1990
2. *Ansonia ornata* Gunther, 1875.
3. *Ansonia rubigina* Pillai & Pattabiraman, 1981.
4. *Bufo abatus* Ahl, 1925.
5. *Bufo beddomii* Gunther, 1875
6. *Bufo brevirostris* Rao, 1937
7. *Bufo camortensis* Mansukhani & Sarkar, 1980
8. *Bufo fergusoni* Boulenger, 1892.
9. *Bufo himalayanus* Gunther, 1864.
10. *Bufo hololius* Gunther, 1875
11. *Bufo koynayensis* Soman, 1963
12. *Bufo latastii* Boulenger, 1882
13. *Bufo melanostictus* Schneider, 1799
14. *Bufo microtympanum* Boulenger, 1882
15. *Bufo parietalis* Boulenger, 1882
16. *Bufo silentvalleyensis* Pillai, 1982
17. *Bufo stomaticus* Lutken, 1862
18. *Bufo stuarti* Smith, 1920
19. *Bufoides meghalayanus* (Yazdani and Chanda, 1971)
20. *Pedostibes kempi* (Boulenger, 1919)
21. *Pedostibes tuberculosus* Gunther, 1875
22. *Kaloula pulchra* Grey, 1831 *Kaloula taprobarica*
23. *Melanobatrachus indicus* Beddome, 1878

24. *Microhyla berdmorei* (Blyth, 1856)
25. *Microhyla chakrapanii* Pillai,1977
26. *Microhyla heymonsi* Vogt, 1911.
27. *Microhyla inornata* Boulenger, 1890
28. *Microhyla ornata* (Dumeril & Bibron, 1841)
29. *Microhyla rubra* Jerdon, 1854
30. *Ramanella anamalaiensis* Rao, 1937
31. *Ramanella minor* Rao, 1937
32. *Ramanella montana* (Jerdon, 1854)
33. *Ramanella mormorata* Rao, 1937
34. *Ramanella triangularis* (Gunther, 1875)
35. *Ramanella variegata* (Stoliczka, 1872)
36. *Uperodon globulosum* (Gunther,1864)
37. *Uperodon systoma* (Schneider, 1799)

RANIDAE

1. *Amolops afghanus* (Gunther, 1858)
2. *Amolops chakrataensis* Ray, 1992
3. *Amolops formous* (Gunther, 1875)
4. *Amolops gerbillus* (Annandale,1912)
5. *Amolops jaunsari* Ray, 1992
6. *Amolops monticola* (Anderson, 1871)
7. *Micrixalus borealis* Annandale,1912
8. *Micrixaluis elegans* (Rao, 1937)
9. *Micixalus fuscus* (Boulenger, 1882)
10. *Micrixaluis gadgili* Pillai & Pattabiraman, 1990
11. *Micrixaluis kottigeharensis* (Rao, 1937)
12. *Micrixaluis narainensis* (Rao, 1937)
13. *Micrixaluis nudis* Pillai, 1978
14. *Micrixaluis phyllophilus* (Jerdon, 1853)
15. *Micrixaluis saxicola* Jordon, 1853
16. *Micrixaluis silvaticus* (Boulenger, 1882)
17. *Micrixaluis swamianus* (Rao, 1937)
18. *Micrixaluis thampii* Pillai, 1981
19. *Minervarya sahyadris* Dubois, Oher & Biju, 2001
20. *Nyctibatrachus aliciae Inger,* Shaffer, Koshy & Bakde 1984
21. *Nyctibatrachus beddomii* (Boulenger, 1882)

22. *Nyctibatrachus deccanensis* Dubois, 1984
23. *Nyctibatrachus humayuni* Bhaduri & Kripalani, 1955
24. *Nyctibatrachus hussaini* Krishnamurthy, Reddy & Gururaja, 2001
25. *Nyctibatrachus kempholeyensis* (Rao, 1937)
26. *Nyctibatrachus major* Boulenger, 1882
27. *Nyctibatrachus minor* Inger, Shaffer, Koshy & Bakde 1984
28. *Nyctibatrachus sanctipalustris* Rao, 1920
29. *Nyctibatrachus sylvaticus* Rao, 1937
30. *Nyctibatrachus vasanthi* Ravichandran, 1997
31. *Rana annandalii* Boulenger, 1920
32. *Rana alticola* Boulenger, 1882.
33. *Rana andamanensis* Stoliczka, 1870. *Fejervarya andamanensis* (Stoliczka, 1870)
34. *Rana assamensis* Sclater, 1892.
35. *Rana aurantiaca* Boulenger, 1904
36. *Rana barmoachensis* Khan & Tasnim, 1989 *Paa hazarensis* (Dubois and Khan, 1979).
37. *Rana beddomii* Gunther, 1875. *Indirana beddomii* (Gunther, 1875)
38. *Rana brachytarsus* Gunther, 1875 *Indirana brachytarsus* (Gunther, 1875)
39. *Rana bilineata* Pillai & Chanda, 1981 and *Rana erythraea* (Schlegel, 1837)
(a junior synonym of *Rana taipehensis*) *Rana taipehensis* van Denburgh, 1909.
40. *Rana blanfordii* Boulenger, 1882. *Paa blanfordii* (Boulenger, 1882)
41. *Rana brevipalmata* Peters, 1871. *Fejervarya brevipalmatus* (Peters, 1871)
42. *Rana cancrivora* Gravenhorst, 1829. *Fejervarya cancrivorus* (Gravenhorst, 1829).
43. *Rana chalconota* Schlegel, 1837.
44. *Rana charlesdarwini* Das, 1998.
45. *Rana crassa* Jerdon, 1853. *Hoplobatrachus crassus* Jerdon, 1853
46. *Rana curtipes* Jardon, 1853.
47. *Rana cyanophlyctis* Schneider, 1799. *Euphlyctis cyanophlyctis* (Schneider, 1799).
48. *Rana danieli* Pillai & Chanda, 1977.
49. *Rana diplosticta* (Gunther, 1875) *Indirana diplosticta* (Gunther, 1875)
50. *Rana doriae* Boulenger, 1887. *Limnonectes doriae* (Boulenger, 1887)
51. *Rana garoensis* Boulenger, 1920.
52. *Rana gerbillus* Annandale, 1912. *Amolops gerbillus* (Annandale)
53. *Rana ghoshi* Chanda, 1990. *Limnonectes ghoshi* (Chanda, 1990)
54. *Rana hascheana* (Stoliczka, 1870) *Limnonectes hascheana* (Stoliczka,1870)
55. *Rana hexadactyla* Lesson, 1834. *Euphlyctis hexadactylus* (Lesson, 1834).
56. *Rana himalayanus* Boulenger, 1888.
(Synonym of *Rana formosa* Gunther, 1875.) *Amolops formosus* (Gunther, 1875)

57. *Rana keralensis* Dubois, 1980. *Fejervarya keralensis* (Dubois, 1980)
58. *Rana khasiana* Anderson, 1871. *Limnonectes khasiensis* (Anderson, 1971)
59. *Rana kuhlii* Tschudi, 1838. *Limnonectes kuhlii* (Tschudi, 1838)
60. *Rana laticeps* Boulenger, 1882. *Limnonectes laticeps* Boulenger, 1882.
61. *Rana leithii* Boulenger, 1888. *Indirana leithii* Boulenger, 1888.
62. *Rana leptodactyla* Boulenger, 1882. *Indirana leptodactyla* Boulenger, 1882
63. *Rana leptoglossa* (Cope, 1868)
64. *Rana liebigii* Gunther, 1860. *Paa liebigii* (Gunther, 1860)
65. *Rana limnocharis* Gravenhorst, 1829 *Fejervarya limnocharis* (Gravenhorst)
66. *Rana livida* (Blyth, 1855)
67. *Rana malabarica* Tschudi, 1838
68. *Rana mawphalangensis* Pillai & Chanda, 1977
Limnonectes mawphalangensis (Pillai & Chanda, 1977).
69. *Rana mawlyndipi* Chanda, 1990. *Limnonectes mawlyndipi* (Chanda,1990)
70. *Rana minica* Dubois, 1975. *Paa minica* (Dubois,1975)
71. *Rana murthii* Pillai,1979. *Fejervarya murthii* (Pillai, 1979)
72. *Rana nicobarensis* (Stoliczka, 1870) *Fejervarya nicobarensis* (Stoliczka, 1870)
73. *Rana phrynoderma* Boulenger, 1882. *Indirana phrynoderma* (Boulenger,1882)
74. *Rana sauriceps* Rao, 1937. *Limnonectes sauriceps* (Rao, 1937.)
75. *Rana semipalmata* Boulenger, 1882. *Indirana semipalmatus* (Boulenger, 1882)
76. *Rana senchalensis* Chanda, 1986.
77. *Rana sikkimensis* Jerdon, 1870. *Chaparana sikkimensis* (Jerdon, 1870).
78. *Rana sternosignata* Murray, 1885. *Paa sternosignata* (Murray, 1885).
79. *Rana syhadrensis* Annandale, 1919. *Fejervarya syhadrensis* (Annandale, 1919)
80. *Rana temporalis* (Gunther, 1864).
81. *Rana travancorica* Annandale, 1910.
82. *Rana tigerina* Daudin, 1803. *Hoplobatrachus tigerinus* (Daudin, 1803)
83. *Rana tenuilingua* Rao, 1937 *Indirana tenuilingua* (Rao,1937)
84. *Rana vicina* Stoliczka, 1872 *Paa vicina* Stoliczka (1872)
85. *Indirana gundia* (Dubois, 1986)
86. *Tomopterna breviceps* (Schneider, 1799)
Tomopterna (Sphaerotheca) breviceps (Schneider, 1799)
87. *Tomopterna dobsonii* (Boulrnger, 1882)
Tomopterna (Sphaerotheca) dobsonii (Boulenger, 1882)
88. *Tomopterna leucorhynchus* (Rao, 1937)
Tomopterna (Sphaerotheca) leucorhynchus (Rao, 1937)

89. *Tomopterna maskeyi* Schleich & Anders, 1998
Tomopterna (Sphaerotheca) maskeyi Schleich & Anders, 1998
90. *Tomopterna parambikulamana* (Rao,1937)
Tomopterna (Sphaerotheca) parambikulamana (Rao, 1937)
91. *Tomopterna rolandae* (Dubois, 1983)
Tomopterna (Sphaerotheca) rolandae (Dubois, 1983)
92. *Tomopterna rufescens* (Jerdon, 1853)
Tomopterna (Sphaerotheca) rufescens (Jerdon,1853)

RHACOPHORIDAE

1. *Chirixalus doriae* Boulenger, 1890
2. *Chirixalus dudhwaensis* Ray, 1992
3. *Chirixalus simus* (Annandale, 1915)
4. *Chirixalus vittatus* (Boulenger, 1887)
5. *Philautus andersonii* (Ahl, 1927)
6. *Philautus annandalii* (Boulenger, 1906)
7. *Philautus argus* (Annandale, 1912)
8. *Philautus beddomii* (Günther, 1876)
9. *Philautus bombayensis* (Annandale, 1919)
10. *Philautus chalazodes* (Günther, 1875)
11. *Philautus charius* Rao, 1937
12. *Philautus cherrapunjiae* Roonwal & Kripalani, 1961
13. *Philautus crnri*, Dutta, 1985
14. *Philautus elegans* Rao, 1937.
15. *Philautus doriae* (Boulenger, 1893)
16. *Philautus dubius* (Boulenger, 1882)
17. *Philautus elegans* Rao, 1937
18. *Philautus femorlis* (Günther, 1864)
19. *Philautus flaviventris* (Boulenger, 1882)
20. *Philautus garo* (Boulenger, 1919)
21. *Philautus glandulosus* (Jerdon, 1853)
22. *Philautus hassanensis* Dutta, 1985
23. *Philautus jerdonii* (Günther, 1875) *Rhacophorus dubius* Boulenger, 1882
24. *Philautus kempiae* (Boulenger, 1919)
25. *Philautus kottigeharensis* Rao, 1937
26. *Philautus leucorhinus* (Lichtenstein and Martens, 1856)
27. *Philautus melanensis* Rao, 1937

28. *Philautus micodiscus* (Annandale, 1912)
29. *Philautus namdaphaensis* Sarkar and Sanyal, 1985
30. *Philautus naraiensis* Rao, 1937
31. *Philautus nasutus* (Günther, 1868)
32. *Philautus noblei* (Ahl, 1927)
33. *Philautus parkeri* (Ahl, 1927)
34. *Philautus pulcherrimus* (Ahl, 1927)
35. *Philautus punctatus* (Anderson, 1871)
36. *Philautus sanctisilvaticus* Das & Chanda, 1997
37. *Philautus shillongensis* Pillai & Chanda, 1973
38. *Philautus shyamrupus* Chanda & Ghosh, 1989
39. *Philautus signatus* (Boulenger, 1882)
40. *Philautus swamianus* Rao, 1937
41. *Philautus temporalis* (Günther, 1864)
42. *Philautus travancoricus* (Boulenger, 1891)
43. *Philautus terebrans* Das & Chanda, 1998
44. *Philautus tinniens* (Jerdon, 1853)
45. *Philautus tuberculatus* (Anderson, 1879)
46. *Philautus variabilis* (Günther, 1858)
47. *Philautus wynaadensis* (Jerdon, 1853)
48. *Polypedates himalayensis* (Annandale, 1912)
49. *Polypedates insularis* Das, 1995
50. *Polypedates jerdonii* Gunther, 1875
51. *Polypedates leucomystax* (Gravenhorst, 1829)
52. *Polypedates maculatus* (Gray, 1834)
53. *Polypedates naso* (Annandale, 1912)
54. *Polypedates pleurostictus* Günther, 1864
55. *Polypedates pseudocruciger* Das & Ravichandran, 1998
56. *Polypedates taeniatus* Boulenger, 1906 57.
57. *Rhacophorus appendiculatus* (Günther, 1859)
58. *Rhacophorus bipunctatus* Ahl, 1927
59. *Rhacophorus bisacculus* Taylor, 1962
60. *Rhacophorus calcadensis* Ahl, 1927
61. *Rhacophorus lateralis* Boulenger, 1883
62. *Rhacophorus malabaricus* Jerdon, 1870
63. *Rhacophorus maximus* Günther, 1858

64. *Rhacophorus namdaphaensis* Sarkar & Sanyal, 1985
65. *Rhacophorus nigropalmatus* Boulenger, 1895
66. *Rhacophorus pseudomalabaricus* Vasudevan & Dutta, 200067.
68. *Rhacophorus reinwardtii* Kuhl and van Hasselt, 1822
69. *Rhacophorus tuberculatus* (Anderson, 1871)
70. *Rhacophorus variabilis* (Jerdon, 1853)
71. *Theloderma asper* (Boulenger, 1886)
72. *Theloderma moloch* Annandale, 1912

GYMNOPHIONA

1. *Gegeneophis carnosus* (Beddome, 1870)
2. *Gegeneophis fulleri* (Alock, 1904)
3. *Gegeneophis krishni* Pillai & Ravichandran, 1999
4. *Gegeneophis ramaswamii* Taylor, 1964
5. *Gegenophis seshachari* Ravichandran, Gower & Wilkinson 2003
6. *Gegenophis danieli* Giri, Gower, Wilkinson, 2003
7. *Gegenophis madhavi* Bhatta & Srinivas, 2004
8. *Gegenophis nadkarni* Bhatta & Prashanth 2004
9. *Indotyphlus battersbyi* Taylor, 1960
10. *Indotyphlus maharastraensis* Giri, Gower, Wilkinson, 2004
11. *Ichthyophis beddomei* Peters, 1879
12. *Ichthyophis bombayensis* Taylor, 1960
13. *Ichthyophis garoensis* Pillai & Ravichandran, 1999
14. *Ichthyophis glutinosus* (Linnaeus, 1758)
15. *Ichthyophis husaini* Pillai & Ravichandran, 1999
16. *Ichthyophis longicephalus* Pillai, 1986
17. *Ichthyophis malabarensis* Taylor, 1960
18. *Ichthyophis peninsularis* Taylor, 1960
19. *Ichthyophis sikkimensis* Taylor, 1960
20. *Ichthyophis subterrestris* Taylor, 1960
21. *Ichthyophis tricolor* Annandale, 1909
22. *Uraeotyphlus interruptus* Pillai & Ravichandran, 1999
23. *Uraeotyphlus malabaricus* (Beddome, 1870)
24. *Uraeotyphlus menoni* Annandale, 1913
25. *Uraeotyphlus narayani* Seshachar, 1939
26. *Uraeotyphlus oxyurus* (Duméril & Bibron, 1841)

TOTAL = 242

REPTILIA

Reptiles were the dominant group of vertebrates during the mesozoic period; most of the orders of reptiles were established by the end of Triassic and some became extinct at that time. Of the 19 orders of Reptiles only 4 survive today (Crocodelia, Testudines, Squamata and Rhynchocephalia). Reptilian fauna has great affinity to the Oriental Region especially a close relationship to those of the Indo–Chinese and Indo-Malayan Regions. The diversity of Indian Reptilian fauna is shown :

Class	Families		Species		Percent
	World	India	World	India	
Crocodylia	3	2	22	3	13.64
Testudines	13	5	242	35	14.46
Squamata					
Lacertelia	20	8	2808	178	6.34
Serpentes	13	10	2744	244	8.90
Rhyncocephlia	1	-	1	-	-
Total	**50**	**25**	**5817**	**460**	**7.91**

Crocodylia includes three extant species (*Crocodylus porosus, Crocodylus palustris* and *Gavialis gangeticus*), of which, two are freshwater and one estuarine species. *Gavialis* has its geographical range extending from the river Ganges and its tributaries, Brahmaputra and occasionally Mahanadi River system.

Testudines or chelonians are a group of primitive, piokilothermous amphibiously adapted animals, living on land, and in fresh, brackish or saline waters. Usually the sizes of these animals vary from a few cm to gigantic leather back turtle weighing over 750 kg. The life span of these animals is long and the available record indicates it is up to 152 years and in the case of giant tortoise *Geochelone gigantia* in Seychelles Islands of the Indian Ocean. The very rapidly deteriorating status of tortoises and freshwater turtles in Southeast Asia has resulted in an increasing number of these species being listed as threatened. Freshwater species are being heavily exploited for food, and in some cases for medicine and the harvest levels are unsustainable and unregulated, recent such harvests have shifted to Indian subcontinent (IUCN Redlist, 2004).

Number of threatened species by turtle and tortoise family

Testudine families	Number of described species	Number of species evaluated	Number of threatened species in 2004	Number threatened as % of species described
Bataguridae	69	57	42	61%
Carettcchelyidae	1	1	1	100%
Chelidae	51	27	13	25%
Chelonidae	6	6	5	83%

Testudine families	Number of described species	Number of species evaluated	Number of threatened species in 2004	Number threatened as % of species described
Chelydridae	3	2	2	67%
Dermatemydidae	1	1	1	100%
Dermochelyidae	1	1	1	100%
Emydidae	41	28	13	32%
Kinosternidae	25	10	4	16%
Palomedusidae	18	6	1	6%
Podocnemididae	8	7	6	75%
Testudinidae	51	38	25	49%
Trionychidae	30	21	14	47%
Total	**305**	**205**	**128**	**42%**

Source : IUCN : 2004.

Recently the status of six species of turtle for its inclusion in Appendices of CITES based on the exploitation for food and medicinal purposes such as Indian Roofed Turtles have been observed on sale in food markets of China, Hong Kong SAR and Taiwan POC. There is a relatively small market for the pet trade in the USA, Europe and Japan. Reported reduced availability in domestic markets may indicate population decline. Captive specimens are held at the Madras Crocodile Bank, but captive breeding has not been successful, it being likely that the specimens are hatched from wild collected eggs. *In 1991* K. *dhongoka and K. kachuga* were reportedly present in a hatchery in Madhya Pradesh, India, which used eggs collected from captives at Chambal National Park. A small-scale hatchery which included *K. smithii* reportedly existed in Uttar Pradesh, India in 1995 (Choudhury *et al.*, 2000). These turtles are largely unprotected throughout their range with the exception of *K. kachuga* and *K. sylhetensis*, which are totally protected in India, were discussed at CITES authorities based on the data available. The six species whose ranges of distribution known are :

K. dhongoka : India, Bangladesh, Myanmar (?), Nepal.

K. kachuga : India, Bangladesh, Myanmar (?), Nepal.

K. smithii : India, Bangladesh, Nepal, Pakistan.

K. sylhetensis : India. Bangladesh,

K. tentoria : India, Bangladesh, Nepal.

K. trivittata : Myanmar.

Already I U C N has considered the criteria as *K. dhongoka :* **EN A1cd+2cd**; *K. kachuga* : **CR A1cd;** *K. smithii :* **LR/nt**; *K. sylhetensis* : **EN B1+2c**; *K. trivittata* : **EN A1c** and *K. tentoria* : **LR/least** concern. In India : *K. tecta, K. kachuga and K. sylhetensis* are included in **Schedule** I of the Indian Wildlife (Protection) Act of 1972 (Choudhury *et al.*, 2000).

Geographical Distribution : Five species of Sea turtles *viz., Dermochelys coriacea* (Leatherback turtle); *Eretmochelys imbricata* (Hawksbill turtle); *Caretta caretta* (Loggerhead Turtle); *Lepidochelys olivacea* (Olive Ridley turtle) and *Chelonia mydas* (Green Sea turtle), and 27 species (including subspecies) of freshwater and land turtles and tortoises are distributed in India. In southeast Indian coast the annual catch of marine turtles is estimated at 4,000-5,000 animals, with *C. mydas* accounting for about 70% of the harvest. *C. caretta* and *L. olivacea* are the most widely consumed species (Salm, 1981). *E. imbricata* is occasionally eaten but it has caused deaths and so is usually caught for its shell trade alone. *D. coriacea* is boiled for its oil which is used for caulking boats and as protection from marine borers. Incidental netting of all marine species is widespread.

The distributional ranges of few turtles are mentioned below :

- Maximum concentration of leatherback in the Indian Ocean has been recorded from Gulf of Kutchh, Okha coast, Goa Coast, Gulf of Mannar and Palk Bay.
- Concentrations of Green turtle is recorded from Gulf of Kutchch, coasts of Maharashtra, Kerala (near Quilon) and Tamil Nadu (eastern coast, Kanyakumari, Rameshwaram, Tuticorin, Point Calimere, Nallatanni Island).
- Hawksbill turtle is concentrated almost in the similar grounds as that of Green turtle, as both of them are distributed in tropical and subtropical seas. Maximum concentration is noticed coastal areas of southern Tamil Nadu, Kerala, coral reefs of Andaman & Nicobar Islands, Gulf of Katchh, Gulf of Mannar, Pak Bay and Lakshadweep Islands.
- Loggerhead sea turtle is distributed in temperate and subtropical waters of the world and in India these turtles are reported to be nesting in the coral reefs of Gulf of Mannar and Palks Bay.
- Olive Riddley is mostly concentrated in the costs of Orissa, however, there are records of its nesting in the coastal areas of Kerala, Maharashtra, Goa, south Tamil Nadu, Andhra Pradesh, West Bengal, Andaman Islands and Lakshadweep Islands.
- Members of the family Emydidae are represented by five genera viz., *Heosemys, Geoclemys, Hardella, Kachuga and Batagar* and seven species.
- *Geoclemys* is a monotypic genus inhabiting Ganges and Sind River system.
- *Heosemys silvatica* a small secretive species distributed in the tropical rainforests of Kudamuthi, Idukki, Kavalai, Masanagudi and Chalakkudi near Kochin (all in Kerala state).
- *Hardella,* is a herbivorous aquatic tortoise distributed in the rivers of Ganga and Brahmaputra.
- *Kachuga,* yet another herbivorous genus, represented by seven species, of which six species are restricted to Ganga, Brahmaputra, Mahanadi, Godavari, and Krishna river systems.

- The seventh species (*Batagar baska*) has wide distribution ranging from Bengal to Myanmar & Malaysia.
- The land tortoise *Geochelone elegans* has wide range of distribution from Pakistan to Sri Lanka through Central India.
- *Geochelone emys* (largest Asiatic species) inhabits hilly tracts of Assam, and similarly the *Geochelone elongate* in northeast states of India.
- *Echelone travancorica* an endemic species found in the hill tracts of Travancore, Cochin (Kerala), Coorg (Karnataka), and Western Ghats of Karnataka and Kerala.
- Trionychids such as *Lissemys, Chitra* and *Trionyx* are freshwater inhabitants of ponds, pools and marshes.
- *Trionyx hurum* occur in Brahmaputra and Ganga, *T. leithi* in Ganga, Mahanadi, Godavari, and Krishna and *T. gangeticus* in the foothills of Himalaya (near Nepal).
- *Lissemys punctata punctata* distributed in Sind and Ganga river systems, *L. punctata granosa* in peninsular India and *L punctata scutata* in northeast India, close to Myanmar.
- *Chitra chitra* distributed in the river systems of north India.

LIZARDS

Ancestry of modern lizards can be traced back to the middle of the Jurassic period of Mesozoic era in the Diapsid reptilian stock, about 155 million years ago. Eosuchia is the order of fossil reptile of sub class Lepidosauria and includes fossil reptiles which inhabited the earth between Upper Triassic and Upper Permian periods (160–190 million years ago). Almost all the Eosuchians perished by the beginning of the Cretaceous period or early Mesozoic era, it gave a chance to the lizards and snakes, when these groups flourished vigorously. An abrupt climatic change such as temperature, humidity, rainfall, and the elevation of the mountain ranges contributed to the change in the ecology of that period resulting in the dispersal of lizards to different ecological niches. Furthermore, the habitat changes brought about the variations in their forms and adaptations for arboreal, scansorial (climbing), sartorial (fossorial or burrowing), cursorial (running), terrestrial (ground dwelling, cave dwelling, rock dwelling); volant (flying, gliding) mode of life. The distributional diversity of lizards in the country is mentioned here.

1. The following lizard species of Palaearctic region with some admixture of Ethiopian elements have mainly originated from the Mediterranean, Irano-Turanian, Saharo-Sindian and Palaeotropic sub regions.

Family GEKKONIDAE
Stenodactylus orientalis,
Family AGAMIDAE
Phrynocephalus theobaldi,
Family SCINCIDAE
Ophiomorus tridactylus,
Chalcides pentadactylus,
Ablepharis grayanus,

Phrynocephalus reticulatus,
Phrynocephalus euptilopus,
Phrynocephalus laungwalansis,

Family Lacertidae :
Ermias guttulata watsoniana.

2. The following lizards species **exclusively endemic to the Indian sub region** are mainly from the climatically diversified geographical zones namely the desert area of Rajasthan and northwestern India; Kashmir and the Western Himalaya; plains of Ganga and Yamuna; Central India; Indian peninsula; Western Ghats; Eastern Ghats; Chota Nagpur area and the northeast India including Eastern Himalaya.

Family GEKKONIDAE
Cyrtodactylus nebulosus,
Cyrtodactylus collegalensis,
Cyrtodactylus dekkanensis,
Cyrtodactylus albofasciatus,
Cyrtodactylus jeyporensis,
Cnemaspis indica,
Cnemaspis sisparensis,
Cnemaspis wynadensis,
Cnemaspis ornata,
Cnemaspis beddomii,
Cnemaspis mysoriensis,
Cnemaspis gracilis,
Cnemaspis littoralis,
Cnemaspis jerdoni,
Cnemaspis goaensis,
Calodactylodes aureus,
Dravidogecko anamallensis,
Hemidactylus subtriedrus,
Hemidactylus prashadi,
Hemidactylus gracilis,
Hemidactylus reticulatus,
Hemidactylus frenatus,
Hemidactylus giganteus,
Hemidactylus bowringi,
Hemidactylus garnoti,
Hemidactylus karenorum,
Hemidactylus porbandarensis,
Hemidactylus albofasciatus,
Hemiphyllodactylus typus aurantiacus,
Lophopholis scabriceps,

Family AGAMIDAE :
Draco dussumieri,
Sitana ponticeriana
Otocryptis beddomii,
Japalura tricarinata,
Japalura planidorsata,
Japalura andersoniana,
Japalura variegata,
Salea horsfieldi,
Salea anamallayana,
Calotes cristatellus,
Calotes jubatus,
Calotes maria,
Calotes jerdoni,
Calotes emma,
Calotes mystaceus,
Calotes nemoricola,
Calotes grandisquamis,
Calotes calotes,
Calotes andamanensis,
Calotes rouxi,
Calotes elliotti,
Calotes danieli,

Calotes bhutanensis,
Psammophilus dorsalis,
Psammophilus blanfordanus.
Family CHAMAELEONIDAE
Chameleo zeylanicus.
Family SCINCIDAE
Mabuya bibroni,
Mabuya innotata,
Mabuya allapallensis,
Mabuya nagarjuni,
Mabuya carinata,
Mabuya multifasciata multifasciata,
Mabuya tytleri,
Mabuya andamanensis,
Mabuya rugifera,
Mabuya beddomii,
Mabuya quadricarinata,
Mabuya trivittata,
Dasia subcaerulea,
Sphenomorphus dussumieri,
Scincella travancoricum,
Scincella beddomii,
Scincella laterimaculatum,
Scincella bilineatum,
Scincella macrotympanum,
Riopa albopunctata,
Riopa punctata,
Riopa guentheri,
Riopa lineata,
Riopa vosmaeri,
Riopa ashwamedhi,
Riopa goaensis,
Riopa pruthi,
Ristella rurki,
Ristella travancorica,
Ristella guentheri,
Ristella beddomii,
Barkudia insularis,
Sepsophis punctatus.
Family EUBLEPHARIDAE
Eublepharis hardwickii,
Family LACERTIDAE
Cabrita leschenaulti,
Cabrita jerdoni,
Ophisops beddomei.
Family VARANIDAE
Varanus flavescens,
Varanus salvator.

3. Lizard species of Palaearctic origin, intruded in the Indian subregion are :

Family GEKKONIDAE : *Teratolepis fasciata,*
Family EUBLEPHARIDAE : *Eublepharis macularius.*
Family SCINCIDAE : *Eumeces taeniolatus.*
Family LACERTIDAE : *Acanthodactylus cantoris cantoris, Ophisops jerdoni.*

4. Lizard species that are common to the Oriental and Palaearctic Regions are :

Family GEKKONIDAE
Cyrtodactylus scaber,
Cyrtodactylus kachhensis,
Cyrtodactylus fasciolatus,
Cyrtodactylus stoliczkai,
Cyrtodactylus lawderanus,
Cyrtodactylus malcolmsmithi,

Cyrtodactylus madarensis,
Hemidactylus maculatus,
Hemidactylus triedrus,
Hemidactylus brooki,
Hemidactylus leschenaulti,
Hemidactylus flaviviridis,
Teratolepis fasciata.

Family LACERTIDAE

Acanthodactylus cantoris cantoris,
Ophisops jerdoni
Ophisops microlepis.

Family VARANIDAE

Varanus griseus
Varanus bengalensis.

Family EUBLEPHARIDAE

Eublepharis macularius,

Family AGAMIDAE

Japalura major,
Japalura kumaonensis,
Calotes versicolor,
Agama himalayana,
Agama tuberculata,
Agma agrorensis,
Agama agilis
Uromastix hardwicki.

Family SCINCIDAE

Mabuya dissimilis,
Mabuya macularia,
Scincella himalayanum,
Scincella ladacense,
Scincella sikkimense
Eumeces poonaensis.

5. Lizard species of Oriental origin (Indo-Chinese and Indian subregions), which intruded in to Palaearctic regions are :

Family AGAMIDAE

Calotes versicolor,
Japalura major,
Japalura kumaonensis

Family SCINCIDAE

Scincella himalayanum,
Scincella ladacense
Riopa punctata.

6. Lizard species exclusively endemic to the Indo-Chinese and Malayan subregions are :

Family GEKKONIDAE

Cyrtodactylus rubidus,
Gekko smithi,
Ptychozoon kuhli,
Phelsuma andamanense

Family AGAMIDAE

Ptyctolaemus gularis,
Mictopholis austeniana
Oriocalotes paulus

Family ANGUIDAE

Ophisaurus gracilis

Family SCINCIDAE

Dasia olivacea,
Dasia nicobarensis,
Sphenomorphus indicum,
Sphenomorphus courcyanum
Tropidophorus assamensis.

Family DIBAMIDAE

Dibamus novae-guineae

Family LACERTIDAE

Takydromus sexlineatus,
Takydromus sexlineatus khasiensis,
Takydromus haughtonianus

7. Lizard species common to Indian, Indo-Chinese and Malayan sub regions are :

Family GEKKONIDAE

Cyrtodactylus hasiensis,
Cyrtodactylus gubernatoris,
Cnemaspis kandiana,
Hemidactylus frenatus,
Hemidactylus bowringi,
Hemidactylus garnoti,
Hemidactylus karenorum,
Cosymbotus platyurus,
Gehyra mutilata,
Gekko gecko

Family AGAMIDAE

Draco maculatus,
Draco norvilli

Family SCINCIDAE

Sphenomorphus maculatum
Riopa bowringi.

Indian Lizard (taxonomic positions) diversity according different authors

Sl. No.	R.C. Sharma (Fauna of India : Reptilia : Testudines) 2002	Indraneil Das (1999) (Hamadryad Vol. 22 : 32-45	T.S.N. Murthy (Cobra, Vol. 17, 1994)
1.	*Stenodactylus orientalis*		
2.	*Cyrtodactylus fedtschenkoi*		
3.	*Cyrtodactylus montium-salsorum*		*Cyrtodactylus montium-salsorum*
4.	*Cyrtodactylus scaber*	*Cyrtopodion scaber*	*Cyrtopodion scaber*
5.	*Cyrtodactylus kachhensis*	*Cyrtopodion kachhensis*	*Cyrtodactylus kachhensis*
6.		*Cyrtopodion baturensis*	
7.	*Cyrtodactylus watsoni*		
8.	*Cyrtodactylus fasciolatus*	*Cyrtodactylus fasciolatus*	*Cyrtodactylus fasciolatus*
9.	*Cyrtodactylus khasiensis*	*Cyrtodactylus khasiensis*	*Cyrtodactylus khasiensis*
10.	*Cyrtodactylus gubernatoris*	*Cyrtodactylus gubernatoris*	*Cyrtodactylus gubernatoris*
11.	*Cyrtodactylus rubidus*	*Cyrtodactylus rubidus*	
12.	*Cyrtodactylus nebulosus*	*Geckoella nebulosa*	*Cyrtodactylus nebulosus*
13.	*Cyrtodactylus collegalensis*	*Geckoella collagalensis*	*Cyrtodactylus collegalensis*
14.	*Cyrtodactylus stoliczkai*	*Cyrtodactylus stoliczkai*	*Cyrtodactylus stoliczkai*
15.	*Cyrtodactylus lowderanus*	*Cyrtodactylus lowderanus*	*Cyrtodactylus lowderanus*
16.	*Cyrtodactylus dekkanensis*	*Geckoella dekkanensis*	*Cyrtodactylus dekkanensis*
17.	*Cyrtodactylus albofasciatus*		*Cyrtodactylus albofasciatus*
18.	*Cyrtodactylus jeyporensis*	*Geckoella jeyporensis*	*Cyrtodactylus jeyporensis*
19.	*Cyrtodactylus madarensis*		

Sl. No.	R.C. Sharma (Fauna of India : Reptilia : Testudines) 2002	Indraneil Das (1999) (Hamadryad Vol. 22 : 32-45	T.S.N. Murthy (Cobra, Vol. 17, 1994)
20.		*Cyrtodactylus walli*	
21.		*Cyrtodactylus pulchellus*	
22.		*Cyrtodactylus mansarulus*	
23.		*Cyrtodactylus malcomsmithii*	*Cyrtodactylus malcomsmithii*
24.		*Cyrtodactylus himalayanus*	*Cyrtodactylus himalayanus*
25.	*Cnemaspis indica*	*Cnemaspis indica*	*Cnemaspis indica*
26.	*Cnemaspis wynadensis*	*Cnemaspis wynadensis*	*Cnemaspis wynadensis*
27.	*Cnemaspis sisparensis*	*Cnemaspis sisparensis*	*Cnemaspis sisparensis*
28.	*Cnemaspis ornate*	*Cnemaspis ornatus*	*Cnemaspis ornate*
29.	*Cnemaspis beddomei*	*Cnemaspis beddomei*	*Cnemaspis beddomei*
30.	*Cnemaspis mysoriensis*	*Cnemaspis mysoriensis*	*Cnemaspis mysoriensis*
31.	*Cnemaspis kandiana*	*Cnemaspis kandianus*	*Cnemaspis kandiana*
32.	*Cnemaspis tropidogaster*	*Cnemaspis tropidogaster*	
33.	*Cnemaspis gracilis*	*Cnemaspis gracilis*	
34.	*Cnemaspis jerdoni*	*Cnemaspis jerdoni*	*Cnemaspis jerdoni*
35.	*Cnemaspis boiei*	*Cnemaspis boiei*	
36.	*Cnemaspis littoralis*	*Cnemaspis littoralis*	*Cnemaspis littoralis*
37.	*Cnemaspis nairi*	*Cnemaspis nairi*	*Cnemaspis nairi*
38.	*Cnemaspis goaensis*	*Cnemaspis goaensis*	*Cnemaspis goaensis*
39.	*Calodactylodes aureus*	*Calodactylodes aureus*	*Calodactylodes aureus*
40.	*Dravidogecko anamallensis*	*Hemidactylus anamallensis*	*Dravidogecko anamallensis*
41.	*Hemidactylus maculatus*	*Hemidactylus maculatus*	*Hemidactylus maculatus*
42.	*Hemidactylus triedrus*	*Hemidactylus triedrus*	*Hemidactylus triedrus*
43.	*Hemidactylus subtriedrus*	*Hemidactylus subtriedrus*	*Hemidactylus subtriedrus*
44.	*Hemidactylus brooki*	*Hemidactylus brooki*	*Hemidactylus brooki*
45.	*Hemidactylus prashadi*	*Hemidactylus prashadi*	*Hemidactylus prashadi*
46.	*Hemidactylus gracilis*	*Hemidactylus gracilis*	*Hemidactylus gracilis*
47.	*Hemidactylus reticulatus*	*Hemidactylus reticulatus*	*Hemidactylus reticulatus*
48.	*Hemidactylus frenatus*	*Hemidactylus frenatus*	*Hemidactylus frenatus*
49.	*Hemidactylus leschenaulti*	*Hemidactylus leschenaulti*	*Hemidactylus leschenaulti*
50.	*Hemidactylus flaviviridis*	*Hemidactylus flaviviridis*	*Hemidactylus flaviviridis*

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51.	*Hemidactylus giganteus*	*Hemidactylus giganteus*	*Hemidactylus giganteus*
52.	*Hemidactylus bowringi*	*Hemidactylus bowringi*	*Hemidactylus bowringi*
53.	*Hemidactylus garnoti*	*Hemidactylus garnoti*	*Hemidactylus garnoti*
54.	*Hemidactylus karenorum*	*Hemidactylus karenorum*	
55.	*Hemidactylus albofasciatus*		*Hemidactylus albofasciatus*
56.		*Hemidactylus scabriceps*	
57.		*Hemidactylus mahendrai*	*Hemidactylus mahendrai*
58.	*Hemidactylus porbandarensis*	*Hemidactylus porbandarensis*	
59.	*Cosymbotus platyurus*	*Cosymbotus platyurus*	*Cosymbotus platyurus*
60.	*Gehyra mutilata*	*Gehyra mutilata*	*Gehyra mutilata*
61.	*Hemiphyllodactylus typus typus*	*Hemiphyllodactylus typus typus*	*Hemiphyllodactylus typus typus*
62.	*Hemiphyllodactylus typus aurantiacus*	*Hemiphyllodactylus typus aurantiacus*	*Hemiphyllodactylus typus aurantiacus*
63.	*Gekko gecko*	*Gekko gecko*	*Gekko gecko*
64.		*Gekko smithi*	*Gekko smithi*
65.		*Gekko vereauxi*	*Gekko vereauxi*
66.	*Lepidodactylus lugubris*	*Lepidodactylus lugubris*	
67.	*Ptychozoon kuhli*	*Ptychozoon kuhli*	*Ptychozoon kuhli*
68.	*Phelsuma andamanense*	*Phelsuma andamanense*	*Phelsuma andamanense*
69.	*Teratolepis fasciata*	*Teratolepis albofasciatus*	*Teratolepis fasciata*
70.	*Lophopholis scabriceps*		*Lophopholis scabriceps*
71.	*Eublepharis hardwickii*	*Eublepharis hardwickii*	*Eublepharis hardwickii*
72.	*Eublepharis macularius*	*Eublepharis macularius*	*Eublepharis macularius*
73.	*Draco maculatus*		*Draco macularis*
74.	*Draco blanfordi*	*Draco blanfordi*	*Draco blanfordi*
75.	*Draco norvilli*	*Draco blanfordi norvilli*	*Draco norvilli*
76.	*Draco dussumieri*	*Draco dussumieri*	*Draco dussumieri*
77.	*Sitana ponticeriana*	*Sitana ponticeriana*	*Sitana ponticeriana*
78.	*Otocryptis beddomii*	*Otocryptis beddomii*	*Otocryptis beddomii*
79.	*Ptyctolaemus gularis*	*Ptyctolaemus gularis*	*Ptyctolaemus gularis*
80.	*Goniocephalus subcristatus*		*Goniocephalus subcristatus*

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81.	*Mictopholis austeniana*	*Mictopholis austeniana*	*Mictopholis austeniana*
82.	*Oriocalotes paulus*	*Oriocalotes paulus*	*Oriocalotes paulus*
83.	*Japalura tricarinata*	*Japalura tricarinata*	*Japalura tricarinata*
84.	*Japalura planidorsata*	*Japalura planidorsata*	*Japalura planidorsata*
85.	*Japalura major*	*Japalura major*	*Japalura major*
86.	*Japalura kumaonensis*	*Japalura kumaonensis*	*Japalura kumaonensis*
87.	*Japalura andersoniana*	*Japalura andersoniana*	*Japalura andersoniana*
88.	*Japalura variegata*	*Japalura variegata*	*Japalura variegata*
89.	*Salea horsfieldi*	*Salea horsfieldi*	*Salea horsfieldi*
90.	*Salea anamallayana*	*Salea anamallayana*	*Salea anamallayana*
91.	*Calotes cristatellus*	*Bronchocela cristalla*	*Calotes cristatellus*
92.	*Calotes jubatus*	*Bronchocela jubata*	*Calotes jubatus*
93.	*Calotes microlepis*		*Calotes microlepis*
94.	*Calotes kakhienensis*	*Salea kakhiensis*	
95.	*Calotes versicolor*	*Calotes versicolor*	*Calotes versicolor*
96.	*Calotes maria*	*Calotes maria*	*Calotes maria*
97.	*Calotes jerdoni*	*Calotes jerdoni*	*Calotes jerdoni*
98.	*Calotes emma*	*Calotes emma*	*Calotes emma*
99.	*Calotes mystaceus*	*Calotes mystaceus*	*Calotes mystaceus*
100.	*Calotes nemoricola*	*Calotes nemoricola*	*Calotes nemoricola*
101.	*Calotes grandisquamis*	*Calotes grandisquamis*	*Calotes grandisquamis*
102.	*Calotes calotes*	*Calotes calotes*	*Calotes calotes*
103.	*Calotes andamanensis*	*Calotes andamanensis*	*Calotes andamanensis*
104.	*Calotes rouxi*	*Calotes rouxi*	*Calotes rouxi*
105.	*Calotes elliotti*	*Calotes elliotti*	*Calotes elliotti*
106.	*Calotes danieli*	*Bronchocela danieli*	*Calotes danieli*
107.	*Psammophilus dorsalis*	*Psammophilus dorsalis*	*Psammophilus dorsalis*
108.	*Psammophilus blanfordanus*	*Psammophilus blanfordanus*	*Psammophilus blanfordanus*
109.	*Agama himalayana himalayana*	*Laudakia himalayanus*	*Agama himalayana*
110.	*Agama tuberculata*	*Laudakia tuberculata*	*Agama tuberculata*

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111.	*Agama agrorensis*	*Laudakia agrorensis*	*Agama agrorensis*
112.	*Agama melanura*	*Laudakia melanura*	
113.	*Agama caucasica*		*Laudakia caucasicus*
114.	*Agama agilis*		*Agama agilis*
115.	*Agama minor*	*Laudakia minor*	*Agama minor*
116.		*Laudakia pakisthanica*	
117.	*Phrynocephalus theobaldi*	*Phrynocephalus theobaldi*	*Phrynocephalus theobaldi*
118.	*Phrynocephalus reticulatus*	*Phrynocephalus reticulatus*	
119.	*Phrynocephalus euptilopus euptilopus*	*Phrynocephalus*	
120.	*Phrynocephalus luteoguttatus*	*Phrynocephalus luteoguttatus*	
121.	*Phrynocephalus laungwalansis*		*Phrynocephalus laungwalansis*
122.		*Phrynocephalus alticola*	
123.	*Uromastix hardwicki*	*Uromastix hardwicki*	*Uromastix hardwicki*
124.	*Chamaeleo zeylanicus*	*Chamaeleo zeylanicus*	*Chamaeleo zeylanicus*
125.	*Mabuya bibroni*	*Mabuya bibronii*	*Mabuya bibroni*
126.	*Mabuya novemcarinata*	*Mabuya novemcarinata*	
127.	*Mabuya dissimilis*	*Mabuya dissimilis*	*Mabuya dissimilis*
128.	*Mabuya innotata*	*Mabuya innotatus*	
129.	*Mabuya allapallensis*	*Mabuya allapallensis*	
130.	*Mabuya macularia*	*Mabuya macularius*	*Mabuya macularia*
131.	*Mabuya nagarjuni*	*Mabuya nagarjuni*	*Mabuya nagarjuni*
132.	*Mabuya carinata*	*Mabuya carinata*	*Mabuya carinata*
133.	*Mabuya multifasciata multifasciata*	*Mabuya multifasciata*	*Mabuya multifasciata multifasciata*
134.	*Mabuya tytleri*		*Mabuya tytleri*
135.	*Mabuya andamanensis*	*Mabuya andamanensis*	*Mabuya andamanensis*
136.	*Mabuya rugifera*	*Mabuya rugifera*	*Mabuya rugifera*
137.	*Mabuya quadricarinata*	*Mabuya quadricarinata*	*Mabuya quadricarinata*

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138.	*Mabuya beddomii*	*Mabuya beddomii*	*Mabuya beddomii*
139.	*Mabuya trivittata*	*Mabuya trivittata*	*Mabuya trivittata*
140.	*Mabuya clivicola*	*Mabuya clivicola*	*Mabuya clivicola*
141.		*Mabuya rudis*	
142.		*Mabuya gansi*	*Mabuya gansi*
143.			*Mabuya grisea*
144.	*Dasia olivacea*	*Dasia olivacea*	
145.	*Dasia subcaerulea*	*Dasia subcaeruleum*	*Dasia subcaerulea*
146.	*Dasia haliana*	*Dasia halianus*	*Dasia haliana*
147.	*Dasia nicobarensis*	*Dasia nicobarensis*	*Dasia nicobarensis*
148.	*Sphenomorphus indicum indicum*	*Sphenomorphus indicus*	*Sphenomorphus indicum*
149.	*Sphenomorphus boulengeri*		
150.	*Sphenomorphus maculatum*	*Sphenomorphus maculatus*	*Sphenomorphus maculatum*
151.	*Sphenomorphus dussumieri*	*Sphenomorphus dussumieri*	*Sphenomorphus dussumieri*
152.	*Sphenomorphus courcyanum*	*Sphenomorphus courcyanum*	*Sphenomorphus courcyanum*
153.	*Scincella reevesi reevesi*	*Sphenomorphus reevesi reevesi*	
154.	*Scincella himalayanum*	*Scincella himalayanus*	*Scincella himalayanum*
155.	*Scincella ladacense*	*Scincella ladacensis*	*Scincella ladacense*
156.	*Scincella sikkimense*	*Scincella sikkimensis*	*Scincella sikkimense*
157.	*Scincella macrotis*	*Scincella macrotis*	
158.	*Scincella travancoricum*	*Scincella travancoricum*	*Scincella travancoricum*
159.	*Scincella palnicum*		*Scincella palnicum*
160.	*Scincella beddomei*		*Scincella beddomei*
161.	*Scincella laterimaculatum*		*Scincella laterimaculatum*
162.	*Scincella bilineatum*	*Scincella bilineatum*	*Scincella bilineatum*
163.	*Scincella macrotympanum*	*Lypinia macrotympanum*	*Scincella macrotympanum*
164.		*Sincella tragbulense*	

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165.	*Ablepharus pannonicus*	*Ablepharus pannonicus*	
166.	*Ablepharus grayanus*	*Ablepharus grayanus*	*Ablepharus grayanus*
167.	*Riopa bowringi*	*Lygosoma bowringi*	
168.	*Riopa albopunctata*	*Lygosoma albopunctata*	*Riopa albopunctata*
169.	*Riopa punctata*	*Lygosoma punctatus*	*Riopa punctata*
170.	*Riopa guentheri*	*Lygosoma guntheri*	*Riopa guentheri*
171.	*Riopa lineolata*		*Riopa lineolata*
172.	*Riopa lineata*	*Lygosoma lineata*	
173.	*Riopa vosmaeri*	*Lygosoma vosmaeri*	
174.	*Riopa ashwamedhi*	*Lyygosoma ashwamedhi*	*Riopa ashwamedhi*
175.	*Riopa goaensis*	*Lygosoma goaensis*	*Riopa goaensis*
176.	*Riopa pruthi*	*Lygosoma prutii*	*Riopa pruthi*
177.	*Tropidophorus assamensis*		
178.	*Ristella rurki*	*Ristella rurkii*	*Ristella rurki*
179.	*Ristella travancorica*	*Ristella travancoricus*	*Ristella travancorica*
180.	*Ristella guentheri*	*Ristella guentheri*	*Ristella guentheri*
181.	*Ristella beddomii*	*Ristella beddomii*	*Ristella beddomii*
182.	*Eumeces schneideri*	*Eumeces schneideri*	
183.	*Eumeces blythianus*	*Eumeces blythianus*	
184.	*Eumeces taeniolatus*	*Eumeces taeniolatus*	*Eumeces taeniolatus*
185.	*Eumeces poonaensis*		*Eumeces poonaensis*
186.	*Ophiomorus tridactylus*	*Ophiomorus tridactylus*	*Ophiomorus tridactylus*
187.	*Ophiomorus raithmai*	*Ophiomorus raithmai*	
188.	*Chalcides pentadactylus*	*Chalcides pentadactylus*	
189.	*Barkudia insularis*	*Barkudia insularis*	*Barkudia insularis*
190.	*Sepsophis punctatus*	*Sepsophis punctatus*	*Sepsophis punctatus*
191.	*Dibamus novae-guineae*	*Dibamus nicobaricum*	*Dibamus novae-guineae*
192.	*Takydromus sexlineatus sexlineatus*	*Takydromus sexlineatus*	*Takydromus sexlineatus sexlineatus*
193.	*Takydromus sexlineatus khasiensis*	*Takydromus sexlineatus khasiensis*	
194.	*Takydromus haughtonianus*	*Takydromus haughtonianus*	

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195.	*Acanthodactylus cantoris cantoris*	*Acanthodactylus cantoris*	*Acanthodactylus cantoris cantoris*
196.	*Acanthodactylus cantoris blanfordi*	*Acanthodactylus blanfordi*	
197.	*Cabrita leschenaulti*	*Ophisops leschenaulti*	*Ophisops leschenaulti*
198.	*Cabrita jerdoni*		
199.	*Ophisops jerdoni*	*Ophisops jerdoni*	*Ophisops jerdoni*
200.	*Ophisops beddomei*	*Ophisops beddomei*	*Ophisops beddomei*
201.	*Ophisops microlepis*	*Ophisops microlepis*	*Ophisops microlepis*
202.		*Ophisops minor*	*Ophisops minor*
203.	*Eremias guttulata watsonana*	*Eremias guttulata*	*Eremias guttulata watsonana*
204.	*Ophisaurus gracilis*	*Ophisaurus gracilis*	*Ophisaurus gracilis*
205.	*Varanus griseus koniecznyi*	*Varanus griseus koniecznyi*	
206.	*Varanus bengalensis*	*Varanus bengalensis*	*Varanus bengalensis*
207.	*Varanus flavescens*	*Varanus flavescens*	*Varanus flavescens*
208.	*Varanus salvator*	*Varanus salvator*	*Varanus salvator*

Snakes

It is believed that the modern lizards and snakes evolved from a common ancestral Diapsid reptile stock which lived on earth roughly 155 million years ago in the middle of the Jurassic period of the Mesozoic era. The order Squamata includes serpents (snakes) with nearly 3,272 species under 357 genera and 12 families known from all over the world, except Artic, New Zealand and Ireland. The species representation in India is comparatively high with 244 species distributed under 10 families [Typhlopidae (14 species, 2 genera); Leptotyphlopidae (2 species–*Leptotyphlops blanfordi* & *L. macrorhynchus* from Rajasthan and Punjab); Uropeltidae (35 species, 8 genera restricted to South Indian hilly areas); Boidae (4 species, 2 genera : *Python molurus, P. reticulatus, Eryx jhoni, E. concius*); Xenopeltidae (1 species–*Xenopeltis unicolor*); Acrocordidae (1 species–*Chersydrus granulatus*); Colubridae (129 species, 41 genera); Elapidae (16 species, 4 genera); Hydrophiidae (19 species, 8 genera) and Viperidae (19 species, 5 genera). These snakes exhibit a unique distributional pattern with that of Palearctic origin with some admixture of Ethiopian elements and some exclusively of Indian origin, some common to Oriental and Palearctic Regions, some species of Oriental origin intruded into Palearctic Region and species exclusively endemic to the Indo-Chinese and Malayan sub region.

1. The following snake species of Palaearctic origin with some admixture of Ethiopian elements have their main origin from the Mediterranean, Irano-Turanian, Saharo-Sindian and Palaeotropic sub regions. Family Leptotyphloplidae: *Leptotyphlops macrorhynchus, Leptotyphlops blanfordi,* Family Colubridae: *Lytorhynchus ridgewayi, Lytorhynchus paradoxus, Lytorhynchus maynardi, Telescopus rhinopoma,* Family Viperidae: *Pseudocerastes persicus, Pseudocerastes bicornis* and *Eristocophis mcmahoni*- all above also distributed in Mediterranean subregion. *Eiremis persica* of family Colubridae is common to Mediterranean and Iranoturanian subregions.

2. The following snake species are exclusively endemic to the Indian sub region mainly from the climatically diversified geographical zones of Indian sub region namely the desert area of Rajasthan and north-western India; Kashmir and the western Himalaya; the plains of Ganga and Yamuna; Central India; the Indian Peninsula; Western Ghats; Eastern Ghats; The Chota Nagpur area and the northeast India, including eastern Himalaya. The Family: Uropeltidae includes *Melanophidium punctatum, Melanophidium bilineatum, Melanophidium wynaudens, Platyplectrurs trilineatus, Platyplectrurs madurensis, Teretrurus sanguineus, Teretrurus rhodogaster, Plectrurus perroteti, Plectrurus guentheri, Plectrurus aureus, Plectrurus canaricus, Uropeltis ellioti, Uropeltis nitidus, Uropeltis ocellatus, Uropeltis dindigalensis, Uropeltis beddomei, Uropeltis macrorhynchus, Uropeltis woodmasoni, Uropeltis macrolepis, Uropeltis ceylanicus, Uropeltis arcticeps, Uropeltis rubromaculatus, Uropeltis rubrolineatus, Uropeltis phipsoni, Uropeltis myhendrae, Uropeltis broughami, Uropeltis maculatus, Uropeltis petersi, Uropeltis liura, Uropeltis pulneyensis, Uropeltis grandis, Uropeltis melanogaster, Uropeltis phillipsi, Rhinophis blythi, Rhinophis drummondhayi, Rhinophis sanguineus, Rhinophis homolepis, Rhinophis fergusonianus, Rhinophis philippinus, Rhinophis travancoricus, Rhinophis punctatus, Rhinophis oxyrhynchus and Pseudotyphlops philippinus;* Family Colubridae : *Coronella brachyura, Cercaspis carinatus, Balanophis ceylonensis, Macropisthodon plumbicolor, Aspidura brachyorrhus, Aspidura copii, Aspidura trachyprocta, Aspidura drummondhayi, Aspidura guentheri, Haplocercus ceylonensis, Xylophis perroteti* and *Xylophis stenorhynchus.*

3. Snake species which are common to the Oriental and Palaearctic Regions are from Family Typhlopidae: *Typhlops porrectus, Ramphotyphlops braminus;* Family Boidae: *Python molurus, Eryx conicus, Eryx johni;* Family Colubridae: *Elaphe helena, Elaphe hodgsoni, Ptyas mucosus, Argyrogena ventromaculatus, Argyrogena rhodorhachis, Argyrogena karelini, Argyrogena ravergieri, Sphalerosophis diadema, Sphalerosophis arenarius, Sphalerosophis atriceps, Oligodon taeniolatus, Oligodon arnensis, Lycodon striatus, Xenochrophis piscater, Xenochrophis cerasogaster, Amphiesma stolata, Boiga trigonata, Psammophis schokari, Psammophis leithi, Psammophis lineolatus* and *Psammophis condanarus;* Family Elapidae: *Bungarus caeruleus* and *Naja naja.* Family Viperidae: *Vipera russelli, Vipera lebetina, Echis carinatus* and *Agkistrodon himalayanus.*

4. None of the snake species of Palaearctic origin intruded in the India subregion

5. Snake species of Oriental origin (Indo-Chinese and Indian subregion), which intruded, into Palaearctic region are *Elaphe helena, Ahaetulla nasutus,* and *Macropisthodon plumbicolor.*

6. Snake species exclusively endemic to the Indo-Chinese and Malayan subregions are from the family Xenopeltitidae are *Xenopeltis unicolor, Pareas margaritophorus, Pareas macularius, Pareas monticola, Pareas hamptoni, Pareas carinatus, Haplopeltura boa, Xenodermus javanicus, Stoliczkaia khasiensis, Achalinus rufescens, Fimbrios klossi, Zaocys carinatus, Zaocys nigromarginatus, Xenelaphis hexagonotus, Opheodrys major, Opheodrys multicinctus, Opheodrys hamptoni, Opheodrys doriae, Rhynchophis boulengeri, Calamaria, Uropeltis ceylanicus, Uropeltis arcticeps, Uropeltis rubromaculatus, Uropeltis rubrolineatus, Uropeltis phipsoni, Uropeltis myhendrae, Uropeltis broughami, Uropeltis maculatus, Uropeltis petersi, Uropeltis liura, Uropeltis pulneyensis, Uropeltis grandis, Uropeltis melanogaster, Uropeltis phillipsi, Rhinophis blythi, Rhinophis drummondhayi, Rhinophis sanguineus, Rhinophis homolepis, Rhinophis fergusonianus, Rhinophis philippinus, Rhinophis travancoricus, Rhinophis punctatus, Rhinophis oxyrhynchus, Pseudotyphlops philippinus.* Family Colubridae: *Coronella brachyura, Cercaspis carinatus, Balanophis ceylonensis, Macropisthodon plumbicolor, Aspidura brachyorrhus, Aspidura copii, Aspidura trachyprocta, Aspidura drummondhayi, Aspidura guentheri, Haplocercus ceylonensis, Xylophis perroteti* and *Xylophis stenorhynchus.*

8. Snake species common to Indian, Indo-Chinese and Malayan sub regions are from family Anilidae : Genus *Cylindrophis* covers the range, *Cylindrophis rufus* is from Indo-Chinese and Malayan subregions while *Cylindrophis maculatus* from Sri Lanka represents the Indian subregion of the Oriental Region; Family Colubridae : *Acrochordus granulatus, Dendrelaphis ahaetulla, Dendrelaphis cyanochloris, Dendrelaphis gorei, Chrysopelea ornata, Dryocalamus nympha* and *Dryocalamus gracilis* are from Indian subregion while *Dryocalamus davisoni* represents the Indo-Chinese and Malayan subregions., *Sibynophis collaris, Sibynophis sagittarius, Xenochrophis piscator, Xenochrophis cerasogaster, Rhabdops bicolor, Ahaetulla fronticinctus, Ahaetulla prasinus, Ahaetulla nasutus, Enhydris enhydris, Enhydris sieboldi, Cerberus rhynchops and Gerardia prevostiana, Elachistodon westermanni;* Family Elapidae: *Callophis macclellandi* and *Ophiophagus hannah.* Family Viperidae : *Trimeresurus monticola, Trimeresurus stejnegeri, Trimeresurus popeorum, Trimeresurus erythrurus* and *Trimeresurus albolabris.*

REPTILE ENDEMICITY

214 species of reptilian fauna are endemic to the country. The Golden Gecko (*Calodactylodes aureus*) present in the Eastern Ghats is unique and endemic to India. Four species of Cat Skinks of the genus *Ristella* is restricted to Western Ghats. The other important ones are *Sitana ponticeriana* (Fan throated Lizard) and *Psammophilus* (Rock lizard). The Barkudi burrowing skink (*Barkudia insularis*), is the world's most endangered skink. Members of Uropeltid snakes are endemic to south Indian hilly areas. *Cantolea violacea* is restricted to Andaman Islands. *Liopeltis nicobarensis,* is a rare species restricted to Nicobar Islands and known by the single type specimen only.

THREATS

A great number of living reptiles of India are slowly disappearing mainly due to the increasing human interference. Growing demand for the reptilian skin, ruthless killing of harmless as well as venomous snakes, devastating forest fires which wipe out their habitats are the major threats. Destruction of mangrove vegetation, ruthless killing for their skin are the major threats to the Crocodiles. Depletion of Gharials is due to the construction of barrages and dams which hinders their movement. Direct persecution by man for the meat and eggs of Turtles and habitat destruction has caused considerable damage. Clearances of the original habitats, destruction of virgin forests, indiscriminate killing and capture are the cause for the depletion of lizards. The IUCN list of threatened animals (2002) includes 23 species of turtles, 3 species of tortoise, 2 species of crocodiles, 3 species of snakes (*Python molurus, Elachistodon westermanni, Oligodon nikhili*) and a species of skink (*Barkudia insularis*).

CONSERVATION

Protection under Indian Wildlife Act of 1972, captive breeding programme for crocodiles, ban on the collection of turtles for meat and eggs, turtle exclusion devises are some of the conservation measures initiated by the Government. The protection offered by the Indian Wildlife Act of 1972 to pythons, egg eating snakes, rat snake and Indian Cobra are other significant conservation efforts initiated by the government, the total list of turtles, lizards and snakes included under schedules of Wildlife (Protection) Act, 1972 is listed below :

Schedule–I Part II

Varanus griseus (Agra monitor lizard)
Varanus flavescens (Yellow monitor lizard)
Varanus bengalensis (Large Bengal Monitor lizard)
Varanus salvator (Water lizard)
Pelochelys bibroni (Audhitha turtle)
Crocodilus porosus
Crocodile palustris
Batagar baska (Terrapin)
Melanochelys tricarinata (Eastern hill Terrapin)
Gavialis gangeticus (Gharial)
Trionyx gangeticus (Gangetic soft shelled turtle)
Calodactyloides aureus (Golden Gecko)
Chelonia mydas (Green sea Turtle)

Erytmochelys imbricata (Hawksbill Turtle)

Elachistodon westermanni (Indian Egg eating Snake)

Lessemys punctata punctata (Indian Softshelled Turtle)

Hoesemys sylvatica (Kerala Forest Terrapin)

Dermochelys coriacea (Leathery Turtle)

Caretta caretta (Loggerhead Turtle)

Lepidochelys olivacea (Olive back Loggerhead Turtle)

Trinyx hurum (Softshelled Turtle)

Python spp. (Pythons)

Kachuga kachuga (Sail Terrapin)

Geoclemys hamiltoni (Spotted black Terrapin)

Schedule–II Part : I

Chameleon zeylanicus (Chameleon)

Uromastix hardwickii (Spiny tailed lizard)

Xenochrophis piscator (Checkered Keelback)

Ptyas mucosus (Rat snake)

Carbrurus rhynchops (Dog faced water snake)

Naja species and subspecies (Indian Cobras)

Ophiophagus hannah (King Cobra)

Artaetium schistosum (Olivaceous keelback)

Vipera russeli (Russel's Viper)

Schedule–III ... Nil

Schedule–IV (vide notification No, Fl 28/78 FRY(WL), dt.9.9.1980

All snakes other than those species listed in Schedule–I Part–II and Schedule–II Part–II *viz.*, :

Amblycaphalidae

Amilidae

Boidae

Colubridae

Dasypeptidae

Elapidae

Glauconnidae

Hydrophidae

Tlysiidae

Leptotyphlopidae

Typhlopidae
Uropeltidae
Viperidae
Xenopeltidae
Geomydas tricarinata (Three keeled Turtle)
Testudinidae and Trionychidae (Tortoise)

Diversity of Snakes in India

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
Family 1. TYPHLOPIDAE Gray 1845; Genus 1. ***Typhlops*** Oppel 1811			
1.	*Typhlops porrectus* Stoliczka 1871	Slender Blind Snake	Non Poisonous
2.	*Ramphotyphlops (Typhlops) braminus* (Daudin 1803)	Common Blind Snake	Non Poisonous
3.	*Typhlops psammeces* Gunther 1864	Gunther's Blind Snake	Non Poisonous
4.	*Typhlops thurstoni* Boettger 1890	Malabar Blind Snake	Non Poisonous
5.	*Typhlops jerdoni* Boulenger 1890	Jerdon's Worm Snake	Non Poisonous
6.	*Typhlops tenuicollis* (Peters 1864)	Peter's Worm Snake	Non Poisonous
7.	*Typhlops diardi* Schlegel 1839	Diard's Blind Snake	Non Poisonous
8.	*Typhlops oatesi* Boulenger 1890	Cacos Blind Snake	Non Poisonous
9.	*Typhlops bothriorhynchus* Gunther 1864	Gunther's Blind Snake/ Assam Worms snake	Non Poisonous
10.	*Typhlops tindalli* Smith 1943	Tindall's Blind Snake	Non Poisonous
11.	*Typhlops beddomei* Boulenger 1890	Beddom's Blind Snake	Non Poisonous
12.	*Typhlops oligolepis* Wall 1909	Wall's Worm Snake	Non Poisonous
13.	*Typhlops andamanensis* Stoliczka 1871	Stoliczka's Blind Snake	Non Poisonous
14.	*Typhlops acutus* Dumeril & Bibron 1844	Beaked Blind Snake	Non Poisonous
Family II. LEPTOTYPHLOPIDAE; Genus 2. ***Leptotyphlops*** Fitzinger 1843			
15.	*Leptotyphlops macrorhynchus* Jan. 1862	Beaked Thread Snake	Non Poisonous
16.	*Leptotyphlops blanfordi* (Boulenger 1890)	Blanford Thread Snake	Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
Family III. UROPELTIDAE Gray 1845; Genus 3. ***Melanophidium*** Gunther 1864			
17.	*Melanophidium punctatum* Beddome 1871	Travancore Melanophidium	Non Poisonous
18.	*Melanophidium bilineatum* Beddome 1870	Peria-tirrhioot Melanophidium	Non Poisonous
19.	*Melanophidium wynaudense* (Beddome 1863)	Wynad Melanophidium	Non Poisonous
Genus 4. ***Platyplectrurus*** Gunther 1868			
20.	*Platyplectrurus trilineatus* Beddome 1867	Anaimalai reddish-brown Worm Snake	Non Poisonous
21.	*Platyplectrurus madurensis* Beddome 1877	Palni Purple Brown Worm Snake	Non Poisonous
Genus 5. ***Teretrurus*** Beddome 1886			
22.	*Teretrurus sanguineus* (Beddome 1867)	Anaimalai Teretrurus	Non Poisonous
23.	*Teretrurus rhodogaster* (Wall 1921)	Palni Teretrurus	Non Poisonous
Genus 6. ***Plectrurus*** Dumeril 1851			
24.	*Plectrurus perroteti* Dumeril & Bibron 1854	Nilgiri Brown Mud Snake	Non Poisonous
25.	*Plectrurus guentheri* Beddome 1863	Sispara Reddish Purple Mud Snake	Non Poisonous
26.	*Plectrurus aureus* Beddome 1880	Chambra Hill Mud Snake	Non Poisonous
27.	*Plectrurus canaricus* (Beddome 1870)	Canara Violet Mud Snake	Non Poisonous
Genus 7. ***Uropeltis*** Cuvier 1829			
28.	*Uropeltis ellioti* (Gray 1858)	Elliot's Uropeltis	Non Poisonous
29.	*Uropeltis nitidus* (Beddome 1878)	Anaimalai Uropeltis	Non Poisonous
30.	*Uropeltis ocellatus* (Beddome 1863)	Nilgiri Uropeltis	Non Poisonous
31.	*Uropeltis dindigalensis* (Beddome 1877)	Dindigul Uropeltis	Non Poisonous
32.	*Uropeltis beddomei* (Gunther 1862)	Beddom's Uropeltis	Non Poisonous
33.	*Uropeltis macrorhynchus* (Beddome 1877)	Ponachi Uropeltis	Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
34.	*Uropeltis macrolepis* (Peters 1861)	Peter's Uropeltis	Non Poisonous
35.	*Uropeltis wood-masoni* (Theobald 1876)	Palni Uropeltis	Non Poisonous
36.	*Uropeltis ceylanicus* Cuvier 1829	Cuvier's Uropeltis	Non Poisonous
37.	*Uropeltis arcticeps* (Gunther 1875)	Tinevelly Uropeltis	Non Poisonous
38.	*Uropeltis rubromaculatus* (Beddome 1867)	Beddom's Uropeltis	Non Poisonous
39.	*Uropeltis rubrolineatus* (Gunther 1875)	Travancore Uropeltis	Non Poisonous
40.	*Uropeltis phipsoni* (Mason 1888)	Bombay Hills Uropeltis	Non Poisonous
41.	*Uropeltis myhendrae* (Beddome 1886)	Myhendra Mountain Uropeltis	Non Poisonous
42.	*Uropeltis broughami* (Beddome 1878)	Sirumallay's Uropeltis	Non Poisonous
43.	*Uropeltis maculatus* (Beddome 1878)	Redsided shiled tail	Non Poisonous
44.	*Uropeltis petersi* (Beddome 1878)	Peters shild tail	Non Poisonous
45.	*Uropeltis liura* (Gunther 1875)	Madura Hill Uropeltis	Non Poisonous
46.	*Uropeltis pulneyensis* (Beddome 1863)		Non Poisonous
47.	*Uropeltis grandis* (Beddome 1867)	Dark-violet Uropeltis	Non Poisonous
48.	*Uropeltis smithi* (Gans 1973)		Non Poisonous
Genus 8. ***Rhinophis*** Hemprich 1820			
49.	*Rhinophis sanguineus* Beddome 1863		Non Poisonous
50.	*Rhinophis fergusonianus* Boulenger 1826		Non Poisonous
51.	*Rhinophis travancoricus* Boulenger 1892		Non Poisonous
Family IV. XENOPELTIDAE Cope 1864 Genus 9. ***Xenopeltis*** Reinwardt 1827			
52.	*Xenopeltis unicolor* Reinwardt 1827	Sunbeam Snake	Non Poisonous
Family V. BOIDAE Gray 1842 Genus 10. ***Python*** Daudin 1803.			
53.	*Python molurus* (Linnaeus 1758)	Indian Python, Rock Python	Non Poisonous
54.	*Python reticulatus* (Schneider 1801)	Reticulated Python	Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
Genus 11. ***Eryx*** Daudin 1803			
55.	*Eryx conicus* (Schneider 1801)	Russell's Sand Boa	Non Poisonous
56.	*Eryx johni* (Russell 1801)	John's Sand Boa	Non Poisonous
Family VI. ACROCHORDIDAE Bonaparte 1840 Genus 12. ***Chersydrus*** Cuvier 1817			
57.	*Chersydrus granulatus* (Schneider 1799)		Non Poisonous
Family VII. COLUBRIDAE Cope 1893 Subfamily DIPSADINAE Amarat 1923 Genus 13. ***Pareas*** Wagler 1830			
58.	*Pareas macularius* Theobald 1868	Darjeeling Snail Eater	Non Poisonous
59.	*Pareas monticola* (Cantor 1839)	Assam Snail Eater	Non Poisonous
Subfamily XENODERMINAE Cope 1898 Genus 14. ***Stoliczkaia*** Jerdon 1870			
60.	*Stoliczkaia khasiensis* Jerdon 1870		Non Poisonous
Subfamily COLUBRINAE Cope 1898 Genus 15. ***Elaphe*** Fitzinger 1833			
61.	*Elaphe-prasina* (Blyth 1854)	Green Tree Racer	Non Poisonous
62.	*Elaphe frenata* (Gray 1853)		Non Poisonous
63.	*Elaphe oxycephala* (Boie 1827)		Non Poisonous
64.	*Elaphe radiata* (Schlegel 1837)	Copperhead Snake	Non Poisonous
65.	*Elaphe helena* (Daudin 1803)	Trinket Snake	Non Poisonous
66.	*Elaphe taeniura* (Cope 1861)	Striped Racer	Non Poisonous
67.	*Elaphe hodgsoni* (Gunther 1860)	Olive-Brown Racer	Non Poisonous
68.	*Elaphe cantoris* (Boulenger 1894)	Black-spotted Gray Racer	Non Poisonous
69.	*Elaphe porphyracea* (Cantor 1839)		Non Poisonous
Genus 16. ***Ptyas*** Fitzinger 1843			
70.	*Ptyas mucosus* (Linnaeus 1758)	Dhaman, Indian Rat Snake	Non Poisonous
71.	*Ptyas korros* (Schlegel 1837)		Non Poisonous
Genus 17. ***Zaocys*** Cope 1860			
72.	*Zaocys nigromarginatus* (Blyth 1854)		Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
Genus 18. ***Argyrogena*** Werner 1924			
73.	*Argyrogena ventromaculatus* (Gray & Hardwicke 1833)		Mildly Venomous
74.	*Argyrogena fasciolatus* (Shaw 1802)	Banded Racer	Non Poisonous
75.	*Argyrogena gracilis* (Gunther 1862)	White-spotted Brown Racer	Non Poisonous
76.	*Argyrogena bholanathi* Sharma 1976		Non Poisonous
Genus 19. ***Sphalerosophis*** Jan 1865			
77.	*Sphalerosophis diadema diadema* (Sehlegel 1837)	Diadem Snake, Rajatbansi	Non Poisonous
78.	*Sphalerosophis atriceps* (Fischer 1885)	Royal Snake	Non Poisonous
79.	*Sphalerosophis arenarius* (Boulenger 1890)	Red-spotted Diadem Snake	Non Poisonous
Genus 20. ***Opheodrys*** Fitzinger 1843			
80.	*Opheodrys doriae* (Boulenger 1888)	Dorial Green Snake	Non Poisonous
Genus 21. ***Liopeltis*** Fitzinger 1843			
81.	*Liopeltis frenatus* (Gunther 1858)	Olivaceous Racer	Non Poisonous
82.	*Liopeltis stoliczkae* (Sclater 1891)	Greyish Racer	Non Poisonous
83.	*Liopeltis calamaria* (Gunther 1858)		Non Poisonous
84.	*Liopeltis nicobariensis* (Stoliczka 1870)		Non Poisonous
85.	*Liopeltis rappi* (Gunther 1860)		Non Poisonous
Genus 22. ***Coronella*** Laurenti 1768			
86.	*Coronella brachyura* (Gunther 1866)	North Indian Olive-brown Snake	Non Poisonous
Genus 23. ***Oligodon*** Boie 1827			
87.	*Oligodon cyclurus* (Cantor 1839) Kukri Snake	North-east Indian	Non Poisonous
88.	*Oligodon juglandifer* (Wall 1909)	Darjeeling Kukri Snake	Non Poisonous
89.	*Oligodon albocinctus* (Cantor 1839)	East-Himalayan Rosy-brown Kukri Snake	Non Poisonous
90.	*Oligodon melazonotus* (Wall 1922)		Non Poisonous
91.	*Oligodon cinereus* (Gunther 1864)	Black Cross-bared Kukri Snake	Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
92.	*Oligodon woodmasoni* (Sclater 1891)	Dark-brown or Blackish Andaman Kukri Snake	Non Poisonous
93.	*Oligodon theobaldi* (Gunther 1868)	Light-brown Assam Kukri Snake	Non Poisonous
94.	*Oligodon venustus* (Jerdon 1853)	Western Ghat Greenish-brown Large Spotted Kukri Snake	Non Poisonous
95.	*Oligodon travancoricus* (Beddome 1877)	Western Ghat Greyish-brown Small Spotted Kukri Snake	Non Poisonous
96.	*Oligodon taeniolatus* (Jerdon 1853)	Streaked Kukri Snake	Non Poisonous
97.	*Oligodon arnensis* (Shaw 1802)	Common Kukri Snake	Non Poisonous
98.	*Oligodon erythrorhachis* Wall 1910		Non Poisonous
99.	*Oligodon melaneus* Wall 1909	Black Kukri Snake	Non Poisonous
100.	*Oligodon affinis* Gunther 1862	Malabar Brown Kukri Snake	Non Poisonous
101.	*Oligodon brevicauda* Gunther 1862	Anaimalai Brown Kukri Snake	Non Poisonous
102.	*Oligodon erythrogaster* Boulenger 1907	Red-bellied Kukri Snake	Non Poisonous
103.	*Oligodon dorsalis* (Gray & Hardwicke 1834)		Non Poisonous
Genus 24. ***Calamaria*** Boie 1826			
104.	*Calamaria pavimentata* Dum. & Bibr. 1854.		Non Poisonous
Genus 25. ***Dendrelaphis*** Boulenger 1890			
105.	*Dendrelaphis pictus* (Gmelin 1789)	Painted Bronze-back	Non Poisonous
106.	*Dendrelaphis cyanochloris* (Wall 1921)	Olive Bronze-back	Non Poisonous
107.	*Dendrelaphis grandoculis* (Boulenger 1890)	NIlgiri Olive-brown Black-blotched Snake	Non Poisonous
108.	*Dendrelaphis gorei* (Wall 1910)	Eastern Himalayan Bronze-brown Snake	Non Poisonous
109.	*Dendrelaphis bifrenalis* (Boulenger 1890)	Travancore Bronze-brown Snake	Non Poisonous
110.	*Dendrelaphis caudolineolata* (Gunther 1869)	Travancore Bronze-olive Snake	Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
111.	*Dendrelaphis tristis* (Daudin 1803)	Common Bronze-back Tree Snake	Non Poisonous
112.	*Dendrelaphis humayuni* Tiwari & Biswas		Non Poisonous
Genus 26. ***Chrysopelea*** Boie 1826			
113.	*Chrysopelea ornata* (Shaw 1802)	Golden Tree Snake	Mildly Venomous
114.	*Chrysopelea paradisi* Boie 1927		Mildly Venomous
Genus 27. ***Lycodon*** Boie 1826 (Wolf Snakes)			
115.	*Lycodon travancoricus* (Beddome 1870)	Travancore Wolf Snake	Non Poisonous
116.	*Lycodon jara* (Shaw 1802)	Shaw's Purple-black Wolf Snake	Non Poisonous
117.	*Lycodon striatus* (Shaw 1802)	Barred Wolf Snake	Non Poisonous
118.	*Lycodon flavomaculatus* (Wall 1907)	Wall's Black Wolf Snake	Non Poisonous
119.	*Lycodon mackinnoni* Wall 1906		Non Poisonous
120.	*Lycodon aulicus* (Linnaeus 1754)	Common Wolf Snake	Non Poisonous
121.	*Lycodon fasciatus* (Anderson 1870)	East Himalayan Wolf Snake	Non Poisonous
122.	*Lycodon tiwari* Biswas & Sanyal 1965	Andaman Wolf Snake	Non Poisonous
Genus 28. ***Dinodon*** Dum. & Bibr. 1853			
123.	*Dinodon septentrionalis* (Gunther 1875)	Gunther's False Wolf Snake	Non Poisonous
124.	*Dinodon gammiei* (Blanford 1878)	Sikkim False WolF Snake	Non Poisonous
Genus 29. *Dryocalamus* Gunther 1858			
125.	*Dryocalamus nympha* (Daudin 1803)	Bridal Snake	Non Poisonous
126.	*Dryocalamus gracilis* (Gunther 1864)	South Indian Bridal Snake	Non Poisonous
Genus 30. ***Sibynophis*** Fitzinger 1843			
127.	*Sibynophis collaris* (Gray 1853)	Collared Black-headed Snake	Non Poisonous
128.	*Sibynophis subpunctatus* (Dum. & Bibr. 1854)	Light-brown Black-headed Snake	Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
129.	*Sibynophis bistrigatus* (Gunther 1868)	Reddish-brown Black-headed Snake	Non Poisonous
130.	*Sibynophis sagittarius* (Cantor 1839)	Cantor's Black-headed Snake	Non Poisonous
Genus 31. ***Amphiesma*** Dumeril & Bibron 1854			
131.	*Amphiesma parallela* (Boulenger 1890)	Olive-brown Keelback	Non Poisonous
132.	*Amphiesma khasiensis* (Boulenger 1890)	Blackish-brown Keelback	Non Poisonous
133.	*Amphiesma modesta* (Gunther 1875)	Brown-black Spotted Keelback	Non Poisonous
134.	*Amphiesma peali* (Sclater 1891)	Dark-brown Keelback	Non Poisonous
135.	*Amphiesma xenura* (Wall 1907)	Dark Olive-brown Keelback	Non Poisonous
136.	*Amphiesma stolata* (Linnaeus 1758)	Striped Keelback	Non Poisonous
137.	*Amphiesma platyceps* (Blyth 1854)	Mountain Keelback	Non Poisonous
138.	*Amphiesma beddomei* (Gunther 1864)	Beddom's Olive-brown Keelback	Non Poisonous
139.	*Amphiesma monticola* (Jerdon 1853)	Green Keelback	Non Poisonous
Genus 32. ***Xenochrophis*** Gunther 1864			
140.	*Xenochrophis piscator* (Schneider 1799)	Checkered Keelback	Non Poisonous
141.	*Xenochrophis cirasogaster* (Cantor 1839)	Dark-bellied Marsh Snake	Non Poisonous
Genus 33. ***Rhabdophis*** Fitzinger 1843			
142.	*Rhabdophis himalayana* (Gunther 1864)	Himalayan Keelback	Non Poisonous
143.	*Rhabdophis subminiata* (Schlegel 1837)		Non Poisonous
Genus 34. ***Natrix*** Laurenti 1768			
144.	*Natrix nicobarensis* (Sclater 1891)		Non Poisonous
Genus 35. ***Pseudoxenodon*** Boulenger 1890			
145.	*Pseudoxenodon macrops* (Blyth 1854)	False Cobra	Mildly venemous
Genus 36. ***Macropisthodon*** Boulenger 1893			
146.	*Macropisthodon plumbicolor* (Cantor 1839)		Non Poisonous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
Genus 37. ***Atretium*** Cope 1861			
147.	*Atretium schistosum* (Daudin 1803)	Olivaceous Keelback	Non Poisonous
Genus 38. ***Trachischium*** Gunther 1858			
148.	*Trachischium monticola* (Cantor 1839)	Assam Hill Worm Snake	Non Poisonous
149.	*Trachischium fuscum* (Blyth 1854)	Darjeeling Oriental Worm Snake	Non Poisonous
150.	*Trachischium guentheri* (Boulenger 1890)	Gunther's Oriental Worm Snake	Non Poisonous
151.	*Trachischium tenuiceps* (Blyth 1854)	Bengal Worm Snake	Non Poisonous
152.	*Trachischium laeve* Peracca 1904	West Himalayan Worm Snake	Non Poisonous
Genus 39. ***Rhabdops*** Boulenger 1893			
153.	*Rhabdops olivaceus* (Beddome 1863)	Olivaceus Slug-eater	Non Poisonous
154.	*Rhabdops bicolor* (Blyth 1854)	Assamese Black Slug-eater	Non Poisonous
Genus 40. ***Blythia*** Theobald 1868			
155.	*Blythia* reticulata (Blyth 1854)	Blyth's Reticulated Snake	Non Poisonous
Genus 41. ***Xylophis*** Beddome 1878			
156.	*Xylophis perroteti* (Dum. & Bibr. 1854)		Non Poisonous
157.	*Xylophis stenorhynchus* (Gunther 1875)		Non Poisonous
Genus 42. ***Boiga*** Fitzinger 1826			
158.	*Boiga multimaculata* (Boie 1827)	Large-spotted Cat Snake	Mildly Venomous
159.	*Boiga ochracea* (Gunther 1868)	Tawny Cat Snake	Mildly Venomous
160.	*Boiga trigonata* (Schneider 1802)	Indian Gamma	Mildly Venomous
161.	*Boiga gokool* (Gray 1834)	Eastern Gamma	Mildly Venomous
162.	*Boiga ceylonensis* (Gunther 1858)	Ceylon Cat Snake	Mildly Venomous
163.	*Boiga quincunciata* (Wall 1908)	Wall's Assam Cat Snake	Mildly Venomous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
164.	*Boiga cyanea* (Dum. & Bibr. 1854)	Green Cat Snake	Mildly Venomous
165.	*Boiga multifasciata* (Blyth 1861)	Himalayan Cat Snake	Mildly Venomous
166.	*Boiga cynodon* (Boie 1827)	Bird-eating Cat Snake	Mildly Venomous
167.	*Boiga forsteni* (Dum. & Bibr. 1854)	Reddish Peninsular Snake	Mildly Cat Venomous
168.	*Boiga dightoni* (Boulenger 1894)	Travancore Cat Snake	Mildly Venomous
Genus 43. ***Psammophis*** Fitzinger 1826			
169.	*Psammophis schokari* (Forskal 1775)	Afro-asian Sand Snake	Mildly Venomous
170.	*Psammophis condanarus* (Merrem 1820)	Indian Sand Snake	Mildly Venomous
171.	*Psammophis longifrons* (Boulenger 1896)	Maharashtra Sand Snake	Mildly Venomous
172.	*Psammophis leithi* (Gunther 1869)	Pakistan Ribbon Snake	Mildly Venomous
Genus 44. ***Psammodynastes*** Gunther 1858			
173.	*Psammodynastes pulverulentus* Boie 1827	Mock Viper	Mildly Venomous
Genus 45. ***Ahaetulla*** Link 1807			
174.	*Ahaetulla perroteti* (Dum. & Bibr. 1854)	Bright-green Whip Snake	Mildly Venomous
175.	*Ahaetulla dispar* (Gunther 1864)	Bronzy-olive Whip Snake	Mildly Venomous
176.	*Ahaetulla fronticinctus* (Gunther 1858)	Assam Bright-green Whip Snake	Mildly Venomous
177.	*Ahaetulla prasinus* (Boie 1827)	Boie's Whip Snake	Mildly Venomous
178.	*Ahaetulla nasutus* (Lacepede 1789)	Common Green Whip Snake	Mildly Venomous
179.	*Ahaetulla pulverulentus* (Dum. & Bibr. 1854)	Brownish Whip Snake	Mildly Venomous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
Subfamily HOMALOPSINAE Boulenger 1890 Genus 46. ***Enhydris*** Sonn. & Latr. 1802		Fresh Water Snakes	
180.	*Enhydris enhydris* (Schneider 1799)		Mildly Venomous
181.	*Enhydris dussumieri* (Dum. & Bibr. 1854)		Mildly Venomous
182.	*Enhydris sieboldi* (Schlegel 1837)		Mildly Venomous
Genus 47. ***Cerberus*** Cuvier 1829			
183.	*Cerberus rhynchops* (Schneider 1799)	Dog-Faced Water Snake	Mildly Venomous
Genus 48. ***Gerardia*** Gray 1849			
184.	*Gerardia prevostiana* (Eydoux & Gervais 1832-1837)	Glossy Marsh Snake	Mildly Venomous
Genus 49. ***Fordonia*** Gray 1842			
185.	*Fordonia leucobalia* (Schlegel 1837)		Mildly Venomous
Genus 50. ***Cantoria*** Girard 1857			
186.	*Cantoria violacea* (Girard 1857)		Mildly Venomous
Subfamily ELACHISTODONTINAE Boulenger 1896; Genus 51. ***Elachistodon*** Reinhardt 1863			
187.	*Elachistodon westermanni* Reinhardt 1863	Indian Egg-eater	Mildly Venomous
Family VIII. ELAPIDAE Boie 1827 Genus 52. ***Bungarus*** Daudin 1803			
188.	*Bungarus bungaroides* (Cantor 1839)	Assam Black Krait	Venomous
189.	*Bungarus fasciatus* (Schneider 1801)	Banded Krait	Venomous
190.	*Bungarus caeruleus* (Schneider 1801)	Common Indian Krait	Venomous
191.	*Bungarus andamanensis* Biswas & Sanyal 1977	Andaman Krait	Venomous
192.	*Bungarus niger* Wall 1908	Black Krait	Venomous
193.	*Bungarus lividus* Cantor 1839	Lesser Black Krait	Venomous
194.	*Bungarus walli* Wall 1907	Wall's Krait	Venomous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
Genus 53. ***Callophis*** Gray 1834; Coral Snakes			
195.	*Callophis melanurus* (Shaw 1802)	Slender Coral Snake	Venomous
196.	*Callophis nigrescens* Gunther 1862	Elongated Coral Snake	Venomous
197.	*Callophis beddomei* Smith 1943		Venomous
198.	*Callophis macclellandi* (Reinhardt 1844)	Macclelland's Coral Snake	Venomous
199.	*Callophis bibroni* (Jan 1858)	Cherry-red Coral Snake	Venomous
Genus 54. ***Naja*** Laurenti 1768			
200.	*Naja naja* (Linnaeus 1758)	Binoocelate Cobra	Venomous
201.	*Naja naja kaouthia* Lesson 1831	Monoocelate Cobra	Venomous
202.	*Naja naja oxiana* (Eichwald 1831)	Oxus Cobra	Venomous
Genus 55. ***Ophiophagus*** Gunther 1864			
203.	*Ophiophagus hannah* (Cantor 1831)	King Cobra, Hamadryad	Venomous
Family IX. HYDROPHIIDAE Boie 1827; Genus 56. ***Laticauda*** Laurenti 1768			
204.	*Laticauda laticaudata* (Linnaeus 1758)		Venomous
205.	*Laticauda colubrina* (Schneider 1799)		Venomous
Genus 57. ***Kerilia*** Gray 1849			
206.	*Kerilia jerdoni* Gray 1849	Jerdon's Olive Sea Snake	Venomous
Genus 58. ***Praescutata*** Wall 1921			
207.	*Praescutata viperina* (Schmidt 1852)	Viperine Sea Snake	Venomous
Genus 59. ***Enhydrina*** Gray 1849			
208.	*Enhydrina schistosa* (Daudin 1803)	Beaked Sea Snake	Venomous
Genus 60. ***Hydrophis*** Latreille 1802			
209.	*Hydrophis nigrocinctus* Daudin 1803	Olivaceous Banded Sea Snake	Venomous
210.	*Hydrophis spiralis* Shaw 1802	Yellow Sea Snake	Venomous
211.	*Hydrophis cyanocinctus* Daudin 1803	Annulated Sea Snake	Venomous
212.	*Hydrophis obscurus* Daudin 1803	Bluish-black Sea Snake	Venomous
213.	*Hydrophis stricticollis* Gunther 1864	Black-headed Greyish Sea Snake	Venomous
214.	*Hydrophis ornatus ornatus* (Gray 1842)	Pale-greyish Sea Snake	Venomous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
215.	*Hydrophis lapemoides* (Gray 1849)	Persian Gulf Sea Snake	Venomous
216.	*Hydrophis mamillaris* (Daudin 1803)	Bombay Sea Snake	Venomous
217.	*Hydrophis caerulescens* (Shaw 1802)	Many Toothed Sea Snake	Venomous
218.	*Hydrophis fasciatus* (Schneider 1799)	Greyish-black White- bellied Sea Snake	Venomous
Genus 61. ***Lapemis*** Gray 1835			
219.	*Lapemis curtus* (Shaw 1802)		Venomous
Genus 62. ***Microcephalophis*** Lesson 1834			
220.	*Microcephalophis gracilis* (Shaw 1802)	Common Small-headed Sea Snake	Venomous
221.	*Microcephalophis cantoris* (Gunther 1864)	Cantor's Small-headed Sea Snake	Venomous
Genus 63. ***Pelamis*** Daudin 1803			
222.	*Pelamis platurus* (Linnaeus 1766)	Yellow-bellied Sea Snake or Pelagic Sea Snake	Venomous
Family X. VIPERIDAE Bonaparte 1840 Genus 64. ***Vipera*** Laurenti 1768			
223.	*Vipera russelli* (Shaw 1797)	Russell's Viper, Doboia	Venomous
224.	*Vipera lebetina* (Linnaeus 1758)	Levatine Viper	Venomous
Genus 65. ***Echis*** Merrem 1820			
225.	*Echis carinatus* (Schneider 1801)	Phoorsa, Saw-scaled Viper	Venomous
Genus 66. ***Agkistrodon*** Beauvois 1799			
226.	*Agkistrodon himalayanus* (Gunther 1864)	Himalayan Pit-viper	Venomous
Genus 67. ***Hypnale***			
227.	*Hypnale hypnale* (Merrem 1820)	Hump-nosed Viper	Venomous
Genus 68. ***Trimeresurus*** Lacepede 1804			
228.	*Trimeresurus macrolepis* Beddome 1862	South Indian Pit-viper	Venomous
229.	*Trimeresurus mucrosquamatus* (Cantor 1839)	East Indian Olive-brown Pit-viper	Venomous
230.	*Trimeresurus monticola* Gunther 1864	East Himalayan Pit-viper	Venomous
231.	*Trimeresurus jerdoni* Gunther 1875	Greenish-yellow Pit-viper	Venomous
232.	*Trimeresurus malabaricus* (Jerdon 1854)	Greenish Malabar Pit-viper	Venomous

Sl. No.	Scientific Name	Common name	Poisonous/Non Poisonous
233.	*Trimeresurus strigatus* Gray 1842	Brown Rock Pit-viper	Venomous
234.	*Trimeresurus gramineus* (Shaw 1802)	Bamboo Pit-viper	Venomous
235.	*Trimeresurus stejnegeri* (Schmidt 1925)	East-Himalayan Green Pit-viper	Venomous
236.	*Trimeresurus popeorum* Smith 1937	Smith's Green Pit-viper	Venomous
237.	*Trimeresurus cantori* (Blyth 1846)	Nicobar Pit-viper	Venomous
238.	*Trimeresurus purpureomaculatus* (Gray & Hardwicke 1830)	Andaman Pit-viper	Venomous
239.	*Trimeresurus erythrurus* (Cantor, 1839)	Naga Hill Pit-viper	Venomous
240.	*Trimeresurus albolabris* Gray 1842	North Indian Green Pit-viper	Venomous
241.	*Trimeresurus labialis* (Fitzinger 1861)	Nicobar Brown Pit-viper	Venomous

Source : Fauna of India, Sankes, 2002

MEDICINAL PROPERTIES OF SELECTED SPECIES OF REPTILES IN AYURVEDA, SIDDA AND UNANI

The shells of *Testudo elegans* is used in curing cough, asthma, Rakta pitta (haemorrhage), tuberculosis, imaciation (shosha), loss of memory, eye diseases, spermatorrhoea, unmada (insanity), apasmara (epilepsy) and the flesh of the animal acts as a brain tonic, useful in eye diseases, in general debility and in Rakta Pitta. It is also used as aphrodisiac. Shell, egg, flesh, whole organism, blood, fat, bile and bone *of Chelone mydas* used to cure diarrhoea, indigestion and cough. It improves eyesight. It is aphrodisiac given in general debility. The ash of the burnt shell gives strength to the bone. It is beneficial to children, parturient and imaciated patients. It is also prescribed in infantile diarrhoea. Various parts of the body are used in Ayurveda and Unani system of medicine as detailed below :

Whole organism : The ash is good for healing cancerous wounds, tuberculosis particularly of the bones, calcium and phosphorus deficiency, dyspepsia, pox and respiratory diseases.

Blood : Externally is useful in rheumatism and gout and internally in epilepsy.

Eggs : are indicated in chronic cough in children.

Bile : Instillation in eyes with honey is useful in eye diseases. Applications in and around nostrils cures epilepsy. Bile is also used in diphtheria and for healing wounds.

Bone : Ash of bones is useful in rectal prolapse, ringworms and for checking uterine discharges. Fumigation is beneficial in piles.

Vaccine from Turtle : The vaccine is valuable in the anti-tuberculosis struggle as having given supervising results after one or two injections. The vaccine is composed of the pure cultures of the *Tuberculus bacilli.*

Fat : Oil extracted from it is a pale yellow liquid of a fishy odour and disagreeable taste. Its dose is 1-2 drachms. It is used as alternative nutrient and demulcent. Fat of turtle is given in scrofula, rickets, anemia and pulmonary infections. It is anti-convulsant when used externally massage on waist improves sexual performance.

AVES

The birds evolved about 150 million years ago, occupied diverse ecological niches and are distributed in all available habitats. The Indian avifauna represents Palearctic, Oriental, Ethiopian, and Australasian zoogeographic elements. It includes about 176 endemic forms. 350 migrating species and subspecies winter in the Indian territory, while a few migrate from India. Morony, Beck and Farrand (1975), recorded 9026 species under 1800 genera, 182 families and 30 orders in the world. About 437 are designated as threatened ones. The Indian subcontinent has 2123 species and subspecies under 78 families and 20 orders thus representing 13.66% of the world avian diversity.

ENDEMICITY

About 176 species under 106 genera, 39 families and 11 orders are endemic to Indian subcontinent, including Pakistan, Nepal, Bhutan, Myanmar, Sri Lanka and Bangladesh. One genus *Ophrysia* and 50 species under 11 genera are exclusively endemic to India. There are 25 monotypic genera. Western Ghats in comparison to northeast Himalayan and northwestern trans Himalayan ranges and even eastern Ghats do not show significantly higher diversity of avian distribution. Though, the Western Ghats is relatively species poor, it is found to be an important area for conservation of bird species along with north western, northeastern Himalayan ranges as well as tropical islands of Andaman and Nicobar group. This is mainly because, the species harboured in Western Ghats are relatively more endemic than those of Eastern Ghats.

THREATS

Hunting, trapping, trade and habitat destruction are the major threats to the group as a whole. Besides the above, decrease in the forest cover, conversion of wetlands for agriculture and aqua-culture are the major reasons to their threat. For ex. Jerdon's Courser *Rhinoptilus bitorquatus* is one of the world's rarest birds found only in Andhra Pradesh, India. The Known distribution was a single site a few hundred metres in diameter, in scrub jungles in Sri Lankamaleswara Wildlife Sanctuary (SLWLS) in Andhra Pradesh. At the time of the rediscovery in 1986, the Jerdon's Courser site was under threat because there were plans to construct the Telugu-Ganga canal across it. Also, the canal was being constructed in the place where Jerdon's Courser was recorded in 2001. Similarly, the Forest Owlet (*Heteroglaux blewitti*)–recently rediscovered (after 117 years), which has only

an estimated 50% chance of survival over the next decade without concerted conservation action. However, due to the stringent measures taken in the last three years, only 98 individuals of the Forest Owlet were observed in Maharashtra, of these 79 were found in Melghat Tiger Reserve (MTR) and 19 individuals were found in Toranmal Reserve Forest. Encroachments, increasing use of pesticide and rodenticides, illicit woodcutting, grazing are said to be the main threats of Forest Owlet. Community management, joint forest management and public awareness are the key factor in long-term conservation of the species. Recently a severe vulture decline in India has been observed especially the three vulture species viz., Long-billed Vulture *Gyps indicus*; White-backed Vulture *Gyps bengalensis* and Slender-billed Vulture *Gyps tenuirostris*. 98% of decline in population of all above mentioned species is during the last 10-12 years. Early evidence suggested that a viral disease may have been the causal agent, but there is now strong evidence that *Gyps* vultures are fatally susceptible to veterinary painkiller diclofenac, however no conclusion has been arrived at due to various reasons. Therefore, the Conservation measures proposed are

- Identify the location and number of remaining individuals.
- Measure the frequency of diclofenac treated carcasses available to vultures.
- Gain government commitment to control veterinary use of diclofenac, and support species management or restoration, as needed.
- Initiate public awareness and public support programmes.

Another important factor that is affecting the bird population is the introduction of exotic fishes in the natural waters of the country. For ex., Introduction of common carps eliminated indigenous Schizothoracinae from the Kashmir valley, *Osteobrama belangari* from Loktak wetland, *H. periyarensis* from Periar Lake, Kerala. Introduction of larvicidal fishes (*G. affinis & P. reticulata*) eliminated indigenous species such as *Aplocheilus parvus* and *Oryzias melastigma* and introduction of Gangetic carps to Peninsular rivers affected the indigenous carps of the Peninsula.

List Critically Endangered Species of Birds as per IUCN (2006)

Pink-headed Duck *Rhodonessa caryophyllacea*
White-rumped Vulture *Gyps bengalensis*
Indian Vulture *Gyps indicus*
Slender-billed Vulture *Gyps tenuirostris*
Himalayan Quail *Ophrysia superciliosa*
Siberian Crane *Grus leucogeranus*
Sociable Lapwing *Vanellus gregarius*
Jerdon's Courser *Rhinoptilus bitorquatus*
Forest Owlet *Heteroglaux blewitti*

List of Endangered Species of Birds (IUCN-2006)

White-bellied Heron *Ardea insignis*
Greater Adjutant *Leptoptilos dubius*
White-headed Duck *Oxyura leucocephala*
White-winged Duck *Cairina scutulata*
Saker Falcon *Falco cherrug*
Great Indian Bustard *Ardeotis nigriceps*
Bengal Florican *Houbaropsis bengalensis*
Lesser Florican *Sypheotides indicus*
Spotted Greenshank *Tringa guttifer*
Spoon-billed Sandpiper *Eurynorhynchus pygmeus*
Rufous-breasted Laughing thrush *Garrulax cachinnans*

Vulnerable species list IUCN-2006

Dalmatian Pelican *Pelecanus crispus*
Spot-billed Pelican *Pelecanus philippensis*
Lesser Adjutant *Leptoptilos javanicus*
Marbled Teal *Marmaronetta angustirostris*
Baer's Pochard *Aythya baeri*
Pallas's Fish-eagle *Haliaeetus leucoryphus*
Nicobar Sparrowhawk *Accipiter butleri*
Indian Spotted Eagle *Aquila hastata*
Greater Spotted Eagle *Aquila clanga*
Imperial Eagle *Aquila heliaca*
Lesser Kestrel *Falco naumanni*
Nicobar Megapode *Megapodius nicobariensis*
Swamp Francolin *Francolinus gularis*
Manipur Bush-quail *Perdicula manipurensis*
Chestnut-breasted Partridge *Arborophila mandellii*
Western Tragopan *Tragopan melanocephalus*
Blyth's Tragopan *Tragopan blythii*
Sclater's Monal *Lophophorus sclateri*
Cheer Pheasant *Catreus wallichi*
Green Peafowl *Pavo muticus*
Sarus Crane *Grus antigone*

Black-necked Crane *Grus nigricollis*
Masked Finfoot *Heliopais personatus*
Houbara Bustard *Chlamydotis undulata*
Wood Snipe *Gallinago nemoricola*
Indian Skimmer *Rynchops albicollis*
Pale-backed Pigeon *Columba eversmanni*
Nilgiri Wood-pigeon *Columba elphinstonii*
Pale-capped Pigeon *Columba punicea*
Dark-rumped Swift *Apus acuticauda*
Rufous-necked Hornbill *Aceros nipalensis*
Narcondam Hornbill *Aceros narcondami*
Yellow-throated Bulbul *Pycnonotus xantholaemus*
Nicobar Bulbul *Hypsipetes nicobariensis*
Grey-sided Thrush *Turdus feae*
Rusty-bellied Shortwing *Brachypteryx hyperythra*
White-bellied Shortwing *Brachypteryx major*
White-browed Bushchat *Saxicola macrorhynchus*
White-throated Bushchat *Saxicola insignis*
Marsh Babbler *Pellorneum palustre*
Rusty-throated Wren-babbler *Spelaeornis badeigularis*
Tawny-breasted Wren-babbler *Spelaeornis longicaudatus*
Snowy-throated Babbler *Stachyris oglei*
Jerdon's Babbler *Chrysomma altirostre*
Slender-billed Babbler *Turdoides longirostris*
Black-breasted Parrotbill *Paradoxornis flavirostris*
Grey-crowned Prinia *Prinia cinereocapilla*
Bristled Grass-warbler *Chaetornis striata*
Broad-tailed Grassbird *Schoenicola platyurus*
Kashmir Flycatcher *Ficedula subrubra*
White-naped Tit *Parus nuchalis*
Beautiful Nuthatch *Sitta formosa*
Green Avadavat *Amandava formosa*
Finn's Weaver *Ploceus megarhynchus*

Source : http://www.birdlife.org/datazone/search/species-2006

Near Threatened bird Species IUCN-2006

Persian Shearwater *Puffinus persicus*
Oriental Darter *Anhinga melanogaster*
Black-necked Stork *Ephippiorhynchus asiaticus*
Black-headed Ibis *Threskiornis melanocephalus*
Lesser Flamingo *Phoenicopterus minor*
Ferruginous Duck *Aythya nyroca*
Lesser Fish-eagle *Ichthyophaga humilis*
Grey-headed Fish-eagle *Ichthyophaga ichthyaetus*
Cinereous Vulture *Aegypius monachus*
Red-headed Vulture *Sarcogyps calvus*
South Nicobar Serpent-eagle *Spilornis klossi*
Andaman Serpent-eagle *Spilornis elgini*
Pallid Harrier *Circus macrourus*
Laggar Falcon *Falco jugger*
White-cheeked Partridge *Arborophila atrogularis*
Satyr Tragopan *Tragopan satyra*
Tibetan Eared-pheasant *Crossoptilon harmani*
Hume's Pheasant *Syrmaticus humiae*
Asian Dowitcher *Limnodromus semipalmatus*
Beach Thick-knee *Esacus magnirostris*
Black-bellied Tern *Sterna acuticauda*
Andaman Wood-pigeon *Columba palumboides*
Andaman Cuckoo-dove *Macropygia rufipennis*
Nicobar Pigeon *Caloenas nicobarica*
Nicobar Parakeet *Psittacula caniceps*
Long-tailed Parakeet *Psittacula longicauda*
Andaman Scops-owl *Otus balli*
Andaman Hawk-owl *Ninox affinis*
Ward's Trogon *Harpactes wardi*
Blyth's Kingfisher *Alcedo hercules*
Brown-winged Kingfisher *Pelargopsis amauroptera*
European Roller *Coracias garrulus*
Malabar Pied-hornbill *Anthracoceros coronatus*
Great Hornbill *Buceros bicornis*

Austen's Brown Hornbill *Anorrhinus austeni*
Yellow-rumped Honeyguide *Indicator xanthonotus*
Andaman Woodpecker *Dryocopus hodgei*
Nilgiri Pipit *Anthus nilghiriensis*
Firethroat *Luscinia pectardens*
Chestnut-backed Laughingthrush *Garrulax nuchalis*
Grey-breasted Laughingthrush *Garrulax jerdoni*
Rufous-throated Wren-babbler *Spelaeornis caudatus*
Wedge-billed Wren-babbler *Sphenocichla humei*
Giant Babax *Babax waddelli*
Rufous-vented Prinia *Prinia burnesii*
Long-billed Bush-warbler *Bradypterus major*
Tytler's Leaf-warbler *Phylloscopus tytleri*
Rufous-rumped Grassbird *Graminicola bengalensis*
Black-and-rufous Flycatcher *Ficedula nigrorufa*
Nilgiri Flycatcher *Eumyias albicaudatus*
Yellow-breasted Bunting *Emberiza aureola*
Andaman Drongo *Dicrurus andamanensis*
Andaman Treepie *Dendrocitta bayleyi*

CONSERVATION

Three species (Pink headed Duck, Mountain Quail, and Forest Owlet) are suspected to be extinct. Jerdon's Courser, which was considered to be extinct, was rediscovered. Altogether, 130 species in India are of conservation concern (IUCN, 2006), of which 9 species are listed as critically endangered, 11 species are endangered, 54 species are vulnerable and 54 species are Near Threatened, and three are data deficient. The list of Indian birds include 29 of forest and woodland threatened species, 14 of grassland threatened species, one of desert threatened species, 4 of scrub threatened species, 29 of wetland (including littoral habitat) threatened species The Protected Area Network (Sanctuaries and National Parks), Wildlife (Protection) Act of 1972, signing the CITES Treaty to check International trade, and captive breeding are some of the steps initiated for conservation.

List of Aves under Wildlife (Protection) Act, 1972

Schedule–I Part : III

Anas gibberifrons allagularis (Andaman Teal)
Bambusicola fytchii (Assam Bamboo Paratridge)

Aveceda jeordone and *Aviceda leuphoes* (Bazas)
Eupodotis bengalensis (Bengal florican)
Grus nigricollis (Black necked Crane)
Ithaginis cruentus tibetanus & Ithaginis cruentus kuseri (Blood Pheasants)
Catreus wallichii (Cheer Pheasant)
Cyconia cyconia boyciana (Eastern white Stork)
Athene blewitti (Forest spotted Owlet)
Batrachostomous spp. (Frogmouths)
Chlorotis nigriceps (Great Indian Bustard)
Buceros bicornis (Great Indian Hornbill)
Accipetri dao (Hawks)
Grus monacha (Hooded Crane)
Ptilolaemus tickelli austeni, Aceros nipalensis, Rhyticeros undulates ticehursti (Hornbill)
Rhyticeros (Undulatus) narcondmani (Narcondam Hornbill)
Chlamydotis undulata (Houbara Bustard)
Syrmaticus humiae (Humes Barbacked Pheasant)
Anthracoceros malabaricus (Indian Pied Hornbill)
Cursorius bitorquatus (Jerdon's Courser)
Gypaetus barbatus (Lammergeir)
Falco perigrinus, Falco biarmicus, Falco chiquera (Large Falcons)
Large Wistling Teal (Anatidae)
Sphoeotides indica (Lesser Floricon)
Lophophorus impeyanus, Lophophorus sclateri (Monal Pheasant)
Ophryusia superciliosa (Mountain Quail)
Caloenas nicobarica palewensis (Nicobar pigeon)
Pandion haliatetus (Osprey or Fish-eating Eagle)
Polypectrodon bicalcaratum (Peacock Pheasant)
Pavo cristatus (Peafowl)
Rhodonessa caryophyllacea (Pink-headed Duck)
Lophophorous sclateri (Sclater's Monal)
Grus leucogeranus (Siberian White Crane)
Tetraogallus melanocephalus, Tragopon blythii, Tragopon satyra, Tragopon temminckii (Tragopan Pheasants)
Haliaetus leucogaster (White bellied Sea Eagle)
Crassoptilon crassoptilon (White eared Pheasant)

Platalea leucoroidea (White Spoonbill)

Cairinia scutellata (White winged Woodduck)

Collocallia unicolor & Collocallia fusifaga (Swiftlets)

Gracula religiosa intermedia, Gracula religiosa peninsularis, Gracula religiosa indica and *Gracula religiosa amanensis* (Hill Myna)

Crassoptilon harmani (Tibetan ear Pheasant)

Lophurus leucomelana (Kilji Pheasant)

Psittacula derbyana (Lord Derby's Parakeet)

Gyps indicus, Gyps bengalensis, Gyps tenuirostris (Vultures)

Ardea insignis (White bellied Heron)

Schedule–IV

Birds other than those, which appear in other Schedules

Avadavat (Estrilidinae)

Avocet (Recurvirostridae)

Babblers (Timalinae)

Barbets (Capitonidae)

Barn owls (Tyto nknae)

Bitterns (Ardeidae)

Brown headed Gull (Larus *brunnicephalus*)

Bulbuls (Pycnonotidae)

Buntings (Emberizidae)

Bustords (Otididae)

Bustard Quails (Turnicidae)

Chloropsis (Irenidae)

Comb duck (*Sarkidiornis melanotus*)

Coots (Rallidae)

Cormorants (Phalacrocoracidae)

Cranes (Gruidae)

Cuckoos (Cuculidae)

Curlews (Scolopacinae)

Darters (Phalacrocoracidae)

Doves including Emarad Dove (Columbidae)

Drongoes (Dicruridae)

Ducks (Anatidae)

Egrets (Ardeidae)

Fairy blue birds (Irenidae)

Falcons (Falconidae) excepting the Shaheen and Perigrine falcons (*Falco perigrinus*) the shaker or chirrug, shanghar and lagger falcons (*Falco biarmicus*) and red headed merlin (*Falco chiquera*)

Finches including the Chaffinch (Fringillidae)

Flamingos (Phoenicopteridae)

Flowerpeckers (Dicaeidae)

Flycatchers (Muscicappidae)

Geese (Anatidae)

Goldfinch and allies (Carduelinae)

Grebes (Policipididae)

Herons (Ardeidae)

Ibises (Threskiornithidae)

Ioras (Irenidae)

Jays (Corvidae)

Jacanas (Jacanidae)

Junglefowl (Phassianidae)

Kingfishers, Larks (Alcedinidae)

Lorikeets (Psittacidae)

Magpies including the hunting Magpie (Corvidae)

Manikins (Estrilidinae)

Megapodes (Megapodidae)

Minavets (Campephagidae)

Munias (Sturnidae)

Nightjars (Caprimulgidae)

Orioles (Oriolidae)

Owls (Strigidae)

Oyster catchers (Haemantopidae)

Parakeets (Psittacidae)

Patridges (Phasianidae)

Pigeons (Columbidae) except Blue rock Pigeon (*Columba liva*)

Pipits (Motacillidae)

Pitas (Pittidae)

Plovers (Charadrinae)

Quails (Phasianidae)

Rails (Rallidae)

Rollers or Blue Jays (Coraciidae)

Sandgrouses (Pteroclididae)
Sandpipers (Scolopacinae)
Spurfolws (Phasianidae)
Starlings (Sturnidae)
Stone Curlews (Burhinidae)
Storks (Ciconidae)
Stilts (Recurvirostridae)
Sunbirds (Nectarinidae)
Swans (Anatidae)
Teals (Anatidae)
Thrushes (Turadinae)
Tits (Paridae)
Tree Pies (Corvidae)
Trognons (Trogonidae)
Vultures (Accipetridae)
Waxbills (Extridinae)
Baya or Weaver birds (Ploceidae)
White-eyes (Zosteropidesa)
Woodpeckers (Picidae)
Wrens (Troglodytidae)

Medicinal properties of aves identified by Sidda, Unani and Aurveda

Name of the species	Uses
Leptoptilos dubius (Adjutant stork)	**Eggs** : These are of value in curing leprosy. **Bile** : It is used with oil of *Viola odorata* for hemicrania. **Excreta** : Pessary of excreta acts as an abortifacient agent. **Skin and Feather** : Powdered skin is styptic and healing. It is beneficial in ring worm cases
Gyps bengalensis Bengal Vulture	**Flesh** : is fibrous and difficult to digest. It is useful in colic, gases, renal calculi, convulsions and respiratory troubles. **Fat** : It is anti-tussive. **Excreta** : It is useful in skin pigmentation and thyroid enlargement. It is an ingredient of a plaster for bursting on non-boils. **Skin and feathers** : Ash of feathers is applied on skin rashes and for healing wounds. The fumigation of beak, feather and droppings is used in epilepsy.

Name of the species	Uses
Dicrurus macrocercus Black Drongo	Whole bird is given for the treatment of epilepsy and hysteria. Acts as anti-convulsant.
Francolinus francolinus (Black patridge)	**Flesh** : It is digestible and of value in paralysis and brain diseases. Flesh of partridges is easily digested and suited to the sick and convulsant. It is recommended for habitual use. It promotes complexion. It is constipative, cures Hikka (hiccup), and alleviates all the three Doshas. It cures Svasa (Asthama) and Kasa (Bronchitis). After conception from fourth to eight months, if Rakt srava (bleeding) occurs then to stop that the pregnant lady is given the Shorva of the meat. In fever, its Shorva is given. It Rakta Pitta this Shorva is beneficial. **Eggs** : Eggs are said to clear the voice. **Liver** : Fresh liver is given in epilepsy. **Excreta** : It is applied on skin pigmentation.
Coracias bengalensis	Anti-tussive and nutritive.
Cuculus varius	It is used in cough, hiccup, asthma and jaundice. Acts as expectorant and antibilious
Choriotis nigriceps	Anti-pyretic, nutritive and aphrodisiac. The flesh is cooling. It cures fever
Turnix tanki	**Flesh** : is useful in gastric and hepatic disorders, paralysis and dropsy. **Blood** : It is useful in eye diseases. **Bone** : Ash of bone is mixed with olive oil and is useful for baldness.
Exobrychus cinnamomeus	It purifies excreta and urine. To overcome milk related diseases of lactating mother, cooked meat is given.
Sturnus vulgaris	It is aphrodisiac, laxative, anti-tussive, and expectorant, anti-bilious, anti-diuretic. It is also easily digestible and tonic for the heart, liver, kidney and general body condition. It is useful in melancholia, tuberculosis and piles.
Anas crecca	**Flesh** : It promotes voice, complexion and strength, increases body weight. It has also anti-inflammatory and lithostriptic properties. **Blood** : It is useful in cystic calculi and cystic colic. **Egg** : Yolk is emmenagogue and anti-tussive. It improves intelligence. Eggshell powder is indicated in diarrhoea and dysentery.

Name of the species	Uses
	Liver : It is delicious and used as a tonic dietary article. **Brain and Spinal Cord** : External application is useful in proctitis, inflammations, spasms and exfoliation of skin. **Excreta** : It is good for dry cough.
Corvus splendens	**Parts Used** : Flesh, beak, feather, blood, bile, skin, hair and whole organism **Flesh** is beneficial in ulcer, phthisis and eye diseases. In the treatment of poisoning, Charaka prescribed meat of crow. The fumigation of beaks feathers and faeces of crow is applied for the alleviation of epilepsy. **Whole organism** : Live bird with some iron dust and vinegar, is put in a vessel and buried in horse dung for 40 days. This procedure causes disintegration of the birds' flesh and exudation of an oily substance. The latter is used for blackening grey hair and stimulating hair growth. **Blood** : Dried blood forms a useful application in piles. **Bile** : It is useful in eye diseases. **Skin and Feather** : Ash of feather promotes hair growth.
Centropus sinensis	**Flesh** : is of value in splenic enlargement. It is strength promoting and wholesome. **Bile** : is used for treating eye diseases. **Excreta** : is useful in skin pigmentation.
Eudynamis scolopaceus	It removes phlegmatic tumours. It is also used in dimness of the vision, premature greying of the hair and complexion disorders. It is good for eyesight, complexion and greying hair.
Anthropoides virgo	It is laxative. It promotes strength and easily digestible
Anas acuta	**Flesh** : It is appetizing, demulcent, anti-tussive, cardiotonic, nutrient and aphrodisiac. It improves complexion, voice and used in general weakness and emaciation. **Eggs** : Stimulant, cardiotonic, immediately strength-promoting and aphrodisiac.
Tadorna ferruginea	**Flesh** : It is difficult to digest but nutritive and aphrodisiac **Blood** : Administration of blood with salt and water is beneficial in *cystic calculi* and *cystic coli.* **Eggs** : Eggs are difficult to digest but are good for chest pain, dry cough and improvement of memory. Powdered eggshell is used for the treatment of dysentery.

Name of the species	Uses
	Brain : Local application of brain is useful in inflammation of anus. **Excreta** : External application is useful in freckles and scrofula. **Skin and Feather** : Ash of feather forms a useful application for freckles and scrofula.
Haliaectus leucoryphus	Anti-tussive. Its soft feathers Kshara are given in hiccup, chronic asthma
Falco peregrine	**Flesh** is fibrous, indigestible, of no nutritive value. It is useful in toxaemic conditions, inflammations and cataract. **Blood** is instilled in eyes for curing blurred vision and eye diseases. **Bile** is applied on snakebite wound. It is instilled in eyes for curing blurred vision and eye diseases.
Coturnix coturnix	**Flesh** : It is nutritive, fattening, aphrodisiac, diuretic, anti-tussive, emmenogogue and lithontriptic. It is recommended for paralysis, facial paralysis and gout. It is delicious and promotor of strength. **Blood** : It is instilled in ear for alleviating earache. **Heart** : are useful in palpitation. **Bile** : It is given for the treatment of epilepsy. **Excreta** : It is applied on freckles and lentigo. **Skin and Feather** : Fumes of feathers possess anti-pyretic properties.
Chalcophaps indica	It is given in epistaxis.
Francolinus pondicerianus	**Flesh** is used in tuberculosis, jaundice, hiccup, asthma. Flesh is easily digestible and suits well to the sick and convulsant subjects. It improves memory. **Fat** with vegetable oils is instilled in ear for alleviating earache. **Blood** is instilled in eyes for the treatment of eye diseases. **Excreta** are useful in eye diseases.
Pelecanus philippensis	Anti-dysenteric, laxative, anti-inflammatory and nervine tonic
Gallus domesticus	**Whole Part** : Eviscerated hen is applied on snake bite wound for absorbing poison and on the foreheads of the patients of cerebritis. **Liver** : It is nutritious but difficult to digest. **Brain** : Brain tonic. Ingestion of raw brain with wine is

Name of the species	Uses
	useful in epistaxis, haemoptysis and as detoxicant in snakebite cases. **Gizzard** : Stones from the food pouch of hen are used along with other medicines for curing diarrhoea due to weakness of stomach and intestines and for the treatment of renal calculi. **Excreta** : Excreta is useful in curing leucoderma. **Scales** : Hairs from the region of rectum are applied on snakebite wound.
Ardeola greyii	**Flesh** : It cures Rakta Pitta (a disease characterized by bleeding from different parts of body, phthisis, paralysis, improvement of memory, oedema, renal and nervine disorders. **Fat** : It is applied externally on bleeding piles.
Upupa epops	Laxative, anti-epileptic, nervine tonic and aphrodisiac. **Blood** : in combination with herbal oils is useful for blackening grey hair. Instillation in eyes cures eye diseases. **Heart** : It is aphrodisiac, memory improving and of value in infantile epilepsy. **Bile** : Forms a useful application for paralysis and 'Surmas' for eye diseases.
Passer domesticus	**Flesh** : Flesh is easily digestible, Palatable, cardiotonic and aphrodisiac. It is useful in dropsy, paralysis, biliousness, jaundice and sexual debility. **Blood** : Sparrow's blood is a general tonic. **Brain and spinal chord** : For invigorating the brain and aphrodisiac **Excreta** : It forms a useful application for moles and skin diseases. **Bone & Teeth** : Powder of bones is stomachic and anti-diarrhoeic. **Skin & feather** : Ash of feathers is anti-inflammatory.
Gallinula chlorophus	It is nourishing, aphrodisiac, laxative, diuretic and check intrinsic haemorrhage.
Saxicoloides fulicata	Anti-diarrhoeal and lithotryptic
Halcyon smyrnensis	**Flesh** : It is difficult to digest but nutritive, so used for the promotion of strength
Haliastur indus	**Eggs** are boiled in oil to form a useful application for the treatment of leucoderma. **Ash of feathers** is useful in gout and tumours.

Name of the species	Uses
Vanellus indicus	It is a nervine tonic and has sleep inducing activity
Eremopterix grisea	**Flesh** : It is useful in gastric and hepatic disorders, paralysis and dropsy. It is said to be of better quality than the flesh of quail or patridges. It is in general a cardiac tonic, cooling, unctuous, constipative and digestive stimulant. **Blood** : It is useful in eye diseases **Bone** : Ash of bone mixed with olive oil is useful for baldness
Phalacrocorax niger *Pyconotus cafer*	**Flesh used in** Chronic, piles, phthisis, malabsorbed syndrome. **Flesh, Eggs, Brain and spinal chord**: aphrodisiac. **Blood** cleans voice **Excreta** is useful in eye diseases and skin pigmentation. **Skin and feathers** : Ash of feathers is wound healing.
Bubo zeylonensis	**Flesh** is beneficial for those suffering from diseases of eye. Given to cure piles and tuberculosis. Its fumigation is given in epilepsy. But by some authors, who concede that its ingestion produces gases. Others attribute no useful property to the flesh of this bird and state that it exerts harmful effect on intelligence and memory. **Blood** : It is incorporated in 'Surma for treating night blindness. **Brain** : It is mixed with oil of *Viola odorata* and instilled in nostrils for relief in hemicrania. **Bile** : It is incorporated in "Surmas" for the treatment of night blindness
Psittacula eupatria	**Flesh** is given in cough, tuberculosis, Sannipata Roga, phthisis, skin pigmentation and for healing wound. **Blood** : It is appetizing and fattening. It is used in eye diseases of children. **Heart** : If taken for three days after menstruation acts as an anti-fertility agent. **Tongue** : It is beneficial in cases of stammering. **Excreta** : Its application is beneficial in skin pigmentation
Pavo cristatus	**Flesh** is used in eye disease, deafness, imaciation, loss of appetite and contracted limbs. It is also used in poison, malaria and sexual, debility. It is given in diseases of enlargement of liver and spleen. Soup is recommended for the treatment of headache, colics, pleurisy and gout. The

Name of the species	Uses
	meat of peacock in diet should be used in intermittent fever. The intake of well-processed meat alleviates dimensia. The ash of Padanala with honey is used in cough, asthma and hiccup. The ash of feather is used in nausea, vomiting, hiccup and poisoning. **Fat** : Fat is aphrodisiac. **Blood of Peacock** with other medicaments forms a useful application for the treatment of malignant ulcers. **Egg** : Oral ingestion and local application is indicated in snakebite cases. **Bile** : It is antihelminthic and anti-diarrhoeic. **Excreta** : It is useful in piles and brain diseases.
Columba livia	**Flesh** : It is used in constipation. It also alleviates internal haemorrhage. It is beneficial in paralysis, trembling, dropsy, asthma, respiratory affections and leprosy, but is harmful in Jaundice. Pigeon's chick (Chooza) cooked in sesame oil without salt is used in the treatment of *renal* and *cystic calculi*. If cooked in its own fat, it is a very good sexual tonic. **Excreta** : It forms a useful application for leucoderma, rheumatism, burns, inflammation, headache, hemicrania, epistaxis and dropsy. Ingestion produces sterility in women. Ash with the juice of raddish is lithotriptic. **Blood** : Fresh blood of pigeon's chicken is applied on forehead for the treatment of epistaxis. It is also useful in eye diseases. **Egg** : Pigeon's eggs are useful in congestion of chest. They improve complexion and when given with honey, induce early speaking ability in children. **Bone** : Ash of bones is given in betel for the treatment of asthma.
Saxicola caprata	Meat soup is useful in paralysis, facial paralysis, convulsions and dementia and ash in renal calculi. Acts as anti-convulsant, lithotriptic and nervine tonic
Streptopelia risoria	**Flesh**: It cures Rakta Pitta (a disease characterized by bleeding from different parts of the body). It is good for people of cool and phlegmatic temperaments. **Eggs** : Eggs are given to children from inducing early speaking ability. Oil extracted from the eggs is massaged on their legs to induce them to walk at an early stage.

Name of the species	Uses
Streptopelia chinensis	**Flesh and soup** are useful in paralysis, trembling and nervous disorders. It is wholesome. But meat of house dove cure Rakta Pitta (a disease of characterized by bleeding from different parts of the body) **Blood** : it is instilled for benefit in eye diseases. **Excreta** with vinegar is useful in skin pigmentation. **Feathers** - fumigation from burnt feathers is good for quartan fever
Lanius vittatus	**Flesh is used in** polyurea.
Mycteria leucocephala	**Flesh** is stomachic and useful in sexual problems and nervine disorders (both sensory and mortor). **Blood** : It is applied externally in skin diseases. **Egg** : Its local application is useful in epilepsy and for blackening grey hair. **Bile** : It is used for the treatment of night blindness. **Excreta** : It is useful in skin diseases.
Hirundo rustica	**Flesh** : It is useful in jaundice, phlegmatic ailments and epistaxis. Ash is made into as aqueous solution. Its gargles are useful in throat infections. Avicenna (Unani Physician) recommended the use of the ash of birds head with honey for the treatment of cataract. **Blood** is used as an external application in skin diseases. **Brain and Spinal Chord**: Avicenna recommended the use of ash of the bird's head with honey for the treatment of cataract. **Excreta** : External application is useful in skin diseases.
Motacilla maderaspatensis	Flesh is given with honey for relief in renal and cystic calculi and urinary obstruction
Cisticola juncidis	Anti-spasmodic and lithotriptic.
Ploceus philippinus	Flesh is anti-diuretic and reduces the quantity of faeces.

Source : Central council for Research in Auyurveda & Sidda

MAMMALIA

The mammalian fauna of the world is represented by 4629 species belonging to 1135 genera, 136 families and 26 orders (Wilson and Reeder, 1993). Of these, 397 species belonging to 179 genera, 44 families and 13 orders are found in the Indian Union. Another 13 orders do not occur in our country. The egg-laying mammals belonging to the order

Monotremata are found only in Australia, Tasmania and New Guinea; 7 orders of Marsupials are distributed in Australia, Indonesia and South America, orders Hyracoidea, Tilidentata and Macroselidea in Africa; order Xenarthra in South America; and order Dermoptera in Java, Sumatra and the Philippines.

Information on the mammalian diversity and utilization dates back to "Vedas" (Rao, 1957) and Linnaeus (1756) describing several Indian species in his monumental work on "*Systema naturae*" Though several workers attempted to study the Indian mammals (Tickel, Horsfield, Hutton, Blyth, Hardwicke, Gray, Hodgson and others during second and third quarters of nineteenth century), the real picture emerged for the first time from the work of Jerdon (1857). A consolidated account of the Indian mammals emerged from the work of Sterndale (1884), Blanford (1888-91), Anderson (1881) and Sclater (1891). A clear picture of the diversity and distribution of Indian mammals came from the work of Pocock (1939-41) on carnivore; Ellerman (1961) on rodentia; Prater (1980) and recently by Prakash (1995), Chakraborty and Agrawal (2000), Alfred et.al. (2002) and others.

An order-wise break up of families, genera and species found in India as against the total number found throughout the world is given below :

Orders	Families		Genera		Species	
	India	World	India	World	India	World
Insectivora	3	7	11	66	28	428
Scandentia	1	1	2	5	3	19
Chiroptera	7	17	34	177	112	925
Primates	3	13	6	60	15	233
Pholidota	1	1	1	1	2	7
Carnivora	7	11	35	129	60	271
Proboscidia	1	1	1	2	1	2
Sirenia	1	2	1	3	1	5
Perissodactyla	2	3	2	6	3	18
Artiodactyla	5	10	21	81	31	220
Lagomorpha	2	2	3	13	11	80
Rodentia	4	29	43	443	104	2021
Cetacea	7	10	19	41	26	78
TOTAL	**44**	**107**	**179**	**1027**	**397**	**4307**

Checklist of Mammals of India

Sl. No. Species	Common English Name
Order INSECTIVORA Family ERINACEIDAE Subfamily ERINACEINAE Genus ***Hemiechinus Fitzinger,*** 1866	
1. *Hemiechinus collaris* (Gray, 1830)	Indian Long eared Hedgehog
2. *Hemiechinus micropus* (Blyth, 1846)	Indian Hedgehog
3. *Hemiechinus nudiventris* Horsfield, 1851)	South Indian Hedgehog
Family SORICIDAE Subfamily CROCIDURINAE Genus ***Crocidura Wagler,*** 1832	
4. *Crocidura andamanensis* Miller, 1902	Andaman White toothed Shrew
5. *Crocidura attenuata* Milne Edwards, 1872	Gray Shrew
6. *Crocidura hispida* Thomas, 1913	Andman Island Spiny Shrew
7. *Crocidura horsfieldi* (Tomes, 1856)	Horsfield's Shrew
8. *Crocidura jenkensi* Chakraborty, 1978	Jenkin's Shrew
9. *Crocidura nicobarica* Miller, 1902	Nicobar Spiny Shrew
10. *Crocidura pergrisea* Miller, 1913	Pale Gray Shrew
11. *Crocidura pullata* Miller, 1913	None
12. *Crocidura fuliginosa (Blyth, 1855)*	South Asian White toothed Shrew
Genus ***Feroculus Kelaart,*** 1852	
13. *Feroculus feroculus*	Kelaart's Long Clawed Shrew
Genus ***Suncus Ehrenberg,*** 1832	
14. *Suncus dayi* (Dobson, 1888)	Day's Shrew
15. *Suncus montanus* (Kelaart, 1850)	Hill Shrew
16. *Suncus etruscus* (Savi, 1822)	Savis's Pygmy Shrew
17. *Suncus murinus* (Linnaeus, 1766)	House Shrew
18. *Suncus stoliczkanus* (Anderson,1877)	Anderson's Shrew
Subfamily SORICINAE Genus ***Anourosorex*** Milne–Edwards, 1872	
19. *Anourosorex squamipes* Milne Edwrds, 1872	Mole Shrew/Szechuan Burrowing Shrew
Genus ***Chimarrogale*** Andersen, 1877	
20. *Chimmarrogale himalayica* (Gray, 1842)	Himalayan Water Shrew

Sl. No. Species	Common English Name
Genus ***Nyctogale*** Milne-Edwards, 1870	
21. *Nyctogale elegans* Milne Edwards, 1872	Elegant Water Shrew
Genus ***Sorex*** **Linnaeus,** 1758	
22. *Sorex minutus* Linnaeus,1766	Lesser Shrew
Genus ***Soriculus*** Blyth, 1854	
23. *Soriculus caudatus* (Horsfield,1851)	Hodgsons Brown toothed shrew
24. *Sorioculus leucops* (Hodgson,1855)	Indian Long tailed Shrew
25. *Soriculus macrurus* Blanford, 1888	Arboreal Brown toothed Shrew
26. *Soriculus nigriscens* (Gray, 1842)	Sikkim Large Clawed Shrew
Family TALPIDAE Subfamily TALPINAE Genus ***Euroscapter*** Miller, 1940	
27. *Euroscapter micrura* (Hodgson, 1841)	Himalayan mole
Genus ***Parascaptor*** Gill, 1875	
28. *Parascaptor leucura* (Blyth, 1850)	Eastern Mole
Order SCANDENTIA Family TUPAIIDAE Subfamily TUPAIINAE Genus ***Anathana*** Lyon, 1913	
29. *Anathana ellioti* Waterhouse, 1850	Madras Tree Shrew
Genus ***Tupaia*** Raffles, 1821	
30. *Tupaia belangeri* (Wagner, 1841)	Common Tree Shrew
31. *Tupaia nicobarica* (Zelbor, 1869)	Nicobar Tree Shrew
Order CHIROPTERA Suborder MEGACHIROPTERA Family PTEROPODIDAE Genus ***Cynopterus*** Cuvier, 1824	
32. *Cynopterus brachyotis* (Mueller, 1838)	Lesser Dogfaced Fruit Bat
33. *Cynopterus sphinx* (Vahl, 1797)	Short nosed Fruit Bat
Genus ***Latidens*** Thonglongya, 1972	
34. *Latidens salimali* Thonglongya, 1972	Fruit Bat
Genus ***Megarops Peters,*** 1865	
35. *Megarops niphanae* Yenbutra & Felton, 1983	Niphan's Tailes Fruit Bat

Sl. No. Species	Common English Name
Genus ***Pteropus*** Erxleben, 1777	
36. *Pteropus fanulus* Miler, 1902	Nicobar Flying Fox
37. *Pteropus giganteus* (Brunnech, 1782)	Indian Flying Fox
38. *Pteropus Melanotus* Blyth, 1863	Nicobar Flying Fox
39. *Pteropus vampyrus* (Linnaeus, 1758)	Malayan Large Flying Fox
Genus ***Rousettus*** Gray, 1821	
40. *Rousettus leschenaulti* (Desmarest, 1821)	Fulvus Fruit Bat
Genus ***Sphaerias*** Miller, 1906	
41. *Sphaerias blanfordi* (Thomas, 1891)	Blanford's Fruit Bat
Subfamily MACROGLOSSINAE Genus ***Eonycterias*** Dobson, 1873	
42. *Eonycterias spelaea* (Dobson, 1871)	Long tongued Fruit Bat
Genus ***Macroglossus*** Cuvier, 1824	
43. *Macroglossus sobrinus* Anderson, 1911	Hill Long tongued Fruit Bat
Suborder MICROCHIROPTERA Family RHINOPOMATIDAE Genus ***Rhinopoma*** Geoffroy 1818	
44. *Rhinopoma hardwickii* Gray, 1831	Lesser Mouse Tailed Bat
45. *Rhinopoma microphyllum* (Brunnech,1782)	Greater Mouse Tailed Bat
Family EMBALLONURIDAE Genus ***Saccolaimus*** (Temminck, 1838)	
46. *Saccolaimus saccolaimus* (Temminck, 1831)	Pouch bearing Bat
Genus ***Taphozous*** Geoffroy, 1818	
47. *Taphozous longimanus* Hardwicke, 1825	Long winged Tomb bat
48. *Taphozous melanopogon* Temminck, 1841	Black bearded Tomb Bat
49. *Taphozous nudiventris* Ctretzschmar, 1830	Naked Rumped Tomb Bat
50. *Taphozous perforatus* Geoffroy, 1818	Egyptian Tomb Bat
51. *Taphozous theobaldi* Dobson, 1872	Theobald's Tomb Bat
Family MEGADERMATIDAE Genus ***Megaderma,*** Geoffroy, 1810	
52. *Megaderma lyra* Geoffroy, 1810	Indian/Greater False Vampire
53. *Megaderma spasma* (Linnaeus, 1758)	Lesser False Vampire
Family RHINOLOPHIDAE Subfamily RHINOLOPHINAE Genus ***Rhinolophus*** Lacepede, 1799	

Sl. No.	Species	Common English Name
54.	*Rhinolophus affinis* Horsfield, 1823	Intermediate Horseshoe Bat
55.	*Rhinolophus cognatus* Andersen, 1906	Little Andaman Horseshoe Bat
56.	*Rhinolophus ferrumequinum* (Schreber, 1774)	Greater Horseshoe Bat
57.	*Rhinolophus hipposideros* (Bechstein, 1800)	Lesser Horseshoe Bat
58.	*Rhinolophus lepidus* Blyth, 1844	Blyth's Horseshoe Bat
59.	*Rhinolophus luctus* Temminck, 1835	Great EasternHorseshoe Bat
60.	*Rhinolophus macrotis* Blyth, 1844	LargearedHorseshoe Bat
61.	*Rhinolophus mitratus* Blyth, 1844	Blyths'Horseshoe Bat
62.	*Rhinolophus pearsonii* Horsfield, 1851	Pearson'sHorseshoe Bat
63.	*Rhinolophus rouxii* Temminck, 1855	PeninsularHorseshoe Bat
64.	*Rhinolophus pusillus* Temminck, 1835	Least Horseshoe Bat
65.	*Rhinolophus subbadius* Blyth, 1844	Nepal Horseshoe Bat
66.	*Rhinolophus trifoliatus* Temminck, 1834	Trefoil Horseshoe Bat
67.	*Rhinolophus yunanensis* Dobson, 1872	Dobson's Horseshoe Bat
Subfamily HIPPOSIDERINAE Genus ***Coleops*** Blyth, 1848		
68.	*Coleops frithi* Blyth, 1848	Tail less leaf Nosed Bat
Genus ***Hipposideros*** Gray, 1831		
69.	*Hipposideros armiger* (Hodgson, 1835)	Himalyan Leaf Nosed Bat
70.	*Hipposideros ater* (Templeton, 1848)	Dusky Leaf nosed Bat
71.	*Hipposideros cineraceus* Blyth, 1853	Least Lef nosed Bat
72.	*Hipposideros diadema* Geoffroy, 1813	Large Malay Leafnosed Bat
73.	*Hipposideros durgadasi* Khajuria, 1970	None
74.	*Hipposideros fulvus* Gray, 1838	Fulvus Leaf nosed Bat
75.	*Hipposideros galeritus* Cantor, 1846	Cantor's Leafnosed Bat
76.	*Hipposideros hypophyllus* Kock & Bhat 1994	None
77.	*Hipposideros lankadiva* Kelaart, 1850	None
78.	*Hipposideros larvatus* (Horsfield, 1823)	Horsfield's Leaf nosed Bat
79.	*Hipposideros pomona* Anderson 1918	Anderson's Leaf nosed Bat
80.	*Hipposideros scgustaceus* Anderson 1918	None
81.	*Hipposideros speoris* (Schneider, 1800)	Schneider's Leaf nosed Bat

Sl. No. Species	Common English Name
Family VESPERTILLIONIDAE Subfamily KERIVOULINAE Genus ***Kerivoula*** Gray, 1842	
82. *Kerivoula hardwickii* (Horsfield, 1824)	Hardwicke's Forest Bat
83. *Kerivoula papillosa* (Temminck, 1840)	Papillose Bat
84. *Kerivoula picta* (Pallas, 1767)	Painted Bat
Subfamily VESPERTILLIONIDAE Genus ***Barbastella***, Gray, 1821	
85. *Barbastella leucomelas* Ctretzschmar, 1830	Eastern Barbastella
Genus ***Episticus*** Rafinisque, 1820	
86. *Episticus nilssoni* (Keyserling & Blasius 1839)	Northern Bat
87. *Episticus pachyotis* (Dobson, 1871)	Thick eared Bat
88. *Episticus serotinus* (Schreber, 1774)	Serotine
89. *Episticus tatei* (Ellerman & Morrison, 1951)	None
Genus ***Hesperoptenus*** Peters, 1868	
90. *Hesperostenus ticklli* (Blyth, 1851)	Tickell's Bat
Genus ***Ia Thomas***, 1902	
91. *Ia io* Thomas, 1902	Great Evening Bat
Genus ***Myotis*** Kaup, 1829	
92. *Myotis annectans* (Dobson, 1871)	Intermediate Bat
93. *Myotis blythii* (Tomes, 1857)	Lesser Mouse eared Bat
94. *Myotis daubentoni* (Kuhl, 1817)	Daubenton's Bat/Water Bat
95. *Myotis formosus* (Hodgson, 1835)	Hodgson's Bat
96. *Myotis hasseltii* (Temminck, 1840)	Lesser Large toothed Bat
97. *Myotis horsfieldii* (Temminck, 1840)	Lesser Large toothed Bat
98. *Myotis longipes* (Dobson, 1873)	None
99. *Myotis montivagus* (Dobson, 1874)	Burmese Whiskered Bat
100. *Myotis muricola* ((Gray, 1846)	None
101. *Myotis mystacinus* (Kuhl, 1817)	Whiskered Bat
102. *Myotis scicarius* (Thomas, 1915	None
103. *Myotis silligorensis* (Horsfield, 1855)	Himalyan Whiskered Bat
Genus ***Nyctalus*** Bowdich, 1825	

Sl. No. Species	Common English Name
104. *Nyctalus leisleri* (Kuhl, 1817)	Liesler's Bat
105. *Nyctalus montanus* (Barrett-Hamilton, 1906)	None
106. *Nyctalus noctula* (Schreber, 1774)	Common Noctule
Genus ***Otonycteris*** Peters, 1859	
107. *Otonycteris hemprichii* Peters, 1859	Hemprich's Long eared Bat
Genus ***Pipistrellus*** Kaup, 1829	
108. *Pipistrellus affinis* (Dobson, 1871)	Chocolate Bat
109. *Pipistrellus babu* Thomas, 1915	Babu's Pipistrelle
110. *Pipistrellus cadornae* Thomas, 1916	Thomas's Pipistrelle
111. *Pipistrellus ceylonicus* Kelaart, 1852)	Kelaart's Pipistrelle
112. *Pipistrellus circumdatus* Temninck, 1840	Large Black Pipistrelle
113. *Pipistrellus coromandra* (Gray, 1838)	Indian Pipistrelle
114. *Pipistrellus dormeri* (Dobson, 1875)	Dormer's Bat
115. *Pipistrellus javanicus* (Gray, 1838)	Javan's Pipistrelle
116. *Pipistrellus kuhlii* (Kuhl, 1817)	Kuhl's Pipistrelle
117. *Pipistrellus mimus* Wroughton, 1899	Indian Pygmy Pipistrelle
118. *Pipistrellus patrerculus* Thomas, 1915	Paternal Pipistrelle
119. *Pipistrellus pipistrellus* Schreber, 1774)	Common pipistrelle
120. *Pipistrellus peguensis Sinha, 1969*	None
121. *Pipistrellus savi* (Bonapaerte, 1837)	Savi's Pipistrelle
Genus ***Plecotus*** Geoffroy, 1818	
122. *Plecotus auritus* Linaneus, 1758	Brown Big eared Bat
123. *Plecotus austriacus* Fischer,1829	Common Long eared Bat
Genus ***Scotecus*** Thomas 1901	
124. *Scotoecus pallidus* (Dobson, 1876)	Yellow Desert Bat
Genus ***Scotomanes*** Dobson, 1875	
125. *Scotomanes emarginatus* (Dobson, 1871)	Large eared Yellow Bat
126. *Scotomanes ornatus* (Blyth, 1851)	Harlafuin Bat
Genus ***Scotophilus*** Leach, 1821	
127. *Scotophilus heathi* Horsfield, 1831	None
128. *Scotophilus kuhli* Leach, 1821	None
Genus ***Tylonictris*** Peters, 1872	
129. *Tylopnycteris pachypus* (Temminck, 1840)	Bamboo Bat, Club footed Bat

Sl. No. Species	Common English Name
Subfamily MURININAE Genus ***Harpiocephalus*** Gray, 1842	
130. *Harpiocephalus harpia* (Temminck, 1840)	Hairy winged Bat
Genus ***Murina*** Gray, 1842	
131. *Murina aurata* Milne-Edwards, 1872	Little tubenosed Bat
132. *Murina cyclotis* Dobson, 1872	Round Eared Tubenosed Bat
133. *Murina grisea* Peters, 1872	Peters Tube nosed Bat
134. *Murina huttoni* (Peters, 1872)	Hutton's Tube nosed Bat
135. *Murina leucogaster* Milne–Edwards, 1872	Greater Tube nosed Bat
136. *Murina tubinaris* (Scully, 1881)	Scully's Tube nosed Bat
Subfamily MINIOPTIRINAE Genus ***Miniopterus*** Bonaparte, 1837	
137. *Miniopterus magnater* Sanborn, 1931	None
138. *Miniopterus pusillus* Dobson, 1876	None
139. *Miniopterus schreibersi* (Kuhl, 1817)	Schreiber's Bat
Family MOLOSSIDAE Genus ***Chaerophon***	
140. *Chaerophon plicata* (Buchnan, 1800)	Wrinkle lipped Bat
Genus ***Otomops*** (Thomas, 1913)	
141. *Otomops wroughtoni* Thomes, 1913)	Wroughton's Freetailed Bat
Genus ***Tadarida*** Rafinisque, 1814	
142. *Tadarida aegyptiaca* (Geoffroy, 1818)	Egyptian Freetailed Bat
143. *Tadarida teniotis* Rafinisque, 1814	European Freetailed Bat
Order PRIMATES Family LORIDAE Genus ***Loris***	
144. *Loris tardigradus* Linnaeus, 1758	Slender Loris
Genus ***Nycticebus*** Geofroy, 1812	
145. *Nycticebus coucang* Boddaert, 1785	Slow Loris
Family CERCOPITHECIDAE Subfamily CERCOPITHICINAE Genus ***Macaca*** Lacepede, 1799	
146. *Macaca arctoides* (Geoffroy, 1831)	Stump tailed Macaque
147. *Macaca assamensis* (M'Clelland, 1840)	Assamese Macaque

Sl. No. Species	Common English Name
148. *Macaca fuscicularis* (Raffles, 1821)	Crab eating Macaque
149. *Macaca mulatta* (Zimmermann, 1870)	Rhesus Macaque
150. *Macaca nemestriana* (Linaneus, 1766)	Pig tailed Macaque
151. *Macaca radiata* (Geoffroy, 1812)	Bonet Monkey
152. *Macaca silenus* (Linaneus, 1758)	Lion tailed Macaque
Sufamily COLOBINAE Genus ***Semnopithecus*** Desmarest, 1822	
153. Semnopithecus *entellus* (Duffresne, 1797)	Langur
Genus ***Trachypithecus*** Reichenbach, 1862	
154. *Trachypithecus geei* (Khajuria, 1956)	Golden/Golden Leaf Langur
155. *Trachypithecus johni* (Fischer, 1829)	Nilgiri Langur
156. *Trachypithecus pharyei* (Blyth, 1847)	Phayre's Leaf Monkey
157. *Trachypithecus pileatus* (Blyth, 1843)	Capped Langur
Family HYLOBATIDAE Genus ***Hylobates*** (Harlan, 1834)	
158. *Bunopithecus hoolock* (Harlan, 1834) *(Hyalobates hoolock)*	Holock Gibbon
Order CARNIVORA Family CANIDAE Genus ***Canis*** Linnaeus, 1758	
159. *Canis aureus* Linnaeus, 1758	Asiatic Jackal
160. *Canis lupus* Linnaeus, 1758	Wolf
Genus ***Cuon*** Hodgson, 1838	
161. *Cuon alpinus* (Pallas, 1811)	Wild Dog, Dhole, Red Dog
Genus ***Vulpes*** Frisch, 1775	
162. *Vulpes bengalensis* (Shaw, 1800)	Indian Fox
163. *Vulpes cana* Blanford, 1877	Blanfofrd's Fox
164. *Vulpes ferrilata* Hodgson, 1842	Small Tibetan Fox
165. *Vulpes vulpes* (Linnaeus, 1758)	Common Red Fox
Family FELIDAE Subfamily ACIONYNCHINAE Genus ***Acionyx*** Brookes, 1828	
166. *Acionyx jubatus* (Schreber, 1775)	Cheetah
Subfamily FELINAE Genus ***Caracal*** Gray, 1843	

Sl. No. Species	Common English Name
167. *Caracal caracal* (Schreber, 1776)	Caracal, Lynx
Genus ***Felis*** Schreber, 1777	
168. *Felis chaus* Schfreber, 1777	Jungle Cat
169 *Felis silvestris*, Schreber, 1775	Wild Cat, Desert Cat
Genus ***Catopuma*** Severtzov, 1858	
170. *Catopuma temminckii* (Vigors & Horsfield, 1827)	Asiatic Golden Cat
Genus ***Lynx*** Kerr, 1792	
171. *Lynx lynx* (Linnaeus, 1758)	
Genus ***Otocolobus*** Brandst, 1842	
172. *Otocolobus manul* (Pallas, 1776)	Palla's Cat
Genus ***Prionailurus*** Severtzov, 1858	
173. *Prionailurus bengalensis* (Kerr, 1792)	Leopard Cat
174. *Prionailurus rubiginosus* (Geoffroy & St. Hilaire, 1831)	Rusty Spotted Cat
175. *Prionailurus viverrinus* (Bennett, 1833)	Fishing Cat
Subfamily PANTHERINAE Genus ***Neofelis*** Gray, 1867	
176. *Neofelis nebulosa* (Griffith, 1821)	Clouded Leopard
Genus ***Panthera*** Oken, 1816	
177. *Panthera leo* (Linnaeus, 1758)	Lion
178. *Panthera pardus* (Linnaeus, 1758)	Leopard
179. *Panthera tigris* Linnaeus, 1758	Tiger
Genus ***Pardofelis*** Severtzov, 1858	
180. *Pardofelis marmorata* (Martin, 1837)	Marbled Cat
Genus ***Uncia*** Gray, 1854	
181. *Uncia uncia* (Schreber, 1775)	Snow Leopard, Ounce
Family HERPESTRIDAE Subfamily HERPESTINAE Genus ***Herpestes*** Illiger, 1811	
182. *Herpestes brachyurus* Gray, 1837	None
183. *Herpestes edwardsii* (Geoffroy St. Hillaire, 1818)	Indian Gray Mangoose
184. *Herpestes javanicus* (Geoffroy St. Hillaire, 1818)	Small Indian Mongoose

Sl. No. Species	Common English Name
185. *Herpestes palustris* Ghose, 1965	Marsh Mangoose
186. *Herpestes smithii* Gray, 1837	Indian Ruddy Mangoose
187. *Herpestes vitticollis* (Bennet, 1835)	Crab eating Mangoose
188. *Herpestes urva* (Hodgson, 1836)	Stripe nacked Mangoose
Family HYANIDAE Subfamily HYANINAE Genus ***Hyaena*** Brunnich, 1771	
189. *Hyaena hyaena* Linnaeus, 1758	Striped Hyaena
Family MUSTELLIDAE Subfamily LUTRINAE Genus ***Lutra*** Brunnich, 1771	
190. *Lutra lutra* Linnaeus, 1758	Common Otter
Genus ***Lutrogae*** Gray, 1865	
191. *Lutrogale perspicillata* (Geoffroy St. Hillaire, 1826)	Smooth coated Otter
Genus ***Amblonyx*** Rafinsisque, 1832	
192. *Amblonyx cinereus* (Illiger, 1815)	Small Clawed Otter
Subfamily MELINAE Genus ***Arctonyx*** Cuvier, 1825	
193. *Arctonyx collaris* Cuvier, 1825	Hog Badger
Genus ***Melogale*** (Geoffroy St. Hillaire, 1831)	
194. *Melogale moschata* Gray, 1831	Chinese Ferret Badger
195. *Melogale personata* (Geoffroy St. Hillaire, 1831)	Burmese Ferret Badger
Subfamily MELLIVORINAE Genus ***Mellivora*** Storr, 1780	
196. *Mellivora capensis* (Schreber, 1776)	Ratel, Honey Badger
Subfamily MUSTELINAE Genus ***Martes*** Pinel, 1792	
197. *Martes flavigula* (Boddaert, 1785)	Yellow throated Marten, Indian Marten
198. *Martes foina* (Erxleben, 1777)	Beech Marten, Stone Marten
199. *Martes gwatekinsii* Horfsfield, 1851	South Indian Yellow throated Marten
Genus ***Mustella*** Linnaeus, 1758	
200. *Mustella altaica* Pallas, 1811	Mountain Weasel, Alpine Weasel

Sl. No. Species	Common English Name
201. *Mustella erminea* Linnaues, 1758	Stoat, Ermine
202. *Mustella kathaiah* Hodgson, 1835	Yellow bellied Weasel
203. *Mustella siberica* Palas, 1773	Siberian Weasel
204. *Mustella strigidorsoa* Gray, 1855	Black Striped Weasel
Family URSIDAE Subfamily AILURINAE Genus ***Ailurus*** Cuvier, 1825	
205. *Ailurus fulgens* Cuvier, 1825	Red Panda
Subfamily URSINAE Genus ***Helaractos*** Horsfield, 1825	
206. *Helaractos malayanus* (Raffles, 1821)	Malayan Sun Bear
Genus ***Melursus*** Meyer, 1793	
207. *Melursus ursinus* (Shaw, 1791)	Sloth Bear
Genus ***Ursus*** Linnaeus, 1758	
208. *Ursus arctos* Linaeus, 1758	Brown Bear, Grizzly Bear
209. *Ursinus thibetanus* Cuvier, 1823	Asiatic Black Bear
Family VIVERRIDAE Subfamily PARADOXINAE Genus ***Arctictis*** Temminck, 1824	
210. *Arctictis binturong* (Raffles, 1821)	Binturong, Bear Cat
Genus ***Arctogalidia*** Merriam, 1897	
211. *Arctogalidea trivirgata* (Gray, 1832)	
Genus ***Paguma*** Gray, 1831	
212. *Paguma larvata* (Hamilton-Smith, 1827)	Masked Palm Civet
Genus ***Paradoxurus*** Cuvier, 1821	
213. *Paradoxurus hermophroditus* (Pallas, 1777)	Common Palm Civet, Tiger Civet
214. *Paradoxurus jerdoni* Blanford, 1885	Jerdon's Palm Civet
Subfamily VIVERRINAE Genus ***Prionodon*** Horfsfield, 1821	
215. *Prionodon pardicolor* Hodsgson, 1842	Spotted Linsang, Tiger Civet
Genus ***Viverra*** Linnaeus, 1758	
216. *Viverra civettina* Blyth, 1862	Malabar Civet
217. *Viverra zibetha* Linnaeus, 1758	Large Indian Civet
Genus ***Vivericula*** Hodgson, 1838	
218. *Vivericula indica* (Desmarest, 1804)	

Sl. No. Species	Common English Name
Order CETACEA Family BALANIDAE Genus ***Balaena*** (Linnaeus, 1758)	
219. *Balaena mysticetus* (Linnaeus, 1758)	Greenland right Whale
Family BALANOPTERIDAE Genus ***Balanoptera*** Lacepede, 1804	
220. *Balanoptera acutorostrata* Lacepede, 1804	Finner Whale, Little Pinked Whale
221. *Balanoptera borealis* Lesson, 1828	Sei Whale
222. *Balanoptera edeni* Anderson, 1879	Bryde Whale, Lesser Rorgul
223. *Balanoptera musculus* (Linnaeus, 1758)	Blue Whale
224. *Balanoptera physalus* (Linnaeus, 1758)	Common Rorgul, Fin Whale
Genus ***Megaptera*** Gray, 1846	
225. *Megaptera novaeangliae* (Borowski, 1781)	Hump-backed Whale
Family DELPHINIDAE Genus ***Delphinus*** Linnaeus, 1758	
226. *Delphinus delphis* Linnaeus, 1758	Common Dolphin, Tropical Dolphin
Genus ***Globicephala*** Lesson, 1828	
227. *Globicephala macrorhynchus* Gray, 1846	Short finned/Indian Pilot Whale
Genus **Lagenodelphis,** Fraser, 956	
228. *Lagenodelphis hosei* Fraser, 1956	Fraser's Dolhin
Genus ***Orcella*** **Gray, 1866**	
229. *Orcella brevirostris* (Gray, 1866)	Irrawady Dolphin
Genus ***Orcinus*** Fitzinger, 1860	
230. *Orcinus orca* (Linnaeus, 1758)	Killer Whale
Genus ***Poponocephala*** Nishiwaki and Norris, 1966	
231. *Poponocephala electra* Gray, 1846	Indian Broad beaked Dolphin
Genus ***Pseudorca*** Reinhardt, 1862	
232. *Pseudorca crassidens* (Owen, 1846)	False Killer Whale
Genus ***Sousa*** Gray, 1866	
233. *Sousa chinensis* (Osbeck, 1765)	Indo-Pacific Hump backed Whale
Genus ***Stenella*** Gray, 1866	
234. *Stenella attenuata* (Gray, 1846)	Malay dolphin
235. *Stenella coeruleoalba* (Meyen, 1833)	Blue white Dolphin
236. *Stenella longirostris* (Gray, 1828)	Gray's Dolphin, Spinner Dolphin

Sl. No. Species	Common English Name
Genus ***Steno*** Gray, 1846	
237. *Steno bredanensis* (Lesson, 1828)	Rough toothed Dolphin
Genus ***Tursiops*** Gervais, 1855	
238. *Tursiops truncates* (Montagu, 1821)	Bottle noosed Dolphin
Family PHOCOENIDAE Genus ***Neophocaena*** Palmer, 1899	
239. *Neophocaena phocaenoides* (Cuvier, 1829)	Black Finless Porpoise
Family PHYSESTERIDAE Genus ***Koiga*** Gray, 1846	
240. *Koiga breviceps* (Blainville, 1838)	Pygmy Sperm Whale
241. *Koiga simus* (Owen, 1866)	Pigmy Sperm Whale
Genus ***Physester*** Linneus, 1758	
242. *Physester macrophalus* Linneus, 1758	Sperm Whale
Family PLATINISTIDAE Genus ***Platinesta*** Wagler, 1830	
243. *Platinesta gangetica* (Roxburgh, 1801)	Ganges Dolphin
Family ZIPHIIDAE Genus ***Ziphus*** Cuvier, 1823	
244. *Ziphus cavirostris* Cuvier, 1823	Cuvier's Beaked Whale
Order SIRENIA Family DUGONGIDAE Genus ***Dogong*** Lacepede, 1799	
245. *Dugong dogon* (Muller, 1776)	Dugong
Order PROBOSCIDEA Family ELEPHANTIDAE Genus ***Elephas*** Linnaeus, 1758	
246. *Elephas maximus* Linnaeus, 1758	Indian Elephant
Family PERISSODACTYLA Family EQUIDAE Genus ***Equus*** Linnaeus, 1758	
247. *Equus kiang* Moorcroft, 1841	Kiang, Tibetan Wild Ass
248. *Equus onager* Boddaert, 1785	Wild Ass
Family RHINOCEROTIDAE Genus ***Rhinoceros*** Linnaeus, 1758	
249. *Rhinoceros unicornis* Linnaeus, 1758	Indian/One horned Rhinoceros

Sl. No. Species	Common English Name
Order ARTIODACTYLA Family SUIDAE Subfamily SUINAE Genus ***Sus*** Linneus, 1758	
250. *Sus salvanius* (Hodgson, 1847)	Pignmy Hog
251. *Sus scrofa* Linnaeus, 1758	Wild Boar
Family TRAGULIDAE Genus ***Moschiola*** Hodgson, 1843	
252. *Moschiola meminna* (Erxleben, 1777)	
Family TRAGULIDAE Genus ***Moschus*** Lineus, 1758	
253. *Moschus chrysogaster* Hodgson, 1839	Forest Musk Deer
254. *Moschus fuscus* Li, 1981	Alpine Musk Deer
Family CERVIDAE Subfamily CERVINAE Genus ***Axis*** H. Smith, 1827	
255. *Axis axis* (Erxleben, 1777)	Spotted Deer
256. *Axis porcinus* (Zimmermann, 1780)	Hog Deer
Genus ***Cervus*** Linnaeus, 1758	
257. *Cervus duacelli* Cuvier, 1823	Swamp Deer
258. *Cervus elaphus* Linneus, 1758	Kashmir Stag
259. *Cervus eldi* Mc Clelland, 1842	Brown Antlered Deer,
260. *Cervus unicolor* Kerr, 1792	Sambar
Family MUNTIACINAE Genus ***Muntiacus*** Rafinsique, 1815	
261. *Muntiacus muntjak* (Zimmermann, 1780)	Barking Deer, Indian Muntjak
Family BOVIDAE Subfamily ANTILOPINAE Genus ***Antilope*** Pallas, 1766	
262. *Antilope cervicapra* (Linneus, 1758)	Blackbuck, Indian Antelope
Genus ***Gazella*** Blainville, 1816	
263. *Gazella benetti* (Sykes, 1831)	Indian Gazelle
Genus ***Panthelops*** Hodgson, 1834	
264. *Panthelops hadgsonii* (Abel, 1826)	Tibetan Antelope
Genus ***Procapra*** Hodgson, 1846	

Sl. No. Species	Common English Name
265. *Procapra picticaudata* Hodgson, 1846	Tibetan Gazelle
Subfamily BOVINAE Genus ***Bos*** Linnaeus, 1758	
266. *Bos frontalis* Lambert, 1804	Indian Bison
267. *Bos grunniens* Linneus, 1766	Yak
Genus ***Boselaphus*** Blainvile, 1816	
268. *Boselaphus tragocemalus* (Pallas, 1766)	Blue Bull
Genus ***Bubalis*** Smith, 1827	
269. *Bubalis bubalis* (Linneus, 1758)	Water/Indian Buffalo
Genus ***Tetracerus*** Leach, 1825	
270. *Tetracerus quadricornis* (Blainvile, 1816)	Four horned Antelope
Subfamily CAPRINAE Genus ***Budorcus*** Hodgson, 1850	
271. *Budorcus taxicolor* Hodgson, 1850	Takin
Genus ***Capra*** Linnaeus, 1758	
272. *Capra falconeri* (Wagner, 1839)	Markhor, Punj
273. *Capra siberica* (Pallas, 1776)	Siberian Ibex
Genus ***Hemitragus*** Hodgson, 1841	
274. *Hemitragus hylocris* (Ogilby, 1838)	Nilgiri Thar
275. *Hemitragus jemlahicus* (Smith, 1826)	Himalayun Thar, Thar
Genus ***Naemorhedus*** Smith, 1827	
276. *Naemorhedus goral* (Hardwicek, 1825)	Goral
277. *Naemorhedus sumatraensis* (Bechstein, 1799)	Mainland Serow, Serow
Genus ***Ovis*** Linnaeus, 1758	
278. *Ovis ammon* (Linnaeus, 1758)	Argali, Great Tibetan Sheep
279. *Ovis vignei* Blyth, 1841	Urial, Shapu, Punj
Genus ***Pseudois*** Hodgson, 1846	
280. *Pseudois nayaur*	Blue Sheep, Bharal
Order PHOLIDOTA Family MANIDAE Genus ***Manis*** Linaeus, 1758	
281. *Manis crassicaudata* (Gray, 1827)	Indian Pangolin
282. *Manis pentadactyla* Linnaeus, 1758	Chinese Pangolin

Sl. No. Species	Common English Name
Order RODENTIA Suborder SCIUROGNATHI Family SCIURIDAE Subfamily SCIURINAE Genus ***Callosciurus*** Gray, 1867	
283. *Callosciurus erythraeus* (Pallas, 1799)	Pallas Squirrel
284. *Callosciurus canipes* (Gray, 1842)	Golden Backed/Gray billed Squirrel
285. *Callosciurus pyrgerythrus* (I. geoffroy Saint Hilaire, 1831)	Irrawady Squirrel
Genus ***Dremnomys*** Heude, 1898	
286. *Dremomys loklriah* (Hodgson, 1836)	Orange billed Himalayan Squirrel
287. *Dremomys pernyi* (Milne-Edwards,1867)	Perny's Long nosed Squirrel
288. *Dremomys rufegens* (Blanford, 1878)	Red Cheeked Squirrel
Genus ***Funambulus*** Lesson, 1835	
289. *Funambulus layardi* (Blyth, 1849)	Layard's Striped Squirrel
290. *Funambulus palmarum* (Linnaeus, 1766)	Indian/Three striped Palm Squirrel
291. *Funambulus pennanti* Wroughton, 1905	Northern Palm Squirrel
292. *Funambulus sublineatus* (Waterhouse,1838)	Dusky striped squirrel
293. *Funambulus tristriatus* (Waterhouse, 1837)	Western Ghats Strriped Squirrel
Genus ***Marmota*** Blumenbach, 1779	
294. *Marmota caudata* (Geoffroy, 1844)	Long tailed Marmot
295. *Marmota himalayana* (Hodgson, 1841)	Himalayan Marmot
Genus ***Ratufa*** Gray, 1867	
296. *Ratufa bicolor* (Sparman, 1778)	Large Malayan Squirrel
297. *Ratufa indica* (Erxleben, 1777)	Indian Giant Squirrel
298. *Ratufa macroura* (Pennant, 1769)	Grizzled Indian Squirrel
Genus ***Tamiops*** Allen, 1906	
299. *Tamiops macclellandi* (Horfsfield, 1840)	Himalyan Striped Squirrel
Subfamily PETAURISTINAE Genus ***Belomys*** Thomas, 1908	
300. *Belomys pearsonii* (Gray, 1842)	Hairy footed Flying Squirrel
Genus ***Biswamyopterus*** Saha, 1981	
301. *Biswamyopterus biswasi* Saha, 1981	Namdapha Flying Squirrel
Genus ***Eupetaurus*** Thomas, 1888	
302. *Eupetaurus cinereus* Thomas, 1888	Wooly Flying Squirrel

Sl. No. Species	Common English Name
Genus ***Hylopetes*** Thomas 1908	
303. *Hylopetes alboniger*	Particoloured Flying Squirrel
304. *Hylopetes baberi*	None
305. *Hylopetes finmbriatus* (Gray, 1837)	Small Kashmir Flying Squirrel
306. *Hylopetes phayrei* (Blyth, 1859)	Phayre's Flying Squirrel
Genus ***Petaurista*** Link, 1895	
307 *Petaurista elegans* (Muller, 1840)	Lesser GiantFlying Squirrel
308. *Petaurista magnificus* (Hodgson, 1836)	Hodgosn's Flying Squirrel
309. *Petaurista nobilis* (Gray, 1842)	None
310. *Petaurista petaurista* ((Pallas, 1766)	Red/Common Giant Flying Squirrel
311. *Petaurista philippensis* (Elliot, 1839)	Indian Giant Flying Squirrel
Genus ***Pectinomys*** Thomas, 1908	
312. *Petinomys fuscocapillus* Jerdon 1847	Small Travancore Flying Giant Squirrel
Family DIPODIDAE Subfamily SICISTINAE Genus ***Sicista*** Gray, 1827	
313. *Sicista concolor* Buchner, 1892	Chinese Birch Mouse
Family MURIDAE Subfamily ARVICOLINAE Genus ***Alticola*** Blanford, 1881	
314. *Alticola albicauda* (True, 1894)	White-tiled Mountain Vole
315. *Alaticola argentatus* (Servertzov,1879)	Silver Mountain Vole
316. *Alticola montosa* (True,1894)	True Vole
317. *Alticola roylei* (Gray, 1842)	Royle's Vole
318. *Alticola stoliczkanus* (Blanford,1875)	Stoliczkaa's Vole
319. *Alticola stracheyi* (Thomas, 1880)	Thomas' Short tailed Vole
Genus ***Eothenomys*** Miller, 1896	
320. *Eothenomys melanogaster* Milne-Edwards, 1867	Pere Davids Vole
Genus ***Hyperacrius*** Miller, 1896	
321. *Hyperacrilus fertilis* (True, 1894)	Trues Vole
322. *Hyperacrilus wynnei* (Blanford, 1881)	Murree's Vole
Genus ***Microtus*** Schrank, 1798	
323. *Microtus leucurus* (Blyth, 1863)	Blyth's Vole

Sl. No. Species	Common English Name
324. *Microtus sikkimensis* (Hodgson, 1849)	Sikkim Vole
Subfamily CRICETINAE Genus ***Cricetulus*** Milne-Edwards, 1867	
325. *Cricetulus alticola* Thomas, 1917	Ladakh Hamster
326. *Cricetulus migratorius* (Pallas, 1773)	Little Grey hamster
Subfamily GERBILLINAE Genus ***Gerbillus*** Desmarest, 1804	
327. *Gerbillus gleadowi* Murray, 1886	Little Hairy-footed Gerbil
328. *Gerbillus nanus* Blanford, 1875	Baluchisthan Gerbil
Genus ***Meriones*** Illiger, 1811	
329. *Meriones hurrianae* (Jerdon, 1867)	Indian Desert Gerbil
Genus ***Tatera*** Lataste, 1882	
330. *Tatera indica* (Hardwicke, 1807)	Indian Gerbil (Antelope rat)
Subfamily MURINAE Genus ***Apodemus*** Kaup, 1829	
331. *Apodemus draco* (Berrett-Hamilton, 1900)	South China Wood mouse
332. *Apodemus rusiges* (Miller, 1913)	Kashmir Field Mouse
333. *Apodemus wardi* (Wroughton, 1908)	Yellow nacked Field Mouse
Genus ***Bandicota*** Gray, 1873	
334. *Bandicota bengalensis* (Gray & Hardwicke, 1833)	Lesser Bandicot rat
335. *Bandicota indica* (Bechstein, 1800)	Large Bandicot rat
Genus ***Berlymus*** Ellerman, 1947	
336. *Berlmys bowersi* (Anderson, 1879)	Bower's Rat
337. *Berlmys mackenziei* (Thomas, 1916)	Mackenzie's Rat
338. *Berlmys manipulus* (Thomas, 1916)	Manipur Rat
Genus ***Chiropodomys*** Peters, 1869	
339. *Chiropodmys gliroides* (Blyth, 1856)	Pencillate Tailed Tree Mouse
Genus ***Cremnomys*** Wroughton 1912	
340. *Cremnomys blandfordi* (Thomas, 1881)	Blanford's Rat
341. *Cremnomys cutchicus* Wroughton, 1912	Cutch Rock Rat
342. *Cremnomys elvira* (Ellerman, 1947)	Large Rock Rat
Genus ***Dacnomys*** Thomas 1917	
343. *Dacnomys millardi* Thomas 1917	Millard's Rat

Sl. No. Species	Common English Name
Genus ***Dyomys*** Thomas 1917	
344. *Dyomys crumpi* Thomas 1917	Crump's Mouse
Genus ***Golunda*** Gray, 1937	
345. *Golunda ellioti* Gray, 1837	Indian Bush Rat
Genus ***Hadromys*** Thomas 1911	
346. *Hadromys humei* (Thomas, 1886)	Hume's Rat
Genus ***Leopoldamys*** llerman, 1947	
347. *Leopoldamys edwardsi* (Thomas, 1882)	Edward's Rat
Genus ***Micromys*** Dehne, 1841	
348. *Micromys minutus* (B Pallas, 1771)	Harvest Mouse
Genus ***Millardia*** Thomas, 1911	
349. *Millardia gleadowi* (Murray, 1885)	Sand colured Metad
350. *Millardia kondana* Mishra & Dhanda, 1975	Large Metad
351. *Millardia meltada* (Gray, 1837)	Soft furred Metad
Genus ***Mus*** Linnaeus, 1758	
352. *Mus booduga* Gray, 1837	Little Indian Field Mouse
353. *Mus cervicolor* Hodgson, 1845	Fawn Coloured Mouse
354. *Mus cooki* Ryley, 1914	Ryley's Spiny Mouse
355. *Mus famulus* Bonhota, 1889	Bonhot's Mouse
356. *Mus musculus* Linnaeus, 1758	House Mouse
357. *Mus pahari* Thomas, 1916	Sikkim Mouse
358. *Mus phillipsi* Wroughton, 1912	Wroughtons Small spiny mouse
359. *Mus platythrix* Bennet, 1832	Brown Spiny Mouse
360. *Mus saxicola* Elliot, 1839	Slliot's Spiny Mouse
361. *Mus terricolor*	None
Genus ***Nesokia*** Gray, 1842	
362. *Nesokia indica* (Gray & Hardwicke, 1832)	Short Tailed Bandicoot rat
Genus ***Niniventer*** Marshall, 1976	
363. *Niniventer brahma* (Thomas, 1914)	Thomas' Chestnut Rat
364. *Niniventer eha* (B Wroughton, 1916)	Little Himalayan rat
365. *Niniventer fulvescens* (Gray, 1847)	Chestnut Rat
366. *Niniventer langbianus* (Robinson & Kloss, 1922)	Dark tailed Rat
367. *Niniventer niniventer* (Hodgson, 1836)	Himalayan White Bellied Rat

Sl. No. Species	Common English Name
368. *Niniventer tenaster* (Thomas, 1916)	Tenasserium Long tailed rat
Genus ***Rattus*** Fischer, 1803	
369. *Rattus burrus* (Miller, 1902)	Miller's Nicobar Rat
370. *Rattus nitidus* (Hodgosn, 1845)	Himalayan Rat
371. *Rattus norvegicus* (Berkenhout, 1769)	Norway Brown rat
372. *Rattus palmarum* (Zelber, 1869)	Palm Rat
373. Rattus *ranjaniae* Agrwal & Ghosh, 1969	Ranjini's Filed Rat
374. *Rattus rattus* (Linnaeus, 1758)	Common House Rat
375. *Rattus sikkimensis* Hinton, 1919	Sikkim Rat
376. *Rattus stoicus* (Miller, 1902)	Andaman Rat
377. *Rattus tanezumi* (Temminck, 1844)	Tenezumi Rat
378. *Rattus turkestanicus* (Satunin, 1903)	Turkestan Rat
379. *Rattus vicerex* (Bonhote, 1903)	Short tailed Turketan Rat
Subfamiily PLATACHANTOMYINAE Genus ***Platacanthomys*** Blyth, 1859	
380. *Platacanthomys lasiurus* Blyth, 1859	Malabar Spiny Dormice
Genus ***Vandeleuria*** Gray, 1842	
381. *Vandeleuria oleracea* (Bennet, 1832)	Long tailed tree mouse
Subfamily PLATACHATHOMYINAE Genus ***Cannomys*** Thomas, 1915	
382. *Cannomys badius* (Hodgson, 1841)	Bay Bamboo Rat
Genus ***Rhizomys*** Blyth, 1859	
383. *Rhizomys pruinosus* Blyth, 1851	Hoary Bamboo rat
Suborder HISTRICOGNATHI Family HISTRICIDAE Genus ***Atherurus*** Cuvier, 1829	
384. *Atherurus macrorus* (Linneus, 1758)	Asiatic Brushtailed Porcupine
Genus ***Histrix*** Linnaeus, 1758	
385. *Histrix brachyura* Linnaeus, 1758	Himalayan Crestless Porcupine
386. *Histrix indica* (Kerr, 1792)	Indian Crested Porcupine
Order LAGOMORPHA Family OCHOTONIDAE Thomas, 1897 Genus ***Ochotona*** Link, 1795	
387. *Ochotona curzoniae* (Hodgson, 1858)	Plateau Pika

Sl. No. Species	Common English Name
388. *Ochotona forresti* Thomas, 1923	Forrest's Pika
389. *Ochotona ladacensis* (Gunther, 1875)	Ladakh Pika
390. *Ochotona macrotis* (Gunther, 1875)	Large eared Pika
391. *Ochotona nubrika* Thomas, 1922	Nubra Pika
392. *Ochotona roylei* (Ogilby, 1839)	Royle's Pika
393. *Ochotona thibetana* (Milne-Edwards, 1971)	Manipur Pika
Family LEPORIDAE Fischer, 1817 Genus ***Caprolagus*** Blyth, 1845	
394. *Caprolagus hispidus* (Pearson, 1839)	Hispid Hare/Assam Rabbit
Order LAGOMORPHA Family LEPORIDAE Fischer, 1817 Genus ***Lepus*** Linnaues, 1758	
395. *Lepus nigricollis* Cuvier, 1823	Indian Hare or Black- napped Hare
396. *Lepus* oiostolus Hodgson, 1840	Wooly Hare
397. *Lepus tolai* Pallas, 1778	Tolai Hare

INTRODUCED SPECIES

The House mouse (*Mus musculus*) and the Norway rat (*Rattus norvegicus*) have reached India through human agencies and established here. In addition, the Andaman & Nicobar Islands are the only areas where some species of mammals have been introduced in the past from the mainland by human beings (Tikader & Das 1985). These species are the Crab-eating Macaque (*Macaca fascicularis*), Pig-tailed Macaque (*Macaca nemestrina leonina*), Jungle Cat (*Felis chaus*), Chital (*Axis axis*), Barking Deer (*Muntiacus muntjak*), Sambar (*Cervus unicolor*) Plam Civet (*Paguma larvata*), Wild pig (*Sus scrofa*), Elephant (*Elephas maximus*), Northern Palm Squirrel (*Funambulus pennanti*) and rats and mice. Of these, the Crab-eating Macaque, Chital, Palm Civet and Wild Boar and various species of rats have established themselves well, so much so that, of late, chital became a pest of crops. However, rest of the species, could not adequately adapt themselves, and hence, in the course of time either disappeared or are present in negligible number. Some of the captive elephants escaped into the jungle and formed small herds of their own and started roaming in the wild.

ANIMAL BREEDS AND LABORATORY ANIMALS

Livestock sector produced 88 million tonnes of milk, 40.4 billion eggs, 48.5 million kgs of wool, and 6 million tonnes of meat in 2003-04. According to the Central Statistical Organization (CSO), the value of output from livestock and fisheries sectors at current prices during 2002-03 were Rs.1,56,080 crore and Rs 30,014 crore, respectively. These

sectors contributed 6.5 per cent of total GDP (5.4 per cent from livestock and 1.1 per cent from fisheries) in 2002-03. Techniques in genetic variation have improved agriculture, aquaculture and domesticated animal productivity, and this new biotechnological tool has stimulated economic prosperity. Knowledge of biodiversity has proved essential for effective decision-making in conservation and sustainable use of biotic resources, especially of domestic breeds such as cattle, goat, camel and farm resources such as finfish and shellfishes by organizations such as Bureau of Fish Genetic resources and Bureau of Animal Genetic Resources. The pariah dog (*Canis familiaris*), domestic cat (*Felis catus*) ass (*Equus asinus* and *E. Cabalus*), pig (*Sus domesticus*), camel (*Camelus dromedarius*), cow (*Bos frontalis*) buffalo (*Bubalus bubalis*), sheep (*Ovis aries*) goat (*Capra hircus*), yak (*Bos grunniens*) and mithun are a few domesticated species, which occur in India.

Year	Milk production (Million tonnes)	Per capita availability (Gms. day)
1950-51	17.0	124
1960-61	20.00	124
1970-71	22.0	112
1980-81	31.6	128
1990-91	53.9	176
2000-01	80.6	220
2001-02	84.4	225
2003-04	88.1	231
2004-05 (P)	91.0	232

Source : Department of Animal Husbandry

Species	No. of Breeds	Name of the Breeds
Buffalo	10	Bhadwari, Jaffarabadi, Marathwada, Mehsana, Murrah, Nagpuri, Nili, Ravi, Phandarapuri, Surti, Toda
Cattle	30	Amrirhmahal, Bachaur, Bargur, Dangi, Deoni, Gangatiri, Gaolao, Gir, Hallikar, Hariana, Kangayam, Kankrej, Kenkataha, Kherigarh, Killari, Krishna valley, Malvi, Mewati, Nagori, Nimari, Ongole, Ponwar, Punganur, Rathi, Red Khandari, Red Sindhi, Sahiwal, Siri, Tarpakar, Umbalchery, Vechur.
Camel	6	Bikaneri, Double Humped, Jaisalmeri, Kachchhi, Mewari, Sindhi
Equine	6	Bhutia, Kathiawadi, Manipuri, Marwari, Spiti, Zanskari

Contd.

Species	No. of Breeds	Name of the Breeds
Goat	20	Barbari, Beetal, Black Bengal, Changthangi, Chegu, Gaddi, Ganjam, Gohilwadi, Jamunapuri, Jakrana, Kannai Adu, Kutchi, Malbari, Marwari, Mehsana, Osmanabadi, Sangamneri, Sirohi, Surti, Zalawadi.
Poultry	18	Ankaleswar, Aseel, Brown Desi, Busra, Chittagong, Daothigir, Denki, Ghagus, Haringatta Black, Kadaknath, Kalasthi, Kashnir Faverolla, Miri, Nicobari, Punjab Brown, Telllichery, Teni, Titri
Sheep	41	Balangir, Bellary, Bhakarwal, Bonpala, Changthangi, Chokla, Chottanagpuri, Coimbatore, Deccani, Gaddi, Ganjam, Garole, Gurez, Hassan, Hissardale, Jaisalmeri, Jalauni, Karnah, Kashmir Merino, Kenguri, Kilakarsal, Madras Red, Magra, Malpura, Mandya, Marwari, Mecheri, Muzafarnagari, Nali, Nellore, Nilgiri, Patanwadi, Poonchi, Pugal, Ramnad White, Rampur Bushair, Shahbadi, Sonadi, Tibetan, Tiruchi Black, Vembur

Source for domestic breeds : Dinesh Kumar, NBAGR, 2005

LABORATORY MAMMALS

Laboratory strains of Mice (*Mus musculus* strains such as BALB/c, AKR/cdri, C3H/cdri, C57BL/6 cdri, Nzb/cdri, SJL/cdri, SMA/cdri, Swiss/cdri (Inbred), db/db (C57BLKS/Bom-db), Hr/cdri (Hairless), cdri /S (Swiss) (Outbred), cdri/p (Parks), NOD/LtJ, C57Bl/6J, A/J Nii, many more breeds) have been developed from wild mouse which had their origin in temperate Asia. The long established Swiss Albino mouse became the source of many inbred white laboratory stocks. A number of out bred and inbred strains with known genetic background are now available. The use of Rats for scientific purposes began as early as 1850. Rat, ***Rattus norvegicus strains*** Fisher 344, Wistar, LEW, Sprague Dawley, Druckery (D), Charles Foster (CF), SHR (Spontaneously Hypertensive Rat), Holtzman, CD y/nin, Wistar (Kyoto) etc., have been developed over past 70 years from the wild brown Norwegian Rat. Hamster, ***Mesocricetus auratus*** strains *viz.*, Syrian Golden Hamster (Out bred), Syrian Golden Hamster (Inbred), White (Mutant) Hamster (Inbred) WWSH/cdri) is a recent addition to the list of laboratory animals. All laboratory strains of Syrian hamster are believed to have originated from three littermates captured near Aleppo in Syria in 1930. Progeny of which is used in the investigation of Kala Azar. Cotton rat, ***Sigmodon hispidus,*** (Cotton Rat cdri) is a wild rat native to North America. Gerbils (***Meriones unguiculatus, Meriones hurrianea strains*** Mongolian Gerbil cdri, Indian Desert Gerbil nimhn) is a native of the desert region of Mongolia and northeastern China.

It is distinguished by monogamous mating behaviour, water conservation mechanism, spontaneous epileptiform seizures and relative freedom from spontaneous diseases. Mastomys, *Paraomys (Mastomys) coucha,* Mastomys (Multimammate Rat) cdri) are recognized agricultural pests in Africa and they also serve as reservoir of plague in South Africa. Guinea Pig, *Cavus procellus,* Duncan Hartley/English/Hartley) a widely distributed species in Argentina, Uruguay and Brazil, is domesticated in South America. Rabbit, *Oryctolagus cuniculus,* New Zealand White, Belgian cdri) is derived from the Wild rabbits of Western Europe and North Western Africa. Non-human primates' *viz., Rhesus* monkey, ***Macaca mulatta;*** Bonnet, *Macaca radiata and* Langur *Semnopithecus entellus* have been used for Biomedical Research in India. Besides the above, *India* has nearly 130 breeds of domestic livestock, goat, sheep, camel, cattle and the poultry, and the commercial value from these biological resources and their contribution to the national economy are of great significance. Goats (*Capra hirus);* Sheep Bannur (*Ovis aries*) and Cow Jersey Holstein Fresian *(Bos sp.)* are very important biotechnological tools in recent years.

Of the three species of monkeys that have been used for biomedical research in India, a large breeding colony of Rhesus is maintained at CDRI, Lucknow. The other places where Rhesus are maintained are AIIMS, New Delhi, National Institute of Immunology, New Delhi, P G Institute of Medical Sciences, Chandigarh, National Institute of Virology, Pune and National Institute of Nutrition, Hyderabad. The animals in these institutes are used mostly for reproductive biology studies, contraceptive testing, vaccine development and immunology. The total number of Rhesus in these institutes does not exceed 300. The only place where Langurs are maintained for establishing normal reproductive parameters such as testosterone level, sperm count, menstrual cyclicity, hormonal profile, contraceptive testing etc. is in the Department of Zoology, University of Rajasthan.

Selected Laboratory Animal strains in India

1 : Albino mouse (Swiss)
2 : Black Mouse (C57BL/6)
3 : Black Mouse (C57BL/AJ Apoe-a disease model for 'Alzheimer's)
4 : Black Obese Mouse (db/db)
5 : Hairless Mouse (Hr/cdri)
6 : BALB/c Mouse
7 : Light black coloured +/+ lean variant of db/db mouse strain.

RAT— Fisher 344; Wistar; LEW; Sprague Dawley; Druckery (D); Charles Foster (CF); SHR (Spontaniously; Hypertensive Rat) Holtzman; CD y/nin; Wistar (Kyoto); WNIN/OB; WNIN/IGI; WNW/ob-IGI

The largest colony of Bonnet Monkeys are maintained in the Primate Research Laboratory, Indian Institute of Science, Bangalore which presently has about 200 specimens, of these 50% were colony born over the last 20 years. The other Institutes maintaining Bonnets are Institute of Research in Reproduction, Bombay and National Institute of Immunology, New Delhi. In these two places, the number does not exceed 150 (*Source* : P Y Guru. Personal communication).

HUMAN-MAMMAL RELATIONSHIP

Our knowledge on the Indian mammals is very old. Descriptions of some mammals are available in the Vedas and even in the prevedic edicts and these include ethical, social, mythological and economic relationships between man and wild mammals. Authorities of Ayurvedic and Unani medicines were aware of medicinal values of some products obtained from certain species of mammals. Some species of monkeys like the Rhesus macaques and the Norway rats are used in experiments of biomedical research. A number of species of rodents are reservoirs of many of the dreadful diseases of man and livestock.

Some species of mammals such as rats, hanuman langur, gaur (bull), elephant, tiger, lion, etc., have special mythological significance amongst Hindus. This is due to their being associated with different gods and goddesses in the Hindu mythology, and hence, are worshipped.

EXPLOITATION OF MAMMALS

In addition to nutritional value, wildlife species may provide utilitarian products for both domestic and commercial markets. Fur, hides, scales, bones may be used to make a variety of clothing's, ornaments, and utensils, while fat may be used as oil and glue. Household implements such as needles and hooks can be made from bones and scales. It is worthwhile to mention that exploitation of wild species does not necessarily entail killing of wild animals or taking from wild stock. In fact, farming of many of the wild species is possible with improved technology. The following are the list of some uses of various wild relatives present in the country :

Animal	Body/organ	Part used as	Purpose	Remarks
Elephant	Molar teeth	Ivory	Statues, jeweler boxes, decorative items	Synthetic material available
Rhino	Tuft of hair on nose	Horn	Oriental medicine as an aphrodisiac	Resulted in large scale poaching
Tiger & Leopards	Skin, bones claws teeth	Skin, bones, claws, teeth	Skin for making coats, bones for oriental medicine, teeth and claws as talisman and faith healing	Undesirable clothing as better cloths available. Faith healings have not proven curing capabilities
Fishing, Marbled, Jungle, Golden cat, fox	Skin	- Do -	For making small coats, gloves	- Do -

Animal	Body/organ	Part used as	Purpose	Remarks
Tibetan Antilope or Chiru	Furry skin	Shatoosh	For making expensive cloth	—
Bear to cure	Gall bladder	Bear bile	Oriental medicine	No proven ability
Musk deer	Musk gland in abdomen male	Musk	Asian medicine	- Do -
Monkeys, Gibbon	—	—	Used in circus, street plays, biomedical researches, pets.	All are avoidable
Slow Loris, Slender Loris	—	—	Pet trade	All are avoidable
Pangolin	Dermal Plants	—	As talisman	- Do-

Medicinal uses in Siddha, Unani and Ayurveda

Mammal species	System of Medicine & Parts used	Action and Uses
Bandicota indica	Unani Flesh, blood, heart, brain, excreta and skin.	Anti-epileptic, depilatory and beneficial to eye. **Flesh** : of head is useful in cataract. **Blood** : cures warts and scars. **Heart** : is made into 7 pieces, one piece if taken daily for 7 days, cures epilepsy. **Brain** : is useful in cataract. **Excreta** : with honey is useful in alopecia. **Skin** : Fumes from skin are given in piles.
Pteropus giganteus	Unani Whole organism, flesh, blood, brain, bile, milk and excreta	Detoxicant, anti-inflammatory and depilatory. **Whole animal** : is boiled in water. The decoction so obtained, when mixed with Sesame oil, forms a useful emulsion for application in rheumatism, sciatica and paralysis. **Flesh** : is detoxicant and anti-

Mammal species	System of Medicine & Parts used	Action and Uses
		inflammatory. It is useful in dropsy, rheumatism, paralysis and gout. Ash is mixed with urine and given in intoxication. **Blood** : is depilatory and it depresses memory growth. **Bile** : local application on vagina facilitates delivery. **Milk** : of bat produces feeling of warmth. It is incorporated in 'Surma' for promoting growth of eyelashes and for curing eye diseases.
Melursus ursinus	Ayurveda and Unani Flesh, fat, lungs, urethra, bile, bones and teeth.	**Flesh** : It is fibrous, indigestible and of low nutritive value but it possesses aphrodisiac properties. **Fat** : It is useful as an external application in rheumatism, leucoderma and alopecia cases. **Lungs** : Warm ash cures shoe sores. **Urethra** : Aphrodisiac properties. **Bile** : is given with honey for the treatment of Epilepsy. Instillation in eyes improves eye-sight and promotes the growth of eye lashes. **Bone & Teeth** : Teeth if rubbed in water and given to infants, facilitate early teething.
Lutra lutra	Ayurveda, Unani and Homeopathy Castoreum or jundbedstar, brain, tongue and bones	**Costoreum** : Used in paralysis, epilepsy, whooping cough, nervous disorders and scorpion poisoning. ***Brain*** is mixed with oil of Viola *odorata* and instilled in nostrils for relief in hemicrania. **Tongue** : It is applied on dog bite wound and its ash for healing wounds. ***Bones*** : Fumigation from burnt cures hemicrania.

Mammal species	System of Medicine & Parts used	Action and Uses
Antilope cervicapra	Ayurveda and Unani Flesh, fat, testicles, milk, excreta and horn.	**Flesh** : It is easily digestible, palatable and tonic for the heart, body and sexual function. It is useful in jaundice, paralysis and nervine disorders. It cures fever. **Fat** : Promotes hair growth. **Milk** : It is lighter than mare's milk. It possesses aphrodisiac properties. **Excreta** : It is good for eye diseases. **Horn** : Ash of horns is nutritive and demulcent. It is of value in sciatica, gout, lumbago, loss of appetite, cough, asthma and diseases of the heart. **Skin** : It is insect repellent.
Boselaphus tragocamelus	Unani Flesh, heart, brain and spinal chord, kidneys and horns.	Cardiac tonic, nervine and sexual tonic and styptic. **Flesh** : It is easily digestible, palatable, nervine and sexual tonic. **Heart** is cardiotonic, so use in heart diseases. **Brain** and spinal chord: It is used in loss of memory and weakness of the brain. **Kidneys** invigorate kidneys. **Horns** : Ash of horn is styptic. It is mixed with gum tragacanth and given in cases of leucorrhoea and bleeding
Fellis chaus	Ayurveda and Unani Flesh, bone and urine	It is beneficial for those suffering from diseases of eye. The flesh is also used in Rajayakshma (tuberculosis). The urine of cat is efficacious as snuff in case of Epilepsy. Flesh is also good for old people and is indicated on backache, pain in joints, hernia and piles. Warm flesh from a freshly killed animal is applied externally on gout and fractures. The powder of rib bones is applied on fistula.

Mammal species	System of Medicine & Parts used	Action and Uses
Viverra zibetha	Ayurveda, Siddha and Unani Secretion from Scent glands	It is used in hysteria, nervous exhaustion and oriental insense. It is also used in abdominal pain, asthma, cardiac disease and libido. It is of value in fasting, nervous exhaustion, hysteria and piles. It is good for eyesight and sensory organs. Inhalation is useful in colds and accompanied headache.
Vulpes bengalensis	Unani Lomri as a whole, flesh, fat, skin	Anti-inflammatory and aphrodisiac **Whole Organism** : is boiled in water. The decoction, so prepared, is used for gout. **Flesh** : Aphrodisiac and useful for patients of dropsy. **Fat** : is good for gout and earache. **Skin** : Ash of skin heals burns and wounds.
Sus salvanius	Ayurveda and Unani Lard (purified internal fat of the hog), flesh, lungs, bile, milk and horns	It is aphrodisiac. It acts well in general debility. It is used in abdominal pain, Vata Dosha, fractures, piles and paralysis. It is used for preparing benzoated lard which contains lard incorporated in benzene powder 3% and which is employed for preparing ointments. Lard oil (*oleum adepis*) is obtained from it. It is also useful in inflammations, deafness and aphrodisiac **Flesh** : cures indigestion, headache, rheumatism, filariasis, mental damage, impotence. **Lungs** : Warm ash cures shoe sores. **Bile** : Application with honey and black pepper promotes hair growth. It is of value in the treatment of ear diseases and piles. **Milk** : It is nutrient and tonic. **Horns** : Ash of hooves is curative for urinary obstruction.

Mammal species	System of Medicine & Parts used	Action and Uses
Hyaena hyena	Ayurveda and Unani Tongue, fat, heart, skin, bone marrow, bile, blood and flesh	It is applied on wounds. In rheumatism, fat of Hyaena is applied on diseased organs. **Flesh** improves complexion and prevents phlegmatic and bilious humours. It is indicated in palpitation of the heart. Decoction of flesh alleviates rheumatic pains. **Blood** is claimed to cure mental disorders **Bile** is good for eye diseases. **Bone marrow and teeth** is rubbed in olive oil for the treatment of gout. Teeth are rubbed in water and given in cases of rabid dog bite.
Gazella gazella	Ayurveda and Unani Flesh	**Flesh** is appetizing, cardiotonic and antispasmodic It is good for paralysis, colic, phlegm and biliousness.
Hystrix indica	Ayurveda & Unani Urine, bile, faeces, skin, hair, nails and hide, fat and flesh	Meat soup acts as carminative and digestive used to cure cough, breathlessness, in retention of stool and flatus Faeces + Skin + Hair + Nails + Hide of porcupine administered in Melancholia, epilepsy, paralysis, tremors, nervine disorders, scrofula, leprosy, filariasis and bed wetting in children. Fat used as local application to cure skin pigmentation. **Bile** : Oral ingestion or administration in the form of a pessary made with wax facilitates expulsion of dead foetus.
Canis aureus	Ayurveda & Unani Flesh, bile, milk, urine and excreta	Anti-epileptic and nutritive. **Flesh** : Prescribed in melancholia. The patients who are drying up and emaciated in Rajayakshma

Mammal species	System of Medicine & Parts used	Action and Uses
		(tuberculosis) should be given the meat of jackal, fox, large mongoose and cats in the name of rabbit. **Milk** : If instilled in eyes, cures cataract. **Urine** : Urine of jackal is very efficacious as snuff in case of Apasmara (epilepsy). **Excreta** : It is useful in skin diseases. **Bile** : Instilled in eyes for the treatment of cataract.
Panthera pardus	Unani Flesh, blood & brain	Anti-inflammatory and aphrodisiac **Flesh** : along with fat is cooked with water and olive oil to form a useful application for rheumatism, gout and paralysis. **Blood** is used for skin pigmentation.
Felis leo	Ayurveda and Unani Flesh, fat, brain, bile, testis, urine, excreta, hair, tail, nail, teeth & milk.	**Flesh** : Paralysis, arthritis, piles. If one sits on the flesh of lion he will not suffer from piles and arthritis. **Fat** : Skin diseases, cold, arthritis, rheumatism and stiffening of joints. It is incorporated in ointment and for paralysis. **Bile** : It is useful in impotency, neck nodules, jaundice, eye diseases and high fever. **Brain** : Brain mixed with oil is applied on tumours. Its massage is also useful in tremoring. **Excreta** : Skin diseases, alcoholism **Hair** : Epilepsy, fumigation of hair is recommended in semi tertiary fever. **Male Gonads** : Piles, pain in uterus, dysentery, diarrhoea, abdominal disorders. **Urine** : It cures asthma and tuberculosis **Milk** : Milk mixed with rose water added to eyes cure blindness.

Mammal species	System of Medicine & Parts used	Action and Uses
Herpestes auropunctatus	Ayurveda & Unani Flesh, blood, leg bone, faeces and beak	Anti-inflammatory, anti-epileptic, depilatory, anti-poioning and nutritive.
Moschus moschiferus	Ayurveda, Siddha and Unani Musk is embedded in a sac which is oval or round with a diameter about 1½ inches. Musk when fresh is milky but later turns viscid and assumes a brownish red-colour. It retains its strong diffusible odour for a long time and has a bitter aromatic taste; it is soluble in alcohol to the extent of about 10% in water to about 50% also in ether and alkalies. The watery solution is faintly acid. It stains the paper yellow and when burnt, it gives off urinous smell, leaving grayish ash about 8%.	It is used in hysteria, hiccup, asthma, palpitation & other cardiac diseases, insanity, epilepsy and coma, loss of memory, paralysis, facial paralysis, numb-ness, colicky pain, Parkinson's disease, bronchitis, pleurasy, typhoid, plague, meningitis, hydrophobia, lock jaw, general debility, Rakta Pitta (bleeding from any part of the body), whooping cough, gonorrhoea, spermatorrhoea, melancholia, eye diseases and sexual debility. Inhalation is good for coryza and headache, deep inhalation may, however, cause epistaxis. It has been listed among Avicenna's tract as cardiac drugs. Anti-inflammatory activity of musk has been investigated on modern scientific lines. Its actions were found to be similar to those of hydrocortisone. Testing on mycobacterium adjuvant induced arthritis in rats revealed that musk was more active than phenylbutazone. It caused improved in secondary lesions also. It strengthens the external and internal sense organs. Due to its good smell commercially, it is used in the perfume. **In Homeopathy :** **Preparation of the tincture**: The whole musk bag is dissolved in diluted alcohol in the proportion of 1 to 20. Dilute alcohol, in the proportion of 20 to 80, is used in making the Ix and 2x dilutions.

Mammal species	System of Medicine & Parts used	Action and Uses
		It is used in curing hysteria, with symptoms like the patient faints from the least excitement, the hysterical spasm is ushered in by a contractive feeling about the throat, suffocation, glubus hystericus, spasms about the chest and alternate crying and laughing. The Moschus also useful in other important symptoms, like a great deal of flatulence, which may cause the fainting by pressure on the solar plexus. Spasmodic asthma and attacks of sudden dyspnoea.
Suncus murinus	Unani : Flesh	Anti-leprotic. It is poisonous and unfit for ingestion. With rose oil it forms a useful application for scrofula and leucoderma.
Manis crassicaudata	Unani : Flesh and scales	**Flesh** : acts as tonic and produces warmth **Scales** : Powder of scales is useful in epilepsy.
Mellivora indica	Unani : Flesh and skin	Anti-emetic, carminative, anti-inflammatory and detoxicant.
Rhinoceros unicornis	Ayurveda & Unani Flesh, fat, horns and excreta	**Flesh** : It is difficult to digest but nutritious. It is anti-emetic, astringent, cardio tonic and good for epistaxis. **Fat** : Along with sesame oil, forms a useful application for boils and wounds. **Horns** : Powder of horns is said to cure mania, insanity, loss of memory, biliousness and tuberculosis. It is considered to be a tranquilizer. Fumes of horns and hooves are given to facilitate delivery and in cases of piles. For the protection, the child

Mammal species	System of Medicine & Parts used	Action and Uses
		should be worn amulets be made up of the tip of the horns of the alive rhinoceros.
Axis axis	Ayurveda & Unani Flesh, horn, blood & excreta	Digestive stimulant. It is delicious, constipative, cooling and light. It is an appetizer **Flesh** : It cures asthma and fever. It alleviates three Doshas as well as the vitiated blood. **Horns** : Ash of horns is styptic and anti-dysenteric, pessary of ash checks uterine bleeding and discharges. Ash of hooves is good for healing wounds.
Funambulus pennanti	Ayurveda & Unani: Flesh	Aphrodisiac, anti-tussive and anti-epileptic The meat of these animals is aphrodisiac, promoter of eye sight and useful in the correction of the vitiation of blood. It cures Svasa (Asthma), Arsha (Piles) and Kasa (Bronchitis). It helps in the elimination of urine and stool. Flesh is given for the treatment of epilepsy
Felis tigris	Ayurveda : Flesh, teeth, nail, clavicle, brain, bile, hair, excreta, fat, bone and tail	**Flesh** : It is promoter of strength. It is always wholesome for patients suffering from the diseases of the eye and anus. **Fat** : In Malaria, Nasya of fat is given. Tiger's face fat along with rose water when rubbed on face acts as vaseline. **Bone** : Tiger's bile along with bone of tiger is rubbed on abscess of hand and feet. **Clavicle** : It is used as Scrap's pin. Apart from its ornamental use, it has its traditional belief that it brings good luck. For that very reason, it is also known as lucky bone. **Bile** : For eye diseases, the anjana's that are prepared, bile of tiger is used.

Mammal species	System of Medicine & Parts used	Action and Uses
		Excreta : It is considered as a good cure for piles. Their excreta is white like chalk. It is applied on pile mass. **Nails** : In all kinds of swelling and poisonings, tiger's nail along with other medicines, is rubbed and given e.g. for eyes as Anjana, in nose as nasal drops and given in form of Lepa. **Brain** : Brain of tiger along with Til oil, prepared and applied to pimples. **Tail** : It is dried and grinded. This powder alongwith soap when applied to the body removes skin diseases. **Teeth** : It has its mythological value that its wearing protects the child from all evil spirits.
Canis lupus	Ayurveda and Unani Fat, liver, brain, penis, bile, excreta, urine, skin, hair, nails and hide	**Fat** : It is useful as an external application in alopecia. Liver : It is useful in jaundice, colic of hepatic origin, liver diseases and enlargement of spleen. **Brain** : is given with milk for the treatment of epilepsy. **Bile** : External application of bile is useful in skin diseases. **Excreta** : is given in colic and inflammed condition. Bones : Ash of tibial bones is useful in diarrhoea, haemorrhages and alopecia.

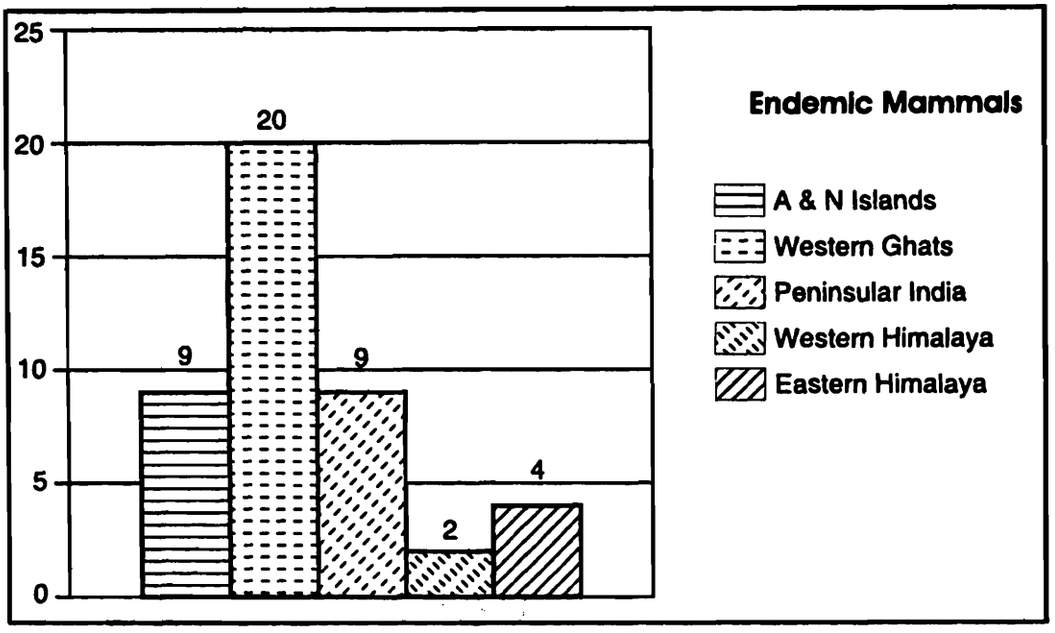
ENDEMICITY

Out of 180 genera of Indian mammals, 61 genera are monotypic (refer table) and 105 are represented in India by a single species. Of these, 10 genera namely, *Scotozous* (Chiroptera), *Loris* (Primates), *Melursus* (Carnivora), *Antelope, Boselaphus, Tetracerus* and *Pantholops* (Artiodactyla), *Eupetaurus* and Golunda (Rodentia) and *Caprolagus* (Lagomorpha) are endemic to Indian sub region, and another 4 genera, namely *Anathana* (Scandentia) *Latidens* (Chiroptera) and *Biswamoyopterus*, and *Platacanthomys* (Rodentia) are endemic to the Indian Union. At specific level, 44 species (Insectivora-7, Scandentia-2, Chiroptera-10,

Primates-3, Carnivora-4, Artiodactyla-1, Rodentia-17) are endemic of which 20 species are restricted to Western Ghats and 9 species to peninsular India, 4 species to northeastern India and two to western Himalaya 9 species to Andman & Nicobar Islands.

Hemiechinus nudiventris (Horsfield), *Crocidura andamanensis* Miller; *Crocidura nicobarica* Miller; *Crocidura jenkinsi* Chakraborty, *Crocidura hispida* Thomas; *Suncus dayi* (Dobson); *Anathana ellioti* (Waterhouse); *Tupaia nicobarica* (Zelebor); *Rhinolophus mitratus* Blyth; *Rhinolophus cognatus* Andersen; *Hipposideros schistaceus* Andersen; Hipposideros *hypophyllus* Kock and Bhat; Otomops *wroughtoni* (Thomas); Eptesicus *tatei* Ellerman and Morrison-Scott; Murina *grisea* Peters; Scotomanes *emarginatus* (Dobson); Macaca *silenus* (Linnaeus); *Macaca radiata* (Geoffroy); *Trachypithecus johnii* (Fischer); *Paradoxurus jerdoni* Blanford; *Viverra civettina* Blyth; *Herpestes palustris* Ghose; *Martes gwatkinsii* Horsfield; *Hemitragus hylocrius* (Ogilby); *Ratufa indica* (Erxleben); *Funambulus tristriatus* (Waterhouse); *Biswamoypterus biswasi* Saha; *Cremnomys elvira* (Ellerman); *Cremnomys cutchicus* Wroughton; *Alticola albicauda* (True); *Alticola montosa* (True); *Alticola roylei* (Gray); *Millardia kondana* Mishra and Dhanda; *Rattus palmarum* (Zelebor); *Rattus ranjiniae* Agrawal and Ghosal; *Rattus stoicus* (Miller); *Rattus burrus* (Miller); *Mus famulus* Bonhote; *Mus phillipsi* Wroughton; *Mus platythrix* Bennett; *Apodemus rusiges* Miller

Distribution of endemic mammals



Monotypic genera in India

Order	Species
Insectivora	*Anourosorex sqamipes, Nectogale elegans, Parascaptor leucura, Feroculus feroculus, Chimnarrogale himalayica, Sorex minutus*
Scandentia	*Anathana ellioti*

Order	Species
Chiroptera	*Otonycteris hemprichi, Sphaerias blanfordi, Otomops wroughtoni, Ia io, Latidens salimalii, Scotozous dormeri*, Megarops niphanae
Primates	*Loris tardigradus, Nycticebus coucang*
Carnivora	*Helarctos malayanus, Cuon alpinus, Melursus ursinus, aliurus fulgens, Arctonyx collaris, Mellivora capensis, Arctogalidea trivirgata, Paguma larvata, Arctictis binturong, Neofelis nebulosa, Acinonyx jubatus, Lutrogale perspicillata, Hyaena hyaena, Pardofelis marmorata, Viverricula indica, Caracal caracal, Otocolobus manul* and *Lynx lynx.*
Proboscidea	*Elephas maximus*
Sirenia	*Dugong dugon*
Artiodactyla	*Boselaphus tragocamelus, Tetracerus quadricornis, Antilope cervicapra, Budorcas taxicolor* and *Pantholops hodgsonii*
Rodentia	*Biswamoyopterus biswasi, Eupetaurus cinereus, Platacanthomys lasiurus, Cannomys badius, Hadromys humei, Golunda ellioti, Dacnomys millardi, Diomys crumpi, Nesokia indica* and *Micromys minutus*
Lagomorpha	*Caprolagus hispidus*
Cetacea	*Tursiops truncatus, Steno bredanensis, Peponocephala electra, Delphinus delphis, Grampus griseus, Lagenodelphis hosei, Orcinus orca, Globicephala macrorhynchus, Ziphius cavirostris, Orcaella brevirostris, Psudorca crassidens, Feresa attenuata, Neophocaena phocaenoides, Physeter macrocephalus and Megaptera novaeangliae*

THREATENED SPECIES

Of a total of 397 species of mammals reported from India, 175 species are threatened with extinction. But the degree of threat varies, and on that basis 75 species have been listed in Schedule I, 73 in Schedule II, 8 in Schedule III and 19 in Schedule IV of the Wildlife (Protection) Act (Appendix III). Of the 75 species in Schedule I, two species namely, the Hunting Leopard and the Lesser One-horned Rhinoceros are supposed to be extinct from India, and 32 species are highly endangered. These species are Lion-tailed Macaque, Phayre's Leaf Monkey, Hoolock Gibbon, Chinese Pangolin, Malayan Sun Bear, Red Panda, Ratel, malabar Civet, Desert Cat, Marbled Cat, Pallas Cat, Golden Cat, Rusty-spotted Cat, Caracal, Indian Lion, Snow Leopard, Great one-horned Rhinoceros, Indian Wild Ass, Kiang, Pigmy Hog, Musk Deer, Thamin, hangul, Swamp deer, Four-horned Antelope, Yak, Indian Buffalo, Himalayan Tahr, Markhor, Nilgiri Tahr, Hispid Hare, and Small Travancore Flying Squirrel (Agrawal *et al.* 1991). From Table 4, it is clear that practically all the species of mammals except insectivores, tree shrews, bats and murid rodents are threatened, to a varying degree. Impact of exotic weeds in recent years especially in alpine areas has far reaching consequences on the distribution of certain

endemic animals for e.g. invasion of woody plants and exotic weeds on the distribution of Nilgiri Tahr (*Hemitragus hyalocris*).

Number of threatened species of mammals (Order-wise) in India

Orders	Total No.	No. of species under Schedules of Wildlife (Protection) Act, 1972				
		I	II	III	IV	Endemic
Insectivora	28	-	-	-	1	7
Scandentia	3	-	-	-	-	2
Chiroptera	112	2	-	-	-	10
Primates	15	9	6	-	-	3
Carnivora	60	28+(1)	21+(4)	-	6(+1)	4
Artiodactyla	31	24	-	8	-	1
Perissodactyla	3	3	-	-	-	-
Cetacea	26	3	26	-	-	-
Sirenia	1	1	-	-	-	-
Proboscidea	1	1	-	-	-	-
Lagomorpha	11	1	-	-	9	-
Rodentia	104	2	16	-	2	17
Pholidota	2	2	-	-	-	-
Total	**397**	**77**	**73**	**8**	**19**	**44**

Siganus spinus

Chaetodon triangulum

Siganus vermiculatus

Chaetodon trifasciatus

Ctenochaetus striatus

Chaetodon vagabundus

Ribbon fishes (*Trichuris* spp.)

Rhacophorus bipunctatus

Rhacophorus maximus

Fejervarya Teraiensis

Leptobrachimus smithi

Bufo melanostictus

Rana danieli

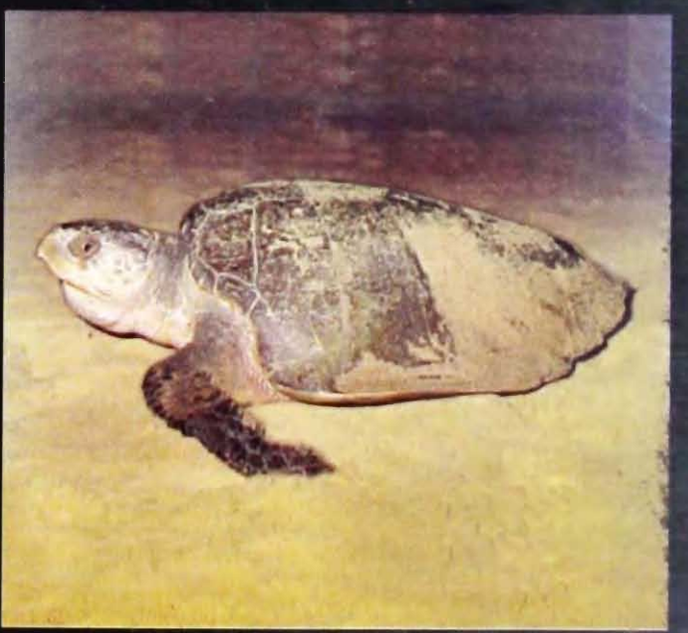
Python molurus

Naja kaouthia

Calotes versicolor

Sitana ponticeriana

Gavialis gangeticus



Lepidochelys olivacea

Tibetan Partridge

Oriental Turtle Dove

Koklass Pheasant

Oriental Magpie–Robin

Demoiselle crane

Blacknecked Crane (A young crane)

Aceros undulates

Paradoxornis atrosuperciliaris

Grus levcogeranus

Halcyon smyrnensis

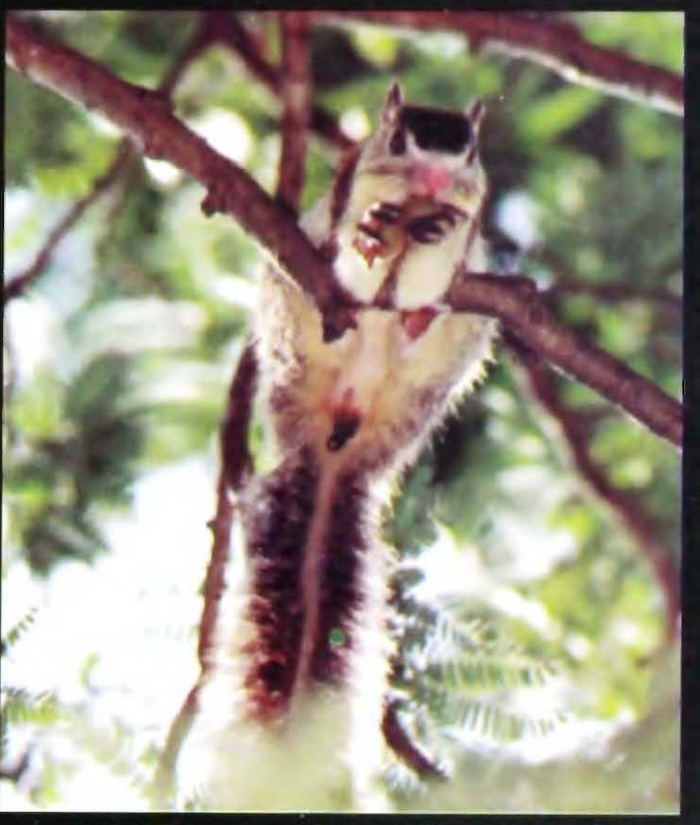
Leptoptilos dubius

Tyto alba

Nycticebus coucang (Slow Loris)

Canis aureus (Asiatic Jackal)

Macaca Assemensis (Assamese Macaque)



Ratufa macroura (Grizzled Giant Squirrel)

Rhinoceros unicornis (Greater One-horned Rhinoceros)

Antilope cervicapra
(Black Buck)

Pteropus giganteus
(Indian Flying Fox)

Eupetaurus cinereus
(Wooly Flying Squirrel)

Ichthyophis sikkimensis Taylor

Ichthyophis malabarensis Taylor

Ichthyophis peninsularis Taylor

Himalayan Salamander,
Tylototriton verrucosus Anderson, 1871

Close view of Himalayan Salamander

Habitat of Himalayan Salamander, Nakhapani Lake
at Gopal Dhara Tea Estate, North Bengal

CHAPTER–8

AREAS RICH IN FAUNAL RESOURCES

An ecosystem is defined as "a community and the physical environment that it occupies at a given time" An ecosystem can exist at any scale, lakes, marshes, and forest stands represent more typical examples of the areas that are compared in discussions of ecosystem diversity. Broadly speaking, the diversity of an ecosystem is dependent on the physical characteristics of the environment, the diversity of species present, and the interactions that the species have with each other and with the environment. Therefore, the functional complexity of an ecosystem can be expected to increase with the number and taxonomic diversity of the species present, and the vertical and horizontal complexity of the physical environment. The ecological services rendered by the ecosystem are numerous invisible but essential such as

- soil formation and control of soil salinity
- nutrient generation through decomposition and waste disposal
- productivity
- foodweb, predator–prey interaction
- absorption of carbon dioxide and balance of atmospheric gases
- stabilization of climate and mitigation of climate change
- maintenance of water table enhancement of water and air quality

Currently, there is no universal classification or unique definition of ecosystems at a global scale, but this area of research is evolving quickly. However, ecosystems may be classified according to the dominant type of environment, or dominant type of species present; for example, a salt marsh ecosystem, a rocky shore intertidal ecosystem and a mangrove swamp ecosystem etc. Because temperature is an important aspect in shaping ecosystem diversity, it is also used in ecosystem classification (e.g., cold winter deserts, versus warm deserts) (*Udvardy, 1975*).

The goals of the ecosystem approach according to the decisions of the V/6 of the conference of parties to the CBD, 2000 (page : 36) are the following :

1. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention : conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

2. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

3. The approach focus on structure, processes, functions and interactions which is consistent with the definition of "ecosystem" provided in Article 2 of the Convention on Biological Diversity:

   "Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their nonliving environment interacting as a functional unit. This definition does not specify any particular spatial unit or scale, in contrast to the Convention definition of "habitat". Thus, the term "ecosystem" does not, necessarily, correspond to the terms "biome" or "ecological zone", but can refer to any functioning unit at any scale. Indeed, the scale of analysis and action should be determined by the problem being addressed. It could, for example, be a grain of soil, a pond, a forest, a biome or the entire biosphere.

4. The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time-lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of "learning-by-doing" or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically.

5. The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions.

The ecosystem approach is a strategy for the integrated management of Land, Water and Living resources viz., variety of genes, species and habitats. An amalgamation of ecosystem-based approach with the species based approach is highly cost effective while addressing the conservation concern. It is widely accepted that the protocols of two complementary approaches viz., Top-down or ecosystem based approach will identify genetic diversity of different habitat types while the Bottom-up approach are well suited for the group based target species that are economically and taxonomically linked.

AQUATIC ECOSYSTEM

Marine Ecosystem

Oceans cover more than two thirds of the Earth's surface and contain marine ecosystems which have more number of phyla than the terrestrial or freshwater ecosystems. The coastal zone - where the land meets the sea and where the freshwater mixes with the salt water - has many of the Earth's most complex, diverse and productive ecological systems which provide a wide range of resources. The benefits provided by the coastal environment in the form of fisheries, transportation, natural food and erosion protection and other services have sustained human societies for millinnia around the environment. As more than two thirds of the world's people live in coastal regions. In the rapidly developing countries of the tropics such as India, industrialisation, natural resource exploitation and steady increase in the human populations are placing coastal environments under severe pressure.

The coastal ecosystem consists of estuaries, mangroves, coral reefs, salt marshes, lagoons and wetlands, back waters and others. Coastal mapping by the Space Application Centre, Ahamedabad [1 : 250,000 scale maps using Landsat TRI/IRS/LISS II data] depicts 80 coastal features including lagoons and estuaries. It shows an area of 4379 km^2 under Mangroves, 2132 km^2 of lagoons and backwaters and 1212 km^2 of reclaimed area. Presently, the coast along Gujarat, specially in the lower part is influenced by the total annual dicharge of four major rivers *viz.* Sabarmati, Mahi, Narmada and Tapti. Gujarat region is made up of Kutchh and Kathiawar peninsula to the west, seperated by the Gulf of Kutchh. This is a region of mudflats while the east, the Khambat region is made up of estuaries and rias. The Gujarat coast is also characterised by High tidal fluctuation (> 9 m), high saline water, steep coastal gradient and arid condition. The west coast is made up of Konkan coast, Karnataka coast and Malbar coast. The north Konkan is low lying with sandy splits, the southern region is rugged and rocky. The coastal formation in the states of Maharashtra (including the state of Goa) and Karnataka is rocky interspersed with sand belts with a very few rivers entering the sea (Netravati, Kali). The state of Kerala, (Malbar coast) having lowest land area per km of coast line is predominated by interconnected backwaters, wetlands, marshes, sand dunes, and lagoons etc. In the east, the Tamil Nadu coastline is under the influence of both the Arabian sea and the Bay of Bengal. The river Cauvery alone brings in about 21,000 million m^3 of upland discharge annually. The coastal stretch of Andhra Pradesh receives considerable quantity of annual discharge of about 92,890 million m^3 through major river systems of Godavari, Krishna, and Pennar. The 470 km long stretch of coast line in Orissa with near flat bottom in its upper part, receives an annual discharge of 1,75,913 million m^3 through major river systems of Mahanadi, Brahmini and Subarnarekha. The West Bengal with a shortest coastline is under the influence of the river Ganges with an annual discharge of 4,93,400 milliom m^3 of land drainage through Ganga (Hugli) estuary, the coastline has innumerable creeks and backwaters, mostly interconnected (Battacharya, 1996). The coast is also characterised by high tidal fluctuations, low salinity, gentle slope, and mangrove forest.

Statewise list of coastline in India

State	Length in Km
Gujarat (including Daman and Diu)*	1,663
Maharashtra	550
Goa	130
Karnataka	270
Lakshadweep	170
Kerala	570
Tamil Nadu (including Pondicherry)	950
Andhra Pradesh (including Yanam)	980
Orissa	470
West Bengal	240
A & N Islands	1962
Total	**7,955**

In respect of the offshore geomorphology, the western continental shelf of India occupies about 0.3 million Km^2 area and stretches from offshore of Kutchchh to Cape Camorin. It widens towards north (about 345 km off Tarapore) and narrows down towards south (60 km off Cochin). The shelf has a gentle slope due west and shelf break occurs between 80 and 140 m water depth. The continental shelf topography is divided into three distinct geomorphic units *viz.* even, uneven and rough. In general, the innner general topography is smooth and even whereas the middle and the outer shelf show uneven and rough topography. The distribution of sediment on the continental shelf is usually catagorised into (i). modern sands of the shore zone extending upto the depth of 5-10 m, located with in a few km of the coast (ii). inner shelf zone of terrigenous mud comprising of silt and clay and extending upto 60 m depth at 90 km off Bombay and towards south these muds extends up to 35-40 km to a water depth of 30-35 m. and (iii). medium to coarse carbonate rich sediment zone containing shells and skeletons of various organisms.

Exclusive Economic Zone (EEZ) and Shelf Area

Indian subcontinent with a vast peninsular coast and several islands and atolls has expansive EEZ and continental shelf areas. Though the EEZ is up to 200 nautical miles (370 km, the area is somewhat restricted by the international boundaries with Bangladesh, Sri Lanka and Myanmar). Table given below indicate the shelf area of different peninsular states as well as Andaman and Nicobar Islands and Lakshadweep Islands. The details of EEZ are given table.

Exclusive Economic Zone and Continental Shelf up to 200 m

Region	Area in thousand	Sq. Km.
	Shelf 0-200 m	EEZ up to 200 Knots (370 Km)
West Coast*	282.2	860.0
East Coast	132.3	561.4
A & N Islands	35.0	596.5
Total	**449.5**	**2017.9**

*including Lakshadweep

State	Shelf area up to different depth contours (sq km)			Coastwise shelf area up to the slope (sq km)
	0-50m	50-200m	0-200m	
Gujarat	64,810	34,563	99,373	
Maharashtra	25,512	79,246	104,758	(West Coast) 283,325
Goa	2,849	7,135	9,984	
Karnataka	7,936	17,537	25,473	
Kerala	12,569	23,372	35,941	
Tamil Nadu	23,255	18,157	41,412	
Andhra Pradesh	16,607	14,437	31,044	
Orissa	17,066	6,563	23,629	
West Bengal	9,935	12,927	22,862	(East Coast) 111,151
Lakshadweep	-	4,336	4,336	(Lakshadweep) 4,336
A & N Islands		15,32878	16,056	(A & N Is.) 16,056
Total				**414,868**

Marine Resource Area in coastal states

No.	State/UT	Continental shelf (000Km²)	Landing Centres	Villages
1.	Andhra Pradesh	33	508	508
2.	Goa	10	80	72
3.	Gujarat	184	854	851
4.	Karnataka	27	29	221
5.	Kerala	40	226	222
6.	Maharashtra	112	184	395

No.	State/UT	Continental shelf (000Km²)	Landing Centres	Villages
7.	Orissa	24	63	329
8.	Tamil Nadu	41	362	442
9.	West Bengal	17	47	652
10.	A & N Islands	35	57	45
11.	Pondicherry	1	28	45
12.	Lakshadweep	4	11	10
13.	Daman & Diu	0	7	31
	Total	**528**	**2456**	**3823**

DIVERSITY IN INDIAN SEAS

It is estimated that nearly 160,000 species are discovered and about 10 million species are to be identified from the marine environment of the world. The phyto-zooplankton analysis in the Indian seas is scanty. The earliest knowledge of marine plants is from the exploratory voyages around India and the collection made by the missionaries who visited this country. Due to the economic importance of certain groups viz. Seaweed, exploration and analysis took prime importance and rest of the algal taxonomy lagged behind. Untawale (1992) compiled the distribution of marine algal species from the Indian coast, accordingly, the Coromondal coast dominate in numbers of algal species (302 species) followed by Gujarat (202) and Maharashtra (159) in the west coast. The expedition conducted in Indian Ocean by International Indian Ocean Expedition (IIOE) and subsequently by R.V. Gaveshani cruises, as early as 1977 revealed the predominance of dinoflagellates (55 species), diatoms (35 species), cyanophytes and other flagellates (100 species). It is believed that the variation in the list of species is very little from region to region and from season to season, however, relative abundance (cell number) may vary considerably (Quasim, 1986). The concentration of phytoplankton in the central areas of Bay of Bengal varies between eutrophic (6,000 cells/ltr.) to oligotrophic (500-1,000 cells/ ltr.).

Sea grass beds are extensive and widespread in tropics; they are typically located in shallow waters between the mangrove communities along the coast and coral reefs, further offshore. Sea grasses are true marine species and some of them inhabit estuaries [*Thallasia* (turtle grass), *Posidonia, Cynodocea, Zoostrea* (eel grass), *Ruppia, Potamogeton,* and *Zinnichellia*]. In India, out of 12 sea grass genera of the world, 9 are distributed in the coast south of Godavari estuary, in the islands, and in the west coast of Gujarat. There are reports of the presence of *Ruppia maritima,* (a temperate community) in the aquaculture areas of West Bengal, and farmers are believed to use this species as anti disease plant in prawn farms. Like mangroves, sea grass communities provide shelter and food for small juveniles of commercial shrimps and other invertebrates. They also trap sediments and also act as

buffer zone to coral ecosystem. Higher marine vertebrates such as Dugong and Turtles prefer sea grass pastures. Seaweed contributes nearly 30% of the world's aquaculture production. About one third of the seaweed resources of the Indian Ocean are found only in the Indian coast. The importance of seaweed has increased in recent years due to wide range of its use in preparing as vitamins, minerals, trace elements and bioactive compounds.

According to Untawale (1993), there are 624 marine algal species of various groups. From the station-wise distribution of seaweeds for different algal groups it seems that Tamilnadu coast dominates in the number of algal species (302), followed by Gujarat (202), Maharashtra (159), Lakshadweep islands (89), Goa (82), belonging to 204 genera, 61 families and 15 orders. Among marine algal resources species of Red Algae such as *Gelidiella acerosa, Gracilaria crassa, Gracilaria edulis, Gracilaria folifera, Gracilaria verrucosa* nearly 1,200 tonnes/year are used to extract Agar and Brown Algae *viz., Sargassum ilicifolium, Sargasum myriocystm, Sargassum wrightii, Turbinaria conoides, and Turbinaria ornata* are used to the tune of nearly 5,000 tonnes/year for Sodium alginate production.

Marine Biodiversity of India

No.	Name of the group	Total	Marine	Percentage
1.	Algae	1500	624	41.60
2.	Protista	2577	750	29.1
3.	Porifera	519	486	96.3
4.	Cnidaria	817	790	96.7
5.	Ctenophora	100	12	12
6.	Platyhelminthes	4920	350	
7.	Gastrotricha	88	88	100
8.	Kinorhyncha	99	99	100
9.	Annelida	840	440	52.4
10.	Mollusca	5070	3370	66.7
11.	Bryozoa	194	170	
12.	Enteropracta	60	10	16.66
13.	Phoranida	11	3	27.23
14.	Brachiopoda	300	3	1.0
15.	Arthropoda a. Crustacea	2994	2430	81.2
16.	b. Pycnogodia	16	16	100
17.	c. Merostomata		2	
18.	Targigrada	10	10	100
19.	Chaetognatha	30	30	100
20.	Echinodermta	765	765	100

No.	Name of the group	Total	Marine	Percentage
21.	Hemichordata	12	12	100
22.	Chordata a. Protochordata	116	116	100
23.	b. Pisces	2546	1800	70.7
24.	c. Amphibia (in estuaries & Mangroves)	240	3	1.4
25.	d. Reptilia	460	26	0.2
26.	e. Aves	1228	145	11.8
27.	f. Mammalia	397	29	7.7

The faunal diversity of the marine environment is striking, there are more phyla in the ocean than in the terrestrial and freshwater environment. Of the 33 known phyla, 32 are found in the sea and 15 are exclusively marine. The marine environment also has more genetic diverstiy based on the number of distinct populations. And also, marine organisms constitute a wider range of forms, shapes and sizes, *i.e.*, from zooplanktons to whales. The coastal habitat and marine environment offers areas for reproduction, recruitment, feeding and shelter. The euphotic zone of the sea (of nearly 200 m depth) is teaming with life having phyto-zooplankton, copepods, eggs, larvae of fishes, jelly fishes, molluscs, pelagic fishes, turtles and mammals.

Mesozoa, a small organised group of endoparasites found in the nephridia of squids and octopuses and in the body cavity of some other marine invertebrates are represented by 10 species under 3 genera (*Dicyema*, *Diccymennea* and *Dodecadicyema*), all recorded from the Bay of Bengal.

455 species of sponges (under 203 genera) are recorded from India, indicating the species richness in the marine environment. According to Thomas (1998), nearly 275 species are recorded from Gulf of Mannar and Palk Bay; 25 species from Gulf of Kutchh, 61 species from Andaman & Nicobar islands, 91 species from Lakshadweep of which 18 species are boring sponges. Six species of boring sponges are known to have devastating effect on chanks, pearl oyster, rock oyster, mussels etc. Only about 60% of the total sponges have been explored from Indian coastal waters. The number of schyphozoa species estimated the world over is around 220 under 75 genera and 23 families, of which 35 species under 24 genera and 18 families are distributed in the east coast of India and Andaman group of islands (Ramakrishna & Sarkar, 2000). Medusae (juvenile or mid developmental stages of cnidarians) of 125 species, 82 genera under different classes have been recorded so far from the Indian coast (Halder and Chaudhury, 1995). 118 species of siphonophora are reported from Indian ocean, of which 89 species are known from the coastal waters of India (Daniel, 1991). 12 species of Ctenophores have been recorded from marine environment from Indian coasts.

Among the molluscs, several species are of ornamental value and support a viable shell-craft industry. Others, such as giant clams (*Tridacna* spp.), oysters *etc.* are of food

value. Windowpane oysters are the source material of aesthetic value, pearl oysters, are of commercial value. The estimated number of Molluscs in the Indian subcontinent is around 5070, species out of the estimated 66,535 species of the world, falling under 242 marine families 22 freshwater and 26 land forms (Subba Rao 1999). At the family level, about 62.8% of the families known from the world are represented in India. The richness of the species is due to the diverse ecosystems and habitats as can be seen below.

Class	India	World	% in India
Aplacophora	Nil	130	Nil
Monoplacophora	Nil	5	Nil
Polylplacophora	40	500	8
Gastropoda	3620	50,000	7.24
Bivalvia	1182	15,000	7.87
Scaphopoda	20	300	6.67
Cephalopoda	210	600	35.0
Total	**5072**	**66,535**	**7.62**

Diversity of molluscs in Marine ecosystem

Class	Family	Genera	Species
Polyplacophora	10	13	40
Gastropoda	140	340	2000
Bivalvia	61	150	1100
Scaphopoda	3	3	20
Cephalopoda	28	85	210
Total	**242**	**591**	**3370**

Species diversity of molluscs in different geographic areas

Andaman & Nicobar islands	1100 species
Lakhadweep	424 species
Tamilandu coast	618 species**
Gulf of Mannar	428 species**
Gulf of Kutch	350 species
Orissa coast	337 species
Andhra Pradesh	226 species**
West Bengal	130 species

** tentative list, species diversity in more than listed.

Utilisation of marine molluscs by various industries

Domestic Shell Craft Industry

- Preparation of Ornaments
- Table Lamps, Astrays, Agarbatti Stands,
- Door Hangings
- Lime Industry
- Poultry Feeds
- Pottery glazes
- Tooth paste (Dental cream)
- Talcum Powder
- Cement & Rayon Industry
- *Production of Calcium carbonate*
- Nacre. Commercially " Mother of pearl" used in decorative inlay
- Shells are used in jewellery items
- Preparation of "Shanka Bhasma" from a marine Bivalve, used in Ayurvedic Medicine

Chaetognaths constitute a major component of the marine environment, with 30 species distributed in epi, meso and bathy planktonic waters of Indian seas. The echinoderms occur in the intertidal region to great depths in the marine environment, occupying all available habitats such as rocks, benthic environment, coral and sandy environment. The group includes 765 species under 332 genera and 90 families in India. The holothurians till recently supported a good *bêche-de-mer* industry in the Gulf of Mannar of Tamil Nadu and used to earn considerable foreign exchange. Though there are prospects of the industry at Lakshadweep and Andaman and Nicobar Islands, the holothurians are included in Schedule-I of the Wildlife (Protection) Act in the interest of protecting the ecosystem.

The Protochordates include two subphylums (Cephalochordata with 6 species and Urochordata having three classes viz. Ascidiacea (47 species), Thaliacea (48 species) and Larvacea (18 species), all occuring in marine environment. The hemichordata includes only one class with 12 species occuring in the intertidal region to the great depths in the marine environment.

- Indian fish fauna consists of two classes' *viz.* Chondrichthyes and Osteichthyes. The Chondrichthyes (cartilaginous fishes) includes 131 species under 67 genera, 28 families and 10 orders, all occurring in the marine ecosystem.

- Among Reptiles, the *Crocodilus porosus* (estuarine or salt water crocodile) is largely confined to Bhitarkanika in Orissa, Sunderban in West Bengal and Andaman & Nicobar group of islands. Its occasional presence in Andhra coast and Tamil Nadu coast is also reported. Among sea turtles, the Logger head sea turtle (*Caretta caretta*) has been recorded from the Indian ocean and Green sea turtle (*Chelonia mydas*) from throughout the Indian coast including Andaman & Nicobar islands, Krusadai, Palk Bay, Tuticorin and Capecomorin, and with a depleted number in Puri coast of Orissa, Vishakapatnam coast in Andhra Pradesh. Reports from various parts of west coast are also common. Many areas in Gulf of Mannar are reported to be the nesting sites of these green turtles. The Hawksbill turtle (*Eretmochelys imbricata*) is generally distributed in Gulf of Kutchh and Gulf of Mannar and also reported from Lakshadweep, Andaman & Nicobar Islands, is one of the most commercially exploited sea turtles in India for its horny shields or keratin layer of its shell used in the manufacture of curios, expensive combs, jewellery and luxury articles such as buttons, snuff boxes, cigar cases etc. The Olive Ridley Turtle (*Lepidochelys olivacea*) is a widely distributed tropical species with reports of its nesting in Gahirmatha (Bitharkanika wildlife sanctuary) in Orissa, Andaman & Nicobar coasts, Digha and Sunderbans coast in West Bengal. There are also reports from Gulf of Mannar, Kerala coast, Konkan coast, Lakshadweep islands, Gulf of Kutchh etc. The Olive Ridley is a circumglobal species of marine turtle and with reports of more than half a million in the Gahirmatha nesting ground in Orissa. The leatherback sea turtle (*Dermochelys coriacea*), a circum global species selected Andaman, Nicobar and Lakhsadweep islands as nesting site. Instances of leather back sea turtle being caught at Vishakapatnam, Quilon (Kerala) and Goa are quite frequent. The turtles are hunted for its eggs rather than its meat, as they are considered great delicacy when they are fresh.

- 26 species of sea snakes belonging to family Hydrophiidae are recorded from the Indian waters. Nesting sites of *Laticauda*, an amphibious snake is reported from the shores of Andaman and Nicobar Islands. Diversity among Indian birds in the marine environment is difficult to estimate, however, from the available data, 145 species under 38 genera and 12 families are known to occur in the Indian coast.

- Among marine mammals (Order : Cetacea), Gangetic dolphins (*Platinistica gangetica*) are found occasionally in the mouth of Ganges leading to the Bay of Bengal. The Irrawadi Dolphin or Snub-nosed Dolphin (*Oracella brevirostris*), normally distributed in warm tropical climate is found in Bay of Bengal, east coast of India and Myanmar (Dandapani, 1992, Ramakrishna *et al.*, 1999). The little Indian Porpoise (*Neophocaena phocaenoides*) occurs in shallow coastal waters of east and west coast. The Dugong, *Dugong dugon* (Order: Sirenia) is reported from Gulf of Kutchh, Konkan coast, Malbar coast on the west and Tuticorin, Danushkoti, Rameswaram, Krusadai and Pamban in the east coast.

Fauna Resouraces of Lakshadwip Island

Group	No. of Species	New to Lakshdwip	New to India	New to Science from Lakshadwip
Meiofauna	152	72	24	6
Polychaeta	69	59	13	-
Sipuncula	17	4	2	1 (sub species)
Echiura	7	7	6	-
Stomatopoda	13	3	2	2
Insecta	79	36	1	-
Mollusca	168	60	13	
Echinodermata	72	16	6	-
Total	**577**	**257**	**67**	**9**

Source : ZSI publication on Faunal diversity of Lakshadwip

Species Richness in Gulf of Mannar Biosphere

Sl. No.	Group	No. of Species
1.	Heterotrophic Bacteria	35
2.	Phytoplankton	126
3.	Sea grasses	13
4.	Foreshore vegetation	10
5.	Inland sandy vegetation	77
6.	Salt marsh vegetation	7
7.	Mangaroves	7+14*
8.	Sea grasses	13
9.	Sponges	280
10.	Corals	120
11.	Annelids	40
12.	Mollusca (Gastropoda)	119
13.	Mollusca (Cephalopoda)	17
14.	Mollusca (Bivlvia)	76
15.	Shrimps	24
16.	Echinodermata	103
17.	Crabs (Brachyura)	106
18.	Fishes	106

Source : Maikhuri *et al.* 1998

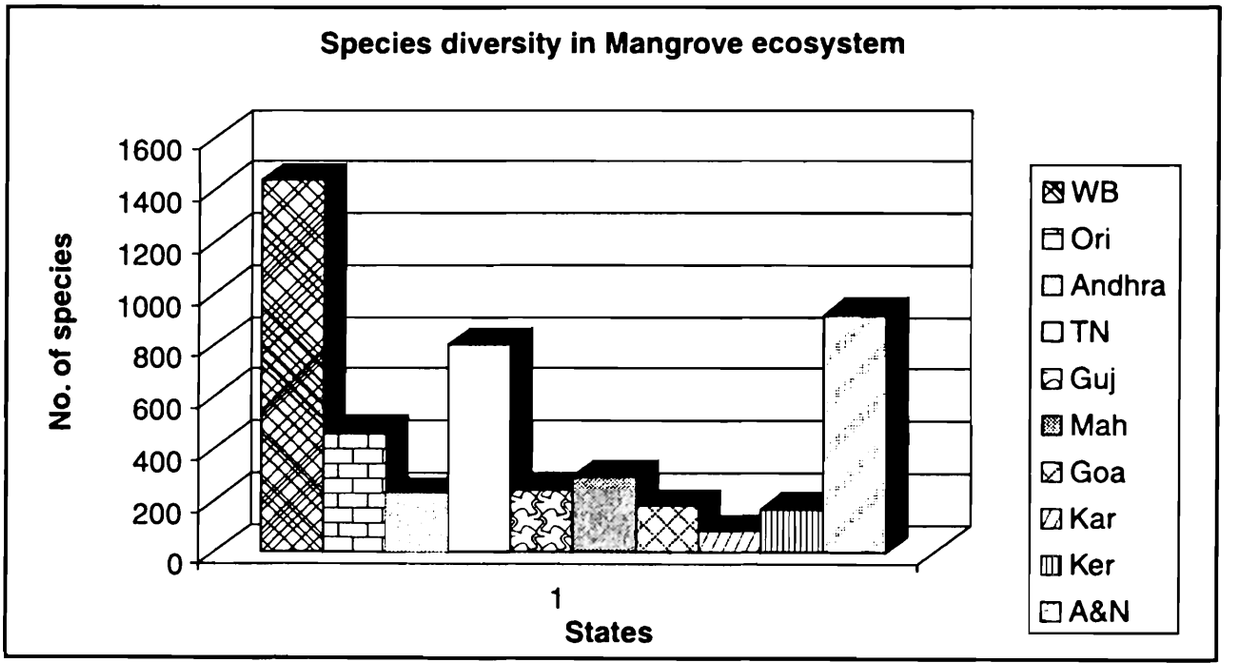
Impact on Benthic communities including sea mount communities, volcanic vent communities, bryozoans, corals, hydroids and sponges are vulnerable to human disturbance. The mechanical disturbance of marine habitats that occurs with some activities such as trawling, dredging, dumping, and oil, gas and mineral exploration and extraction; can substantially change the structure and composition of benthic communities (Froude, 1998). This is well noticed in recent years for the construction of a canal in the Gulf of Mannar (Sethusamudram Canal Project). As a result of the dredging operation, a large number of molluscs, polychaetes have been affected as can be seen by visual representations from the recent site excavation.

MANGROVE ECOSYSTEM

Mangroves represent a characteristic littoral forest ecosystem, dominated by some specially adapted salt tolerant plant communities that grow at land-sea interphase and border sheltered seacoasts and estuaries of tropical and subtropical regions. 'Mangroves' are also usually referred to a community of plants and animals in a tidal swamp forest, which exchanges matter and energy with adjacent terrestrial and marine ecosystems. Their distribution, association and zonation from deepwater to upland communities are influenced by climate (temperature and rainfall), salinity and tidal range, substrate, underlying geology and wave energy. Mangrove requires areas with sufficient protection from strong winds and wind generated waves, as wave action prevents seedling establishment. As a consequence, the mangrove communities tend to be located in sheltered coastal areas, surrounding highly indented estuaries, embankment and offshore islands protected by reefs and shoals.

Of the several ecosystems, mangroves are least understood, though it is a valuable resource in tropics, being used traditionally and directly as timber, firewood and building material. It supports commercial fishing, charcoal and tannin production and provides food in the form of crabs, prawns, honey and molluscs; indirectly it serves as an area of recreation. The importance of mangrove can be well understood by the fact that the leaves of the mangrove contain large amount of tough, comparatively indigestible cellulose, lignin and wax, unsuitable for terrestrial herbivore. One of the major processes occurring in the mangrove ecosystem is the formation of detritus by micro-organisms such as *Methanobacterium, Methanosprillum, Methanococcus* (anaerobic microbes) and nitrogen fixing bacteria such as *Azatobacter* and *Desulfovibrio.* The meiofauna work on cellulose, lignin, resin and carotenoids of the leaf and transforms into proteins and carbohydrate enriched particles ready for digestion by the faunal groups.

In India, the mangroves are distributed in east and west coasts as well as Andaman and Nicobar group of Islands. The extent of distribution of this group is as given below: The total area occupied by mangroves in the country as estimated by FSI during 1999, is 4,871 km^2 which forms 0.15 percent of the total geographic area, in comparison to IRS (1993) data of 4474 km^2 and 6740 km^2 of the MoEF (1987). The total area under mangrove vegetation is always a subject of discussion, the area wise distribution is given :



Distribution of Mangroves in different states of India

No	State/UT	Mangrove cover (km^2)		
		MoEF (1987)	IRS (1993)	FSI (1999)
1.	Andaman & Nicobar Islands	1190	770	966
2.	Andhra Pradesh	200	480	397
3.	Goa	5	5	5
4.	Gujarat	260	1166	1031
5.	Karnataka	60	19	3
6.	Maharashtra	330	138	108
7.	Orissa	150	187	215
8.	Tamil Nadu	150	150	21
9.	West Bengal	4200	1619	2125
	TOTAL	**6740**	**4474**	**4871**

Faunal Composition

The faunal components in a mangrove ecosystem comprising of terrestrial, estuarine or marine groups, are adapted to stressful condition and widely fluctuating environmental conditions. The faunal groups are generally confined to hard substrates offered by mangrove vegetation and comprise of sessile (porifers, cnidarians) and wandering species (king crabs), muddy substrate dwelling burrowing forms (in-fauna consisting of polychaetes, brachyuran crabs, wood boring animals, mud burrowing bivalves and gobid fishes) and forms living on the substratum (epi-fauna exemplified by oysters, barnacles).

Gopal and Krishnamurthy (1993) reported more than 229 species of crustaceans, 212 species of molluscs, 50 species of nematodes, 150 species of planktonic and benthic organisms and 500 species of other invertebrates from the Indian mangroves. Vertebrates are represented by 36 species of mammals, 177 species of birds, 22 species of reptiles and 300 species of fishes. The high degree of species diversity can be well understood from the case study on the Sunderban mangrove by Das and Nandi (1997) who reported 1434 species distributed in supralittoral (486 species), intertidal (499 species), and estuarine (449 species) areas. Species richness in mangrove inhabiting fauna of West Bengal, Tamil Nadu and Andaman & Nicobar Islands are well studied while that of west coast are fragmentary. In terms of species richness, Sunderban Mangroves of West Bengal ranks first with 1434 species representing 20 phyla followed by 914 species in Andaman & Nicobar Islands and 801 in Tamil Nadu.

Wood boring Molluscs

The first publication on the wood boring molluscs of mangroves of India, causing extensive damage dates back to 1954 by Roonwal, who reported the occurrence of teredinid borer *Bactranophorus thoracites* as a 'pest' in Sunderbans mangroves. Since then the species diversity and damage caused by several species have been recorded from various parts of the country by Rajgopal (1970), Subba Rao (1983), Santhakumaran (1986), Dev Roy & Das (1985), and others. Among the ten species of Teredinids, six species viz., *Teredo fercifera, Nausitora hedleyi, Bankia bipennata, Banka rochi, Nototeredo edax* and *Uperotus rehderi* are reported from Andaman and four species viz., *Bactranophorous thoracites, Dicyathifer manni, Lyrodus pedicellatus, Nausitora dunlopei* have been recorded both from Andaman and Nicobar Islands. Besides the above, several bivalves such as *Isognomon ephippium* and *Modiolus striatulus* cover thickly the underground roots and stems of mangroves.

Terrestrial components in Mangrove ecosystem : Faunal components occupying the mangrove ecosystem in various habitats such as mangrove canopy (birds and insects), creeks and bays (fishes, reptiles, mammals) and soil and litter (larval stages of insects, crustaceans). The mammalian species are represented by 31 species (maximum in Orissa), nearly about 58 species of reptiles [Sunderbans alone has a species of crocodile (*Crocodilus porosus*), 3 species of monitor lizard, 12 species of turtles and terrapins and 40 species of lizards and snakes]; nearly about 178 species of birds are recorded from the mangroves. Special mention may be made in respect of one species of Mammal viz., the Royal Bengal Tiger (*Panthera tigris tigris*), which occurs in the Sunderbans mangrove of India and Bangladesh. This is the only combined chunk of mangroves of the world, which the tiger species inhabits.

Faunal Distribution Pattern : Faunal distribution in mangroves are usually associated with tidal expanse and tidal amplitude in respect of shore animals, while in the case of mangrove associated fauna, the distribution varies horizontally from the landward mangroves towards the sea as well as vertically from the tree canopy to the lower parts of the plants as shown below :

Principal habitat	**Key faunal species**
Tree canopy	Bats, Birds, Insects, mites & spiders
Higher part	*Littorina scabra, Lamprid* beetles,
Lower part & Roots	*Littorina scabra, Onchidium, Sesarma,*
Mud flats	*Terebralia palustris, Cerithedia alata,* Fiddler crabs (*Uca* spp.)
Coralline/rocky flat	*Cerithium corallinum, Planaxus sulcatus, Grapsus strigosus, Thalamita* sp.
Coast mud of mangrove edge	Polychaetes, Bivalves (*Batissa & Gelonia* spp.)
Seaward mangroves	Sessile fauna (*Modiolus striatulus, Isognomon ephippium,* Oysters, barnacles, and Serpulid worms
Dead trees & Stumps	Marine wood borers, sessile fauna
Edge of streams & rivulets	*Scylla serrata, Periopthalmus* spp., *Boleopthalmus boddarti, Cerubrus rhyncopus*
Creeks & bays	Shrimps, prawns, & fishes

Amphibian diversity is comparatively low and limited to freshwater species intruding in to the area occasionally from the coastal environment; amphibian species such as *Rana cyanophlictis, R. tigerina, R. hexadactyla, R. limnocharis, Rhacophorus maculates and Microhyla ornata* inhabit the mangroves of Sunderbans (Mandal & Nandi, 1989). Reptiles that inhabit the mangroves include crocodile, turtles, snakes and lizards. Salt-water crocodile *Crocodilus porosus* is found almost in all large islands of Andman and Nicobar and occasionally in Sunderbans, which support mangrove swamps. Andaman water monitor lizard (*Varanus salvator andamanensis)* is common during the breeding season of the crocodiles, as the lizard is fond of lifting crocodile eggs. Dog faced water snake *Cerberus rhynchops* is frequently seen, showing that reptiles penetrate deep into mangroves. Furthermore, many lizards, of the genus *Goniocephalus subcristatus, Calotes versicolor, Mabuya carinata, M. dissimilis,* are seen throughout the mangroves. Turtles and terrapins are represented *by Batagar baska, Lepidochelys olivacea, Trionyx gangeticus, Trionix hurum* and *Lissemys punctata.* Of these, *Lepidochelys olivacea* is distributed in all the mangrove areas of the country. Birds use mangroves as the roosting and feeding sites. It is common to see the Grey herons (*Ardeola cinera*), Night herons (*Nycticorax nycticorax*) and Egrets (*Egretta intermedia* and *Egretta garzetta*) in Sundarban mangroves, besides the above as many as 16 species belonging to the family Ardeidae have been recorded. Among kingfishers, as many as 6 species have been recorded from the Sunderbans and 8 species from Andaman & Nicobar Islands (usually represented by *Alcedo atthis, Halcyon smirnensis, H. pileata, H. chloris, H. coromanda, Ceryle rudis, Pelargopsis amauropera, P. capensis).* This is mainly related to the unique adaptations noticed in the intertidal ecosystem, by the fishes, especially the mudskippers belonging to Gobidae. It has also been postulated that mangroves are nursery

grounds for many commercially important fish species and positive correlations have been drawn between fish population abundance and mangroves. Mammals present in the mangroves include monkeys (*Macaca fascicularis umbrosa* in Andaman, *Macaca mulatta* in Sunderbans) and flying foxes (*Pteropus melanotus, Pteropus giganteus and Cynopterus sphinx).* Several casual visitors of bats such as *Megaderma lyra, Rhinopoma hardwickii, Hipposideros lankadiva, Pipistrellus mimus, Scotophilus kuhli*) are also on record, besides wild pigs which frequent the mangroves (*Sus scrofa andamanensis, Sus scrofa nicobarica*).

The majority of mangrove fauna is composed of invertebrates, arachnids and insects, besides fouling communities on mangrove roots consisting of members belonging to porifera, coelenterata, bryozoa, polychaeta, mollusca and arthropoda. Among molluscs, *Littorina, Nerita, Cerithedia, Neritina, Telescopium, Pythia, Stenothyara, Haminea, Assiminia* and *Onchidium* are the dominant forms.

Brachyuran Crabs : Brachyuran crabs occupy a major part of the intertidal zone of mangrove ecosystem. As many as 35 species of crabs have been recorded from Andaman & Nicobar Islands which belong to the families Portunidae, Grapsidae, Ocypodidae, Mictyridae, Xanthidae and Gerarcinidae and the common genera are *Uca, Ocypode, Dotilla, Macropthalamus, Grapsus, Metopograpsus, Sesarma, Metaseserma, Metaplax, Portunus, Thalamita, Scylla, Charybdis, Mictyris, Epixanthus, Pilumnus, Baptozius* and *Cardisoma.* In contrast to Andaman & Nicobar group of Islands, the diversity of crabs in Sundarbans is comparatively higher with nearly 52 species, of which 13 are pelagic and 39 are benthic and they belong to 11 families and 26 genera. Mangrove crab diversity is very high with an estimated 275 species from six families of brachyurans (true crabs) associated with the mangrove ecosystems of the world (Lee, 1998). The distribution of crabs in major mangrove area of the country (Andaman & Nicobar and Sunderbans) *vis-a-vis* of the world given below :

Family	No. of species World	A &N and Sunderbans	Percent
Geocarcinidae	4	1	25
Grapsidae	166	26	15.66
Mictyridae	1	1	100
Ocypodidae	87	19	21.84
Portunidae	5	3	60
Xanthidae	12	3	25

Primary production and standing stock in a mangrove ecosystem is dominated by mangrove angiosperm tissue, algae and bacteria (Macnae, 1968, Macintosh, 1984; Alongi *et al.*, 1993). This provides leaf litter and sediment organics as the primary food source for grazers. Among them, *Uca* spp. are deposit feeders, but to some extent so are the sesarmids. However, the primary food source for gerapsids is believed to be leaf litter, supplemented with algae and animal matter (Dahdouh-Guebas *et al.*, 1999). The Xanthids and Portundids are primarily carnivorous but may supplement their diet with leaves and algae (Cannicci *et al.*, 1998).

Role of Crabs in Mangrove ecosystem : Mangrove crabs have been shown to be ecologically significant in many ways, as they keep much of the energy within the forest by burying and consuming leaf-litter. The faeces may form the basis of a coprophagous food chain contributing to mangrove secondary productivity (Lee, 1997), such as food for juvenile fish inhabiting the adjacent waterways; indicating that crabs also help shore fisheries. Crabs themselves are food for threatened species such as the crab plover. Their burrows alter the topography and sediment grain size of the mangrove and help to aerate the sediment (Ridd, 1996). Smith *et al.* (1991) found that removing crabs from an area caused significant increases in sulfides and ammonium concentrations, which in turn affects the productivity and reproductive output of the vegetation. Their findings support that mangrove crabs are **keystone *species.***

Faunal distribution pattern : Faunal components that are distributed towards landward side of the mangroves are large crabs belonging to *Cardiosoma carnifex,* medium crabs such as *Sesarma (Chiromantes) bidens* and *Sesarma longipes;* small crabs such as *Uca lactel, Uca (Deltuca) dusumieri and Uca (Thalassuca) vocans;* Molluscs such as *Cerithedia allata, Cerithedia quadrata.* Animals that are distributed in the mid-forest mangroves are large crabs belonging to *Scylla serrata, Thalamita crenata, Epixanthus frontalis* and *Euricarinus grandidieiri,* species belonging to smaller crabs (*Sesarma, Uca, Macropthalamus*), molluscs (*Terebralia, Cerethidia, Crossastrea, Isognomon, Perenia*), the gobid fishes (*Glossogobius giuris, Gobiopterus chuno, Apocryptes bato, Brachygobius nanus, Boleopthalmus boddarti, Periopthalmus vulgaris, P. koelreuteri, Ophiocara aporos, Oxyurichthys dasi and Quisquilius eugenius*) and several species of insects. Faunal components that are distributed towards the seaward side of the mangroves are several species of crabs belonging to *Sesarma, Epixanthus, Ocypode, Scylla, Thalamita, Macropthalamus, Dotilla, Uca;* mollusks such as *Terebralia, Cerethedia* and *Saccostrea.* A commonality has been found in the distribution of crabs and mollucs in the mid forest as well towards the seaward, as many of them occupy both the niches and the demarcation is incomplete.

Values : The coastal environment with its resource system is interlinked with the human activities with both land and marine environments. The coastal zone may encompass a wide variety of diverse habitats and ecosystems such as estuaries, lagoons, mangroves, coral reefs, and sea grass beds. These ecosystems have inbuilt features often known as "functions" in the context of coastal resource system. These functions may be in the form of primary and secondary productivity to sustain a large percentage of the flora and fauna and also forms the linkage with the marine, terrestrial as well as the mangrove vegetation in the coastal environment. In mangrove communities, much of the primary production is exported to the other coastal communities that are related to energy flows in the coastal ecosystem. Microbial action is most important to transform the hard cellulose to more usable forms of organic compounds of proteins, simple sugars and fatty acids. In conditions, where the mangroves are present in low wave energy and depositional conditions, high amount of peat formation will occur, which in turn helps in primary productivity and subsequent deposition of plant organic matter. The valuation of the

goods and services from the mangrove vegetation (modified in relation to Indian context from Hamilton and Snedaker 1984) that are often neglected/left out in understanding such ecosystem is given below in the Table. However, it should be taken into account to assess the value of each ecosystem.

	Location of "goods" and "services"	
	On-site	**Off-site**
Marketed	Usually included in an economic analysis (*e.g.*, charcoal. woodchips, tannin, timber, mangrove crabs)	May be included (*e.g.*, fish or shellfish caught in the adjacent waters)
Non Marketed	Seldom included (*e.g.*, medicinal uses of mangrove, domestic fuel wood, food in times of famine, nursery area for juvenile fish, feeding ground for estuarine fish, aesthetic and wildlife)	Usually ignored (*e.g.*, nutrient flows to estuaries, buffer to storm damage)

The policy and management actions to be involved in addressing the coastal developmental activities are therefore to be based on the sound knowledge of natural processes and the functions of the mangrove ecosystem that are operating at that given time and place. Further, the changes involved for e.g., construction of barrages and dams in the upper stretches of the river that cause substantial damage to the river flow, thus altering the environmental conditions, resulting in widespread damage to the nursery grounds of juvenile fishes which affect affect the fish catch composition, also need to be looked into for policy management.

In terms of economic value (Barbara Brown, 1997), mangrove ecosystem stands unique in terms of goods and ecological services, mangrove ecosystem can not be directly evaluated through market mechanism (after Costanza *et al.*, 1997 and Moberg and Folke, 1999). But involvement of community participation will certainly enhance the value of this ecosystem.

Ecosystem functions	**Corresponding goods and services**
Habitat for resident and transient population	Refusia (ex. nursery and habitats of rich floral, faunal and microbial taxa)
Portion of gross primary production extractable as food	Food production (exs., sea weeds, finfish, shell fish, and sea food products)
Portion of gross primary production extractable as raw material	Raw materials (ex. Poles, charcoal, wood chips, domestic fuel, wood for house construction, material for medicines and curio
Tropic-dynamic regulations of populations	Biological control (ex. feeding places within and between ecosystems)

Ecosystem functions	Corresponding goods and services
Capacity, damping and integrity of ecosystem in response to environmental fluctuations	Disturbance regulation (ex. shoreline protection, sediment retention, buffer for storm)
Recovery of mobile nutrients and removal or breaking down excess pr xenic nutrient compounds	Waste treatment (waste assimilation and nitrogen fixation)
Providing opportunities for recreational values	Recreation (tourism, recreation, viewing and studying wildlife)
Providing opportunities for non commercial use	Social and cultural (ex. aesthetic value, artistic inspiration and support of cultural and religious value)

Community Utilisation of Animal Resources : The increasing interest shown by government on tribal people living in Andaman & Nicobar Islands and an upsurge in respect for knowledge held by these tribals, demonstrate a fundamental change in attitude towards these tribes and their skills and talents. The Tribes in the Andaman & Nicobar for example are the major users of the mangroves, where there is an abundance of animal and plant resources. There are three potential types of use for plants in tribal society, for food, for medicines and for other purposes including tools and weapons. Recent exploration by the scientists of Zoological Survey of India (2002) in the tribal dominated areas of Andaman and Nicobar has yielded positive results on their dependency on the faunal resources. The main vertebrate components of the mangrove fauna are the fishes and birds, which are mostly transitory. Besides spearing fish, tribals make use of various types of fish traps, in the mangrove. The mangrove monitor *(Varanus indicus)* and the estuarine crocodile *(Crocodylus porosus)*, are consumed by these tribes occasionally. The crustaceans and molluscs are the main two invertebrate groups, which are exploited by tribal as a food source in Andamans. The mud crab, *Scylla seratta*, is an important food source. Prawns and shrimps are other components of the crustacean fauna of the mangroves but usually occur in small numbers. Records of exploitation of molluscs *viz., Telescopium telescopium* and *Terebra palustris, Nerita nerita, Pugilina cochlidium, Saccos*trea and *Crossastrea* as food are also available. The tribals of Nicobar use fruit to immobilize reef fishes and participate in a collective harvest of taking only those which they need to be eaten and leaving the unwanted in the same water which after the effect of the poison is over go back to their ecosystem. Sensitivity to nature is anninate attribute of indigenous people. In respect of usage of animal resources, there appears to be a similarity with the aboriginals of Australia; whether this is accidental or due to the similarity in distribution pattern of faunal elements is a matter of discussion.

Faunal diversities in the mangrove ecosystems in India

Faunal groups	Number of species occurring in	
	Sundarbans mangrove, West Bengal	Andaman& Nicobar mangrove
Protozoa	104	–
Porifera	1	–
Cnidaria	33	–
Ctenophora	2	–
Platyhelminthes	41	–
Nemathelminthes	68	29
Acanthocephala	3	–
Nemertinea	2	–
Rotifera	4	–
Gastrotricha	–	1
Kinorhyncha	–	1
Mollusca	142	100
Sipuncula	2	2
Echiura	3	–
Annelida	78	9
Arthropoda		
Crustacea	240	116
Insecta	201	33
Arachnida	35	2
Chilopoda	–	–
Merostomata	2	–
Bryozoa	3	–
Entoprocta	1	–
Brachiopoda	1	–
Chaetognatha	4	6
Echinodermata	20	–
Hemichordata	1	–
Chordata		
Pisces	176	223
Amphibia	8	3
Reptilia	58	7
Aves	163	53
Mammalia	40	8
Total	**1434**	**601**

Source : ZSI publications

CORAL REEF ECOSYSTEM

A coral reef is like a huge rock garden under the sea. A reef is made of billions of tiny sea-animals called corals. Most coral reefs are found in sunny, shallow waters in the warmest parts of the world. Corals have soft bodies, and grow hard skeletons to protect themselves. The tiny skeleton is shaped like a cup. Coral reef includes animals belonging to Phylum : Coelenterata, Order : Scleractinia (Hard, Reef forming, Zooxanthellate corals) with 18 families and 111 genera

Coral reefs grow in the tropical shallow waters on a substrate of limestone and require sunlight, high salinity, and temperature of 22-28° celsius for optimum development. Coral reefs are an assemblage of many types of plants and animals of which coral form one of the dominant components. Coral reefs constitute a productive ecosystem, which contribute immensely to the socio-economic well being of the coastal population, providing food, building material, pearls, shells for jewelry as well as a sheltered harbour for boats. In addition to the above, the importance of Coral reefs can be well understood by their contribution to the socio-economic development of the country as they serve as :

- Breeding and nursery ground for many organisms including fishes, lobsters, cephalopods and other molluscs
- A buffer zone against sea erosion
- Store house for medicinally valuable species and bioactive material (nearly 78 species are screened, 24 possesses bioactive compounds)
- An area of most aesthetically pleasing underwater communities
- Potential zone for ornamental fishes. From Andaman alone nearly 200 species of ornamental fishes are reported.

About 800 species of true corals or stony corals are distributed in the world seas, of these 600 species are represented in Indonesia, Malaysia, Philippines and South Japan, 400 species in Philippines and Japan, 400 species in Indonesia and nearly 200+ species in India. In India, the reef ecosystems extend over approximately 18,000 km^2 as against the total 1.6 million km^2 areas of all seas. Reefs are present in Andaman & Nicobar Islands (Fringing and Barrier Reefs), Lakshadweep (Atolls), Gulf of Kutchh; Gulf of Mannar and Palk Bay (Fringing Reefs). Reef building corals are also reported from Gopalpur in Orissa and Vishakapatnam in Andhra Pradesh. The species diversity in the reef area is very rich and the reef associates include several species of coralline algae (Red algae, *Lithothmnion*, green algae, *Halimeda* and *Padina* in Gulf of Mannar); several species of sea grasses such as *Thallassia, Halophila, Cymodacea* and *Halodule*, the last two are preferred by the *Dugong*). Several species of molluscs are known to occur in reefs (300 species of molluscs occur in the reefs of Andaman & Nicobar Islands, Subba Rao & Dey, 2000). In Andaman Islands, 43.3% (520 species) of the fishes are known to occur in reef ecosystem

Category	Coral Reef Area (in km²)			
	Gujarat	Tamil Nadu	Lakshadweep	Andaman & Nicobar Islands
Reef flat	148.40	64.90	136.50	795.70
Sand over reef	11.80	12.00	7.30	73.30
Mud over reef	117.10	–	–	8.40
Coralline shelf	–	–	230.90	45.00
Coral heads	–	–	6.80	17.50
Live coral platform	–	–	43.30	–
Algae	53.80	0.40	0.40	–
Sea weeds	–	–	0.70	–
Sea grass	–	–	10.90	–
Reef vegetation	112.10	13.30	–	8.90
Vegetation over sand	17.00	3.60	0.40	10.50
Lagoon	–	0.10	322.80	–
Sand substrate	–	–	(67.40)	–
Reef patch	–	–	(13.40)	–
Deep	–	–	(98.50)	–
Uncertain	–	–	(143.50)	–
Total	**460.20**	**94.30**	**816.10**	**959.30**

Diversity of Reef Building corals in India

Reef Area	No. of Families	No. of Genera	No. of Species
Gulf of Kutchh	9	23	37
Lakshadweep	13	37	105
Gulf of Mannar	13	36	96
Andaman Islands	16	31	82
Nicobar Islands	18	43	103

Coral Associates

	Gulf of Kutchh	Lakshadweep	Gulf of Mannar	Andaman & Nicobar Islands
Sponges	25	109	275	112
Mollusca	340	424	428	300
Echinodermata	24*	77	108	257
Fishes	264*	603	538	750

*Tentative, need updating

Source : ZSI publications

COASTAL WETLAND ECOSYSTEM

Coastal wetlands play a major role in the economics of the region, as these areas are highly productive for aquaculture, both for fin fisheries and shell fisheries. The productivity in back water wetlands show a value of 2,500 (g/m^2/year) in comparison to tropical rain forest and freshwater wetlands (2,000) and 1000 for other forest types. The coastal wetlands include water spread areas in the deltas of major rivers and include excellent mangrove vegetation. The partial closure of the estuary outlet results in the formation of coastal wetlands that too in the form of lagoons as can be seen in Chilka lake in Orissa and Pulicat in Andhra Pradesh and Tamil Nadu. The state of Kerala is also known for several coastal wetlands, the important being the Astamudi lake.

The Backwaters and Estuaries : These are more along the east coast. Their area overlaps with that of the mangroves. Their extent also varies greatly. The available information is given table.

State	Area in lakh acres		Area in Sq. Km	
	Backwaters	**Estuaries**	**Backwaters**	**Estuaries**
Gujarat	9.2	10.0	3723.9	4046.94
Maharashtra	2.0	1.0	809.39	404.69
Karnataka	2.0	0.5	809.39	202.35
Kerala	5.0	1.0	2023.7	404.69
Tamil Nadu	2.0	1.0	809.39	404.69
Andhra Pradesh	5.0	8.0	2023.7	3237.56
Orissa	0.2	7.5	80.94	3035.21
West Bengal	10.0	10.0	4046.4	4046.94
Total	**35.4**	**39.0**	**1432.8**	**15783.07**

The scientists of Zoological Survey of India have documented the faunal and floral resources and extensively studied the fast changing dynamics of the wetlands in the case of Chilka wetland, Orissa. The richness of faunal resources of coastal lagoon (Chilka wetland) is well understood from the reports of the survey and analysis of Chilka lagoon Expedition published in the Memoirs of Indian Museum from 1915-1924 (volume-V). The analysis of the recent multidisciplinary study brought out during 1995 is given below.

Species diversity in coastal wetland (lagoon) of Chilka Lake, Orissa

No.	Category	No. of Family	No. of Genera	No. of Species
1.	Protozoa	31	37	67
2.	Porifera	4	5	7
3.	Anthozoa	4	5	7
4.	Platyhelminthes	13	26	29

No.	Category	No. of Family	No. of Genera	No. of Species
5.	Nematoda	20	28	37
6.	Polychaeta	14	23	31
7.	Stomatopoda	1	2	3
8.	Crustacea			
	a. Brachyura	9	22	28
	b. Decapoda	10	18	30
9.	Mollusca	66	96	136
10.	Sipuncula	1	1	1
11.	Echiura	1	2	3
12.	Echinodermata	3	4	5
13.	Protochordata	1	1	1
14.	Pisces	71	147	217
15.	Amphibia	4	4	7
16.	Reptilia	11	26	30
17.	Birds	35	91	175
18.	Mammals	10	18	19
	TOTAL	**299**	**556**	**827**

Source : Fauna of Chilka Lake, ZSI Publication

Potential Crab and Prawn fishery resource in fresh and brackish water

CRAB SPECIES	PRAWNS
Barytelphusa guerini	*Exopalaemon styliferus*
Paratelphusa hydrodromus	*Caridina nilotica*
Paratelphusa spinigera	*Macrobrachium sulcatus*
Paratelphusa (paratelphusa) jacquamontii	*Palaemon (Nematopalaemon) tenuipes*
Clistocoeloma merguiense	*Macrobrachium aemulum*
Dotillopsis brevitarsis	*Macrobrachium lar*
Metaplax crenulata	*Periclimenes demani*
Metaplax dentipes	*Caridina gurneyi n. sp.*
Metaplax distincta	*Caridina kempi n. sp.*
Metaplax indica	*Caridina panikkari n. sp.*
Metaplax intermedia	*Caridina shenoyi (Jalihal and Sankolli)*
Metasesarma rousseauxii	*Caridina weberi sumatrensis*
Metopograpsus maculates	*Caridina williamsoni n. sp.*

CRAB SPECIES	PRAWNS
Pachygrapsus propinquus	*Leptocarpus fluminicola*
Ptychognathus dentatus	*Macrobrachium acanthurus*
Pyxidognathus deianira	*Macrobrachium altifrons altifrons*
Pyxidognathus fluviatilis	*Macrobrachium americanum*
Sesarma bidens	*Macrobrachium andamaniicum*
Sesarma edwardsi	*Macrobrachium assamense assamense*
Sesarma intermedia	*Macrobrachium assamense peninsularae*
Sesarma kraussi	*Macrobrachium australe*
Sesarma longipes	*Macrobrachium banjarae*
Sesarma quadrata	*Macrobrachium birmanicum*
Sesarma smithi	*Macrobrachium birmanicum choprai*
Sesarma taeniolatum	*Macrobrachium canarae*
Sesarma tetragona	*Macrobrachium cavernicola*
Metopograpsus messor	*Macrobrachium concinnus*
Ptychognathus onyx	*Macrobrachium dayanum*
Scylla serrata	*Macrobrachium equidens*
Scylla tranquebarica	*Macrobrachium gangeticum*
	Macrobrachium hendersodayanum

Faunal diversity in two estuarine ecosystem

Faunal group	Number of species occurring in	
	Hugli-Matla estuary (West Bengal)	Mahanadi estuary (Orissa)
Protozoa	54	-
Porifera	1	2
Cnidaria	24	3
Ctenophora	2	-
Platyhelminthes	13	-
Nemathelminthes	67	-
Nemerleans	2	-
Annelida	78	34
Rotifera	4	-
Mollusca	130	149
Echiura	4	-

Faunal group	Number of species occurring in	
	Hugli-Matla estuary (West Bengal)	Mahanadi estuary (Orissa)
Sipuncula	1	-
Ectoprocta	3	-
Arthropoda		
Crustacea	182	48
Insecta	162	3
Merostomata	2	-
Arachnida	33	1
Chaetognatha	4	-
Echinodermata	20	2
Hemichordata	1	-
Chordata		
Pisces	156	180
Amphibia	5	-
Reptilia	56	5
Aves	163	46
Mammalia	40	-
Total	**1207**	**473**

Source : ZSI publications

CONSERVATION STATUS

Marine Biosphere Reserves

Realising the potential for marine resources located, in the coastal environment and the concern over damages caused over the years with degradation of wetlands, flood plains, mangroves and coral reefs due to the influx of sewage pollutants, oil spills, over exploitation of marine living resources, conservation efforts have been initiated by developing Marine Biosphere Reserves in the country, on the basis of the guidelines of UNESCO's Man and Biosphere Programme. The main idea is to provide

In-situ conservation of biological diversity (genetic resources, species, ecosystems) of natural and semi-natural ecosystem and land scapes. Further it also envisages the sustainable economic development of human population living within the area of the biosphere and to serve as site for long term ecological studies and monitoring related to local, national and global issues of conservation and sustainable development. The Marine Biosphere Reserves notified include :

- Great Nicobar Biosphere Reserve
- Gulf of Mannar Biosphere Reserve
- Sunderban Biosphere Reserve

MAB Committee of the Ministry of Environment & Forests, Govt. of India has identified but not notified the following two sites and the expert group suggested to include Lakshadweep Islands also (Maikhuri *et al.*, 1998).

1 Little of Run of Kutch

- North Islands of Andaman

Marine Protected Areas (National Parks and Sanctuaries)

Sl. No.	Name of the MPA (District) State/UT	Declaration	Area (km^2)	Ecosystem
1.	Mahathma Gandhi Marine NP, Wandoor (South Andaman) Andaman	1983	281.50	Tropical evergreen forest, mangroves, Coral reefs, creeks and seawater.
2.	Rani Jhansi Marine NP (Richies Archipelogo) Andaman	1996	256.14	Evergreen forest, mangroves and Coral reefs
3.	Laha barrack (Salt water crocodile) Sanctuary (South Andaman) Andaman	1987	100.00	Dense mangroves (tidal forest), littoral forest, creeks, marine water and tropical evergreen forest.
4.	Gulf of Kachchh Marine NP (Jamnagar) Gujarat	1982	162.89	Mangroves, coral reefs, mudflats, creeks, beaches and scrub forest.
5.	Marine Sanctuary Gulf of Kutchchh (Jamnagar) Gujarat	1980	295.03	Mangroves, intertidal mudflats, beaches and coral reefs.
6.	Malvan Marine Sanctuary (Sindhudurg) Maharashtra	1987	29.12	Intertidal area, marine water, coral patches and sandy beach.
7.	Bhitar Kanika NP (Cuttak) Orissa	1988	145.00	Estuary, delta and mangroves.
8.	Bhitar Kanika Sanctuary (Kendrapara) Orissa	1975	672.00	Estuary, mangroves, terrestrial forest and ecotone with marine environment.
9.	Gahirmatha Marine sanctuary (Kendrapara) Orissa	1997	1,435.00	Sea water, sandy beach, estuary mangroves and ecotone with marine environment.

Sl. No.	Name of the MPA (District) State/UT	Declaration	Area (km^2)	Ecosystem
10.	Chilka (Nalabund) WLS (Khundra, Puri, Ganjam) Orissa	1987	15.50	Island, lagoon and brackish water.
11.	Gulf of Mannar NP (Ramanathapuram/ Tuticorin) Tamil Nadu	1980	6.23	21 islands, coral reefs, mangroves, sea grass beds and beaches.
12.	Pulicat Lake (Bird) Sanctuary Tiruvellore, Tamil Nadir	1980	153.67	Lake of brackish water of rain and seawater, mangrove and estuarine environment.
13.	Point Calimere Sanctuary (Nagapattinam) Tamil Nadir	1967	17.26	Tidal swamp, mangroves, creek and evergreen forests.
14.	Coringa Wildlife Sanctuary (East Godavary) Andhra Pradesh	1978	235.70	Mangroves, estuary, back water, creek and mud flats.
15.	Krishna Wildlife Sanctuary (Krishna/Guntur) Andhra Pradesh	1999	194.81	Mangroves, back water, creeks and mud flats.
16.	Pulicat Lake Bird Sanctuary (Nellore) Andhra Pradesh	1976	500.00	Brackish water of rain and seawater, mangroves, estuarine and algal beds.
17.	Sunderbans National Park-Tiger Reserve (North & South 24-Pargana) West Bengal	1973/1984	1,330.10	Mangroves, estuarine, creeks, swampy islands and mud flats.
18.	Halliday Sanctuary (South 24-Parganas) West Bengal	1976	5.95	Mangroves, estuaries, swampy islands and mudflats.
19.	Lothian Island Sanctuary (South 24-Parganas) West Bengal	1998	38.00	Mangroves, estuaries, creeks, swampy islands and mudflats.
20.	Sajnakhali Sanctuary (South 24-Parganas) West Bengal	1976	362.4	Mangroves, estuaries, creeks, swampy islands and mudflats.

Marine Protected Areas (Andaman & Nicobar and Lakshadweep Islands)

Sl. No.	Name of the MPA (District) State/UT	Declaration	Area (km^2)	Ecosystem
1.	North Button NP (Middle Andaman) Andaman	1987	0.44	Evergreen forest, littoral forest, mangroves, beach and coral reefs.
2	South Button NP (Middle Andaman) Andaman	1987	0.03	Evergreen forest, littoral forest, mangroves and beach.
3.	North Reef Island Sanctuary (North Andaman) Andaman beach.	1987	3.48	Evergreen forest, littoral forest, mangroves and
4.	South Reef Island Sanctuary (Middle Andaman) Andaman	1987	1.17	Beach and Coral reefs.
5.	Cuthbert Bay Sanctuary (Middle Andaman)	1987	5.82	Splendid beach and creek.
6.	Cinque Sanctuary (south Andaman) Andaman	1987	9.51	Evergreen forest, coral reef and beach.
7.	Galathea Bay sanctuary Great Nicobar	1997	11.44	Evergreen forest and mangroves.
8.	Parkinson Island Sanctuary Middle Andaman	1987	0.34	Evergreen and littoral forest and mangroves.
9.	Mangrove Island Sanctuary Middle Andaman	1987	0.39	Mangroves and marine life
10.	Blister Island Sanctuary North Andaman	1987	0.26	Mangroves and beach.
11.	Sandy Island Sanctuary South Andaman	1987	1.58	Sandy islands.
12.	Pitti wildlife Sanctuary Lakshadweep	2000	0.01	A small sandy island surrounded by sea.

Biosphere Reserves in Marine Areas

Name	State	Year of notification	Area (Sq. km)
Sundarbans	West Bengal	1989	9,630
Gulf of Mannar	Tamil Nadir	1989	10,500
Great Nicobar	Andaman and Nicobar	1989	885

LEGISLATION

The effective coastal zone management requires legislation on a few basic points. Several international laws are already in force under Clean Water Act. The first United Nations Conference on the Law of the Sea (UNCLOS) convened in the year 1958 at Geneva, commonly known as the Geneva Convention adopted four conventions *Viz.* (i). Convention on Territorial Sea and Contiguous Zone (ii). The Convention on High Seas (iii). The Convention on Fishing and Conservation of the Living Resources of the High Seas and (iv). Convention on Continental Shelf. The third UNCLOS Convention held during April 1982 and the Preparatory Commission (PREPCOM period being 1982-1994) carried out its functions which included the registration of the pioneer investors and making preparatory arrangements for the establishment of the International Sea Bed Authority and International Tribunal for Law of the Sea. This came into force on 16th November 1994, which India ratified Convention in June 1995. According to the Convention the Coastal States are entitled to

- Territorial Sea of 12 nautical miles the state has complete sovereignity
- Contigious Zone of 12 miles the state has specific rights with extension of National Laws over that area
- Exclusive Economic Zone not exceeding beyond 200 Nautical Miles, the state having only Jurisdictional rights over the resources. (The Exclusive Economic Zone of the country covers 1.8 million km^2 and represents about 2.7% of the Indian Ocean. In India the EEZ on the west coast (including Lakshadweep) constitutes the maximum area (42.5%) followed by Andaman & Nicobar islands (29.7%) and east coast (27.8%).

Further, United Nations Conference on Environment and Development (UNCED) added momentum to the growing consensus on the need for enviromentally sustainable development. Chapter 17 of Agenda 21–UNCED's blue print for action highlights the need for the integraded management activities and means of implementation.

Government of India, in consultation with the Zoological Survey of India and Wildlife Institute of India has already intiated conservation measures by protecting animal species especially mammals, birds, reptiles, amphibians and fishes by including them under Schedules of Wildlife (Protection) Act of 1972, based on the guidelines of IUCN and CITES. Legislative Measures initiated in India for protection of Coastal and Marine environment are :

- The Fisheries act of 1897
- Indian Ports Act of 1908
- Merchant shipping Act of 1958
- The Major Ports Act of 1963
- Formation of MPEDA, 1972

- The territorial waters, continental shelf, Exclusive Economic Zone and other Maritime Zone Act of 1976
- Coast guard Act of 1978
- The Merchant Shipping Amendment Act of 1983
- Environmental Protection Act of 1986
- Coastal Zone Regulation Notification of 1991 (direct outcome of EPA, 1986)

Besides the bove, MARPOL (Marine Pollution) of 73, as modified by the protocol of 1978 and the Environmental Impact Assessment of 1994 are most important in the conservation of the coastal resources.

Maritime Zones of India Act, 1981 : In exercise of the powers conferred by the section 25 of this act, the Central Government framed some rules. The relevant rule is given below :

Rule 5.1h (i) and (ii)

i) The crew of the vessel shall fish only for the stocks described in the licence :

ii) The crew of the vessel shall not catch any fish by aspecies, size or age set out in the licence as prohibited catches, that are covered under the Wild Life (Protection) Act, 1972 (53 of 1972) and where such fish are caught they shall be retained and preserved on board the vessel, accounted for in Form c and shall be surrendered at such places as may be directed by the authorized officer.

Marine Fishing Act (1981) : The main management measure adopted in this Act is that the restriction of trawling during monsoon period may be beneficial to juvenile sharks landed by trawlers. However, the ban on the fishing by mechanized trawlers during the Southwest monsoon period has only limited application to shark fishery, as *Scoliodon* are taken by catch in the trawl fishery. There is no regulation, prohibiting catch of immature sharks or minimum sized sharks in the dol nets and trawls.

The Deep Sea Fishing Policy : This was formulated by "The Murari Committee" in 1984, headed by Mr. P. Murari, former Secretary to the Government of India. Some of the recommendations of this committee are given below :

1. Government should setup a fishery authority of India bringing all types of marine fisheries under its umbrella to formulate policy for the industry as well as to ensure its implementation.
2. All deep-sea regulations should be enacted by the parliament after consulting the fishing community to avoid conflicts among fishermen.
3. Upgradation of the technical skill of the fishermen and equipments should be done and fuel subsidy should be given to the fishermen.

4. Government should provide infrastructure facilities like cold storage, ice factories and fish processing facilities to prevent wastage of fishery resources.
5. The Coast Guard has to be strengthened, expanded and upgraded technically with adequate navigational and surveillance equipment and weaponry to prevent poaching by foreign vessels.

This committee further recommended certain restrictions to deep-sea fishing. They are as follows :

1. No renewed licenses should be issued in future to joint ventures, leased or test fishing vessels;
2. Foreign vessels which are more than 20 meters in size, should not be permitted to exploit areas where fishermen in traditional crafts or small mechanized vessels ply their trade,

The fleet size for different fishing grounds may be fixed taking into account the maximum sustainable yield and the need for conservation of resources.

Wild Life Protection Act Under this act, the Central Government issued a notification in 1991 declaring coastal stretches as Coastal Regulation Zone (CRZ) and regulating activities in the CRZ. In the CRZ there are restrictions on the setting up and expansion of industry, operation or processes.

The Environment (Protection) Act 1986 makes it obligatory for the Government to take necessary steps for the protection of the environment. Under this Act, the Central Government issued a notification in February 1991 declaring coastal stretches up to 500m from the High Tide Line as Coastal Regulation Zone (CRZ) and regulating industrial and other activities in the CRZ. However, the thrust of this law is protection of the land and not the seas and therefore it does not directly affect shark fisheries.

THREATS

Over 3.5 billion years of evolution and unique combination of physical factors have created diversity of life, all of which is ultimately linked. These linkages means vulnerability, the flow of ocean currents and the lack of firm boundaries means that if one habitat is under threat, it also affects neighbouring habitats.

The main threat to the coastal environment are :

- Conversion of coastal habitat by exploitation of corals and coral sand as building material; mangroves for wood, paper, medicines; destruction of sea grass beds for consruction of harbours or for coastal tourism; conversion of wetlands for aquaculture;
- Overharvesting of resources especially fin fish, wanton destruction by improper adoption of meshes in the nets, cyanide fishing and other methods. Recently,

collection of post larvae of *Panaeus monodon* for prawn farms by the local fishermen (Bagda netting) led to the wanton destruction of other larvae on the sea beach and this threatenned the ecology as well as the resources in the sea.

- A number of untargetted fish and other biota are collected from their habitat and discarded as waste (By-catch). Shrimp trawlers have the highest rate of by-catch having more than 90% of "Trash Fishes"
- Overfishing has its impact on shell fisheries; sacred chank (*Turabinella pyrum*) was fished so heavily, that it became commercially extinct in the Gulf of Kutchh. Similar is the case of *Pictanda fucata* (Pearl oyster) in the Gulf of Kutchh
- Surface run-off, pollution, alteration in the water quality by pesticides, heavy metals from the industry (land based polution) and nutrient loading
- Oil spillages from tankers near the coast as well as occasional catostrophic disasters from oil tankers in the mid ocean, thereby affecting larval stages and many zoo-phytoplankton communities
- Alteration of the catchment areas by construction of dams result in the deposition of sediments in the estuaries. Construction of fishing jetties, harbours, dredging operation and silt accumulation lead to turbid conditions and clogging of burrows in the intertidal zones.
- Recently, the coastal tourism has affected the sandy beaches, coral reefs (due to anchoring of boats, snorkellers and swimmers).

The destruction of mangroves for converting them into rice fields has severely limited the survival chances of vanishing Indo-pacific crocodile (loss of nesting habitat). The meat and eggs of all species of marine turtles are edible and their skin is valuble. The other factors that endanger the turltes (five species) are the commercial hunting for oil and cartilage (Green sea turtle), effects of deforestation, pollution and destruction of habitat. The construction of fishing jetty near Gahirmatha beach in Orissa, has threatened the World's largest rookery for the Olive ridley (*Lepidochelys olivacea*).

Whales and dolphins are captured for their oil, fins are used for soup, skin for making leather and the flesh as fish meal and manure.The greatest threat to dolphins is from the gillnet fishery.

Economically 12 species of holothurians (Echinoderamata) are known to be exploited in India. On a large commercial scale, they belong to 5 genera viz., *Actinopyga, Bohadischia, Holothuria, Stichopus* and *Thelenota.*

Bioactive compounds have been extracted recently that are potentially rich in hormones and toxins. *Acanthaster planci* (Crown-of-thorns) is a voracious carnivore that destroys large areas of coral polyps. Many other asteroids cause destruction to oyster and shell fish culture.

FRESHWATER ECOSYSTEM

The wetlands are defined as transitional areas between terrestrial and aquatic ecosystems; encompass a wide variety of habitat and includes lakes, rivers, estuaries, coastal lagoons, mangroves and even coral reefs. The classification of these is based on its geographical location (Himalayan, Peninsular, Coastal, floodplains, etc), limnological (Fresh Water, Brackish or marine Water), functional (Irrigation, Water Supply, Hydropower), water quality (Oligotrophic, Eutrophic) or based on management. The National Water Policy, revised in 2002 gives importance to Institutional mechanism by a directive that gives effect to the planning and management of the water resources on a hydrological unit basis, along with a multisectoral, multidisciplinary and participatory approach as well as integrating quality, quantity and the environmental aspects. Therefore, in the last few years the role and value of wetlands are recognized as they support a wide range of functions that are essential for maintaining the quality of environment, genetic diversity, faunal and floral resource besides constituting an important gene pool for potential exploitation and management. In fact, the wetland value is mainly related to the primary production in providing the food energy that drives the ecosystem (Mitsch, 1986). Besides primary production, wetland serves as the reservoirs for storing water, flood control, prevention of soil erosion, aquifer recharge, cultural, aesthetic, recreation and areas of biological diversity especially waterfowl habitat.

Indian Wetland Types, Number and Area

Wetland Type	Wetland Category	Number	Area (ha)
Inland	Natural lakes & Ponds	4646	679530
	Ox-bow lakes	3197	151051
	Waterlogged (Seasonal)	4921	285744
	Playas	79	118519
	Swamp/Marsh	1814	197784
Man-made	Reservoirs	2208	1481987
	Tanks	5549	558344
	Waterlogged	892	77302
	Abandoned quarries	105	5774
	Ash ponds/cooling ponds	33	2281
Total	**Indian Wetlands**	**2344**	**3558915**

Source : Vijayan and Prasad, 2003

Faunal diversity in Freshwater ecosystem

Zooplanktons are the microscopic free swimming organisms of the aquatic ecosystem represented by the wide array of taxonomic groups, of which protozoa, rotifer, cladocera and copepoda are most coomon and dominant group of consumer communities. Ecological

categories of freeliving protozoans are flagellates, rhizopods (*Arcella, Difflugia, Trinema*) and ciliates (*Paramaecium, Spirostomum, Vorticella, Opercularia*) that occur in ponds, lakes and rivers. Rotifers comprise a very small group of animal kingdom but are often the most abundant metazoans in inland waters, both qualitatively and quantitatively. Sharma and Sharma (2004) recorded 330 species spread over 63 genera and 25 families from the Indian waters. Cladocerans are the most primitive group of crustaceans primarily inhabit freshwater ecosystems and frequently occur in the littoral, limnetic, benthic, interstitial and ground water environments. Members of the families chydoridae and macrothricidae colonize littoral weedy margins of the lakes and ponds. The genera *Ilocryptis* and *Monospilus* are benthic forms while the *Alona quadrangularis* and *Drepanothrix* live near the bottom, while the limnetic communities includes species such as *Daphnia, Diaphanasoma, Ceriodaphnia, Bosmina* and *Moina* (Sharma and Sharma, 2004). Nearly 110 species are known to occur in India. Copepods are microscopic organisms distributed in marine as well as freshwater environs include free living and planktonic calanoida (*Diaptomus, Neodiaptomus, Heliodiaptomus, Phyllodiaptomus Allodiaptomus, Spicodiaptomus* species); Cyclopoida includes both freeliving and parasitic, the freeliving species are *Cyclops, Mesocyclops, Macrocyclops, Eurycyclops, Paracyclops, Tropocyclops*).

A case study on the Faunal diversity of Aquatic Hemiptera in India

Knowledge on the ecological aspects of aquatic and semi-aquatic species is essential for the study of fish biology and for the proper management of hatcheries. Role of many of the aquatic faunal groups has also been studied to understand the predator–prey interaction for ex., several aquatic bugs have been identified as predators in biological control of mosquitoes (Jenkins, 1964). There are 9 families of water bugs that are natural predators on mosquito larvae and pupae. The nepid genus *Cercotmetus* has been found established as a potential natural mosquito control agent. The belostomatid, *Limnogeton* sp. is important as an obligatory feeder on freshwater snails that serve as intermediate hosts of human veterinary schistosomiasis. Besides above, hemipterans form an important component in the food webs of fresh water communities. Thus, in a fresh water ecosystem, the aquatic bugs bridge the gap between the producers and the consumers because most of them are polyphagus and carnivorous. Because of their diverse habitats and poor dispersal capability, these water bugs serve as zoogeographical indicators (Hungerford, and Matsuda. 1958).

Many of the aquatic heteropterans, odonate laravae constitute natural food for fishes besides some species predating on fish fry. Moreover, the artificial feed of turtles and tropical fishes are mainly made of aquatic bugs. Yet another contribution by the aquatic bugs to the ecosystem is that, they form main food for many aquatic and semi-aquatic animals. Many vertebrates like newts, salamanders, frogs, water snakes and birds feed partially upon aquatic insects during their aquatic phase. Therefore, many of the aquatic insects including water bugs are important to these vertebrates as a main source of protein. Importance of the faunal diversity in a freshwater ecosystems can be well understood by understanding a single group of aquatic insects as detailed below.

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Leptopodomorpha contains bugs that are ground dwelling and predacious. They are distributed in boreal, temperate, subtropical, zones and associated with littoral habitats, including marine intertidal zones where they regularly undergo submergence, while a few are partial or truly terrestrial and xerothermeic habitats are may even occur in caves. Globally 310 species and 36 genera are known accommodated in 4 families, out of which 10 species and 3 genera in 2 families are so far recorded from India.

ECOLOGICAL NICHES

Families within the suborder Heteroptera associated with aquatic ecosystem

Family	Habitat
	Infraorder **Leptopodomorpha**
Saldidae	(shore bugs)–margins of streams & ponds
	Infraorder **Gerromorpha**
Mesoveliidae	(water treaders)–vegetated banks of ponds & lakes
Gerridae	(water striders)–surface of fresh & brackish waters (sea)
Veliidae	(riffle bugs)–surface of ponds & streams, also brackish
Hydrometridae	(water measurers)–surface of calm waters
Hebridae	(velvet water bugs)–marshes & wet riparian mosses
	Infraorder **Nepomorpha**
Aphelocheiridae	lentic & lotic
Nepidae	(water scorpions)–ponds, on vegetation
Belostomatidae	(giant water bugs)–ponds, in vegetation
Corixidae	(water boatmen)–fresh & brackish lentic waters
Notonectidae	(backswimmers)–ponds and lakes
Naucoridae	(creeping water bugs)–lentic & lotic, stones & vegetation
Ochteridae	(shore bugs)–stream margins, pond vegetation
Gelastocoridae	(toad bugs)–shorelines, in mud & plant debris
Pleidae	(pygmy backswimmers)–ponds & lakes, in vegetation
Helotrephidae	ponds & lakes, in vegetation

Taxonomic analysis of semi-aquatic bugs from the geographical divisions of Himalaya establishes a distribution of increasing number of similar species of from Western to Eastern Himalaya (Thirumalai, 2000). The different ecological conditions, altitudinal zonation and other peculiarities that determine the distribution of fauna from west to east in the Himalaya (Mani, 1974). The peculiarities of topography climate and altitudinal variations together with mixing of the elements from the Turkman's subregion of the Palaearctic and the Indian peninsular elements presumably has contributed to the greater concentration of this group in Uttar Pradesh (Fig-3). Moreover out of 12 species known from Assam, 8 species are similar in occurrence with Arunachal Pradesh through which

almost uninterrupted interchanges of fauna have taken place between the peninsular India and Asia (Mani, 1974). Altogether 45% of the Indian Gerromorpha is distributed in the Himalayan states.

Species diversity in Freshwater & Estuarine Wetlands in India

Taxonomic group	No. of species occurring in		% in wetlands
	India*	Wetland	
Kingdom : PROTISTA			
Protozoa	2577	1250	48.5
Kingdom : ANIMALIA			
Mesozoa	10	10	100.0
Porifera	486	400	82.3
Cnidaria	842	540	64.1
Ctenophora	12	10	83.3
Platyhelminthes	1622	1200	73.9
Nemertinea	-	-	-
Rotifera	330	330	100.0
Gastrotricha	100	80	80.0
Kinorhyncha	10	10	100.0
Nematoda	2850	500	17.5
Nematomorpha	-	-	-
Acanthocephala	229	150	65.5
Sipuncula	35	30	85.7
Mollusca	5070	2300	45.3
Echiura	43	40	93.0
Annelida	840	500	59.5
Onychophora	1	-	-
Arthropoda	68389	7302	10.6
Crustacea	2934	2000	68.1
Insecta	59353	5000	8.4
Arachnida	5818	300	5.1
Pycnogonida	16	-	-
Pauropoda	-	-	-
Chilopoda	100	-	-
Diplopoda	162	-	-
Symphyla	4	-	-
Merostomata	2	2	100.0
Phoronida	3	3	100.0
Bryozoa (Ectoprocta)	200	100	50.0
Entoprocta	10	5	50.0
Brachiopoda	3	3	100.0

Taxonomic group	No. of species occurring in		% in wetlands
	India*	Wetland	
Pogonophora	-	-	-
Priapulida	-	-	-
Pentastomida	-	-	-
Chaetognatha	30	10	33.3
Tardigrada	30	20	66.6
Echinodermata	765	500	65.3
Hemichordata	12	10	83.3
Chordata	4952	2550	51.5
(Cephalachordata + Urochordata)	119	70	58.8
Pisces	2546	2000	78.5
Amphibia	209	150	71.7
Reptilia	456	50	10.9
Aves	1232	250	20.3
Mammalia	390	30	7.7
Total	**89,451**	**17,853**	**19.9**

ENDEMISM IN FRESHWATER WETLANDS

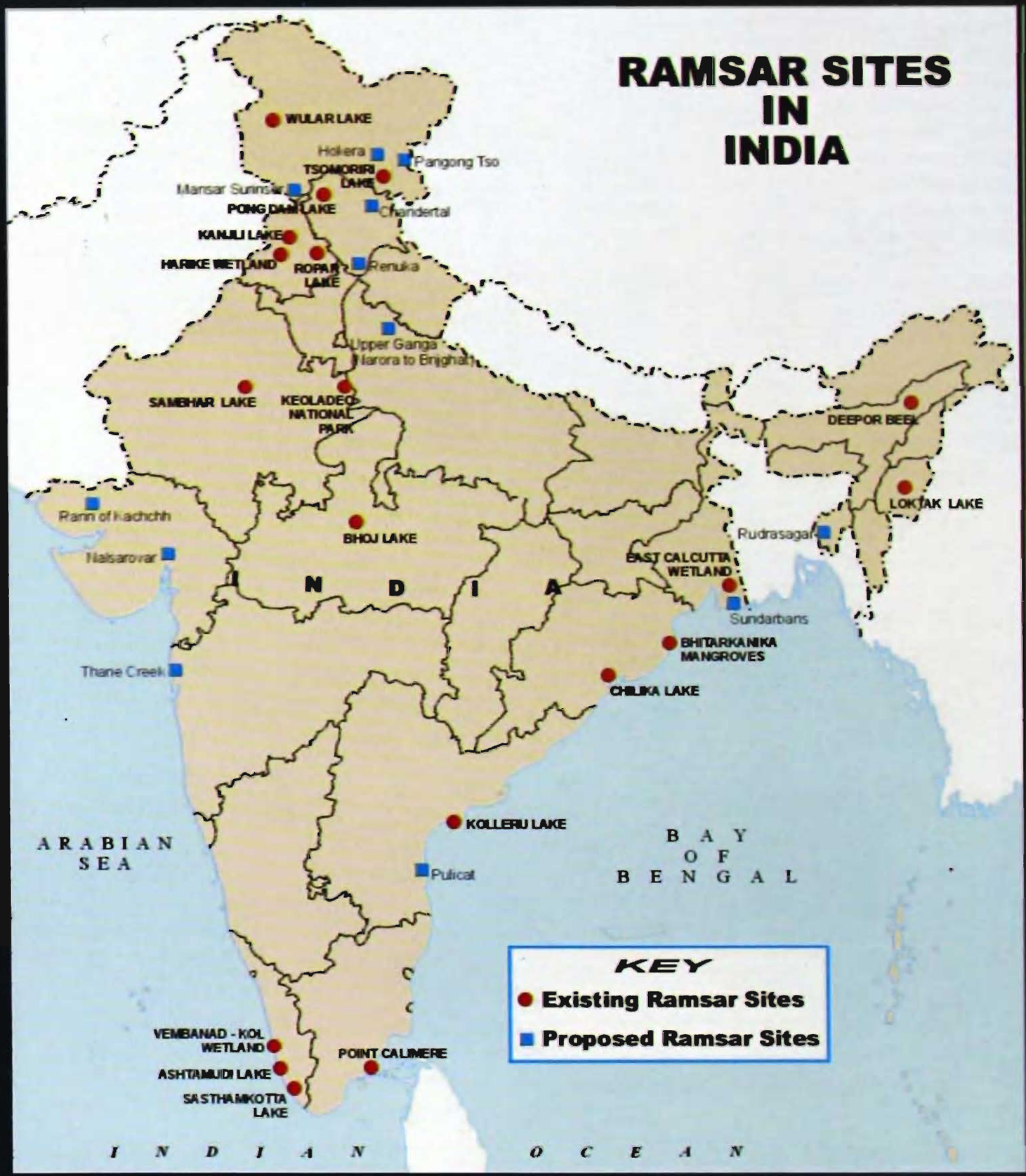
Endemism in wetland fauna is very difficult to assess because of paucity of such studies. In groups such as freshwater sponges, freshwater molluscs and leeches as stated above endemism seems to be more than 40% at the species level while according to Subba Rao (1995) generic endemism in freshwater molluscs is as high as 66% in contrast to land molluscs (7.14%).

At the species level although 36 species of mammals are endemic to India yet only the Marsh Mongoose, *Herpestes palustris* reported from Salt Lake swamp by Ghose (1965) could be recognized as an endemic wetland mammal in India. Among birds 50 species and 11 genera are endemic exclusively to India of which 44 species including Open billed Stork, mandarin Duck, Pink headed Duck, Red crested Pochard, Whitewinged Wood Duck, etc., are known to occur in wetlands. In reptiles endemic wetland species are altogether absent while only a single species namely the Himalayan Newt, *Pleurodeles verrucosus*, represents endemic wetland amphibians in India. On the other hand, the fish fauna contain 223 endemic species belonging to 78 genera and 23 families. The fishes of India also represent two endemic families viz., Parapsilorhynchidae and Horaichthyidae. The maximum number of endemic species (97 species) are represented by the family Cyprinidae that dominates freshwater wetlands in India.

A CASE STUDY OF A GANGETIC OXBOW LAKE

The river Ganges and its tributaries are constantly vulnerable to the changes in the course in the delta region. Changes are seen in the geologic history especially since 1750

Map 1. Key wetland region for threatened birds in Asia (*Source* : Birdlife International, 2003)



Map 2. Location map of Ramsar sites in India (*Source* : WWF-India, New Delhi)

Madras Coast, Mahabalipuram, Rocky coast

Wright Mayo Mangrove creek, South Andaman

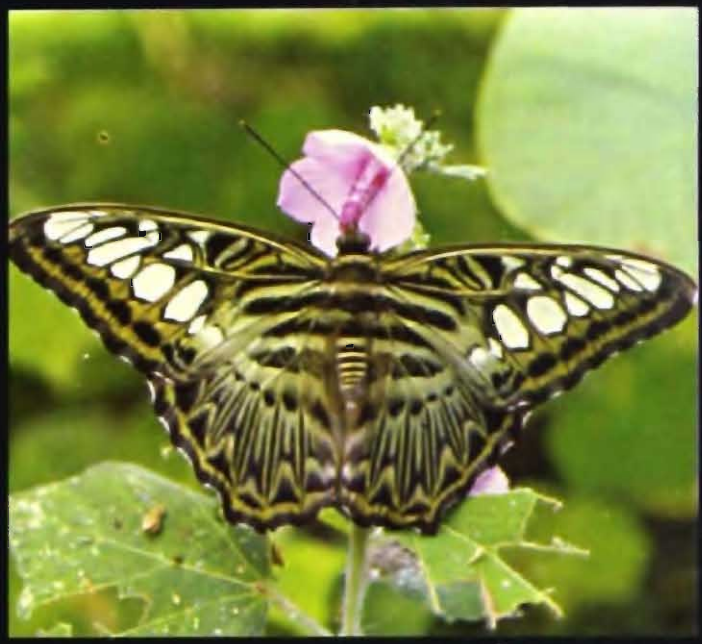
Retland Island, South Andaman

Chilka Lagoon

Shallow Mangrove, Krishna Estuary

Mangrove forest, Krishna Estuary

Euploes core andamangla



Andaman clipper (Parthenos sylvia roestorffi)

Charybdis cruciata

Microhyla Hemoncy

South Nicobar Megapode

(Chaturvedi, 1985), such changes leave behind many natural depressions, which are later fed by rain and floods. These river courses are also characterized by palaeo levees, swamps or flood basins locally called "Chaurs", relict palaeo channels aggraded in varying degrees, meander belts, ox-bow lakes and cut-of loops (Ahmad, 1971). In general, the drainage pattern of the rivers of this region forms a part of the greater Gangetic plain, which is characterized as dendritic drainage pattern. However, locally they exhibit their typical characteristics exhibiting high sinuosity and are typically meandering rivers. The Burhi Gandhak flood plain which ultimately joins the Ganges flood plain are very low lying areas and are prone to the flood. The floods owe their origin to the complex interplay of fluvial geomorphic elements in the upstream sections of the Kosi, Bagmati-Kareh-Budhi Gandak and related rivers. These two flood plains converge in the southeastern part of the Begusarai district of Bihar, which is lowland. The streams flowing in the region show a shifting tendency. In the course of their shifting, the rivers leave behind their scars of their previous channels. Thus due to shifting nature of streams and physiographic characteristic, this part is full of wetlands, back swamps and oxbow lakes. An oxbow is a saucer/crescent-shaped depression lying alongside a winding river. The oxbow lake is created over time as erosion and deposits of soil change the river's course. One such largest lakes situated in the in the Burhi Gandak and Ganges flood plain is Kabar lake wetland (Kanwar Jheel, Kabar Tal, Kanwar Jheel Pakshi Vihar) whose details are as under. The water spread area of the lake is subjected to high floods and during normal monsoon the lake extends to nearly 18,290 acres (7400 ha) with adjoining wetlands (commonly called "Chaurs") and during lean season due to letting of water for various reasons the lake water is located only in pockets in an area of about 5,000-6,000 acres (300 – 400 ha), and the entire mudflat is converted into paddy fields during lean period.

Details of Kabarlake wetland

Location	:	latitudes 25°15'N & 25°30'N and longitudes 85°45'E & 87°05'E Begusarai district, Bihar
Biogeographic Province	:	Indo-Malayan (Udwardy, 1975)
Biogeographic Zone	:	Indo-Gangetic
Biological Category	:	Freshwater
Wetland type	:	Oxbow lake
Altitude	:	32-45 m msl
Area in Hectares	:	7,400 ha during floods, 300–400 ha during lean period
Depth of the lake	:	1–5 m

Legal status of the Lake : The legal boundaries are with the private ownership. During monsoon months and high floods, when the wetland is full, the fishing rights are with the landless Sahanis and during the lean period the exposed lake bed is used by land owners for cultivation.

Historical Significance : The Jaimangal Temple and Jaimangal fort on the bank of Kabar lake is of historical significance, as a number of relics of Terracotas, Glazed wares, Iron sickle, belonging to Post Suguna period, coins of Tuglak period, earthern seal belonging to Gupta dynasty who ruled between 400–600 AD were excavated from the area.

Geology and Geological Hazards : The morpho strategic sequence of the land system in the meander belt of the older flood plain of Munjhol Terrace (in which the lake is located) belongs to Holocene period. The lithographic information collected reveals that the entire sediments of Kabar lake is composed of unconsolidated clastics viz., silt, clay, sands of various grades, gravel and course granular material. The soil type is of loam and clay depending on the admixture of sand and silt. The floor of the lake is covered with black clay mixed with peat; therefore the porosity varies from 17–30 percent. The ground water is saline with high chloride content between the depths varying from 131–135 m. It is believed that the salinity is due to the stagnancy of water. Since Kabar lake is saucer shaped depression receives surface runoff from all sides and therefore liable for frequent inundation during monsoon. Sheet wash erosion of the top soil is common as the slope along the lake is towards the centre.

Soil and Sediment : Lake sediment is loamy rich in humus, turns gray during winter due to low organic content and gradually turns black during summer due to high organic component (2.50–17.94%), and therefore calls for the classification as mineral sediment. Soil is marginally acidic (pH-5.0–6.5) perhaps due to humus, alkaline (0.76–3.2 mg/l; chloride–5.2–36.00 mg/l), conductivity is high (248 – 820 umho/cm, characteristic of mineral sediment) with higher trophic status of bottom sediments (Nitrate 1.42–1.51 g/100gm).

Limnology : Details of the limnology of the oxbow lake has not been studied to date and what follows is the first ever limnological investigations of the lake. In general the lake water is alkaline, rich in carbonates and relatively infertile i.e., Oligotrophic or nutrient poor chemically. Standard methodology was followed for analysis in the field as well as in laboratory. Secchi disc transparency indicated the visibility was less during monsoon (Zsd 0.95–1.45 m), followed by summer (1.55–2.10) and winter months (2.45–2.90 m). The obvious reasons being the suspended solids carried by flood entered the lake and during summer, the lake water become turbid due to senescence. Depth varied between 0.5–3.2 m, hence the lake is quite shallow. Surface water temperature varied between 18° (minimum) to 28°C (maximum) and the range of variation between the subsurface and bottom samples were not much significant as no thermal stratification occurred during the period. Chemically the lake water is generally alkaline (pH 7.0–8.3) while the lake bottom showed marginal variation in the vertical profile (pH 7.5–7.9). Range of dissolved oxygen content (1.8–9.4 mg/l) between surface and bottom layers of the lake was nil as the lake was shallow. Free carbon dioxide was absent in both the layers indicating the presence of carbonates and no carbonic acid. Calcium carbonate hardness varied between 75.0–200 mg/l and the chloride content ranged from 7.0–28.00. Biochemical Oxygen Demand (BOD) varied in a narrow range of 2.6–4.6 during winter and 3.8–6.2 during summer indicating the lake water can be classified as fairly clean using common pollution classification.

Ecologically speaking wetlands have been known to function as "Biotic filters" and "Sediment traps" and requires understanding of the nutrient dynamics in the lake. In the present context, Nitrate–nitrogen exhibited a narrow range (2.26–2.93mg/l), Nitrite–nitrogen below detectable limits, organic nitrogen marginally higher (Average 2.324 mg/l), Ammonia–nitrogen (0.795-1.456) and the total nitrogen content (1.994 in surface and 4.508 mg/l bottom) indicating the detritus being the possible source of the nitrogen content. No major variation in the vertical profile of Phosphorous (ortho-phosphate 1.642 in winter) indicating appreciably the higher than the reported mean phosphate content of most of the lake. The sulphate content is in general agreement with the general values for natural lakes and Hydrogen sulphide was absent in most of the sampling stations. Silica concentration found to relate to surface runoff and sediment, the spatial and seasonal relationship is linked with the diatoms.

Phytoplankton Diversity : Phytoplankton exhibited a similar trend of increase during the day time and decrease during the night in surface water of summer months; however the trends varied during monsoon and winter months. Bacillariophyceae were the most dominant group followed by mixophyceae and chlorophyceae in terms of average density. Chlorophyceae dominated during monsoon and post monsoon, the cyanophycean members' increases from the end of monsoon. However, the phytoplankton diversity indicated the preponderance of chlorophyceae (24 species), cyanophyceae (10 species), bacillariophyceae (8 species) and 2 species of Euglininae. The members also exhibited vertical and horizontal migration in the lake water and this has a profound effect on the feeding behaviour of many of the species especially fishes. Further, no "Algal blooms" were observed during the period indicating the absence of offensive odour, creating noxic or toxic condition leading fish kills.

Macrophytic Vegetation : Macrophytic diversity of aquatic vegetation in the lake both in quantity and content is simply impressive with 112 species making the system highly productive besides serving as suitable major habitat for residential and migratory birds, ichthyofauna and microhabitat for a whole gamut of entamofauna, malacofauna and periphyton. Several species are of socio-economic importance, viz., *Phragmites karka* found to be an excellent fodder for cattle and thatching material for huts, The litter formed by the senescent vegetation is an excellent fodder for pigs and hence the villagers around the lake has taken up to piggery especially during summer months.

Zooplankton Diversity : The relative abundance and composition of heterogeneous assemblage of phenotypically different zooplankton community in any aquatic ecosystem is prelude to an understanding of the nature of secondary production and energy flow pattern. The communities so distributed will also indicate the function of the prevailing abiotic, biotic attributes, exploitation, competition, and predator-prey interaction operating in the system. In general the copepoda (3 species) quantitatively outnumber all other zooplankter groups, followed by cladocera (28 species), rotifera (29 species), ostracoda (9 species), conchostraca (2 species), annelida (9 species), insect larvae, nematodes and protozoans. The copepod component of zooplankton in the oxbow lake is dominated by

2–3 species of calanoid and 2 species of cyclopoid genera in the limnetic region while the macrophytic rich, shallow littoral region are richer in cyclopoid and calanoid fraction. This ecological coexistence stems primarily from the greater variety of available ecological and food niches, the temporal and habitat partitioning the extensive lake offers. Of the calanoid genera, *Heliodiaptomus viduus, Phyllodiaptomus blanci* predominate limnetic waters in association with *Mesocyclops leucarti.*

Other Faunal Assemblage : The macrobenthic and periphytic molluscs constitute a major group with a total of 13 species under 9 genera and 7 families. The bivalves are represented by 2 species of which the infraspecific forms such as *Bellamya bengalensis* f. *annandalei* and *doliaris* are recorded for the first time from Bihar. 4 species viz., *Pila globosa, Bellamya bengalensis, Lamellidens marginalis* and *L. corianus* have considerable economic importance as they are widely consumed as favoured food by the common people. Diversity of 6 species of adult odonata and the abundance of odonate larvae indicate the healthy nature of the water body. 17 species of aquatic coleopteran belonging to 10 genera and 3 families, of which 2 species are endemic to India, 2 are new records to Bihar state and rest of them are cosmopolitan in distribution. Aquatic bugs (Hemiptera) comprised of 14 species under 12 genera belonging to 9 families. The occurrence of *Merragata pallescens* of the family Hebridae is very significant, as this has been recorded after a lapse of 90 years. Fishes form the major group of the lake next to birds in diversity, but also the entire gamut of socio-economic conditions of the people living adjacent to the lake are dependent on this group, as this can be seen with nearly 3400 fishermen and 1500 small boats are operating in the lake ecosystem. It is for this reason adjoining wetlands are developed as fish culture centres, to reduce the load on the lake. Of the nearly 270 species of fishes recorded in Indo-Gangetic plain, Kabar lake alone accounts for 60 species. Seven species of amphibian are recorded from the lake of which *Rana erythraea* is the first record from Bihar. Reptilian fauna though not impressive in the lake, has 5 species representing 4 genera and 3 families.

The most significant feature of the lake is the avian distribution. It revealed 59 migratory species belonging to 34 genera, 16 families, 9 orders and 107 residential birds under 81 genera, 35 families. The extensive array of avian fauna can be gauged by the disturbing earlier reports of netting the wintering migratory population. This was felt during the course investigation, the decline in the Anatidae population. Further more, the unchecked release of lake water leading to the dried up swamp bed, dead and decaying aquatic vegetation, increased in the reedy grasses of *Phragmites*, resulted in the dwindling population of many groups. Partial census taken from the lake revealed *Anastomosus osciatans* (100 exs.), *Dendrocygna bicolor* (50–60 exs.), *Anas acuta* (1,500 exs.), *Anas quadrecauda* (2,000 exs.), *Netta rufina* (150 exs.), *Aythia nyroca* (500 exs.) and *Porphyrio porphyrio* (250 exs.).

Conclusion : Kabar lake wetland has already been declared as "closed area" and called Kanwar Jheel Pakshi Vihar and also identified as an Important Bird Area located in the Indo Gangetic plain forming a freshwater oxbow lake. The surface water quality

was in the permissible range for irrigation. Ground water needs a closer look as it has more salinity intrusion. Apart from it, the lake is free from any pollution source except agricultural runoff. Public health problems of breeding of *Anopheles* leading to Malaria is controlled as the diversity of dipteran larvae are minimum and the extensive growth of Chara species are also believed to have inhibitory effect on the mosquito larvae. Exploitation of *Phragmites* as fodder and thatching material needs a closer watch. The water spread area is subjected to floods and letting of the water for irrigation. The legal boundaries need to be demarcated, as often conflicting interests arise in respect of the rights of the Fishing Sahanis. Poaching of winter visitors have comparatively very low. The development of piggery in the lake bed need to be closely monitored as senescent vegetation forms the food for these animals. Besides, the uprooting of macrophytic vegetation such as *Scirpus, Cyperus, Nymphaea, Eleocharis* by pigs will deprive the food for cranes.

Functions : Kabarlake wetland is significant in terms of biodiversity representation, waterfowl habitat, life support to cultural and socio-economic heritage, mitigates flood from the adjoining Burhi Gandak rive, removes sediments by trapping as it is saucer shaped, exhibits oligotrophic condition by extracting nutrients by the planktons and macrophytes, recharges the aquifer as the porosity is 17–30%, a wildlife habitat of mammals such as nearly 300 temple monkeys (*Macaca mulatta*), *Vulpes bengalensis, Canis aureus, Lepus nigricollis* besides the migratory and residential birds and lastly harbours several species under threat.

CHAPTER–9

TERRESTRIAL ECOSYSTEMS

RAIN FORESTS

Rainforests cover less than 7 per cent of the Earth's surface, but they are estimated to contain about half of the plant and animal species on the planet. Besides this, the rain forests also are one of the world's natural reservoirs of carbon dioxide, which is captured through photosynthesis and stored in trees, vegetation and soil. Rain forests encircle the Earth in a 3,000 mile-wide green band around the equator. Rain forests once covered at least 14 per cent of the Earth's land surface. Now only less than seven per cent remains. Brazil contains one-third and Indonesia and Zaire each have ten per cent of what's left. The rest is scattered in rapidly diminishing remnants in other countries of Africa, South America, South-East Asia and Oceania. The Southeast Asian rainforests are the oldest and consistent areas on Earth, dating back to the Pleistocene Epoch 70 million years ago. It has a biological richness and diversity unequaled by that of the Amazon or African rainforests. The consistency in climate is one of the most important criteria in the rainforests because of its closer location on the equator and being surrounded by water resulted in consistent forests over very long periods of time. These areas also have small pockets of forests known as "forest refugia", or reservoirs of wildlife from which various species could reestablish themselves. In India, more than 2,500 plant species have been officially recognized for their medicinal uses in these rainforests. In addition, the U.S. National Cancer Institute has identified cancer fighting properties in 73 per cent of the 30,000 plants unique to the rain forest ecosystem. Preserving these species directly benefits humankind (From Global Environment by UNEP, 1996). All 25 primates on the 2004-2005 list are found in the world's biodiversity hotspots-34 regions identified by Conservation International that cover just 2.3 percent of the Earth's land surface but harbor well over 50 percent of all terrestrial plant and animal diversity. Eight of the hotspots in tropics are considered the highest priorities for the survival of the most endangered primates: Indo-Burma, Madagascar and the Indian Ocean Islands, Sundaland, Eastern Afro-montane, Coastal Forests of Eastern Africa, Guinean Forests of West Africa, the Atlantic Forest of Brazil, and Western Ghats-Sri Lanka.

Mittermeier and Werner (1990) identified International Priority Areas for Conservation on the basis of biodiversity and endangered ecosystems. Some tropical countries of the world contain a high percentage of world's species and these are the "Mega diversity Countries" Norman Myers (1988) identified International Conservation Priority Areas called 'hotspots' on the basis of species richness, endemism and level of threat to an area,

natural habitats from human activities. Initially 10 Tropical Rainforest Hotspots were identified to which were added 8 more in 1990. These 18 areas collectively occupy only a half percent of the earth's land surface, yet they are exclusively home for one fifth of the flora and many species of fauna of the world. To these seven more were added in 2002 and recently the number has gone up to 34 (2005). Three of the hotspots are partly represented in India. Much of the areas of the two hotspots –1. Western Ghats and Sri Lanka and 2. Eastern Himalaya fall within India's geographical limits with some areas of the eastern border state and 3. Andaman & Nicobar Islands are represented in the Indo-Burma Hotspot. Hotspots are the priority areas of the biodiversity conservation, for about 70% of the original vegetation of which has been altered and harbours 0.5% of the endemic plants species of the world.

Faunal diversity in Western Ghats

The Peninsular India was geologically separated from the Gondwana land in the late Jurassic times. The faunal composition has undergone a series of changes during the later part of the Jurassic period. The fishes, dinosaurs and micro-mammals died out of the peninsula and several invertebrate groups of animals escaped from the hostile environment and retreated to the areas south of Deccan trap, interspersed with forests, lagoons, marshes, that are suitable for their survival (Menon, 1992). Rainforests of Western Ghats is unique because of its richness in biodiversity ('Hot spot'), having evolutionary continuity for more than 50 million years and is the only area in India having an admixture of the following biotic elements, resultant of the biogeographic evolution of the country *viz*,

Gondwana derivatives
Peninsular endemics
Madagascan elements
Indo-Chinese derivatives
Malayan elements
Palaearctic elements.

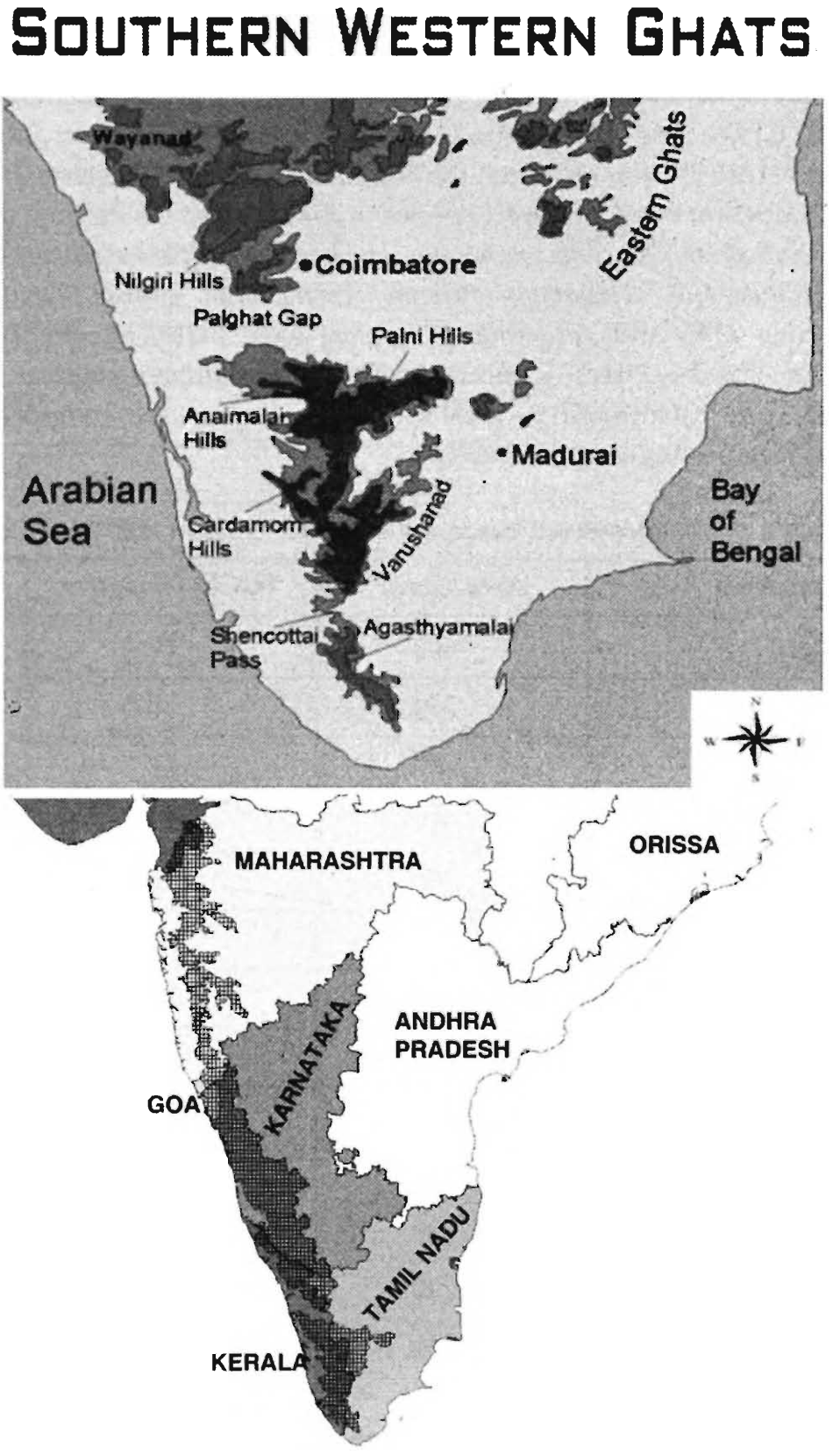
The Deccan Peninsular biogeographic zone in India is one of the most extensive but relatively homogeneous zones covering nearly 43% of the total Indian land mass. Peninsular India includes several microcentres of endemism; a major part of it is included in the Western Ghats. The area includes:

1. Agasthyanmalai Hills (South Travancore and Tirunelveli hills)
2. Anamalai and High Ranges
3. Palni Hills
4. Nilgiris Silent Valley–Wyanad-Kodagu
5. Mahabaleshwar–Khandala Ranges

6. Konkan Raighad
7. Southern Deccan

The Western Ghats, generally considered a typical forest ecozone, fall under the Paleo-tropical (Indo-Malayan) biogeographical zone. It is relatively homogeneous and biologically distinctive zone divided into the biotic provinces of the Malabar coasts/plains and the Western Ghats mountains. The Western Ghats is located on the west coast of the peninsula, running in the north–south direction from the mouth of river Tapti (Gujarat) to Kanyakumari (Tamilnadu) in the south, covering nearly 1600 km long mountain chains, except for a small gap of 30 km (Palakkad Gap). The hill ranges are located in the states of Gujarat, Maharashtra, Goa, Karnataka, Tamilnadu and Kerala, with a steep slope on the western side (Windward) running upto the Arabian Sea and with sloping hills on the leeward side. The altitude in this area varies from 300–1,500 m, excluding isolated peaks with conical and flat-topped hills interspersed with valleys and spurs. The climate of the area is influenced by the southwest monsoon, the rainfall varying from 2,350 mm to 7,450 mm in the southern part. The mean annual temperature is about 24 degree Celcius. The area is marked by the origin of three major rivers of the south viz. Krishna, Godavari and Cauveri and a chain of small rivers (Gayathri, Netravathi, Sharavathi, Bharatpuzha, Periyar, Chalakudi etc.) directly entering the sea. Thus the Western Ghats form the major watershed in Peninsular India. Water fall like Gerusoppa and smaller streams harbour a number of aquatic species often endemic and restricted in distribution. The windward side of the Western Ghats receives heavy southwest monsoon and the leeward side in the east has a major part dipicting the rain shadow area. According to Nayar (1996), presence of mosaic of soil types and soil nutrients have resulted in mosaic of ecological islands, niches, and refugia, which favour a high degree of endemism, vicariants and relict species. In India, protected areas account for nearly 4.6% of the total geographical area, of which Western Ghats alone, comprising 34 National Parks, Wildlife sanctuaries and one Biosphere reserve covers an area of 7,300 km^2

The fauna of Western Ghats in addition to being derivatives of the ancient Gondwana elements show prominent affinity to the Malayan and Indo-Chinese biota. There are also large numbers of tropical American and Australian elements besides pleistocene relicts which are temperate and boreal species of the Himalaya, which once had a contiguous range but later became isolated in the post glacial climatic and consequent ecological changes. Many hilltops and plateaus reaching 2000 m or more harbour such relict biota. Delimited by the sea to the west, the Vindhya and Satpura ranges to the North and the arid Deccan plateau to the east, the Western Ghats are both insulated and isolated, and have provided conditions for evolving a large number of endemic flora and fauna. The very humid climate with relatively short spells of dry season has resulted in the occurrence of many groups of plants and animals showing rich species diversity. Some of the faunal components of the Ghats are of great zoogeographical significance. Freshwater fishes



Western Ghats

Source : K.N. Ganeshaiah, 2005

belonging to genera *Lepidopygopsis, Horabagrus, Bhavania* and *Travancoria* are restricted to the Western Ghats. Amphibian genera *Micrixalus, Nyctibatrachus* and most of the limbless amphibians (Gymnophiona); entire family of Uropeltid snakes, grass warbler belonging to genus *Schoenicola* and among mammals the monotypic genus *Platycanthomys* are endemic to Western Ghats. The Tahr genus *Hemitragus* exemplifies a most intriguing pattern of geographical distribution restricted the higher elevations of Western Ghats. However, the recent introduction of exotic insect species in the Western Ghats such as *Antestia cruciata, Leptocorisa varicornis, Eutectona machaeralis, Hyblaea puera, Pteroma plagiophleps, Ithome lassula, Heteropsylla cubana, Ophiomya lantanae, Tropicomyia coffeae, Japanagromyza indica, Procecidochares utilis* and *Teleonemia scrupulosa* have partly altered the original species composition. Among Pisces, Rainbow Trout (*Salmo gairdnerii gairdnerii*) and *Oreochromis mossambica* have established in Western Ghats, altering the composition of many hill streams, which are highly vulnerable.

Protected areas on Western Ghats (9490 Km²)

Protected Area	Area (km²)	IUCN Category	State
Anamalai	600	IV	Tamilnadu
Anshi	360	II	Karnataka
Aralam	50	IV	Kerala
Bhadra	530	IV	Karnataka
Bhimashankar	30	IV	Maharashtra
Brahmagiri	190	PRO	Karnataka
Chandoli	180	IV	Karnataka
Cotigao	170	IV	GOA
Dandeli	1,060	UA	Karnataka
Eravikulam	70	II	Kerala
Idukki	80	IV	Kerala
Kalakad-Mundanthurai	290	IV	Tamilnadu
Karimpuzha	230	PRO	Kerala
Karnala	50	IV	Karnataka
Koyna	250	PRO	Maharashtra
Kudremukh	820	II	Karnataka

Protected Area	Area (km^2)	IUCN Category	State
Megamalai	120	PRO	Tamilnadu
Mookambika	300	IV	Karnataka
Mukurty National Park	60	PRO	Tamilnadu
Parambikulam	260	IV	Kerala
Peppara	40	IV	Kerala
Periyar	540	IV	Kerala
Purna	150	IV	Karnataka
Pushpagiri	130	IV	Kerala
Radhanagari	350	IV	Maharashtra
Schollpaneshwar	330	IV	Karnataka
Sharavathi Valley	590	IV	Karnataka
Shenduruny	300	IV	Karnataka
Shettihally	750	IV	Karnataka
Silent Valley	110	II	Kerala
Someswara	40	IV	Karnataka
Talakaveri	250	PRO	Karnataka
Tansa	210	IV	Maharashtra

DIVERSITY AND DISTRIBUTION OF ENDEMIC MAMMALS

Of the 397 species of mammals distributed in the country, nearly 150 species are found distributed in Western Ghats alone of which 14 species are endemic to Western Ghats. *Hemiechinus nudiventris* (Horsfield) distributed in plains with patches of bush or scrub forest of Kerala and Tamil Nadu. *Suncus dayi* (Dobson) is found in montane humid forests at elevations from 1000 to 2500 in Kerala and Tamil Nadu and was recently recorded from a number of localities in Anamalai and Nilgiri hills. However, exact population is not known, but it appears to be moderately common. *Otomops wroughtoni* (Thomas) is known from a single location in Barapede cave near Talewadi, North Kanara, Karnataka. Evergreen forests are particularly suited to frugivorous arboreal primates and squirrels while the deciduous forests offer the best habitat for the larger grazing herbivores like the gaur and deer. Drought resistant ungulates, particularly antelopes are specially adapted

to the open dry scrub. Elsewhere in the Western Ghats of Karnataka, the distribution and biomass of large herbivores have been studied. From this it emerged that the large herbivores biomass was highest in moist deciduous forests and adjacent teak plantations whereas it was the lowest in the dry deciduous forests.

Among Primates *Macaca silenus* (*Population* : 3000-4000) is found in dense evergreen or semi-evergreen rainforests on high trees in secluded and unfrequented areas between 600-1600 m. altitudes. The endemic primate *Macaca silenus* (Lion-tailed macaque or LTM) is amongst the few carefully studied mammals in the Western Ghats. In 1985, the population of this primate in the state of Karnataka was estimated as 3000. More recent estimates have placed the numbers in Karnataka around 1000-2000. A smaller population is known from Tamilnadu. Including the nearly 2000 individuals in Kerala, the population of LTM has been most recently placed at 4000. LTM is an inhabitant of evergreen rainforests, below 700 m ASL, with a home range of 1.25 sq km. Shape of the patches of these forests has a significant effect on the population of LTM. An opening of 0.5 sq km of canopy may block the path of a moving troop of LTM. In addition, it occurs in tea and cardamom plantations interspersed with undisturbed or selectively logged evergreen forests. *Trachypithecus johnii* (Fischer) (*Population*: 5000-7000) is found distributed in tropical moist evergreen and moist deciduous forests between 150-2500m, particularly in *Sholas* and do not prefer evergreen forests that are either selectively logged or fragmented.

Paradoxurus jerdoni Blanford was fairly plentiful in Coorg, Karnataka. At present its exact population is not known, but due to hunting pressure and loss of habitat, it is believed to be rare, though widely spread. *Viverra civettina* Blyth was plentiful during 19th century (Jerdon, 1874), but became rare from the beginning of 20th century (Pocock, 1939). Goodwin and Holloway (1972) regarded it as extinct as there was no record of its occurrence for a long period during 20th century. Karanth (1986) based on sighting in Koppa Forest Division; Karnataka opined that Malabar Civet still maintains a large distributional range. Further, sighting of a specimen in 1970 at Thiruvalla and capture of three specimens at Elayur, Kerala, proves its existence beyond doubt (Kurup, 1987). At the moment the species maintains its wide spread distribution, but the population appears to have declined drastically mainly due to habitat destruction and rapid increase of human population in its areas of occurrence. Estimates of home ranges of civets and mongooses in the Western Ghats have suggested that the Indian Grey Mongoose (*Herpestes edwardsii*) and the Small Indian Civet (*Viverricula indica*) have monthly home ranges of 20.69-102 ha and 3.4-4.9 ha, respectively. In another study of small carnivores in the Nilgiris it was found that civets were the most abundant (especially in evergreen forests) followed by mongooses, cats and marten. Canopy opening and the consequent weed infestation in evergreen forests adversely affects the civets.

Martes gwatkinsii Horsfield is found among the shola grassland, dry and moist deciduous forests and tropical evergreen forests between 350-2500 m in the Western Ghats in Kerala,

Karnataka and Tamil Nadu. During a recent survey in the Western Ghats neither a single specimen could be observed nor could a recent record of its sightings by the local people be obtained. From indirect evidence, the species appears to be very rare. *Hemitragus hylocrius* (Ogilby) once ranged over the greater part of the Western Ghats. Present range is restricted to Tamil Nadu and Kerala, from Nilgiri Hills in the north to Ashambu hills in the South (11°30'N to 8°20'N). It has been reported from at least 20 different locations, but its number has depleted to an alarming stage. Over this 400 km range, around 2000 animals are estimated to occur: 150 in the Nilgiris, 570-690 in Anaimalais, 890 in Eravikulam, 280-310 in Palni Hills and a handful over the rest of the range. Davidar (1978) gave a total estimate of 2230 animals. Daniel *et al.* (1998) recorded a slight increase in its population to about 2500 individuals, with highest concentration at Eravikulum National Park, Kerala. Asian Elephant *(Elephas maximus)* is another species of mammal that has attracted both scientific and popular interest. Recent estimates place the population of elephants in the states of Karnataka, Tamilnadu and Kerala at 12,500. A majority of this population is within protected areas in the Western Ghats. Unlike the LTM, the elephant is more of a habitat generalist utilising a wide range of natural and man-made habitats in and around the Western Ghats.

Funambulus tristriatus (Waterhouse) is found in semi-evergreen, evergreen, moist deciduous forests, as also in shrubs and tea gardens, north of Bombay. Its exact population is not known, but could frequently be met within the forested tracts of Western Ghats. *Millardia kondana* Mishra and Dhanda is known only from type locality; Sinhgarh Plateau, Pune, Maharashtra. *Rattus ranjiniae* Agrawal and Ghosal is found in the cultivated fields but also moves to water at the time of emergency. The p*opulation* of this species is exactly not known, but from the collection of specimens appears to be not so rare. *Mus famulus* Bonhote is distributed at around 1500 m elevations in Nilgiri, Anaimalai and Palni Hills in South India. *Platacanthomys lasiurus* Blyth is distributed south of Shimoga district, Karnataka in Western Ghats between 900 to 2500 m. in moist deciduous and rain forests. The population of this species is not known, but quite a good number of individuals have been recorded at different localities during recent surveys.

Faunal diversity in Western Ghats

Following is the list of Mammals exclusively from the Rain forests of Kerala (Western Ghats) : **Endemic** : 1 subspecies- *Petinomys fuscocapillus fuscocapillus* (Small Travancore Flying Squirrel). **Threatened** (Schedule-I) : 18 Species : 1. *Loris tardigradus*–Slender Loris; 2. *Macaca silenus*–Lion-tailed Macaque; 3. *Melursus ursinus*–Sloth Bear; 4. *Viverra civettina*–Malabar Civet; 5. *Panthera tigris*–Tiger; 6 *Panthera pardus*–Leopard; 7. *Prionailurus viverrinus*–Fishing Cat; 8. *Prionailurus bengalensis*–Leopard Cat; 9. *Prionailurus rubiginosus*–Rusty Spotted Cat; 10. *Elephas maximus*–Asian Elephant; 11.*Tragulus meminna*–Mouse Deer; 12. *Tetracerus quadricornis*–Four-horned Antelope; 13. *Hemitragus hylocrius*–Nilgiri Tahr; 14. *Manis crassicaudata*–Indian Pangolin; 15. *Ratufa macroura*–Grizzled Giant Squirrel; 16. *Bos frontalis*–Indian Bison; 17. *Presbytis johni*–Nilgiri Langur; 18. *Amblonyx cinereus*–Clawless Otter.

List of mammals from Western Ghats

S. No.	Common Name	Zoological Name
1.	Oriental Small-clawed (Clawless) Otter	*Amblonyx cinereus* Illiger
2.	South Indian (Madras) Tree Shrew	*Anathana ellioti* (Waterhouse)
3.	Black Buck, Indian Antelope	*Antelope cervicapra* (Linn.)
4.	Spotted deer	*Axis axis* (Erxleben)
5.	Indian Mole Rat	*Bandicota bengalensis* (Gray & Hardwicke)
6.	Large (Greater) Bandicoot Rat	*Bandicota indica* (Bechstein)
7.	Gaur	*Bos gaurus* Smith
8.	Bluebull	*Boselaphus tragocamelus* (Pallas)
9.	Golden Jackal	*Canis aureus* Linn.
10.	Wolf	*Canis lupes* Linn.
11.	Sambar	*Cervus unicolor* Kerr
12.	Wrinkle-lipped Free-tailed Bat	*Chaerephon plicata* (Buchanan)
13.	White-tailed Wood (Blanford's) Rat	*Cremnomys blanfordi* (Thomas)
14.	Cutch Rat	*Cremnomys cutchicus* Wroughton
15.	Horsefield's Shrew	*Crocidura horsfieldi*(Tomes)
16.	Indian Wild Dog	*Cuon alpinus* (Pallas)
17.	Lesser dog faced Fruit Bat	*Cynopterus brachyotis* (Muller)
18.	Short-nosed Fruit Bat	*Cynopterus sphinx* (Vahl)
19.	Asian Elephant	*Elephas maximus* Linn.
20.	Dawn (Cave Fruit) bat	*Eonycteris spelaea* (Dobson)
21.	Jungle Cat	*Felis chaus* Schreber
22.	Kelaart's Long-clawed Shrew	*Feroculus feroculus* (Kelaart)
23.	Kelaart's long-clawed Shrew	*Feroculus feroculus* Kelaart
24.	Layard's Striped Squirrel	*Funambulus layardi* (Blyth)
25.	Three-striped Palm Squirrel	*Funambulus palmarum* (Linn.)
26.	Five-striped Palm Squirrel	*Funambulus pennantii* Wroughton
27.	Dusky Striped Squirrel	*Funambulus sublineatus* (Waterhouse)
28.	Jungle striped squirrel	*Funambulus tristriatus wroughtoni* Ryley
29.	Indian Gazelle	*Gazella bennettii* (Sykes)
30.	Indian Bush Rat	*Golunda ellioti* Gray
31.	Hairy-winged Bat	*Harpiocephalus harpia* Gray

S. No.	Common Name	Zoological Name
32.	——	*Harpiocephalus harpia madrassius* Thomas
33.	Indian (Pale) Hedgehog	*Hemiechinus micropus* (Blyth)
34.	Madras Hedgehog	*Hemiechinus nudiventris* (Horsefield)
35.	Nilgiri Tahr	*Hemitragus hylocrius* (Ogilby)
36.	Brown Mongoose	*Herpestes brachyurus* Gray
37.	Grey (Common) Mongoose	*Herpestes edwardsii* (E. Geoffroy Saint-Hilaire)
38.	Indian brown Mongoose	*Herpestes fuscus* Waterhouse
39.	Ruddy Mongoose	*Herpestes smithii* Gray
40.	Stripe-necked Mongoose	*Herpestes vitticolis* Bennett
41.	Tickell's Bat	*Hesperoptenus tickelli* (Blyth)
42.	Dusky leaf-nosed bat	*Hipposideros ater* Templeton
43.	Bicoloured leaf nosed bat	*Hipposideros bicolor* (Temminck)
44.	Fulvus Leaf-nosed Bat	*Hipposideros fulvus* Gray
45.	Cantor's (Fawn) Leaf-nosed Bat	*Hipposideros galeritus* Cantor
46.	Kolar Leaf-nosed Bat	*Hipposideros hypophyllus* Kock & Bhat
47.	Kelaart's Leaf-nosed Bat	*Hipposideros lankadiva* Kelaart
48.	Andersen's Leaf-nosed Bat	*Hipposideros pomona* K. Andersen
49.	Bellary Leaf-nosed Bat	*Hipposideros schistaceus* K. Andersen
50.	Schneider's Leaf-nosed Bat	*Hipposideros speoris* (Schneider)
51.	Striped Hyaena	*Hyaena hyaena* (Linn.)
52.	Indian Porcupine	*Hystrix indica* Kerr
53.	Hardwick's Forest Bat	*Kerivoula hardwickii* (Horsfield)
54.	Painted Bat	*Kerivoula picta* (Pallas)
55.	Salim Ali's Fruit Bat	*Latidens salimali* Thonglongya
56.	Indian Hare, Black naped Hare	*Lepus nigricollis* F. Cuvier
57.	Slender Loris	*Loris tardigradus* (Linn.)
58.	Common Otter	*Lutra lutra* (Linn.)
59.	Smooth-coated Otter	*Lutrogale perspicillata* (I. Geoffroy Saint-Hilaire)
60.	Bonnet Macaque	*Macaca radiata* (E. Geoffroy)
61.	Lion-tailed Macaque	*Macaca silenus* (Linn.)

S. No.	Common Name	Zoological Name
62.	Indian Pangolin	*Manis crassicaudata* Gray
63.	Nilgiri Marten	*Martes gwatkinsi* Horsfield
64.	Greater False-vampire Bat	*Megaderma lyra* E. Geoffroy
65.	Lesser False-vampire Bat	*Megaderma spasma* (Linn.)
66.	Ratel, Honey Badger	*Mellivora capensis* (Schreber)
67.	Sloth Bear	*Melursus ursinus* (Shaw)
68.	Kondana Rat	*Millardia kondana* Mishra & Dhanda
69.	Soft-furred field Rat (Metad)	*Millardia meltada* (Gray)
70.	Nicobar Long-fingered Bat	*Miniopterus pusillus* Dobson
71.	Schreiber's Long-fingered Bat	*Miniopterus schreibersi* (Kuhl)
72.	Indian Muntjac, Barking Deer	*Muntiacus muntjac* (Zimmermann)
73.	Round-eared Tube-nosed Bat	*Murina cyclotis* Dobson
74.	Little Indian Field Mouse	*Mus booduga* (Gray)
75.	Fawn coloured Mouse	*Mus cervicolor palnica* (Thomas)
76.	Cook's Mouse	*Mus cookii* Ryley
77.	Bonhote's Mouse	*Mus famulus* Bonhote
78.	House Mouse	*Mus musculus* Linn.
79.	—do—	*Mus phillipse* Wroughton
80.	Spiny field (Indian Brown Spiny) Mouse	*Mus platythrix* Bennett
81.	Elliot's Brown Spiny Mouse	*Mus saxicola* Elliot
82.	Pygmy (Earth Coloured) Field Mouse	*Mus terricolor* Blyth
83.	Horsefield's Mouse-eared Bat	*Myotis horsfieldii* (Temminck)
84.	Burmese Whiskered Bat	*Myotis montivagus* (Dobson)
85.	——	*Myotis peshwa* (Thomas)
86.	Wroughton's Free-tailed Bat	*Otomops wroughtoni* Thomas
87.	Leopard	*Panthera pardus* (Linn.)
88.	Tiger	*Panthera tigris* (Linn.)
89.	Common palm Civet/Toddy Cat	*Paradoxurus hermaphroditus* (Pallas)
90.	Brown (Jerdon's) Palm Civet, Coffee Civet	*Paradoxurus jerdoni* Blanford
91.	Common giant flying squirrel	*Petaurista petaurista* (Pallas)
92.	Elliot's Giant (Large) Flying Squirrel	*Petaurista phillipensis* (Elliot)
93.	Travancore Flying Squirrel	*Petinomys fuscocapillus* (Jerdon)

S. No.	Common Name	Zoological Name
94.	Chocolate Bat	*Pipistrellus affinis* (Dobson)
95.	Kelaart's Pipistrelle	*Pipistrellus ceylonicus* (Kelaart)
96.	Indian Pipistrelle	*Pipistrellus coromandra* (Gray)
97.	Dormer's Pipistrelle	*Pipistrellus dormeri* (Dobson)
98.	Javan Pipistrelle	*Pipistrellus javanicus* (Gray)
99.	Indian Pigmy Pipistrelle	*Pipistrellus mimus* Wroughton
100.	——	*Pipistrellus mordax* (Peters)
101.	Least Pipistrelle	*Pipistrellus tenuis* (Temminck)
102.	Malabar Spiny Dormouse	*Platacanthomys lasiurus* Blyth
103.	Common Langur	*Presbytis entellus* (Dufresne)
104.	Nilgiri Langur/Hooded Leaf Monkey	*Presbytis johni* (Fischer)
105.	Leopard Cat	*Prionailurus bengalensis* (Kerr)
106.	Rusty-spotted Cat	*Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire)
107.	Fishing Cat	*Prionailurus viverrinus* (Bennett)
108.	Indian Flying Fox	*Pteropus giganteus* (Brunnich)
109.	White tailed Wood Rat	*Rattus blanfordi* (Thomas)
110.	Brown (Norway) Rat	*Rattus norvegicus* (Berkenhout)
111.	Ranjini's Rat	*Rattus ranjiniae* Agarwal & Ghosal
112.	House (Roof, Black) Rat	*Rattus rattus* (Linn.)
113.	White-belly Rat	*Rattus rattus wroughtoni* Hinton
114.	Indian (Malabar) Giant Squirrel	*Ratufa indica* (Erxleben)
115.	Indian Giant Squirrel	*Ratufa indica bengalensis* (Blanford)
116.	——	*Ratufa indica maxima* (Schreber)
117.	——	*Ratufa indica superans* Ryley
118.	Grizzled giant Squirrel	*Ratufa macroura* (Pennant)
119.	Lesser Woolly Horseshoe Bat	*Rhinolophus beddomei Andersen*
120.	Blyth's (Little Indian) Horseshoe Bat	*Rhinolophus lepidus Blyth*
121.	Woolly (Great Eastern) Horseshoe Bat	*Rhinolophus luctus Temminck*
122.	Least Horseshoe Bat	*Rhinolophus pusillus Temminck*
123.	Rufous Horseshoe Bat	*Rhinolophus rouxii Temminck*
124.	Lesser mouse tailed (Lesser Rat tailed) Bat	*Rhinopoma hardwickii* Gray

S. No.	Common Name	Zoological Name
125.	Greater Mouse-tailed Bat	*Rhinopoma microphyllus* (Brunnich)
126.	Small mouse-tailed Bat	*Rhinopoma muscatellum* Thomas
127.	Fulvous (Rousette) Fruit Bat	*Rousettus leschenaulti* (Desmarest)
128.	Pounch bearing Bat	*Saccolaimus saccolaimus* (Temminck)
129.	Common Yellow Bat	*Scotophilus heathii* (Horsfield)
130.	Asiatic Lesser Yellow House bat	*Scotophilus kuhlii* Leach
131.	Day's Shrew	*Suncus dayi* (Dobson)
132.	Pygmy (White-toothed) Shrew	*Suncus etruscus* (Savi)
133.	Hill (Mountain) Shrew	*Suncus montanus* (Kelaart)
134.	House (Grey Musk) Shrew, Musk Rat	*Suncus murinus* (Linn.)
135.	——	*Suncus murinus malabaricus* Lindsay
136.	House shrew	*Suncus murinus murinus* (Linn.)
137.	—do—	*Suncus murinus niger* (Horsefield)
138.	Anderson's (Yellow-throated) Shrew	*Suncus stoliczkanus* (Anderson)
139.	Savi's Pygmy Shrew	*Suncus struscus* (Savi)
140.	Wild Boar	*Sus scrofa* Linn.
141.	Egyptian Free-tailed Bat	*Tadarida aegyptiaca* (E. Geoffroy)
142.	Long-armed Sheath-tailed Bat	*Taphozous longimanus* Hardwickie
143.	Bearded Sheath-tailed Bat	*Taphozous melanopogon* Temminck
144.	Naked-rumped Tomp Bat	*Taphozous nudiventris* Cretzschmar
145.	Theobald's Tomb Bat	*Taphozous theobaldi*Dobson
146.	Indian Gerbile (Antelope Rat)	*Tatera indica* (Hardwicke)
147.	Four-horned Antelope	*Tetracerus quadricornis* (de Blainville)
148.	Indian Chevrotain, Mouse Deer	*Tragulus meminna* (Erxleben)
149.	Bamboo Bat	*Tylonycteris pachypus* (Temminck)
150.	Indian long-tailed Tree Mouse	*Vandeleuria oleracea* (Bennett)
151.	Long tailed tree mouse	*Vandeleuria oleracea nilagirica* (Jerdon)
152.	Malabar Civet	*Viverra civettina* Blyth
153.	Large spotted Civet	*Viverra megaspilla civettina* (Blyth)
154.	Small Indian Civet	*Viverricula indica* (Desmarest)
155.	Bengal (Indian) Fox	*Vulpes bengalensis* (Shaw)

Birds, fishes and Invertebrates distributed in Western Ghats

Class/Order/family	No. of Species	No. of Endemic species
Class Aves	310	73
Ciconiformes	6	—
Falconiformes	18	—
Galliformes	12	5
Gruiformes	5	–
Charadriformes	6	1
Columbiformes	9	1
Psittaciformes	4	2
Cuculiformes	12	3
Striaiformes	8	2
Canrimulaiformes	4	1
Anodiformes	6	—
Troagoniformes	1	1
Coraciformes	19	5
Piciformes	17	4
Passeriformes	183	48
Class : Reptilia	163	89
Order Testudines	8	2
Class Amphibia	138	106
Order Gymnonhiana	13	13
Anura	120	93
Class Pisces	209	120
Invertebrates	4623	39
Phylum Protozoa	111	—
Phylum Porifera	18	4
Phylum Cnidaria	1	—
Phylum Annelida	26	—
Phylum Arthropoda		
Class Crustacea	18	—
Class Insecta	4056	—
Class Arachinida	193	9
Class Chilopoda	40	9
Class Symphyla	2	
Class Diplopoda	4	—
Phylum Mollusca	436	221

Records from various sources indicate nearly 508 species of birds distributed in Western Ghats, of which 144 are aquatic (28%), and 324 (64%) are resident birds. 19 species are considered to be endemic to the area (Ranjit Daniels, 2003). As per the personal communication of Radhakrishnan (2005) the following list of birds distributed in the rain forests of Kerala part of Western Ghats which are under various levels of threat. It is interesting to note that none of the bird species mentioned are endemic to Kerala. Broad patterns of distribution and diversity have been discerned in the birds of the Western Ghats. In general, most of the resident and typically forest birds are restricted in distribution to the Western Ghats of Goa. Few endemic species extend north of Goa. In general, the endemic bird species of the Western Ghats are primarily birds of the rainforests and the higher elevation shola-grassland complexes. In Kerala, the presence of some of the endemic birds (Malabar grey hornbill, Rufous babbler and Crimson backed sunbird) is associated with greater abundance of mammals such as Nilgiri langur, Lion-tailed macaque and Sambar.

Threatened birds of Kerala

1.	*Batrachostomus moniliger*	21.	*Butastur teesa*
2.	*Buceros bicornis*	22.	*Spizaetus cirrhatus*
3.	*Chlamydotis undulata*	23.	*Heiraetus fasciatus*
4.	*Anthracoceros coronatus*	24.	*Hieraetus pennatus*
5.	*Falco peregrinus*	25.	*Hieraetus kienerii*
6.	*Dendrocygna bicolor*	26.	*Aquila clanga*
7.	*Eupodotis indica*	27.	*Aquila pomarina*
8.	*Pavo cristatus*	28.	*Ictinaetus malayensis*
9.	*Platalea leucorodia*	29.	*Haliaetus albicilla*
10.	*Elanus caeruleus*	30.	*Haliaetus leucogaster*
11.	*Aviceda jerdoni*	31.	*Icthyophaga ichthyaetus*
12.	*Aviceda leuphotes*	32.	*Circus macrourus*
13.	*Pernis ptilorhynchos*	33.	*Circus pygargus*
14.	*Milvus migrans*	34.	*Circus melanoleucos*
15.	*Haliastur indus*	35.	*Circus aeruginosus*
16.	*Accipiter badius*	36.	*Circaetus gallicus*
17.	*Accipiter trivirgatus*	37.	*Spilornis cheela*
18.	*Accipiter nisus*	38.	*Pandion haliaetus*
19.	*Accipiter virgatus*	39.	*Falco biarmicus*
20.	*Buteo buteo*	40.	*Falco chiquera*

Avian Fauna of Western Ghats

S. No.	Common Name	Zoological Name
1.	Shikra	*Accipiter badius* (Gmelin)
2.	Crested Goshawk	*Accipiter trivirgatus***
3.	Basra Sparrowhawk	*Accipiter virgatus besra* Jerdon
4.	Jungle Myna	*Acridotheres fuscus mahrattensis* (Sykes)
5.	Common Myna	*Acridotheres tristis* (Linn.)
6.	Bank Myna	*Acridotheris ginginanus***
7.	Thickbilled Warbler	*Acrocephalus aedon*
8.	Indian Paddy field Warbler	*Acrocephalus agricola* (Jerdon)
9.	Blyth's Reed Warbler	*Acrocephalus dumetorum* Blyth
10.	Indian Great Reed Warbler	*Acrocephalus stentoreus brunnescens* Jerdon**
11.	Common Iora	*Aegithina tiphia deignani* Hall
12.	Vigor's Yellow backed Sunbird	*Aethopyga siparaja vigorsii* (Sykes)
13.	Eastern Skylark	*Alauda gulgula australis* Brooks
14.	Small Blue Kingfisher	*Alcedo atthis* (Linn.)
15.	Quaker Babbler	*Alcippe poioicephala* (Jerdon)
16.	Southern rufous tailed Finch Lark	*Ammomanes phoenicurus testaceous* Koelz
17.	White-breasted water hen	*Amourornis phoenicurus (Penn.)*
18.	Teal	*Anas crecca***
19.	Spot bill	*Anas poecilorhyncha***
20.	Stork open billed	*Anastomus orcitans***
21.	Darter	*Anhinga rufa melanogaster* Pennant
22.	Malabar Pied Hornbill	*Anthracoceros coronatus* (Boddaert)
23.	Indian Tree Pipit	*Anthus hadgsonii* Richmond
24.	Nilgiri pipit	*Anthus nilghiriensis* Sharpe
25.	Indian pipit	*Anthus novaeseelandiae* Gmelin
26.	Rufous rock Pipit	*Anthus similis similis* Jerdon
27.	European tree Pipit	*Anthus trivialis trivialis* (Linn.)
28.	Shoveller	*Anas clypeata***
29.	House Swift	*Apus affinis affinis* (J.E. Gray)
30.	Alpine Swift	*Apus melba nubifuga* Koelz
31.	Little Spiderhunter	*Arachnothera longirostris longirostris* (Latham)
32.	Large Egret	*Ardea alba***
33.	Grey Heron	*Ardea cinerata***

S. No.	Common Name	Zoological Name
34.	Pond heron	*Ardeola grayii (Sykes)*
35.	Indian Pond Heron/Paddy Bird	*Ardeola grayii (Sykes)*
36.	Ashy Swallow Shrike	*Artamus fuscus* Vieillot
37.	Spotted Owlet	*Athene brama brama* (Temminck)
38.	Blackcrested Baza	*Aviceda leuphotes***
39.	Ceylon Frogmouth	*Batrachostomus moniliger* Blyth
40.	Rufous bellied Short Wing	*Brachyteryx major* (Jerdon)
41.	Great Horned Owl/Eagle Owl	*Bubo bubo bengalensis* (Franklin)
42.	Dusky horned Owl	*Bubo coromandus coromandus* (Latham)
43.	Forest Eagle Owl	*Bubo nepalensis* Hodgson
44.	Brown Fish Owl	*Bubo zeylonensi leschenaulti* (Temminck)
45.	Cattle Egret	*Bubulcus ibis* (Boddaert)
46.	GreatPied Hornbill	*Buceros bicornis* Linn.
47.	White-eyed Buzzard Eagle	*Butastur teesa* (Franklin)
48.	Japanese Buzzard	*Buteo buteo japonicus* Temminck & Schlegal
49.	Indian Plaintive Cuckoo	*Cacomantis merulinus passerinus* Vahl
50.	Bay Banded Cuckoo	*Cacomantis sonneratii* Latham
51.	Rufous short toed Lark	*Calandrella cinerea dukhunensis* (Sykes)
52.	Common Indian Nightjar	*Caprimulgus asiaticus* Latham
53.	Jungle Nightjar	*Caprimulgus indicus* Latham
54.	Longtailed Nightjar	*Caprimulgus macrurus atripennis* Jerdon
55.	Common Rosefinch	*Carpodacus erythrinus roseatus* (Blyth)
56.	Crow pheasant	*Centropus sinensis* (Stephens)
57.	Lesser Coucal	*Centropus toulou bengalensis* (Gmelin)
58.	Lesser Pied Kingfisher	*Ceryle rudis leucomelanura* Reichenbach
59.	Indian threetoed forest King fisher	*Ceyx erithacus* (Linn.)
60.	Large Brownthroated Spinetail Swift	*Chaetura gigantea indica* Hume
61.	Whiterumped Spinetail	*Chaetura sylvatica* (Tickell)
62.	Emerald Dove	*Chalcophaps indica* (Linn.)
63.	Little ringed Plover	*Charadrius dubius***
64.	Gold fronted Chloropsis	*Chloropsis aurifrons frontalis* (Pelzeln)
65.	Jerdon's Chloropsis/Leaf Bird	*Chloropsis cochinchinensis jerdoni* (Blyth)

S. No.	Common Name	Zoological Name
66.	Indian black backed Wood Pecker	*Chrysocolaptes festivus* (Boddaert)
67.	Large Goldenbacked Woodpecker	*Chrysocolaptes lucidus* (Scopoli)
68.	Yellow-eyed Babbler	*Chrysomma sinense* (Gmelin)
69.	Whitenecked Stork	*Ciconia episcopus* (Boddaert)
70.	Short-toed Eagle	*Circaetus gallicus* (Gmelin)
71.	Harrier	*Circus* sp.
72.	Redheaded Fan tail Warbler	*Cisticola exilis erythrocephala* Blyth
73.	Streaked Fantail Warbler	*Cisticola juncidis cursitans* Franklin
74.	Pied Crested Cuckoo	*Clamator jacobinus jacobinus* (Boddaert)
75.	Edible-Nest Swiftlet	*Collocalia unicolor***
76.	Nilgiri Wood Pigeon	*Columba elphinstonion* (Sykes)
77.	Blue rock Pigeon	*Columba livia* Gmelin
78.	Wild Pigeon	*Columba palumbus***
79.	Shama	*Copsychus malabaricus malabaricus* (Scopoli)
80.	Magpie Robin	*Copsychus saularis ceylonensis* Sclater
81.	Blue jay/Indian Roller	*Coracias benghalensis indica*Linn.
82.	Blackheaded Cuckoo-Shrike	*Coracina melanoptera sykesi* (Strickland)
83.	Large Cuckoo-Shrike	*Coracina novaehollandiae macei* (Lesson)
84.	Jungle Crow	*Corvus macrorhynchus culminatus* Sykes
85.	House Crow	*Corvus splendens* Vieillot
86.	Common Quail	*Coturnix coturnix* (Linn.)
87.	Redwinged Crested Cuckoo	*Cuculus coromandus***
88.	Cuckoo	*Cuculus poliocephalus* Latham
89.	Large hawk Cuckoo	*Cuculus sparverioides sparverioides* Vigors
90.	Common Hawk Cuckoo	*Cuculus varius* Vahl
91.	Greyheaded Flycatcher	*Culicicapa ceylonensis* (Swainson)
92.	Palm Swift	*Cypsiurus parvus batasiensis* (J.E. Gray)
93.	European House Martin	*Delichon urbica* (Linn.)
94.	Whitebellied Treepie	*Dendrocitta leucogastra* Gould
95.	Indian Tree Pie	*Dendrocitta vagabunda* (Latham)
96.	Lesser Whistling Teal	*Dendrocygna javanica***
97.	Indian thickbilled Flower pecker	*Dicaeum agile* (Tickell)
98.	Nilgiri Flowerpecker	*Dicaeum concolor* Jerdon

S. No.	Common Name	Zoological Name
99.	Tickell's Flowerpecker	*Dicaeum erythrorhychos* (Latham)
100.	Black Drongo	*Dicrurus adsimilis macrocercus* Vieillot
101.	Bronze Drongo	*Dicrurus aeneus* Vieillot
102.	Whitebellied Drongo	*Dicrurus caerulescens* (Linn.)
103.	Haircrested Drongo	*Dicrurus hottentottus* (Linn.)
104.	Grey/Ashy Drongo	*Dicrurus leucophaeus* Vieillot
105.	Greater Racket-tailed Drongo	*Dicrurus paradiseus* (Linn.)
106.	Golden back woodpecker	*Dinopium benghalense* (Linn.)
107.	Threetoed Goldenbacked Woodpecker	*Dinopium javanense malabaricus* Whistler & Kinnear
108.	Great black woodpecker	*Dryocopus javensis hodgsonii* (Jerdon)
109.	Southern green Imperial Pigeon	*Ducula aenea* (Linn.)
110.	Green imperial pigeon	*Ducula badia* (Raffles)
111.	White-throated/Rufous bellied Babbler	*Dumetia hyperythra albogularis* (Blyth)
112.	Little Egret	*Egretta garzetta* (Linn.)
113.	Smaller Egret	*Egretta intermedia***
114.	Blackwinged Kite	*Elanus caeruleus* (Desfontaines)
115.	Red headed Bunting	*Emberiza bruniceps* Brandt
116.	Ashy-crowned Finch Lark	*Eremopterix grisea* (Scopoli)
117.	Indian Blue Chat	*Erythacus brunneus* (Hodgson)
118.	Red Munia	*Estrilda amandava***
119.	Koel	*Eudynamys scolopacea* (Linn.)
120.	Great Eared Nightjar	*Eurostopodus macrotis***
121.	Broadbilled Roller	*Eurystomus orientalis laetior* Sharpe
122.	Lesser Kestrel	*Falco naumanni* Fleischer
123.	Shaheen Falcon	*Falco peregrinus perigrinator* Sundevall
124.	Kestrel	*Falco tinnunculus* Linn.
125.	Red legged Falcon	*Falco vespertinus amurensis* Radde
126.	Grey partridge	*Francolinus pondicerianus***
127.	Coot	*Fulica atra* Linn.
128.	Deccan/Sykes' Crested Lark	*Galerida deva* (Sykes)
129.	Malabar Crested Lark	*Galerida malabarica* (Scopoli)
130.	Red spur fowl	*Galloperdix spadicea* (Gmelin)

S. No.	Common Name	Zoological Name
131.	Red jungle fowl	*Gallus gallus* Linn.
132.	Grey Jungle fowl	*Gallus sonneratti* Temminck
133.	Nilgiri Laughing Thrush	*Garrulax cachinnans* (Jerdon)
134.	Wynaad Laughing Thrush	*Garrulax delesserti delesserti* (Jerdon)
135.	Whitebreasted laughing Thrush	*Garrulax jerdoni* Blyth
136.	Jungle Owlet	*Glaucidium radiatumradiatum*(Tickell)
137.	Malay or Tiger Bittern	*Gorsachius melanolophus* (Raffles)
138.	Hill Myna	*Gracula religiosa* (Cuvier)
139.	Indian Whitebacked Vulture	*Gyps bengalensis***
140.	White breasted kingfisher	*Halcyon smyrnesis fusca* (Boddaert)
141.	Brahmni Kite	*Haliastur indus* (Boddaert)
142.	Malabar trogan	*Harpactes fasciatus malabaricus* (Gould)
143.	Heartspotted Woodpecker	*Hemicircus canente* (Lesson)
144.	Crested Tree Swift	*Hemiprocne longipennis coronata* (Tickell)
145.	Pied Flycatcher-Shrike	*Hemipus picatus* (Sykes)
146.	Rufousebellied Hawk-Eagle	*Hieraaetus kienerii* (Gmelin)
147.	Booted Hawk-Eagle	*Hieraaetus pennatus* (Gmelin)
148.	Black-winged stilt	*Himantopus himantopus***
149.	Booted tree Warbler	*Hippolais caligata* (Lichtenstein)
150.	Booted tree Warbler	*Hirundo concolor* Martin
151.	Redrumped Swallow	*Hirundo daurica erythropygia* Sykes
152.	Common Swallow	*Hirundo rustica* Linn.
153.	Indian wire tailed Swallow	*Hirundo smithii filifera* Stephens
154.	House Swallow	*Hirundo tahitica domicola* Jerdon
155.	Pheasant tailed Jacana	*Hydrophasianus chirurgus***
156.	Blacknaped Flycatcher	*Hypothymis azurea***
157.	Yellowbrowed Bulbul	*Hypsipetes indicus* (Jerdon)
158.	Black bulbul	*Hypsipetes madagascariensis ganeesa* Sykes
159.	Greyheaded Fishing eagle	*Ichthyophaga icthyaetus***
160.	Black Eagle	*Ictinaetus malayensis perniger* (Hodgson)
161.	Fairy blue bird	*Irena puella* (Latham)
162.	Brown Shrike	*Lanius cristatus* Linn.
163.	Rufousbacked Shrike	*Lanius schach caniceps* Blyth
164.	Baybacked Shrike	*Lanius vittatus* Valenciennes

S. No.	Common Name	Zoological Name
165.	Eastern Grasshopper Warbler	*Locustella naevia straminea* Seebohm
166.	Rufousbellied Munia	*Lonchura kelaarti jerdoni* (Hume)
167.	White throated Munia	*Lonchura malabarica* (Linn.)
168.	Southern black headed Munia	*Lonchura malacca malacca* (Linn.)
169.	Munia spotted	*Lonchura punctulata punctulata* (Linn.)
170.	Whitebacked Munia	*Lonchura striata striata* (Linn.)
171.	Indian Lorikeet	*Loriculus vernalis* (Sparrman)
172.	Crimson-throated barbet	*Megalaima haemacephala* (Muller)
173.	Malabar Crimson throated Barbet	*Megalaima rubricapilla malabarica* (Blyth)
174.	Small Green Barbet	*Megalaima viridis* (Boddaert)
175.	Large Green Barbet	*Megalaima zeylanica* (Gmelin)
176.	Chestnut headed Bee-Eater	*Merops leschenaultii* Vieillot
177.	Green Bee-Eater	*Merops orientalis* Latham
178.	Rufous Wood Pecker	*Micropternus brachyurus jerdonii* (Malherbe)
179.	Pariah Kite	*Milvus migranus* (Boddaert)
180.	Bush Lark	*Mirafra assamica affinis* Blyth
181.	Red winged Bush Lark	*Mirafra erythroptera* Blyth
182.	Singing Bush Lark	*Mirafra javanica cantillans* Blyth
183.	Indian blacknaped Monarch Flycatcher	*Monarcha azurea styani* (Hartaub)
184.	Blueheaded Rock Thrush	*Monticola cinclorhynchus* (Vigors)
185.	Indian Blue rock Thrush	*Monticola solitarius* (Linn.)
186.	Indian Pied or White Wagtail	*Motacilla alba dukhunensis* Sykes
187.	Grey Wagtail	*Motacilla caspica caspica* (Gmelin)
188.	Grey Wagtail	*Motacilla cinerea***
189.	Yellow Wagtail	*Motacilla flava* Linn.
190.	Forest Wagtail	*Motacilla indica* Gmelin
191.	Large Pied Wagtail	*Motacilla maderaspatensis* Gmelin
192.	Nilgiri Flycatcher	*Muscicapa albicaudata* Jerdon
193.	Brown fly catcher	*Muscicapa latirostris* Raffles
194.	Brownbreasted Flycatcher	*Muscicapa muttui* (Layard)
195.	Black and orange fly catcher	*Muscicapa nigrorufa* (Jerdon)
196.	Whitebellied Blue Flycatcher	*Muscicapa pallipes* Jerdon
197.	Eastern Red breasted Flycatcher	*Muscicapa parva albicilla* Pallas

S. No.	Common Name	Zoological Name
198.	Bluethroated Flycatcher	*Muscicapa rubeculoides* (Vigors)
199.	Rufoustailed Flycatcher	*Muscicapa ruficauda* Swainson
200.	Verditer fly catcher	*Muscicapa thalassina* Swainson
201.	Tickell's Blue fly catcher	*Muscicapa tickelliae* (Blyth)
202.	Painted stork	*Mycteria leucocephala* (Peeant)
203.	Malabar Whistling Thrush	*Myiophonus horsfieldii* (Vigors)
204.	Purple Sunbird	*Nectarinia asiatica asiatica* (Latham)
205.	Loten's sunbird	*Nectarinia lotenia hindustanica* (Linn.)
206.	Small Sunbird	*Nectarinia minima* (Sykes)
207.	Purple rumped sunbird	*Nectarinia zeylonica sola* (Vieillot)
208.	Scanvenger Vulture	*Neophron percnopterus* (Linn.)
209.	Brown Hawk-Owl	*Ninox scutulata hirsuta* (Temminck)
210.	Night Heron	*Nycticorax nycticorax* (Linn.)
211.	Blue bearded Bee eater	*Nyctyornis athertoni* (Jardine & Selby)
212.	Blacknaped Oriole	*Oriolus chinensis diffusus* Sharpe
213.	Golden Oriole	*Oriolus oriolus kundoo* Sykes
214.	Blackheaded Oriole	*Oriolus xanthornus madraspatanus* Franklin
215.	Tailor Bird	*Orthotomus sutorius* (Pennant)
216.	Collared Scops Owl	*Otus bakkamoena* Pennant
217.	Scops owl	*Otus scops rufipennis* (Sharpe)
218.	Osprey	*Pandion haliaetus* (Linn.)
219.	Grey Tilt	*Parus major stupae* Koelz
220.	Yellowcheeked Tit	*Parus xanthogenys travancorensis* (Whistler and Kinnear)
221.	House Sparrow	*Passer domesticus indicus* Jardine and Selby
222.	Peafowl	*Pavo cristatus* Linn.
223.	Brown headed Stork billed King fisher	*Pelargopsis capensis* (Linn.)
224.	Pelican	*Pelicanus phillippensis***
225.	Peninsular or Kerala Spotted Babbler	*Pellorneum ruficeps olivaceum* Jerdon
226.	Konkan Jungle Bush Quail	*Perdicula asiatica* (Latham)
227.	Painted Bush Quail	*Perdicula erythrorhyncha* (Sykes)
228.	Small Minivet	*Pericrocotus cinnamomeus* (Linn.)

S. No.	Common Name	Zoological Name
229.	White bellied Minivet	*Pericrocotus erythropygius* (Jerdon)
230.	Scarlet Minivet	*Pericrocotus flammeus* (Forster)
231.	Crested Honey Buzzard	*Pernis ptilorhynchus ruficollis* Lesson
232.	Indian Yellow Sparrow	*Petronia xanthocollis xanthocollis* (Burton)
233.	Little Cormorant	*Phalacrocorax niger* (Vieillot)
234.	Large Cormorant	*Phalocrocorax carbo***
235.	Oriental Bay owl	*Phodilus badius ripleyi***
236.	Eastern black red Start	*Phoenicurus ochruros rufiventris* (Vieillot)
237.	Tytler's Leaf Warbler	*Phyllocscopus tytleri* Brooks
238.	Tickell's Leaf Warbler	*Phylloscopus affinis* (Tickell)
239.	Largebilled Leaf Warbler	*Phylloscopus magnirostris* Blyth
240.	Large Crowned Leaf Warbler	*Phylloscopus occipitalis* (Blyth)
241.	Dull Green Leaf Warbler	*Phylloscopus trochiloides* (Sundevall)
242.	Pied Woodpecker	*Picoides mahrattnesis* (Latham)
243.	Pigmy Woodpecker	*Picoides nanus hardwickii* (Jerdon)
244.	Speckled Piculet	*Picumnus innominatus malayorum* Hartert
245.	South Indian small Yellownaped Woodpecker	*Picus chlorolophus chlorigaster* Jerdon
246.	Indian Pitta	*Pitta brachyura* (Linn.)
247.	White spoonbill	*Platalea leucoradia***
248.	Indian Streaked Weaver Bird	*Ploceus manyor flaviceps* Lesson
249.	Baya Weaver Bird	*Ploceus phillippinus phillippinus* (Linn.)
250.	Slatyheaded Scimitar Babbler	*Pomatorhinus horsfieldii schisticeps***
251.	Kerala Scimitar Babbler	*Pomatorhinus schisticeps travancorensis* Harrington
252.	Franklin's Wren-Warbler	*Prinia hodgsonii* Blyth
253.	Ashy Wren Warbler	*Prinia socialis* Sykes
254.	Indian Wren Wabbler	*Prinia subflava* (Gmelin)
255.	Jungle Wren-Warbler	*Prinia sylvatica* Jerdon
256.	Black Ibis	*Pseudibis papillosa*
257.	Bluewinged Parakeet	*Psittacula columboides* (Vigors)
258.	Blossomheaded Parakeet	*Psittacula cyanocephala* (Linn.)
259.	Rose ringed parakeet	*Psittacula krameri*
260.	Red-vented Bulbul	*Pycnonotus cafer* (Linn.)

S. No.	Common Name	Zoological Name
261.	Red whiskered Bulbul	*Pycnonotus jocosus fuscicaudatus* (Gould)
262.	Whitebrowed Bulbul	*Pycnonotus luteolus* (Lesson)
263.	Rubythroated Bulbul	*Pycnonotus melanicterus gularis* (Gould)
264.	Greyheaded Bulbul	*Pycnonotus priocephalus* (Jerdon)
265.	Yellowthroated Bulbul	*Pycnonotus xantholaemus***
266.	White spotted Flycatcher	*Rhipidura albicollis albogularis* Lesson
267.	Southern White browed faintail Flycatcher	*Rhipidura aureola compressirostris* Blyth
268.	Blackheaded Babbler	*Rhopocichla atriceps bourdilloni* (Hume)
269.	Small greenbilled Malkoha	*Rhopodytes viridirostris* (Jerdon)
270.	King Vulture	*Sarcogyps calvus* (Scopoli)
271.	Pied Bush chat	*Saxicola caprata nilgiriensis* Whistler
272.	Indian Robin	*Saxicoloides fulicata* (Linn.)
273.	Wood cock	*Scalopax rusticola* Linn.
274.	Broadtailed Grass Warbler	*Schoenicola platyura* (Jerdon)
275.	Peninsular Chestnut bellied Nuthatch	*Sitta castanea castanea* Lesson
276.	Velvetfronted Nuthatch	*Sitta frontalis* Swainson
277.	Crested Serpant eagle	*Spilornis cheela* (Latham)
278.	Crested hawk eagle	*Spizaetus cirrhatus* (Gmelin)
279.	Common Tern	*Sterna hirundo***
280.	Spotted dove	*Streptopelia chinensis* (Scopoli)
281.	Ring Dove	*Streptopelia decacta (Frvaldszky)*
282.	Indian ring Dove	*Streptopelia decacto* (Frivaldszky)
283.	Little Brown Dove	*Streptopelia senegalensis* (Linn.)
284.	Brown wood Owl	*Strix leptogrammica indranee* Sykes
285.	Greyheaded Myna/Greyheaded Myna	*Sturnus malabaricus blythii* (Jerdon)
286.	Blackheaded Myna/Brahmini Myna	*Sturnus pagodarum* (Gmelin)
287.	Rosy starling/Rosy Pastor	*Sturnus roseus* (Linn.)
288.	Siberian Lesser White Throat	*Sylvia curruca* (Linn.)
289.	Eastern Orphan Warbler	*Sylvia hortensis* (Gmelin)
290.	Sirkeer Cuckoo	*Taccocua leschenaultii* Lesson

S. No.	Common Name	Zoological Name
291.	Little Grebe	*Tachybabtus ruficollis***
292.	Malabar Wood Shrike	*Tephrodornis gularis sylvicola* Jerdon
293.	Common Woodshrike	*Tephrodornis pondicerianus* (Gmelin)
294.	Large Woodshrike	*Tephrodornis virgatus***
295.	Paradise Flycatcher	*Terpsiphone paradisi* Linn.
296.	White Ibis	*Threskiornis aethiopica***
297.	White Ibis	*Threskiornis melanocephala***
298.	Grey Hornbill	*Tockus birostris* (Scopoli)
299.	Malabar grey horn bill	*Tockus griseus* (Latham)
300.	Indian Orange breasted green Pigeon	*Treron bicincta* (Jerdon)
301.	Yellow legged green Pigeon	*Treron phoenicoptera* (Latham)
302.	Green Pigeon/Pompadour Pigeon	*Treron pompadora* (Gmelin)
303.	Wood sandpiper	*Tringa glareola* Linn.
304.	Common sandpiper	*Tringa hypoleucos* Linn.
305.	Green sand piper	*Tringa ochropus* Linn.
306.	Whiteheaded Babbler	*Turdoides affinis* (Jerdon)
307.	Large Grey Babbler	*Turdoides malcolmi* (Sykes)
308.	Jungle Babbler	*Turdoides striatus orientalis* (Jerdon)
309.	Rufous Babbler	*Turdoides subrufus* (Jerdon)
310.	Common Babbler	*Turdoides caudatus* (Dumont)
311.	Blackbird	*Turdus merula simillimus* (Jerdon)
312.	Barn Owl	*Tyto alba* (Scopoli)
313.	Grass Owl	*Tyto capensis* (A. Smith)
314.	Hoopoe	*Upupa epops* Linn.
315.	Red wattled Lapwing	*Vanellus indicus* (Boddaert)
316.	Yellow wattled Lapwing	*Vanellus malabaricus* (Boddaert)
317.	White throated Ground Thrush	*Zoothera citrina cyanotus* (Jardine and Selby)
318.	Nilgiri or Small billed Thrush	*Zoothera dauma neilgherriensis* (Blyth)
319.	White eye	*Zosterops palpebross nilgiriensis* Ticehurst

**Migratory species to Western Ghats

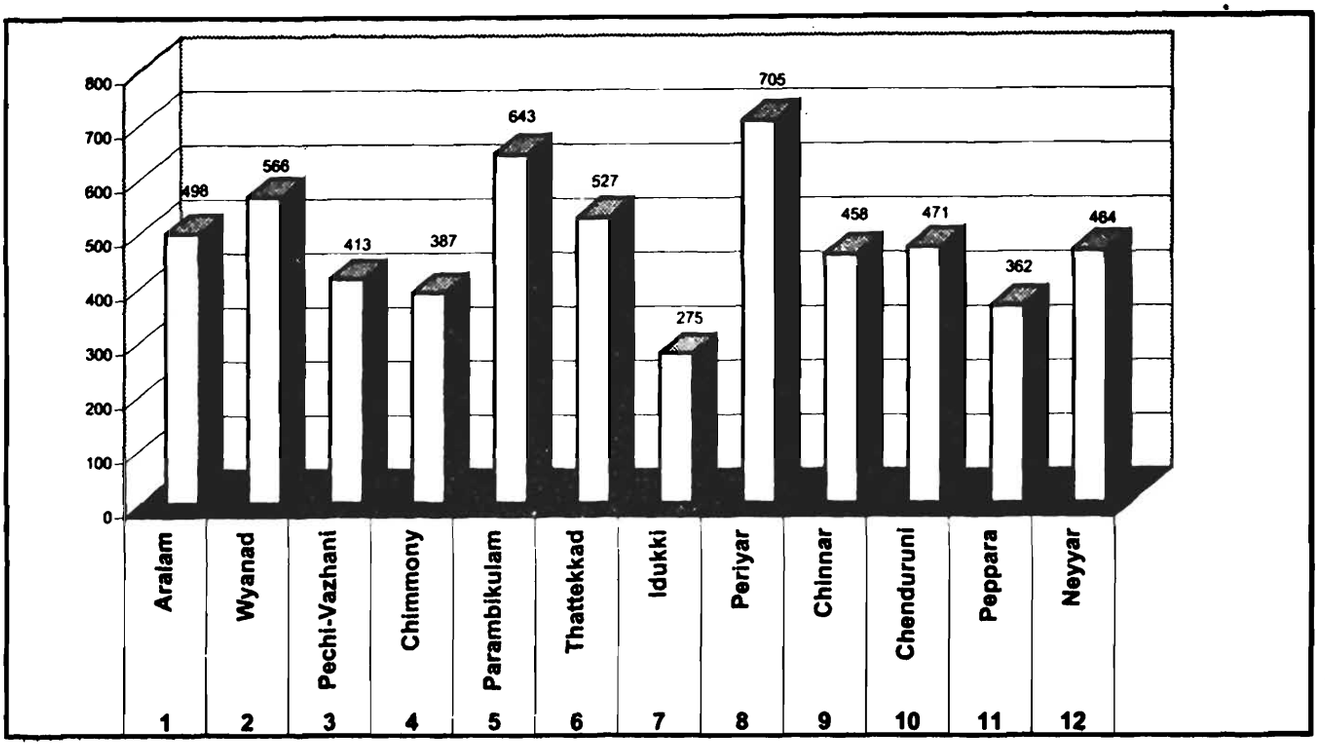
Comparative faunal distribution in two national parks of Western Ghats

Faunal Groups	Number of Species	
	Eravikulam N.P.	Silent Valley N.P.
INVERTEBRATE		
Insecta	87	626
Annelida	—	3
Arachnida	5	—
Nematomorpha	1	—
Mollusca	1	5
VERTEBRATE		
Pisces	4	12
Amphibia	18	30
Aves	132	211
Mammalia	47	34

Note : Silent Valley- Tropical wet evergreen rain forest system and Eravikulam- Shola-grassland system.

Table showing faunal distribution in different Wildlife Sanctuaries of Kerala : 1. Aralalam 2. Wyanad 3. Peechi-Vazhani 4. Chimmony 5. Parambikulam 6. Tattekkad 7. Idukki 8. Periyar 9. Chinnar 10. Chenduruni 11. Peppara 12. Neyyar given below :

Faunal Groups	Number of Species											
	1	2	3	4	5	6	7	8	9	10	11	12
INVERTEBRATE												
Odonata	22	13	6	14	25	11	–	41	19	–	–	–
Lepidoptera (Butterflies)	143	111	58	87	124	120	–	124	79	78	–	103
Hymenoptera (Chalcidoidea)	40	50	45	14	55	–	22	50	16	15	–	3
VERTEBRATA												
Pisces	39	69	40	33	47	47	–	38	26	42	27	27
Amphibia	23	30	17	14	24	15	13	27	15	22	13	25
Reptilia	22	45	31	25	61	30	9	45	52	35	46	46
Mammalia	23	45	39	39	39	34	30	62	26	34	43	43



Distribution of Lizards in Western Ghats

The following species of lizards are distributed in Western Ghats : *Cyrtodactylus collegalensis* (Beddome 1870) [*Geckoella collegalensis*], *Cyrtodactylus dekkanensis* (Gunther, 1864) [*Geckoella dekkanensis*], *Cyrtodactylus albofasciatus* (Boulenger 1885), *Cnemaspis indica* (Gray 1846), *Cnemaspis wynadensis* (Beddome 1870), *Cnemaspis sisparensis* (Theobald 1876), *Cnemaspis ornata* (Beddome 1870), *Cnemaspis beddomei* (Theobald 1876), *Cnemaspis mysoriensis* (Jerdon 1853), *Cnemaspis gracilis* (Beddome 1870), *Cnemaspis jerdoni* (Theobald 1868), *Cnemaspis littoralis* (Jerdon 1853), *Cnemaspis nairi* Inger, Marx & Koshy, 1983, *Cnemaspis goaensis* Sharma 1976, *Dravidogecko anamallensis* (Gunther 1875) [*Hemidactylus anamallensis*], *Hemidactylus maculatus* Dum. & Bibr. 1836, *Hemidactylus brooki* Gray 1845, *Hemidactylus prashadi* Smith 1935, *Hemidactylus albofasciatus* Grandison & Soman 1963 [*Teratolepis albofasciatus*], *Hemiphyllodactylus typus aurantiacus* Beddome 1870, *Draco dussumieri* Dum. & Bibr. 1837, *Otocryptis beddomii* Boulenger 1885, *Salea horsfieldi Gray 1845, Salea anamallayana* (Beddome 1878), *Calotes nemoricola* Jerdon 1853, *Calotes grandisquamis* Gunther 1875, *Calotes calotes* (Linnaeus 1758), *Calotes rouxi* Dum. & Bibr. 1837, *Calotes elliotti* Gunther 1864, *Psammophilus dorsalis* (Gray 1831), *Mabuya clivicola* Inger, Shaffer, Koshy & Bakde 1994, *Dasia subcaerulea* (Boulenger 1891), *Sphenomorphus dussumieri* (Dum. & Bibr. 1839), *Scincella travancoricum* (Beddome 1870), *Scincella palnicum* (Boettger 1892), *Scincella beddomei* (Boulenger 1887), *Scincella laterimaculatum* (Boulenger 1887), *Scincella bilineatum* (Gray 1846), *Riopa guentheri* (Peters 1879) [*Lygosoma guntheri*], *Riopa lineata* (Gray 1839) [*Lygosoma lineata*] *Riopa goaensis* Sharma 1976 [*Lygosoma goaensis*], *Riopa pruthi* Sharma 1977 [*Lygosoma pruthi*], *Ristella rurki* Gray 1839,*Ristella travancorica* (Beddome 1870), *Ristella guentheri* Boulenger 1887, *Ristella beddomii* Boulenger 1887, *Eumeces poonaensis* Sharma 1964, *Ophisops beddomei* (Jerdon1870).

Distribution of snakes in Western Ghats

Out of 14 families of snakes, members of the the family : Typhlopidae, *Typhlops acutus* is distributed in peninsular India, *Typhlops beddomei* in the hilly tracts of Kerala and Anamalai hills and Tirunelveli. *Typhlops tindali* in the Nilambur Forests of Kerala, *Typhlops porrectes* is distributed in the whole of India, including Western Ghats. Members of the family Uropeltidae show a very interesting pattern of distribution and exhibits fossorial habits. It is restricted to southern India and comprises of 45 species : 21 species are **Rare** (Not according to IUCN Guidelines, but based on frequency of occurence) in occurrence (*Melanophdium bilineatum* (known by three juvenile specimens), *M. punctatum, M. wynaudens, Teretrurus sanguineus, T rhodogaster, Plectrurus guentheri, P. aureus, Uropeltis ellioti, U. nitidus, U. dindigelensis, U. beddomei, U. macrorhychus, U rubromaculatus, U. rubrolineatus, U. phipsoni, U. petersi, U. smithi, Rhinophis fergusonianus, R. oxyrhynchus, R. homolepis, R. fergusonianus),* 10 **Common** (*Melanophidium punctatum, Uropeltis wood-masoni, U. arcticeps, Uropeltis myhendrae, U. broughami, U. maculates, U.liura, U. melanogaster, U. phillipsi, U. pulneynsis)* and 14 **very common** species (*Platyplectrurus trilineatus, P. madurensis, Plectrurus peroteti, P. canaricus, Uropeltis ceylanicus, U. ocellatus, U. macrolepis, U. grandis, Rhinophis blithi, R. drummondhayi, R. sanguineus, R. philippinus, R. punctatgus, R. travancoricusm).* Among them only one species has (*Uropeltis elioti)* been recorded from the Tirumala hills of Andhra Pradesh. All Members of Uropeltids found in India are endemic to the country.

The family Boidae is represented by 4 species, of which 3 species (*Python molurus, Eryx conicus, Eryx johni johni*) are distributed throughout the country, including Western Ghats. The family Colubridae, which includes, terrestrial, arboreal, burrowing and aquatic snakes, represented in the Western Ghats are *Elaphe helena, Argyrogena ventrimaculatus, Boiga fosteni, Psammophis condanarus* (in Dang districts of Gujarat), *Ptyas mucosus, Argyrogena fasciolatus, Argyrogena gracilis* in Maharastra, *Leiopeltis calameria, Amphiesma beddomei, Xylophis perroteti, Xylophis stenorhynchus,* (Western Ghats as far north as Matheran, Tinelvelly, Mysore plateau, Karnataka), *Coronella brachyura* (Pune, Maharashtra), *Oligodon travancoricus, Boiga dightoni,* (Western Ghat, South of Palgat (Palakkad) gap, high altitude ranges of Travancore), *Oligodon arnensis,* (Dang & Peninsular India), *Oligodon affinis, Dendrelaphis grandoculis, D. bifrenalis, D. caudolineata,* (Western Ghats, Wynad to Travancore), *Dendrelaphis pictus pictus, D. tristis, Lycodon aulicus, Dryocalamus gracilis, Amphiesma stolata, Xenochrophis piscator, Macropisthodon plumbicolor, Atretium schistosum, Boiga trigonata,* (Western Ghat & Peninsular India), *Chrysopelia ornate, Amphiesma monticola* (Dang, Goa, Kerala), *Lycodon travancoricus* (north of Matheran in Western Ghats), *Lycodon flavomaculatus* (Nasik, Pune, Sangli and Dharwar area of Western Ghats), *Ahaetulla perroteti, A. dispar,* (common in Nilgiri hills), *Ahaetulla pulverulentus* (common in Castle Rock, North Karnataka, Nellampatty hills in Travancore, Dang district of Gujarat).

The family Elapidae which includes *Bungarus, Naja, Ophiophagus* and *Callophis,* are represented by *Bungarus caeruleus, Callophis melanurus* (Coimbatore -Anamalai hills, Malabar region of Kerala, Dharwar in Karnataka), and *Callophis nigriscens* (Dang, Gujarat; Nilgiri, Anamalai, Shevroy hills, Panchagani in Maharashtra), a true endemic snake of Western

Ghats. *Callophis beddomei* recorded from Koppa in Chikkamagalore district of Karnataka, and Shevroy hill. Tamil Nadu), *Callophis bibroni* (distributed south of Coorg, Karnataka); *Naja naja naja* (the entire Western Ghats and Peninsular India), *Ophiophagus Hannah* (including Peninsular India).

The family Viperidae comprise viviparous terrestrial or arboreal snakes with *Viper russelli,* distributed throughout the country except certain parts of Northeastern India, *Echis carinatus* (Peninsular and Western part) and *Hypnale hypnale* distributed in Western Ghats as north as latitude 16^0 and *Trimeresurus macrolepis, T malabaricus, T strigatus,* distributed in Mahabaleshwar hills, hills of Goa, Nilgiri hills, Palni hills, Shevroy hills, Anamalai hills, Nellampati hills near Trivendrum, usually above 2000 ft msl., where as *Trimeresurus gramineus* distributed from Dang district in Gujarat to the entire Peninsular India.

In all, nearly 65 snakes are distributed in the Western Ghats of which 32 are rare, 21 are common and 12 are very common species. The entire family of Uropeltidae with 45 species is restricted to Western Ghats only. Habitat fragmentation, anthropogenic pressure and trade are the other causes for the dwindling number of snake species, besides making them vulnerable especially species such as *Python reticulates, Chrysoplea ornate, Sibynophis subpunctatus, Ahaetulla nasutus, Ahaetulla pulverulentus, Ophiophagus hannah, Naja naja naja* and few others. Ecological studies of reptilian communities in the Western Ghats are those limited to the Kalakad-Mundanthurai Tiger Reserve. Survey-type studies of reptiles in the Western Ghats have provided the most information on species diversity and habitat use. Higher diversity of species has been observed in the moist deciduous forests. As per one study in the Nilgiris, the number of reptilian species is negatively correlated with altitude, but positively correlated with number of herbs, number of fallen logs and slope. However, detailed studies in the Kalakad-Mundanthurai Tiger reserve have suggested that mid-elevations of 1000-1100m ASL in the Western Ghats have the highest diversity of reptiles. Further, the density of forest floor reptiles in the Western Ghats is generally low being 0.26 per 25 sqm. It is interesting to note that snakes dominate the forest floor reptilian communities at altitudes of 1200m ASL and above.

Reptiles of Western Ghats

S. No.	Common Name	Zoological Name
1.	Gunther' whip snake	*Ahaetulla dispar* (Gunther)
2.	——	*Ahaetulla nasutus* (Lacepede)
3.	——	*Ahaetulla pulverulentus* (Dum. & Bibr.)
4.	Forest Keelback	*Amphiesma beddomei* (Gunther)
5.	——	*Amphiesma monticola* (Jerdon)
6.	Buff-striped Keelback	*Amphiesma stolata* (Linn.)
7.	——	*Boiga dightoni*

S. No.	Common Name	Zoological Name
8.	——	*Boiga trigonata* (Schneider)
9.	——	*Brachyphidium rhodogaster* Wall
10.	Common Krait	*Bungarus caeruleus* (Schneider)
11.	Leschenault's Cabrita	*Cabrita leschenaulti* (Milne-Edwards)
12.	——	*Calliophis beddomei*
13.	——	*Calliophis nigrescens* (Gunther)
14.	Golden Gecko	*Calodactylodes aureus*
15.	——	*Calotes calotes* (Linn.)
16.	——	*Calotes elliotti* Gunther
17.	——	*Calotes grandisquamis* Gunther
18.	——	*Calotes nemericola* Jerdon
19.	——	*Calotes rouxi* Dumeril & Bibron
20.	Indian Garden Lizard	*Calotes versicolor* (Daudin)
21.	Indian Chameleon	*Chameleo zeylanicus* Laurenti
22.	Indian ornate flying snake	*Chrysopelea ornata ornata* (Shaw)
23.	——	*Cnemaspis beddomei* (Theobald)
24.	——	*Cnemaspis goaensis* Sharma
25.	Nilgiri Dwarf Gecko	*Cnemaspis indica* (Gray)
26.	——	*Cnemaspis jerdoni* (Theobald)
27.	——	*Cnemaspis kandianus* (Kellart)
28.	——	*Cnemaspis littoralis* (Jerdon)
29.	——	*Cnemaspis mysoriensis* (Jerdon)
30.	——	*Cnemaspis nairi*
31.	——	*Cnemaspis ornata* (Beddome)
32.	——	*Cnemaspis sisparensis* (Theobald)
33.	——	*Cnemaspis wynadensis* (Beddome)
34.	——	*Cyrtodactylus albofasciatus* (Boulenger)
35.	Collegal Rock-gecko	*Cyrtodactylus collegalensis* (Beddome)
36.	——	*Cyrtodactylus dekkanensis* (Gunther)
37.	——	*Dasia subcaerulea* (Boulenger)
38.	——	*Dendrelaphis grandiculis*
39.	Common Bronze-back Tree Snake	*Dendrelaphis tristis* (Daudin)
40.	South Indian Flying Lizard	*Draco dussumieri* Dum. & Bibr.

S. No.	Common Name	Zoological Name
41.	Anamalai Dravid Gecko or Southern Forest Gecko	*Dravidogecko anamallensis* (Gunther)
42.	——	*Dryocalamus nympha*
43.	——	*Elaphe helena* (Daudin)
44.	Common sand Boa	*Eryx conicus* (Schneider)
45.	Spotted Cat-eyed Gecko	*Eublepharis macularius* (Blyth)
46.	Pune Mole Skink	*Eumeces poonaensis* Sharma
47.	Stump-toed Gecko	*Gehyra mutilata*
48.	Cochin Forest Cane Turtle	*Geomyda silvatica*
49.	Spotted Indian House Gecko	*Hemidactylus brooki* Gray
50.	——	*Hemidactylus flaviviridis* Ruppell
51.	——	*Hemidactylus frenatus* Schlegal
52.	——	*Hemidactylus giganteus* Stoliczkii
53.	Slender Hemidactyle	*Hemidactylus gracilis* Blanford
54.	——	*Hemidactylus leschenaulti* Dum. & Bibr.
55.	——	*Hemidactylus maculatus* Dumeril & Bibron
56.	——	*Hemidactylus prashadi* Smith
57.	Reticulate Hemidactyle	*Hemidactylus reticulatus* Beddome
58.	Blotched Gecko	*Hemidactylus triedrus* (Daudin)
59.	——	*Hemiphyllodactylus typus auranticus* (Beddome)
60.	——	*Hypnale hypnale* (Merrem)
61.	Travancore Tortoise	*Indotestudo forestenii*
62.	——	*Lycodon aulicus* (Linn.)
63.	Yellow spotted wolf snake	*Lycodon flavamaculatus* Wall
64.	——	*Lycodon travancoricus* (Beddome)
65.	——	*Mabuya beddomii* (Jerdon)
66.	——	*Mabuya bibroni* (Gray)
67.	Common Skink	*Mabuya carinata* (Schneider)
68.	——	*Mabuya clivicda*
69.	——	*Mabuya macularia* (Blyth)
70.	——	*Mabuya trivittata* (Hardwicke & Gray)
71.	Green Keelback	*Macropisthodon plumbicolor* (Cantor)
72.	Madras Pond Tortoise	*Melanochelys trijuga trijuga* (Schweigger)

S. No.	Common Name	Zoological Name
73.	——	*Melanophidium punctatum* Beddome
74.	——	*Oligodon arnensis* (Shaw)
75.	——	*Oligodon taeniolatus* (Jerdon)
76.	King Cobra	*Ophiophagus hannah*
77.	Beddome's Snake-eyed Lacertid	*Ophisops beddomei* (Jerdon)
78.	Punjab Snake-eyed Lacertid	*Ophisops jerdoni* Blyth
79.	——	*Otocryptis beddomii* Boulenger
80.	——	*Platyplectrurus madurensis madurensis* Beddome
81.	——	*Platyplectrurus trilineatus* (Beddome)
82.	Rough tailed Snake	*Plecturus perroteti* Dum.& Bibron
83.	——	*Psammophilus blanfordans* (Stoliczka)
84.	Peninsular Rock Lizard	*Psammophilus dorsalis* (Gray)
85.	——	*Rhabdops divaceus*
86.	——	*Riopa goaensis* Sharma
87.	Gunther's Garden Skink	*Riopa guentheri* (Peters)
88.	Lined Garden Skink	*Riopa lineata* (Gray)
89.	Dotted Garden Skink	*Riopa punctata* (Gmelin)
90.	Beddome's Cat Skink	*Ristella beddomii* Boulenger
91.	Gunther's Cat Skink	*Ristella guentheri* Boulenger
92.	Rurk's Cat Skink	*Ristella rurki* Gray
93.	Reddish-brown four fingered Skink	*Ristella travancorica* (Beddome)
94.	Deark Brown Bush Lizard	*Salea anamallayana* (Beddome)
95.	Agamid	*Salea horsfieldi* Gray
96.	Beddome's Ground Skink	*Scincella beddomei* (Boulenger)
97.	Nilgiris Ground Skink	*Scincella bilineatum* (Gray)
98.	Black-striped Ground Skink	*Scincella laterimaculatum* (Boulenger)
99.	Palnis Ground Skink	*Scincella palnicum* (Boettger)
100.	South Indian Ground Skink	*Scincella travancoricum* (Beddome)
101.	——	*Sibynophis subpunctatus* (Dum. & Bibr.)
102.		*Sitana ponticeriana* Cuvier
103.	——	*Sphenomorphus dussumieri* Dum. & Bibr.
104.	Rough tailed Snake	*Teretrurus sanguineus* (Beddome)

S. No.	Common Name	Zoological Name
105.	——	*Trimeresurus gramineus* (Shaw)
106.	——	*Trimeresurus macrolepis* Beddome
107.	Malabar Pit Viper	*Trimeresurus malabaricus* (Jerdon)
108.	——	*Typhlops beddomei* Boulenger
109.	——	*Typhlops braminus* (Daudin)
110.	——	*Uropeltes ceylanicus Cuvier*
111.	——	*Uropeltes macrorhynchus (Beddome)*
112.	Rough tailed Snake	*Uropeltes maculates* (Beddome)
113.	——	*Uropeltes ocellatus (Beddome)*
114.	Rough tailed Snake	*Uropeltes pulneyensis (Beddome)*
115.	Red striped Uropelt	*Uropeltes rubrolineatus (Gunther)*
116.	——	*Varanus bengalensis* (Blyth)
117.	——	*Xenochrophis beddomei* (Gunther)
118.	Checkered Keelback	*Xenochrophis piscator* (Schneider)
119.	——	*Xylophis perroteti* (Dumeril & Bibron)
120.	——	*Xylophis sternorhynchus* (Gunther)

Amphibia

The amphibian fauna of Western Ghats include *Ansonia kamblei* Ravichandran & Pillai, 1990 from hill streams of Sholapur in Maharashtra, *Ansonia ornata* Günther,1875 from Coorg, Karnataka; *Ansonia rubigina* Pillai & Pattabiraman, 1981 from Silent Valley ; *Ansonia rubigina* Pillai & Pattabiraman,1981 from all three southern states ; *Bufo brevirostris* Rao, 1937 from Kempuhole, Karnataka with no further recovery from the type or other localities. *Bufo fergusoni* Boulenger, 1892. ; Bufo *hololius* Günther, 1875; *Bufo koynayensis* Soman, 1963 from Satara; *Bufo parietalis* Boulenger, 1882, *Bufo microtympanum* Boulenger, 1882 from Malabar ; *Bufo silentvalleyensis* Pillai, 1982 from Silent valley ; *Pedostibes tuberculosus* Günther, 1875 (Malabar); *Melanobatrachus indicus* Beddome, 1878 (Anamalai hills); *Microhyla ornata* (Dumeril & Bibron, 1841) (Malabar) ; *Ramanella minor* Rao, 1937; *Ramanella anamalaiensis* Rao, 1937 with no record after original description; *Ramanella montana* (Jerdon, 1854) ; *Ramanella mormorata* Rao, 1937 and *Ramanella triangularis* (Günther, 1875); are the important Microhylids.

Among Caecelians (Gymniophiana) the following species are endemic viz., *Gegeneophis carnosus* (Beddome, 1870); *Gegeneophis krishni* Pillai & Ravichandran, 1999; *Gegeneophis ramaswamii* Taylor, 1964; *Indotyphlus battersbyi* Taylor, 1960; *Ichthyophis beddomei* Peters, 1879; *Ichthyophis bombayensis* Taylor,1960; *Ichthyophis husaini* Pillai & Ravichandran, 1999; *Ichthyophis longicephalus* Pillai,1986; *Ichthyophis malabarensis* Taylor, 1960; *Ichthyophis*

peninsularis Taylor, 1960; *Ichthyophis subterrestris* Taylor, 1960; *Ichthyophis tricolor* Annandale, 1909; *Uraeotyphlus malabaricus* (Beddome, 1870); *Uraeotyphlus menoni* Annandale, 1913; *Uraeotyphlus narayani* Seshachar, 1939 *and Uraeotyphlus oxyurus* (Duméril & Bibron, 1841). Out of 24 known caecelians, nearly 22 are recorded from Western Ghats alone with 16 endemic species accounting for nearly 73% of caecelians. Caecilians prefer moist soils rich in organic carbon (essentially derived from rotting wood and leaf litter). The highest diversity of species in any given landscape is noticed in the southern half of the Western Ghats.

Among endemic Rhacophoridae distributed in the Western Ghats are *Philautus beddomii* (Günther, 1876); *Philautus bombayensis* (Annandale, 1919) ; *Philautus chalazodes* (Günther, 1875); *Philautus charius* Rao, 1937; *Philautus crnri,* Dutta, 1985 ; *Philautus elegans* Rao, 1937; *Philautus elegans* Rao, 1937; *Philautus flaviventris* (Boulenger,1882) ; *Philautus glandulosus* (Jerdon, 1853); *Philautus hassanensis* Dutta,1985 ; *Philautus kottigeharensis* Rao, 1937; *Philautus melanensis* Rao, 1937; *Philautus naraiensis* Rao, 1937; *Philautus noblei* (Ahl, 1927); *Philautus parkeri* (Ahl, 1927); *Philautus pulcherrimus* (Ahl, 1927); *Philautus punctatus* (Anderson, 1871); *Philautus signatus* (Boulenger, 1882); *Philautus swamianus* Rao, 1937; *Philautus travancoricus* (Boulenger, 1891); *Philautus tinniens* (Jerdon, 1853); *Philautus wynaadensis* (Jerdon, 1853); *Polypedates pleurostictus* Günther, 1864; *Polypedates pseudocruciger* Das & Ravichandran, 1998; *Orus calcadensis* Ahl, 1927; *Rhacophorus lateralis* Boulenger, 1883; *Rhacophorus malabaricus* Jerdon, 1870 and *Rhacophorus pseudomalabaricus* Vasudevan & Dutta, 2000.

Some of the frogs and toads described earlier need reinventorisation, as many of them are known only from the type localities and further descriptions or records of the species have not been made. The only species that show uniform distribution throughout the country is the *Bufo melanostictus.* Among others, *Euphlyctys cyanophlyctis, Limnonectes limnocharis, Haplobatrachus tigerinus, Polypedatus maculatus* and *Tomopterna brevipes* show a wide distribution in Western Ghats.

The community structure of amphibians at Kalakad–Mundanthurai Tiger Reserve (Karthikeyan *et al.*, 2001) was analysed by the multi-species clusters indicated the distribution of 32 species of which, 43% *Rana,* 30% *Micrixalus,* 18% *Philautus,* 7% *Indirana,* 1% *Ramanella* and 1% *Bufo. R. temporalis* was the dominant group forming 49% (N = 84) in summer and 39% (N = 141) in south-west monsoon, *Micrixalus* was the next dominant genus in both the seasons (27% & 31%, respectively) and *Indirana* the third (17% & 19%, respectively). After pooling data for seasons and sites, the dominant members of the amphibian community were *R. temporalis* 43% and *M. fuscus* 21%. *R. temporalis* clearly dominated (84%) the amphibian community in Sengaltheri. Both *Micrixalus* (45%) and *Philautus* (32%) were dominant in Kakachi. In Kannikatti, *R. temporalis* (48%) and *Philautus* (25%) were the dominant taxa.

India has an Amphibian diversity of 240 species of which Western Ghats is home for 138 species. The family Ranidae (true frogs) has the largest number of species (56) amounting to 44% of the amphibian fauna of the Western Ghats. The next largest family

is Rhacophoridae (treefrogs) with 34 species (26% of the amphibian fauna). In general; there are more species of terrestrial and arboreal amphibians in the Western Ghats than aquatic ones. Most species are found in the altitudinal range of 0-1200 m ASL. Highest diversity of species is at 800-1000 m. Analaysis of the patterns of amphibian distribution in the Western Ghats has suggested that widespread rainfall, shorter dry season and a more uniform local climate have contributed to the high levels of diversity and endemism than elevation *per se*.

Amphibian Fauna of Western Ghats

S. No.	Common Name	Zoological Name
1.	Malabar torrent toad	*Ansonia ornata* Gunther
2.	Silent valley torrent toad	*Ansonia rubrigina* Pillai and Pattabiraman
3.	Beddome's toad	*Bufo beddomii* Gunther
4.	——	*Bufo brevirostris* Rao
5.	Boulenger's burrowing toad	*Bufo fergusonii* Boulenger
6.	——	*Bufo hololius* Gunther
7.	——	*Bufo koynaensis* Soman
8.	The common Indian toad	*Bufo melanostictus* Schneider
9.	Southern hill toad	*Bufo microtympanum* Boulenger
10.	Timber forest toad	*Bufo parietalis* Boulenger
11.	——	*Bufo scaber* Schneider
12.	South Indian hill-toad	*Bufo silentvallenyensis* Pillai
13.	——	*Bufo stomaticus* Lutken
14.	——	*Euphlyctis cyanophlyctis* (Schneider)
15.	——	*Euphlyctis hexadactylus* (Lesson)
16.	——	*Fejervarya brevipalmata* (Peters)
17.	——	*Fejervarya greenii* (Boulenger)
18.	——	*Fejervarya keralensis* (Dubois)
19.	——	*Fejervarya limnocharis* (Gravenhorst)
20.	——	*Fejervarya murthii* (Pillai)
21.	——	*Fejervarya mysorensis* (Rao)
22.	——	*Fejervarya nilagirica* (Jerdon)
23.	——	*Fejervarya parambikulamana* (Rao)
24.	——	*Fejervarya rufescens* (Jerdon)
25.	——	*Fejervarya sauriceps* (Rao)
26.	——	*Fejervarya syhadrensis* (Annandale)

S. No.	Common Name	Zoological Name
27.	——	*Gegeneophis carnosus* Beddome
28.	——	*Gegeneophis krishni* Pillai & Ravichandran
29.	——	*Gegeneophis ramaswamii* Taylor
30.	——	*Hoplobatrachus crassus* (Jerdon)
31.	——	*Hoplobatrachus tigerinus* (Daudin)
32.	——	*Ichthyophis beddomei* Peters
33.	——	*Ichthyophis bombayensis* Taylor
34.	——	*Ichthyophis longicephalus* Pillai
35.	——	*Ichthyophis malabarensis* Taylor
36.	——	*Ichthyophis peninsularis* Taylor
37.	——	*Ichthyophis sikkimensis* Taylor
38.	——	*Ichthyophis subterrestris* Taylor
39.	——	*Ichthyophis tricolor* Annandale
40.	Beddome's Frog	*Indirana beddomii* Gunther
41.	——	*Indirana brachytarsus* (Gunther)
42.	——	*Indirana diplosticta* (Gunther)
43.	——	*Indirana gundia* (Dubois)
44.	——	*Indirana leithii* (Boulenger)
45.	——	*Indirana leptodactylus* (Boulenger)
46.	——	*Indirana longicrus* (Rao)
47.	——	*Indirana phrynoderma* (Boulenger)
48.	——	*Indirana semipalmata* Boulenger
49.	——	*Indirana tenuilingua* (Rao)
50.	——	*Indotyphlus batfersbyi* Taylor
51.	The Painted Frog	*Kaloula pulchra* Gray
52.	——	*Kaloula taprobanica* (Parker)
53.	Black Microhylid Frog	*Melanobatrachus indicus* Beddome
54.	——	*Micrixalus elegans* (Rao)
55.	Brown tropical Frog	*Micrixalus fuscus* (Boulenger)
56.	Gadgils tropical Frog	*Micrixalus gadgili* Pillai & Ravichandran
57.	Myer's Frog	*Micrixalus herrei* Myers
58.	——	*Micrixalus kottigeharensis* (Rao)
59.	——	*Micrixalus narainensis* (Rao)

S. No.	Common Name	Zoological Name
60.	Pillai's tropical Frog	*Micrixalus nudis* Pillai
61.	Black banded Frog	*Micrixalus opisthordus* (Gunther)
62.	——	*Micrixalus phyllophilus* (Jerdon)
63.	Jerdon's olive-brown Frog	*Micrixalus saxicola* Jerdon
64.	Boulenger's Malabar Frog	*Micrixalus silvaticus* (Boulenger)
65.	——	*Micrixalus swamianus* (Boulenger)
66.	Thampi's tropical Frog	*Micrixalus thampii* Pillai
67.	Ornate Microhylid Frog	*Microhyla ornata* (Dum. & Bibron)
68.	Densely spotted microhylid Frog	*Microhyla rubra* (Jerdon)
69.	——	*Microhyla sholigari* Dutta & Ray
70.	——	*Minervarya sahyadris* Dubois, Ohler & Biju
71.	——	*Nanobatrachus beddomii* Boulenger
72.	Cream spotted Frog	*Nyctibatrachus aliceas* Inger, Shaffer, Koshy and Bakde
73.	——	*Nyctibatrachus beddomii* (Boulenger)
74.	——	*Nyctibatrachus deccanensis* Dubois
75.	——	*Nyctibatrachus humayuni* Bhaduri & Kripalani
76.	——	*Nyctibatrachus kempholeyensis* (Rao)
77.	——	*Nyctibatrachus major* Boulenger
78.	——	*Nyctibatrachus minor* Inger, Shaffer, Koshy & Bakde
79.	——	*Nyctibatrachus pygmaeus* (Gunther)
80.	——	*Nyctibatrachus sanctipalustris* Rao
81.	——	*Nyctibatrachus sylvaticus* Rao
82.	——	*Nyctibatrachus vasanthi* Ravichandran
83.	Malabar Tree toad	*Pedostibes tuberculosus* Gunther
84.	——	*Philautus beddomii* (Gunther)
85.	——	*Philautus bombayensis* (Annandale)
86.	——	*Philautus chalazodes* (Gunther)
87.	——	*Philautus charius* Rao
88.	——	*Philautus femoralis* (Gunther)
89.	——	*Philautus flaviventris* (Boulenger)
90.	——	*Philautus glandulosus* (Jerdon)

S. No.	Common Name	Zoological Name
91.	——	*Philautus leucorhinus* (Lichtenstein, Weinland & Martens)
92.	——	*Philautus nasutus* (Gunther)
93.	——	*Philautus pulcherrimus* (Ahl)
94.	——	*Philautus punctatus* (Boulenger)
95.	——	*Philautus signatus* (Boulenger)
96.	——	*Philautus temporalis* (Gunther)
97.	——	*Philautus tinnuens* (Jerdon)
98.	——	*Philautus travancoricus* (Boulenger)
99.	——	*Philautus variabilis* (Gunther)
100.	——	*Philautus wynaadensis* (Jerdon)
101.	Common Tree Frog	*Polypedatus maculatus* (Gray)
102.	——	*Polypedatus pleurostictus* (Gunther)
103.	——	*Polypedatus pseudocruciger* Das & Ravichandran
104.	Reddish brown Microhylid Frog	*Ramanella anamalaiensis* Rao
105.	Olive banded Frog	*Ramanella minor* Rao
106.	Malabae hill Frog	*Ramanella montana* (Jerdon)
107.	Dark banded Frog	*Ramanella mormorata* Rao
108.	Triangular spotted Frog	*Ramanella triangularis* Gunther
109.	Termite nest forg	*Ramanella variegata* Stoliczka
110.	Skipper Frog	*Rana (Occidozyga) cyanophlyctis* (Schneider)
111.	Bicoloured Frog	*Rana (Clinotarsus) curtipes* Jerdon
112.	Fungoid Frog	*Rana (Hydrophylax) malabarica* Tschudi
113.	Dubois's hill Frog	*Rana (Limnonectes) keralensis* Dubois
114.	Paddy field Frog/Indian Cricket Frog	*Rana (Limnonectes) limnocharis* Boie
115.	Indian Bull Frog	*Rana (Limnonectes) tigerina* Daudin
116.	Golden Frog	*Rana (Sylvirana) aurantiaca* (Boulenger)
117.	Bronzed Frog	*Rana (Sylvirana) temporalis* (Gunther)
118.	——	*Rana brevipalmata* Peters
119.	Gunther's Frog	*Rana diplosticta* (Gunther)
120.	Indian green/Pond Frog	*Rana hexadactyla* Lesson
121.	Boulenger's brown Frog	*Rana leithii* Boulenger

S. No.	Common Name	Zoological Name
122.	Thin-limbed Frog	*Rana leptodactyla* Boulenger
123.	——	*Rana limnochares* Gravenhorst
124.	——	*Rana murthii* Pillai
125.	——	*Rana nilagirica* Jerdon
126.	Toad skinned Frog	*Rana phrynoderma* Boulenger
127.	——	*Rana travancorica* Annandale
144.	——	*Rhacophorus calcadensis* Ahl
128.	——	*Rhacophorus lateralis* Boulenger
129.	Malabar Gliding Frog	*Rhacophorus malabaricus* Jerdon
143.	Green Tree Frog	*Rhacophorus pleurostictus* Gunther
142.	——	*Rhacophorus pseudomalabaricus* Vasudevan & Dutta
130.	——	*Rhacophorus variabilis* (Jerdon)
131.	——	*Tomopterna (Sphaerotheca) breviceps* (Schneider)
132.	——	*Tomopterna (Sphaerotheca) pluvialis* (Jerdon)
133.	——	*Tomopterna (Sphaerotheca) rolandae* (Dubois)
134.	Rufescent Burrowing frog	*Tomopterna (Sphaerotheca) rufescens* (Jerdon)
135.	Balloon Frog	*Uperodon globulosum* (Gunther)
136.	Marbled balloon Frog	*Uperodon systoma* (Schneider)
137.	——	*Uraeotyphlus interruptus* Pillai & Ravichandran
138.	——	*Uraeotyphlus malabaricus* (Beddome)
139.	——	*Uraeotyphlus menoni* Annandale
140.	——	*Uraeotyphlus narayani* Seshachar
141.	——	*Uraeotyphlus oxyurus* (Dumeril & Bibron)

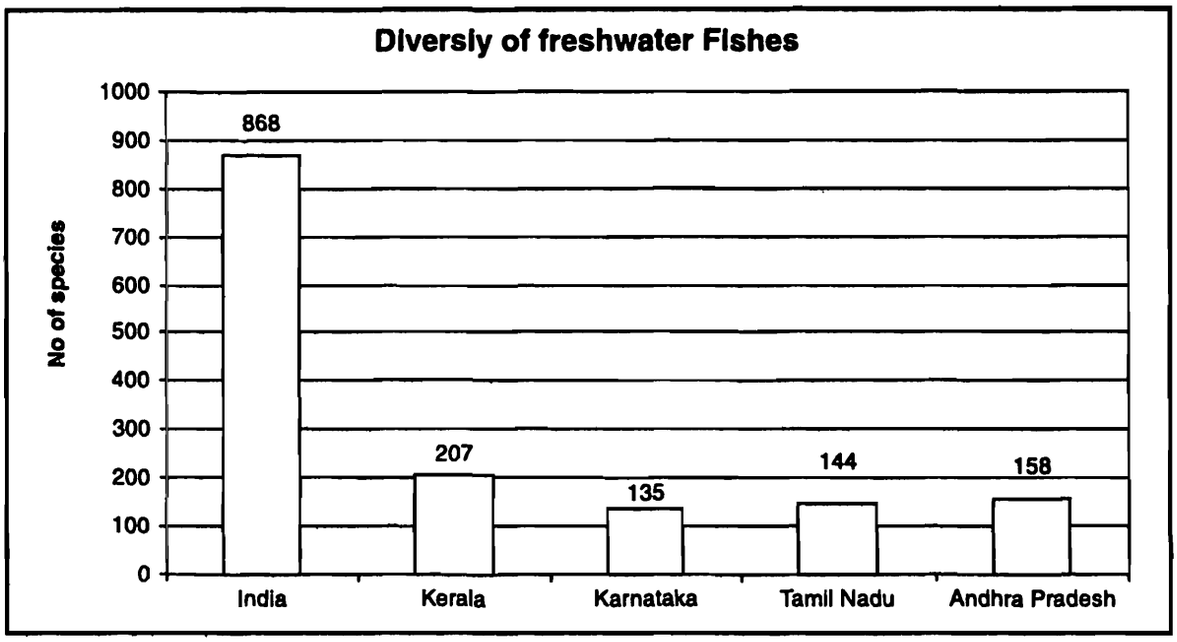
Of these Kerala alone has to its credit 94 species, highest diversity for any state in the country. Of these, 25 species are endemic to Kerala which are :

1. *Ichthophis longicephalus* Pillai
2. *Ichthyophis malabarensis* Taylor
3. *Ichthyophis tricolor* Annadale
4. *Uraeotyphlus menoni* Annandale
5. *Uraeotyphlus narayani* Seshachar

6. *Uraeotyphlus interruptus* Pillai & Ravichandran
7. *Ansonia rubigina* Pillai & Pattabiraman
8. *Bufo silentvalleyensis* Pillai
9. *Pedostibes tuberculosus* Gunther
10. *Philautus beddomii* (Gunther)
11. *Philautus flaviventris* (Boulenger)
12. *Philautus noblei* (Ahl)
13. *Philautus parkeri* (Ahl)
14. *Philautus pulcherrimus* (Ahl)
15. *Philautus travancoricus* (Boulenger)
16. *Rhacophorus lateralis* Boulenger
17. *Rana semipalmata* Boulenger
18. *Micrixalus gadgili* Pillai & Pattabiraman
19. *Micrixalus nudis* Pillai
20. *Micrixalus thampii* Pillai
21. *Nyctibatrachus minor* Inger et. al.
22. *Nyctibatrachus aliciae* Inger et.al.
23. *Rana travancorica* Annandale
24. *Temopterna parambikulamana* (Rao)
25. *Nasikabatrachus sahyadrensis* Biju & Bossyut.

Pisces : River Cauveri originates from the Brahmagiri hills of Sahyadri range of Western Ghats. The Cauveri basin with nearly 29 principal tributaries and 27 distributaries has a rich biotic wealth with 1095 algal species, 345 fungal species, 1050 angiosperms, 690 species of zooplankton, 304 species of benthic organisms and 267 species of fishes (Jayaram *et al.*, 2000). The same is true in case of river Krishna and river Godavari that originate from the Western Ghats. However the species compositions in most of the freshwater ecosystems are being changed very rapidly by the recent anthropogenic activities, including the introduction of exotic species. This needs continuous monitoring as well as conservation efforts to retain the pristinity. With the description of four new species of fishes from the river Chalakudi alone in recent years, a thorough survey of the west flowing rivers of Kerala also need to be initiated. The species diversity of the west flowing rivers are given below :

Chalakudi	- 98 species
Periyar	- >100 species (Cherian recorded 88 species in 1985)
Bharataphuza	- 61 species



Endemic fishes of Western Ghats

Order CYPRINIFORME

Family CYPRINIDAE

1. *Osteobrama vigorsii* (Sykes) (30 cm)
2. *Rohtee ogilbi* (Sykes) (50cm)
3. *Puntius dorsalis* (Jerdon) (25cm)
4. *Barbodes bovanicus* (Day) (36cm)
5. *B. carnaticus* (Jerdon) (60cm)
6. *B. sarana subnasutus* (Val.) (25cm)
7. *Hypselobarbus curmuca* (Ham.) (30cm)
8. *H. dubius* (Day) (25.5 cm)
9. *H. kurali* Menon and Remadevi (35cm)
10. *H. lithopidos* (Day) (60cm)
11. *H. micropogon* (Val)(30cm)
12. *Cirrhinus fulungee* (Sykes) (30cm)
13. *Labeo ariza* (Ham.) (56cm)
14. *L. boggut* (Sykes) (29cm)
15. *L. dero* (Ham.) (30cm)
16. *L. boga* (Ham.) (30cm)
17. *L. dussumieri* (Val.) (35cm)
18. *L. pangusia* (Ham.) (90cm)
19. *L. potail* (Sykes) (30cm)
20. *L. porcellus* (Ham.) (30cm)

Order SILURIFORMES

Family BAGRIDAE

21. *Horabagrus brachysoma* Gunther (45cm)
22. *Mystus cavasius* (Ham.) (40cm)
23. *M. gulio* (Ham.) (45cm)
24. *M. krishnensis* Ramakrishnaiah (115cm)
25. *M. menoda* (Ham.) (45cm)
26. *M. punctatus* (Jerdon) (45cm)
27. *M. vittatus* (Bloch) (21cm)
28. *Rita kuturnee* (Sykes) (30cm)
29. *R. pavimentata* (Val.) (26cm)

Family SILURIDAE

30. *Ompok malabaricus* (Val.) (26cm)

Order ATHERINIFORMES

Family BELONIDAE

31. *Xenentodon cancila* (Ham.) (40cm)

Order MASTACEMBELIFORMES

Family MASTACEMBELIDAY

32. *Macrognathus guentheri* (Day) (26cm)
33. *M. pancalus* Ham. (18cm)
34. *Mastacembelus armatus* (Lecepede) (60cm)

Order PERCIFORMES

Family NANDIDAE

35. *Nandus nandus* (Ham.) (20cm)
36. *Pristolepis marginatus* Jerdon (15cm)

Family GOBIIDAE

37. *Glossogobius giuris* (Hamilton) (30cm)

Order CHANNIFORMES

Family CHANNIDAE

38. *Channa orientalis* (Schneider) (33cm)

The other rare and endemic fish species available for fish culture in Western Ghats are the following :

Order CYPRINIFORMES

Family CYPRINIDAE

1. *Hypselobarbus dobsoni* (Day) (120cm)

2. *H. jerdoni* Day (45cm)
3. *Kantaka brevidorsalis* (Day) (26.5cm)
4. *Schismatorhynchos nukta* (Sykes) (30cm)

Order SILURIFORMES

Family SILURIDAE

5. *Silurus waynaadensis* Day (30cm)

Family SCHILBEIDAE

6. *Eutropiichthys goongwaree* (Sykes) (30cm)
7. *Proeutropiichthys taakree* (Sykes) (40cm)
8. *Pseudeutropius mitchelli* Gunther (90cm)
9. *Silonia childreni* (Sykes) (48cm)

Family CLARIIDAE

10. *Clarias dussumieri dussumieri* Val. (25cm)

The important endemic and threatened species of fishes of Kerala are :

1. *Crossocheilus latius periyarensis* Menon & Jacob
2. *Osteobrama bakeri* (Day)
3. *Kantaka brevidorsalis* (Day)
4. *Neolissochilus wynadensis* (Day)
5. *Osteochilichthys longidorsalis* Pethiyagoda & Kottelat
6. *Puntius denisonii* (Day)
7. *Puntius ophiocephalus* (Raj)
8. *Amblypharyngodon chakaiensis* Babu & Nair
9. *Barilius bakeri* Day
10. *Lepidopygopsis typus* Raj
11. *Garra menoni* Rema Devi & Indra
12. *Garra surendranathanii* Shaji, Arun & Easa
13. *Garra periyarensis* Gopi
14. *Homaloptera menoni* Shaji & Easa
15. *Homaloptera pillaii* Indra & Rema Devi
16. *Travancoria elongata* Pethiyagoda & Kottelat
17. *Travancoria jonesi* Hora
18. *Oreonectes (Indoreonectes) keralensis* Rita & Nalbant
19. *Mesonemacheilus menoni* (Zacharias & Minimol)
20. *Batasio travancoria* Hora & law
21. *Horabagrus brachysoma* (Gunther)

22. *Horabagrus nigricollaris* Pethiyagoda & Kottelat
23. *Pseudeutropius mitchelli* Gunther
24. *Glyptothorax anamalaiensis* Silas
25. *Glyptothorax devisinghi* Manimekalan & Das
26. *Horaglanis krishnai* Menon
27. *Hyporhamphus xanthopterus* (Valenciennes)
28. *Monopterus (Amphipnous) fossorius* (Nair)
29. *Monopterus (Monopterus) eapeni* Talwar
30. *Monopterus (Monopterus) roseni* Bailey & Carlgans
31. *Monopterus digressus* Gopi
32. *Pristolepis marginata* Jerdon
33. *Tetradon travancoricus* Hora & Nair

A few species of the genera such as *Notopterus, Barillus, Rasbora, Puntius, Labeo, Aplocheilus, Masgecembulus, Garra and Aphanius* are common to India and Africa are represented in Western Ghats.

There are around 218 species of primary and secondary freshwater fishes in the Western Ghats. 53% of all fish species (116 species in 51 genera) in the Western Ghats are endemic. From what little has been understood of the distribution and diversity of freshwater fishes in the Western Ghats, it is apparent that the streams and rivers in the south are more diverse, including a larger number of endemic species, than those in the north. A study of the freshwater fishes in the Kerala part of the Nilgiri Biosphere Reserve has suggested that the east and west flowing rivers in the region do not significantly differ in the number of species and those species exclusive to them – 69 species, 24 being exclusive in the east flowing rivers as against 68 species and 23 being exclusive in those flowing west.

Fish Fauna of Western Ghats

S. No.	Common Name	Zoological Name
1.	——	*Ambassis miops* Gunther
2.	——	*Amblypharyngodon melettinus* (Valen.)
3.	——	*Anabas testudineus* (Bloch)
4.	Freshwater Eel	*Anguilla bengalensis* (Gray & Hardw.)
5.	——	*Anguilla bicolor bicolor* Mc Clelland
6.	——	*Aplocheilus blochii* (Arnold)
7.	Malabar killie	*Aplocheilus lineatus* (Valen)
8.	——	*Aplocheilus parvus* (Raj)
9.	Slender stone loach	*Balitora mysorensis* Hora

S. No.	Common Name	Zoological Name
10.	Bowany barb	*Barbodes bovanicus* (Day) (36cm)
11.	Karnatic Carp	*Barbodes carnaticus* (Jerdon) (60cm)
12.	——	*Barbodes sarana subnasutus* (Val.) (25cm)
13.	——	*Barilius bakeri* Day
14.	Hamilton's baril	*Barilius bendelisis* (Hamilton)
15.	Jerdon's baril	*Barilius canarensis* (Jerdon)
16.	——	*Barilius evezardi* Day
17.	River carp baril	*Barilius gatensis* (Valen.)
18.	Vagra baril	*Barilius vagra* (Hamilton)
19.	——	*Batasio travancoria* Hora & Law
20.	Western Ghat loach	*Bhavania australis* (Jerdon)
21.	——	*Botia striata* Rao
22.	——	*Catla catla* (Hamilton)
23.	——	*Chanda nama* Hamilton
24.	Giant snake head	*Channa marulius* (Hamilton-Buchanan)
25.	Asiatic snake head	*Channa orientalis* (Bloch & Schneider)
26.	Spotted snake head	*Channa punctatus* (Bloch)
27.	Striped or banded snakehead	*Channa striatus* (Bloch)
28.	Silver hatchet chela	*Chela (Chela) cachius* (Hamilton)
29.	——	*Chela fasciatus* Silas
30.	——	*Cirrhinus fulungee* (Sykes) (30cm)
31.	——	*Cirrhinus mrigala* (Hamilton)
32.	Deccan white Carp	*Cirrhinus reba* (Hamilton)
33.	Magur	*Clarias batrachus* (Linn.)
34.	Air breathing cat-fish	*Clarias dayi* Hora
35.	Malabar clariid	*Clarias dussumieri dayi* (Hora)
36.	——	*Clarias dussumieri dussumieri* Val. (25cm)
37.	Gangetic Latia	*Crossocheilus latius latius* (Hamilton)
38.	——	*Crossocheilus periarensis* Menon and Jacob
39.	——	*Ctenopharyngodon idellus* (Valen.)
40.	——	*Cyprinion brevidorsalis* (Day)
41.	——	*Cyprinion longidorsalis* (Pethiyagoda & Kottelat)
42.	——	*Cyprinion nashii* (Day)

S. No.	Common Name	Zoological Name
43.	Common Carp	*Cyprinus carpio* Linn.
44.	Giant danio	*Danio aequipinnatus* (Mc Clelland)
45.	——	*Danio malabaricus* (Jerdon)
46.	Peninsular Danio	*Danio neilgherriensis* (Day)
47.	——	*Danio rerio* (Hamilton)
48.	——	*Dayella malabarica* (Day)
49.	Flying Barb	*Esomus danricus* (Hamilton & Buchanan)
50.	South Indian Flying Barb	*Esomus thermoicos* (Valen.)
51.	Canara pearlspot	*Etroplus canarensis* Day
52.	Spotted etroplus/Orange chromide	*Etroplus maculatus* (Bloch)
53.	Banded pearlspot/Striped chromide	*Etroplus suratensis* (Bloch)
54.	——	*Eutropiichthys goongwaree* (Sykes) (30cm)
55.	——	*Gagata itchkeea* (Sykes)
56.	Mosquito fish	*Gambusia affinis* (Baird & Girard)
57.	——	*Garra kalakadensis* Rema Devi
58.	Mullya Garra	*Garra mullya* (Sykes)
59.	——	*Garra surendranathanii* Shaji *et al.*
60.	Tunga Garra	*Garrah bicornuta* Rao
61.	Nilgiris Garra	*Garrah gotyla stenorhynchus* (Jerdon)
62.	Cardamom Garra	*Garrah hughi* Silas
63.	Cauveri Garra	*Garrah mc Clellandi* (Jerdon)
64.	——	*Garrah menoni* Rema devi & Indra
65.	——	*Gerres lucides* (Cuv.)
66.	Tank Goby	*Glossogobius giuris* (Hamilton) (30cm)
67.	——	*Glyptothorax annandalei* Hora
68.	——	*Glyptothorax housei* Herre
69.	——	*Glyptothorax lonah* (Sykes)
70.	——	*Glyptothorax madraspatanus* (Day)
71.	——	*Glyptothorax poonaensis* Hora
72.	——	*Glyptothorax trewavasae* Hora
73.	Stinging Catfish	*Heteropneustes fossilis* (Bloch)
74.	——	*Heteropneustes microps* (Gunther)

S. No.	Common Name	Zoological Name
75.	——	*Homaloptera montana* Herre
76.	——	*Homaloptera pillaii* Indra & Rema Devi
77.	——	*Horabagrus brachysoma* Gunther (45cm)
78.	——	*Horabagrus nigricollaris* Pethiyagoda & Kottelat
79.	——	*Horaglanis krishnai* Menon
80.	——	*Horalabiosa joshuai* Silas
81.	——	*Horalabiosa palaniensis* Rema Devi & Menon
82.	——	*Hypselobarbus thomassi* (Day)
83.	——	*Hypselobarbus curmuca* (Ham.) (30cm)
84.	——	*Hypselobarbus dobsoni* (Day) (120cm)
85.	——	*Hypselobarbus dubius* (Day) (25.5 cm)
86.	——	*Hypselobarbus jerdoni* Day (45cm)
87.	——	*Hypselobarbus kolus* (Sykes)
88.	——	*Hypselobarbus kurali* Menon and Remadevi (35cm)
89.	Canara barb	*Hypselobarbus lithopidos* (Day)
90.	——	*Hypselobarbus micropogon* (Val) (30cm)
91.	Mussullah mahseer/High backed Mahseer	*Hypselobarbus mussullah* (Sykes)
92.	——	*Kantaka brevidorsalis* (Day) (26.5cm)
93.	Ariza labeo	*Labeo ariza* (Ham.) (56cm)
94.	Bata Labeo	*Labeo bata* (Hamilton)
95.	——	*Labeo boga* (Ham.) (30cm)
96.	Boggut Labeo	*Labeo boggut* (Sykes) (29cm)
97.	Kalbasu/Black rohu	*Labeo calbasu* (Hamilton)
98.	——	*Labeo dero* (Ham.) (30cm)
99.	Malabar Labeo	*Labeo dussumieri* (Val.) (35cm)
100.	——	*Labeo fimbriatus* (Bloch)
101.	Pig mouth Carp	*Labeo kontius* (Jerdon)
102.	Pangusia Labeo	*Labeo pangusia* (Ham.) (90cm)
103.	——	*Labeo porcellus* (Ham.) (30cm)
104.	——	*Labeo potail* (Sykes) (30cm)
105.	The Rohu	*Labeo rohita* (Hamilton)

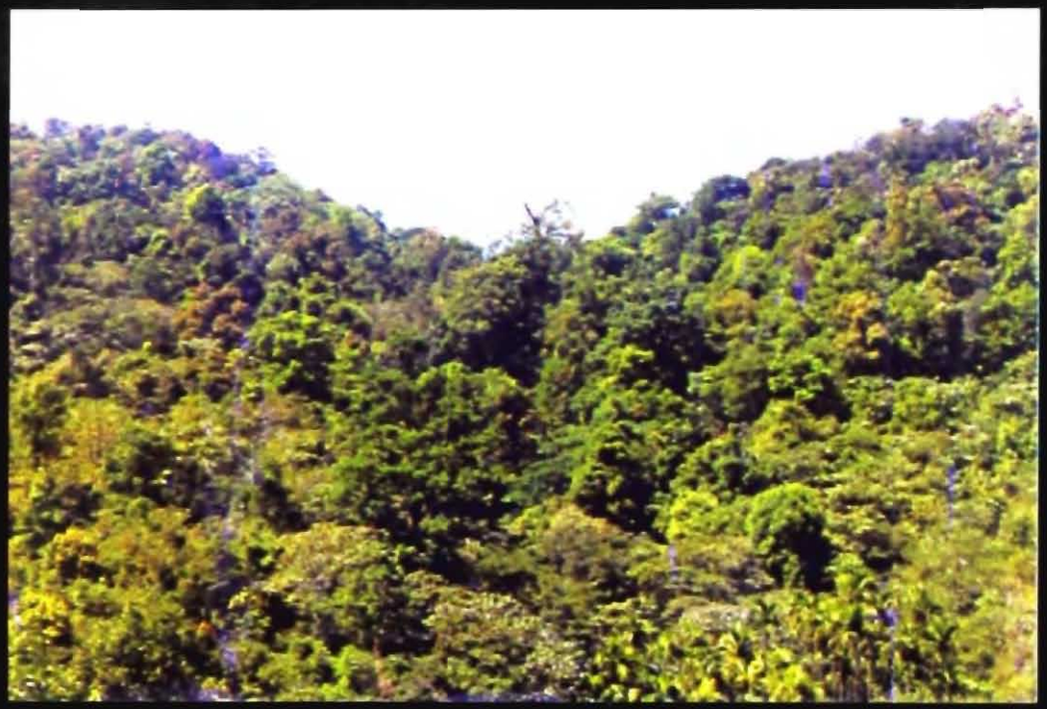
S. No.	Common Name	Zoological Name
106.	——	*Lebistes reticulata* Peters
107.	Malabar loach	*Lepidocephalus thermalis* (Valen.)
108.	One-stripe spiny eel	*Macrognathus aral* (Bloch & Schneider)
109.	——	*Macrognathus guentheri* (Day) (26cm)
110.	Malabar spiny eel	*Macrognathus malabaricus* (Jerdon)
111.	——	*Macropodus cupanus* (Valen.)
112.	Tire-track spiny eel	*Mastacembelus armatus* (Lecepede) (60cm)
113.	——	*Mastacembelus guentheri* Day
114.	——	*Mesonoemacheilus petrubanarescui*
115.	——	*Microphis cuncalus* (Hamilton & Buchanan)
116.	——	*Monopterus eapeni* Talwar
117.	——	*Monopterus fossorius* (Nair)
118.	——	*Mugil cephalus* Linn.
119.	Kerala mystus	*Mystus armatus* (Day)
120.	Day's mystus	*Mystus bleekeri* (Day)
121.	Gangetic mystus	*Mystus cavasius* (Ham.) (40cm)
122.	——	*Mystus gulio* (Ham.) (45cm)
123.	——	*Mystus keletius* (Valen.)
124.	——	*Mystus krishnensis* Ramakrishnaiah (115cm)
125.	Jerdon's mystus	*Mystus malabaricus* (Jerdon)
126.	——	*Mystus menoda* (Ham.) (45cm)
127.	Wynaad mystus	*Mystus montanus* (Jerdon)
128.	Malabar mystus	*Mystus oculatus* (Valen.)
129.	——	*Mystus pancalus* Ham. (18cm)
130.	Nilgiri mystus	*Mystus punctatus* (Jerdon) (45cm)
131.	Striped dwarf catfish	*Mystus vittatus* (Bloch) (21cm)
132.	——	*Nandus nandus* (Ham.) (20cm)
133.	——	*Neolissochilus wynaadensis* (Day)
134.	——	*Noemacheilus anguilla* Annandale
135.	——	*Noemacheilus denisoni denisoni Day*
136.	——	*Noemacheilus denisoni mukambbikaensis* Menon
137.	——	*Noemacheilus denisoni pambaensis* Menon
138.	——	*Noemacheilus evezardi* Day
139.	——	*Noemacheilus guentheri* Day

S. No.	Common Name	Zoological Name
140.	——	*Noemacheilus keralensis* (Rita & Nalbant)
141.	——	*Noemacheilus kodaguensis* Menon
142.	——	*Noemacheilus monilis* Hora
143.	——	*Noemacheilus moreh* (Sykes)
144.	——	*Noemacheilus nilgiriensis* Menon
145.	——	*Noemacheilus pambarensis* Rema Devi & Indra
146.	——	*Noemacheilus pulchellus* Day
147.	——	*Noemacheilus semiarmatus* Day
148.	——	*Noemacheilus striatus* Day
149.	——	*Noemacheilus triangularis tambaraparniensis* Menon
150.	——	*Noemacheilus triangularis triangularis* Day
151.	——	*Noemachilichthys rupelli* (Sykes)
152.	Feather Back	*Notopterus notopterus* (Pallas)
153.	Indian butter Catfish	*Ompok bimaculatus* (Bloch)
154.	——	*Ompok malabaricus* (Val.) (26cm)
155.	Sockeye salmon	*Oncorhynchus nerka* (Walbaum)
156.	Cosuatis barb	*Oreichthys cosuatis* (Hamilton)
157.	Mozambique cichlid/Tilapia	*Oreochromis mossambica* (Peters)
158.	——	*Oreonectes (Indoreonectes) evezardi* Day
159.	——	*Oreonectes (Indoreonectes) keralensis* Rita, Banarescu & Nalbant
160.	Estuarine rice fish	*Oryzias melastigma* (Mc Clelland)
161.	——	*Osteobrama bakeri* Day
162.	——	*Osteobrama cotio peninsularis* Silas
163.	——	*Osteobrama nashii* (Day)
164.	Nilgiri Osteobrama	*Osteobrama neilli* (Day)
165.	——	*Osteobrama thomassi* (Day)
166.	——	*Osteobrama vigorsii* (Sykes) (30 cm)
167.	Kantaka barb	*Osteochilichthys brevidorsalis* (Day)
168.	Nash's Konti Barb	*Osteochilichythys nashii* (Day)
169.	——	*Osteochilus longidorsalis* Pethiyagoda & Kottelat

S. No.	Common Name	Zoological Name
170.	——	*Pangio goaensis* (Tilak)
171.	——	*Parambassis dayi* (Bleeker)
172.	——	*Parambassis thomassi* (Day)
173.	Blackline Rasbora	*Parluciosoma daniconius* (Hamilton)
174.	——	*Pisodonophis boro* (Hamilton)
175.	——	*Pristolepis fasciatus* (Bleeker)
176.	——	*Pristolepis malabarica* (Gunther)
177.	Malabar Catopra	*Pristolepis marginatus* Jerdon (15cm)
178.	——	*Proeutropiichthys taakree* (Sykes) (40cm)
179.	——	*Pseudeutropius mitchelli* Gunther (90cm)
180.	——	*Pseudoambassis ranga* (Hamilton)
181.	——	*Pseudobagrus chryseus* Day
182.	——	*Pseudobagrus nigricollari* (Pethiyagoda & Kollelat)
183.	——	*Pseudosphromenus cupanus* (Valen.)
184.	——	*Pseudosphromenus dayi* (Kohler)
185.	Scarlet-banded barb	*Puntius amphibius* (Valen.)
186.	Aruli barb/Long fin barb	*Puntius arulius arulius* (Jerdon)
187	Two spot barb	*Puntius bimaculatus* (Bleeker)
188.	Swamp barb	*Puntius chola* (Hamilton)
189.	Rosy/Red barb	*Puntius conchonius* (Hamilton)
190.	——	*Puntius curmuca* (Hamilton)
191.	——	*Puntius denisonii* (Day)
192.	Long snouted barb	*Puntius dorsalis* (Jerdon) (25cm)
193.	Melon barb	*Puntius fasciatus* (Jerdon)
194.	Black spot barb/Indian tiger Barb	*Puntius filamentosus* (Valen.)
195.	Jerdons carp	*Puntius jerdoni* Day
196.	Black spot barb	*Puntius mahecola* (Valen.)
197.	——	*Puntius melanampyx* (Day)
198.	Wynaad barb	*Puntius melanostigma* (Day)
199.	——	*Puntius mudumalaiensis* Menon & Rema Devi
200.	Narayan barb	*Puntius narayani* Hora
201.	——	*Puntius ophiocephalus* (Raj)

S. No.	Common Name	Zoological Name
202.	Parrah barb	*Puntius parrah* Day
203.	——	*Puntius punctatus* (Day)
204.	Olive barb	*Puntius sarana sarana* (Hamilton)
205.	Peninsular olive barb	*Puntius sarana subnasutus* (Valen.)
206.	Spot fin swamp barb	*Puntius sophore* (Hamilton)
207.	Ticto barb/Firefin barb/ Two spot barb	*Puntius ticto* (Hamilton)
208.	Kooli barb	*Puntius vittatus* (Day)
209.	Cauvery Rasbora	*Rasbora caverii* (Jerdon)
210.	——	*Rasbora daniconius daniconius* (Hamilton)
211.	——	*Rita kuturnee* (Sykes) (30cm)
212.	——	*Rita pavimentata* (Val.) (26cm)
213.	——	*Rohtee ogilbi* (Sykes) (50cm)
214.	——	*Salmo gairdnerii gairdnerii* Richardson
215.	Silver razorbelly minnow	*Salmostoma acinaces* (Valen.)
216.	Boopis razor belly minnow	*Salmostoma boopis* (Day)
217.	Bloch razorbelly minnow	*Salmostoma clupeoides* (Bloch)
218.	Hora razorbelly minnow	*Salmostoma horai* (Silas)
219.	Mahanadi razorbelly minnow	*Salmostoma untrahi* (Day)
220.	——	*Schismatorhynchos nukta* (Sykes) (30cm)
221.	——	*Schistura nilgiriensis*
222.	——	*Sicydium fasciatum*
223.	——	*Sicyopterus griseus* (Day)
224.	——	*Silonia childreni* (Sykes) (48cm)
225.	Malabar silurus	*Silurus waynaadensis* (Bloch) (30cm)
226.	——	*Terapon jarbua* (Forskal)
227.	——	*Tetraodon travancoricus* Hora & Nair
228.	Deccan mahseer	*Tor khudree* (Sykes)
229.	——	*Travancoria elongata* Pethiyagoda & Kottelat
230.	——	*Travancoria jonesi* Hora
231.	——	*Wallago attu* (Schneider)
232.	Freshwater garfish	*Xenentodon cancila* (Ham.) (40cm)

Map of Nilgiri Biosphere Reserve



Evergreen Forest of
Western Ghat

Bhamagiri Hills, Western Ghat

Shola Vegetation in Karnataka

Ischnura aurora aurora

Libellago lineata indica

Orthetrum pruinosum neglectum

Diplacodes trivialis

Pseudagrion rubriceps rubriceps

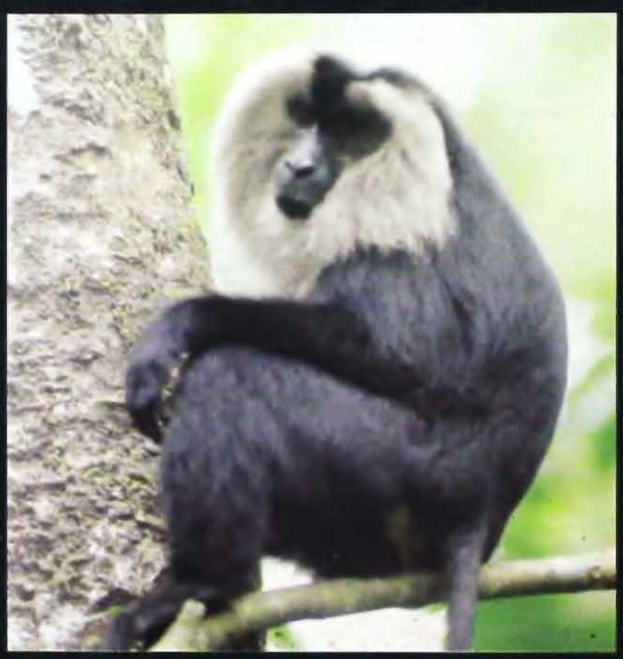
Orthetrum sabina sabina

Copera marginipes (Rambur) in tandem

Crocothemis servilia servilia (Drury) resting on a twig.

Nilgiri Tahr

Wroughton's free tail bat



Lion-tailed Macaque

Small travancore flying squirrel

Elephant Herd

Insect diversity

Records of insect diversity in Western Ghats dates back to Hampson (1896), who recorded 128 species from Nilgiri's alone. Subsequent workers have added nearly 500 species to the list of Hampson. At present, though a consolidated list is not available, yet site specific records include, 299 species from Nilgiris by Larsen(1988) and 118 species from Periyar (Jafar Palot et.al. 1997), 90 species from Silent Valley (Mathew et.al, 1988); 35 species of Lepidoptera from Idukki (Cherian, 1985) and 133 species from Amarambalam. Butterflies of Western Ghats analysed from five families includes 166 genera and 330 species. Of these, 37 species are endemic. These 330 species of butterflies depend on over 1000 species plants for feeding and breeding. In comparison, of the 1501 species of butterflies known from India, 322 species occur in Kerala and therefore further exploration is necessary to assess the actual distribution of the group. Following are included in the Scheduled-butter flies of Kerala.

1. *Pachliopta hector*—Crimson Rose
2. *Papilio liomedon*—Malabar Banded Swallowtail
3. *Euthalia telchinia*—Blue Baron
4. *Eriboea schreiberi*—Blue Nawab
5. *Hypolimnas misippus*—Danaid Egg fly

Distribution of Butterflies in the Western Ghats

Regions	Families and Species					
	Papillionidae	Pieridae	Nymphalidae	Lycaenidae	Hesperiidae	Total
India	107	109	521	443	321	1501
Western Ghats	19	33	96	101	81	330
Kerala	19	31	95	93	76	314
Tamil Nadu	19	31	94	97	75	316
Karnataka	19	29	92	98	78	316
Goa	18	27	70	78	56	249
Maharashtra	13	24	59	71	40	208
Gujarat	11	23	41	51	32	158

Source : ENVIS, WII, Dec. 2003

Faunal diversity of Coleopterans show a very interesting pattern of distribution, the first record dates back to Horn (1905) followed by those of Gahan (1906), Jacoby (1908) and Maulik (1919). Recent investigations by teams from Zoological Survey of Silent Valley recorded 128 species during 1979-80; 9 species by Cherian (1985) from Idukki area; 46 species by Biswas and Chatterjee (1986) and others. Given the land-area availability of different states, Kerala is smaller in size, but has higher species diversity of Gerromorpha,

possibly an indicator of its wetland wealth. The dipteran insect resource exploited at Western Ghats, most importantly, are the large honey bees *(Apis dorsata)* whose honeycombs hang like enormous wedges from the underside of its branches.

Endemic insects of rainforests of Kerala (Radhakrishnan, 2003)

Order COLEOPTERA (13 spp.)

1. *Oxylobus silenticus*
2. *Autoserica mutabilis*
3. *Autoserica tranquebarica*
4. *Onthophagus keralicus*
5. *Onthophagus sahai*
6. *Onthophagus taruni*
7. *Stenus (Hypostenus) decanus*
8. *Paederus mussardi*
9. *Cryptobium bhattacharyyai*
10. *Philonthus castaneus*
11. *Ichthyurus silentvalleyensis*
12. *Neocollyris shyarupi*
13. *Copelatus biswasi*

Order DIPTERA (2 spp.)

14. *Microstylum ananthakrishnani*
15. *Ommatius pillai*

Order HEMIPTERA (15 spp.)

16. *Tenagogonus longispinulus*
17. *Pleciobates indicus*
18. *Pleciobates nostras*
19. *Metrocoris malabaricus*
20. *Metrocoris variegans*
21. *Ventidius aquarius*
22. *Enithares fusca*
23. *Gellia kuntiae*
24. *Lanceonotus mukkaliensis*
25. *Lanceonotus malabaricus*
26. *Hemicentrus suffulata*
27. *Tricentrus erectus*

28. *Tricentrus purpureus*
29. *Tricentrus syrandrikae*
30. *Parayasa variegata*

Order ODONATA (6 spp.)

31. *Protosticta antelopoides*
32. *Indoneura risi*
33. *Davidiodes martini*
34. *Lamelligomphus malabarensis*
35. *Idionyx rhinoceroides*
36. *Merogomphus longistigma tamaracherriensis*

NILGIRI BIOSPHERE A PART OF WESTERN GHATS – A CASE STUDY

The Nilgiri Biosphere Reserve (NBR) is located in the Western Ghats between the coordinates of 76°–76°45′ E. and 11.15′–12.15′ N lying in the trijunction of three states (Karnataka, Kerala and Tamil Nadu) falls under the Malabar Rainforest realm no. 4, province no.1 and biome no. 1 of Udwardy's classification and is extremely rich in biological resources. The exploration of the Nilgiri Biosphere by the scientists of Zoological Survey of India yielded substantial scientific knowledge on the taxonomy, ecology as well as distributional range of several important groups as described below :

Invertebrate Fauna

111 species of protozoa are reported from NBR of which 69 are rare. 2 species exclusively known from here includes two species of *Gregerina* from the insect *Lepisma saccharina*. 31 species of Cladocera reported from here *Alona inreticulata* is known only from NBR, while *Simocephalus exspinosus* and *Pleuroxus aduncus* have their range of distribution confined to this reserve in southern India. 16 species of Centipedes, 41 species of Millipedes (9 species endemic) and 13 species (2 species endemic) of Scorpions are known from NBR.

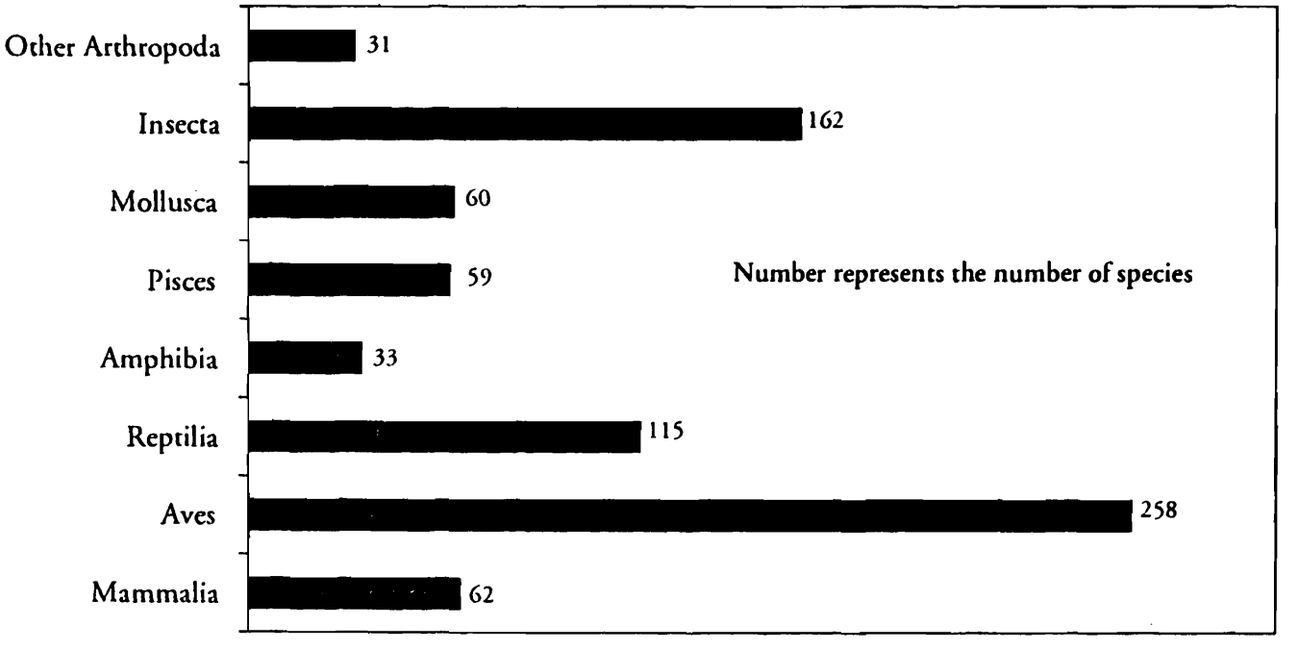
Among insects 82 species of Orthoptera (Grylloidea), 171 species of Odonata, 106 species of Leaf Hoppers have been recorded which represent 7% of the fauna of these groups from India. 37 species representing 35.5% are endemic to NBR. 74 species of Aquatic and 262 species of Semi aquatic Heteropterans are known from this reserve. 15% of this fauna are endemic. 300 species of Lepidoptera are recorded some of which belong to various threatened IUCN Categories. Diptera includes Agromyzidae with 16 species (1 endemic), Chloropidae, and 63 species representing more than 25% known species from India of which 15 species are endemic to NBR. Tephritidae with 35 species out of 187 known species from India are known from this Biosphere and of these 4 are confined to NBR. Hymenoptera includes 130 species of Chalceidoidea (12 endemic species) and 15 species of Proctotrupoidea (5 endemic species).

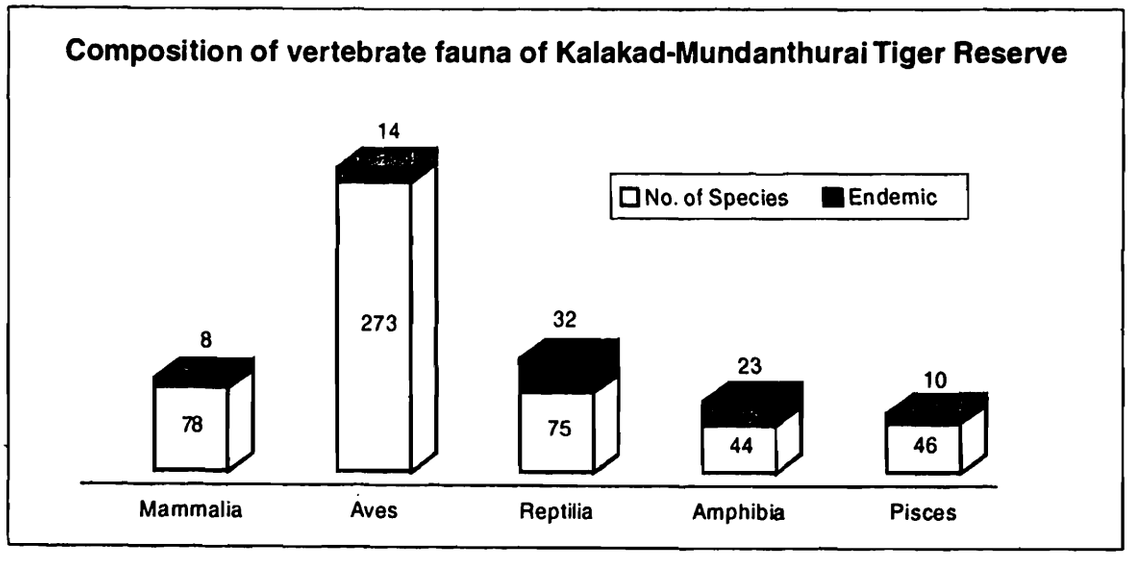
Vertebrate fauna

116 species of fishes under 46 genera and 20 families are known from NBR and of these 20 are endemic to NBR and 4 are exotic. Amphibians are represented by **55** species comprising 25% of the Indian species of which 38 are endemic to India, 9 are found in Sri Lanka and 8 are widely distributed. 5 of the Indian endemics are restricted to NBR

Reptilia are known by 21 species from this reserve, though none of the species recorded are endemic to NBR, 10 are Indian Endemics. 313 species of birds are known from NBR. 130 species are endemic to India of which 32 are widely distributed, 39 are restricted to peninsula and 59 are found only in Western Ghats. Among the species found in the Western Ghats 13 species/subspecies have a range limited to the NBR and its adjoining hills. Mammals with 97 species representing 24% of the 397 species of mammals known

Faunal composition of Indira Gandhi (Anaimalai) National Park





from India are distributed in NBR. This includes 30 species belonging to various threatened /endangered IUCN categories. 20 of these species are Indian endemics of which 2 exclusively confined to NBR are Nilgiri Tahr (*Hemitragus hylocrius*) and the lion tailed macaque (*Macaca silenus*). NBR has the largest South Indian population of Indian Elephants (*Elephas maximus*), tiger (*Panthera tigris*) gaur (*Bos gaurus*), sambar (*Cervus unicolor*), and Chital (*Axis axis*). The rare bats include Peshwa Bat (*Myiotis peshwa*)) and the hairy winged bat (*Harpiocephalus harpia*).

In conclusion it may be said that the wealth of the Western Ghats is mainly due to its natural resources, especially those wherein the living systems play a vital role. The functional value of the Ghats is that it serves as the last refugium of Peninsular Indian flora and fauna. Western Ghats is equally important as a location of different resources and ecosystems, on which the socio-economic aspect of some of the tribes like Todas, Irulas, Kaniṣ depend on it. A spurt of discoveries in new taxa in recent years for ex., five species of caecelians in one year *Indotyphlus maharashtraenis, Gegenophis seshachari, Gegenophis danieli, Gegenophis madhavi* and *Gegenophis nadkarni* are brought to light. It is obvious, a number of taxa particularly lower plants and invertebrate animals yet to remain to be discovered.

CHAPTER–10

FAUNAL RESOURCE IN EASTERN HIMALAYA

The Himalaya stretches to about 3,000 km. in length and varies between 220-300 km. in width. From Myanmar in the east to the borders of Afghanistan in the west (between 72°91′ E and 27°36′ N lat.), it passes through Pakistan, India, Nepal, Bhutan and Bangladesh. The Indian Himalaya occupies about 54,00,000 sq. km, spread over the states of Jammu & Kashmir, Himachal Pradesh, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, and a part of Assam, along with eight districts of Uttar Pradesh and one district of West Bengal. Biogeographically, the Indian Himalayan region falls under Boreal Zone, which has two sub-zones, viz., Sino-Siberian and Sino-Himalayan. The area can be divided longitudinally into four distinct zones (1) the Siwalik (900-1500 m), (2) the Outer Himalaya (1500-3500 m), (3) the Middle or Lesser Himalaya (3600-4600 m), and (4) the Greater Himalaya (above 4,600 m). Five climatic zones can be delineated in the Himalayan region based on geographic and physiographic factors. These are the warm Tropical, warm Sub-Tropical, cool Temperate, Alpine, and Arctic. While these are only broad zonations, there are many local variations in the climate due to precipitation, temperature, wind patterns, humidity, etc.

Himalayan region is endowed with biodiversity richness, and in fact, eastern Himalaya is considered one of the hot spots of the world. Several factors have contributed to this richness. Himalayan region is unique in its topographical variety along with great diversity of climate. There is a great contrast between the southern part of the Himalaya exposed to the summer monsoon, with a gradient of rainfall from east to west, and the aridity of the Trans Himalayan valley and Tibetan Plateau with a very low rainfall combined with extreme temperatures. In the eastern Himalaya, winter limit of snow is 2000 m., whereas in the western Himalaya it reaches 1,600 m. All these variations have resulted in areas of dry cold desert on one hand, and areas of all possible floral combinations or forests on the other. In fact, at least 9, 10, and 8 different types of forests characterize western, central and eastern Himalaya respectively. Again, each forest type is further sub-divided on the basis of predominant species. Apart from diverse climatic, vegetative and topographical situations, Himalaya also provide numerous unique wildlife habitats serving special functions, which are geomorophic in nature, e.g. caves, overhangs, shelves, crevices, etc. Each of these habitats is teeming with millions of faunal species. Himalayan fauna is further diversified owing to its location at the boundary of so many biogeographical regions, viz. Palaearctic (Tibetan Ass), Mediterranean (Ibex), Indo-Chinese (Takin), Indo-Malayan (Sun bear, Gibbon) and Peninsular India (Jungle Fowl). All these factors combine to make the Himalaya one of the richest biodiversity areas of the world in terms of habitat and species diversity. However, biological resource base of the region has drastically changed in the past few decades due to one or other reasons. 36 mammalian species listed

under Schedule-I of the Indian Wildlife Protection Act occur in the Himalaya. These include Slow Loris, Hoolock Gibbon, Brown Bear, Asiatic Black Bear, Spotted Linsang, Binturong, Marbled Cat, Golden Cat, Himalayan Lynx, Clouded Leopard, Snow Leopard, Kiang, Pygmy Hog, Musk Deer, Tibetan Gazelle, Tibetan Antelope, Hangul, Rhinoceros, Wild Buffalo, Takin, Himalayan Tahr, Ibex, Serow, Markhor, Urial, yak, Nyan and Hispid Hare. The endangered avian species include Himalayan Bearded Baza, Tibetan Snowcock, Mountain Quail, Tibetan Blood Pheasant, Western Tragopan, Satyr Tragopan Blyth Tragopan, Temmincks Tragopan, Himalayan Monal Pheasant, Elwee's Eared Pheasant, Cheoe Pheasant, Koklass Pheasant, Black necked Crane, Rufous necked Hornbill, etc. Most of the endangered avian species are recorded from central or northwest Himalaya.

Number of faunal species in the Himalaya (Indian Part) as compared to whole of India (All groups not covered)

Group	No. of species in India	*No. of species in the Himalaya	% of species in the Himalaya
Protozoa	2577	430	16.70
Porifera (freshwater)	33	14	42.42
Rotifera	330	121	36.70
Nematoda	2850	250	08.80
Annelida	840	120	14.30
Mollusca	5070	670	13.30
Onychophora	1	1	100.00
Insecta	61151	6700	11.26
Pisces	2546	306	12.00
Amphibia	240	81	33.75
Reptilia	460	121	26.50
Aves	1232	824	66.90
Mammalia	397	242	62.1

*Tentative number compiled from available literature. Actual number is much higher

Today, several protected areas—Corbett National Park, Manas National Park, Kaziranga National Park, Chitwan National Park, and Sagarmatha National Park—have been distinguished as World Heritage Sites for their contribution to global biodiversity. Furthermore, Tran's boundary conservation areas offer an important opportunity for conservation in the Himalaya region. The adjoining Manas National Park in Bhutan and Manas Tiger Reserve in Assam, India, is one such complex. Another important initiative is the tri-national peace park with the Kanchanjunga Conservation Area in Nepal, the Kanchendzorga Biosphere Reserve in Sikkim, India, and an extension of the Qomolungma Nature Reserve in the Tibet. Table showing the potential Protected Areas for Tran's boundary Conservation Co-operation in the Himalayan belt :

Tran's boundary Conservation Areas in Eastern Himalaya

Name of Protected Area	Country	Counterpart Protected Area	Country
1. Royal Manas National Park	Bhutan	Manas Tiger Reserve	India
1. Royal Chitwan National Park 2. Parsa Wildlife Reserve	Nepal	Valmiki Tiger Reserve	India
1. Suklaphanta Wildlife Reserve 2. Royal Bardia National Park	Nepal Nepal	Dudwa National Park	India
1. Tongbiguan Nature Reserve	China, Yunnan	Pidaung Wildlife Sanctuary	Myanmar (Kachin State)
1. Kanchandzonga National Park 2. Qomolongma Nature Reserve	Sikkim, India China	Kanchandzonga Conservation Area	Nepal
1. Khunjerab National Park	Pakistan (Northern Area)	Taxkorgan Nature Reserve	China (Xinjiang)
1. Medog Nature Reserve (Tibet)	China	Dibang Wildlife Sanctuary	India
1. Zayu Nature Reserve	China (Tibet)	Kakaborazi National Park	Myanmar
1. Kakaborazi National Park	Myanmar	Dichu Forest Reserve	India (Arunachal Pradesh)

Number of National Parks and Wildlife Sanctuaries in the different States of Eastern Himalayas

States	National Parks		Wildlife Sanctuaries	
	Number	Area (Km^2)	Number	(Area (Km^2)
Arunachal Pradesh	2	2468.23	10	7114.45
Assam	5	590.511	12	530.38
Manipur	1	40.00	1	184.00
Meghalaya	2	267.48	3	34.20
Mizoram	2	50.00	4	634.00
Nagaland	1	202.00	3	24.41
Sikkim	1	1784.00	5	265.10
Tripura	–	–	4	603.62
Darjeeling, W.B.	4	362.45	6	697.03
Total	**16**	**6647.89**	**49**	**10497.49**

Distribution of major forest types in the different States of the Eastern Himalaya

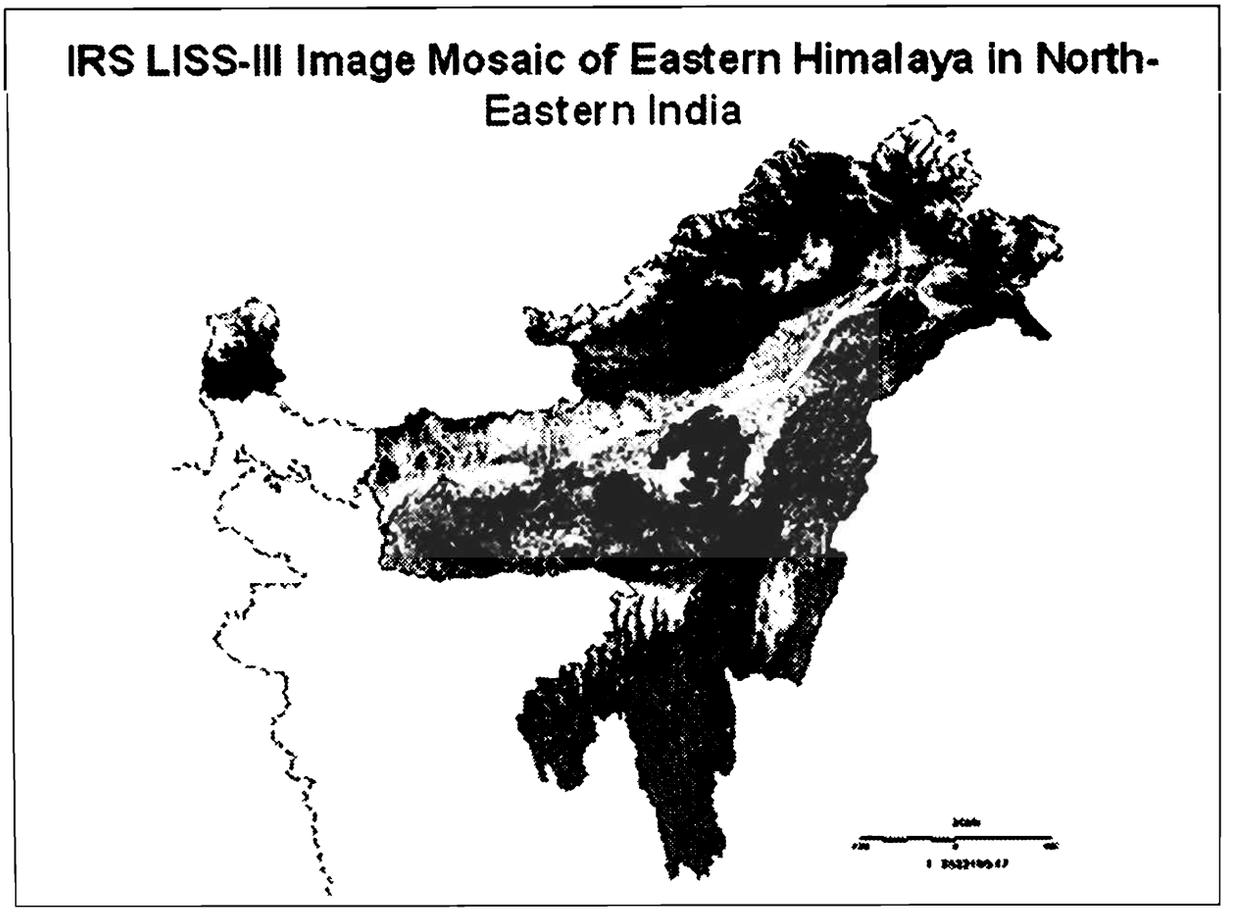
Forest types	Assam Pradesh	Arunachal	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura	West Bengal Darjeeling)
Tropical Wet Evergreen	+	+	+	–	+	+	+	–	+
Tropical Semi-Evergreen	+	–	–	–	–	+	–	–	+
Tropical Moist Deciduous	+	–	+	+	+	–	–	+	+
Sub Tropical Broadleaved Hill	+	–	–	–	–	–	–	–	+
Sub Tropical Pine	–	+	+	+	–	+	+	–	+
Montane Wet Temperate	–	+	–	–	–	+	–	–	+
Sub Alpine	–	+	+	–	–	+	+	–	+
Dry Alpine Scrub	–	+	–	–	–	–	+	–	–
Moist Alpine Scrub	–	+	–	–	–	–	+	–	–

Changes of forest cover during 1991-1999 (Km^2)

No.	State	Forest Cover 1999	Change during different assessments 1991-93	1993-95	1995-97	1997-99
1.	Arunachal pradesh	68847	-96	-40	-19	245
2.	Assam	23688	-243	-447	-237	-136
3.	Manipur	17384	-64	-63	-140	-34
4.	Meghalaya	15633	-106	-55	-57	-24
5.	Mizoram	18338	-156	-121	199	-437
6.	Nagaland	14164	27	-57	-70	-57
7.	Tripura	5745	3	0	8	199
	Total	**163799**	**-635**	**-783**	**-316**	**-244**

EASTERN HIMALAYA

The Eastern Himalayan region lies between the latitudes 26°40'–29°30'N and longitudes 88°5'–97°5'E and covers a total area of 93,988km^2 comprising Arunachal Pradesh, Sikkim and Darjeeling hills of West Bengal with 83,743; 7,096 and 3,149 km^2 of area respectively. In the north, the *Himadri* marks the international boundary with Tibet, which corresponds



Source : Indian Institute of Remote Sensing, Dehradun

with the internationally accepted, well-known McMohan Line in the north-east. The Singalila range separates the region from Nepal in the west, while the Burma ranges of the Assam valley mark the eastern and southern boundary of the region. The Kingdom of Bhutan located between the Tibetan plateau and Assam-Bengal plains of India, separates Sikkim and Darjeeling hills from Arunachal Pradesh. The eastern boundary of the kingdom is Arunachal Pradesh while it is separated from Sikkim Himalaya by the Chumbi valley in the west. The eastern extension of Eastern Himalaya has the concealed Peninsular Block of Shillong Plateau commonly known as **Purvanchal Himalaya**. This block merges in the Tertiary ranges of the Purvanchal Himalaya, which belongs to the great Arakan consisting of tightly packed parallel ridges and valleys. The Purvanchal Himalaya lies between the latitudes 21°5'–28°23'N and longitudes 91°13'–97°25'E, covering a total area of 108,229 km^2 comprising Assam Hills (15,322 km^2), Manipur (22,327 km^2), Meghalaya (22,429 km^2), Mizoram (21, 081km^2), Nagaland (16,579 km^2), and Tripura (10,491 km^2). The region is extended in NE-SW direction touching the Tirap district of Arunachal Pradesh in the north-east and Chitagong Hill Tracts of Bangladesh in the south-west while the Assam valley is the southern boundary. The region lies at a strategic position in northeast India having international boundary both in the east and the west with Myanmar and Bangladesh respectively.

Himalaya in the northeast represents the transition zone between Indian, Indo-Malayan, and Indo-Chinese bio-geographical regions as well as meeting place of the Himalayan Mountains and Peninsular India. This unique positon coupled with physiography, has led

a foundation for the proliferation of a variety of habitats, which harbours a diverse biota with high level of endemism (Mani, 1974). It was in the northeast that the north ward migrating "Deccan Peninsula" first touched the Asian landmass after the break up of Gondwanaland in the early Tertiary period. The northeast is thus a biogeographical "Gateway" for much of India's fauna and flora and as a consequence, is one having the richest biological value (Rodgers & Panwar, 1988). Nayar (1986) calls Sikkim, Darjeeling Himalaya, Arunachal Pradesh and also the eastern border of Patkkoi, Naga hills along with Assam, Meghalaya, Mizoram, Tripura, Nagaland, the *Megadiversity centre* which constitute the *"Cradle of flowering plants"* A wide range of physiography and eco-climatic conditions has already expressed themselves in giving rise to rich gene pool of wild and cultivated plant species. Several species having affinity to nearby Sino–Himalayan, Bhutan, Myanmar, Malaysia and to a lesser extent Peninsular India could be collected from this region, as they biogeographically belong to a single landmass, Indo–Chinese sub Chinese sub region (Mani, 1974). Mountain species with narrow habitat tolerance, particularly higher elevation forms and those with low dispersal capacity, are likely to be at high risk from the environmental effects of climate change. In recent years, factors such as demographic pressure (according to the Census Report 2001, support a seizable population of 26.6 million i.e., 340 persons per square kilometers), unplanned utilisation of resources (Forest extraction in low and middle level elevation), agricultural practices (Jhum/slash and burn, changes of forest cover during 1991-1999 (Km^2) given above in the table), introduction of alien species and application of chemicals (according to Northeastern Development Finance Corporation Report, 2001, about 2300 square km of foothill tracts of Assam state is covered with Tea plantation yielding 425,430 tonnes of Tea annually, more than any other country except China, which requires pesticides and synthetic manures) have affected the ecosystem balance of the area thereby decreasing the genetic diversity.

The vegetation in eastern Himalayan states is well known. The state of Meghalaya exhibits tropical evergreen to temperate vegetation, estimated to harbour nearly 3000 plant species in East and West Garo hills, East and West Khasi hills, Jaintia hills and Ri Bhoi districts. The state of Mizoram presents a mountainous terrain with more or less parallel hill ranges running in the north south direction with deep river valleys. According to the estimate by Botanical Survey of India, the state harbours nearly 2141 species of flowering plants distributed within 905 genera and 176 families. Nagaland is entirely a hilly state except a narrow belt of foot hills bordering Assam and the small valleys in between the lower ranges of the western and north western flank. Five major hill ranges running from northwest to southeast and alternating with marshy valleys are located in the state of Nagaland. The floral diversity is estimated to be 2431 species of angiosperms belonging to 963 genera and 186 families. Manipur is a small landlocked hilly state, represented by 681 species of dicots and 615 species of monocots. Orchid species being the highest with 226 species. The state of Sikkim holds nearly 5000 species of flowering plants. A striking feature of northeast Indian flora is the presence of many primitive flowering plants, besides a variety of agriculturally important gene pools.

Distribution of major wetlands (over 100 ha) in the States of Arunachal Pradesh & Assam of the Eastern Himalaya

State	Sl. No.	Name of district	Name of Wetland	Name of nearest Town/ Village	Lat.	Long.	Area (Ha)	Ecological Category
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Arunachal	1.	Kameng	Pakhui(N)	Tejpur	26°50'	92°00'	20,000	Freshwater
Pradesh	2.	Subansiri	Talley Valley(N)	Hapoli	28°30'	94°00'	200	Freshwater
Assam	3.	Dibrugarh	Ladkhowa Ghats(N)	Saikhowa	26°27'	92°35'	2,800	Freshwater
	4.	Goalpara	Dalani Beel(N)	Calanta Para	26°15'	90°35'	200	Freshwater
	5.	Goalpara	Dhir Beel(N)	Chapper	26°15'	90°25'	450	Freshwater
	6.	Goalpara	Chandakhal Beel(N)	Dhubri	26°00'	89°55'	250	Freshwater
	7.	Goalpara	Hahilia Beel(N)	Goalpara	26°10'	90°35	400	Freshwater
	8.	Goalpara	Kanar Beel(N)	Haripani	26°17'	90°40'	450	Freshwater
	9.	Goalpara	Medo Beel(N)	Majadar Hat	26°00'	90°05'	300	Freshwater
	10.	Goalpara	Sareswar Beel(N)	Gouripur	25°55'	90°05'	350	Freshwater
	11.	Goalpara	Tamaranga Beel(N)	Haripur	26°17'	90°40'	500	Freshwater
	12.	Goalpara	Urpad Beel(N)	Solmari	26°15'	90°40'	1000	Freshwater
	13.	Kamrup	Andheri Beel(N)	Chatgano	26°00	91°40'	200	Freshwater
	14.	Kamrup	Chand Dubi Beel(N)	Pabsabri	26°25'	91°25'	1500	Freshwater
	15.	Kamrup	Dipor Beel(N)	Guwahati	26°07'	91°40'	1000	Freshwater
	16.	Kamrup	Laothari Beel(N)	Mukalana	26°50'	92°25'	260	Freshwater
	17.	Karbi Anglong	Amreng Beel(N)	Diphu	25.50	93°25'	150	Brackish water

While in much of India forests are owned by the government and are managed by the respective state forest departments, in the North-East Reserve (NER) forests are largely under community ownership barring 4-5% that are under government control as in table. The community decides how the forest wealth is utilised. In the past the ecological wisdom of indigenous communities made for sustainable use, however, in recent years low literacy levels and lack of alternative livelihoods compounded the problem (Saikia, 1998).

Ownership of forests in North East India (Area in Km^2)

Province/State	Forest Area	Forest ownership type		
		Reserved	Protected	Unclassified
Arunachal Pradesh	51540	15329	8	36211
Assam	30708	18242	3934	8532
Manipur	15154	4171	9520	1463
Meghalaya	9496	981	12	8503
Mizoram	15935	7127	3568	15935
Nagaland	8629	86	507	8036
Tripura	6293	509	2196	3588

FAUNAL DIVERSITY

Eastern Himalayan states have unique distinction of harbouring 8 species of primates viz., *Bunopithecus hoolock; Trachypithecus geei* (Golden langur restricted to Manas and Sankosh rivers in the Himalayan foothills); *Trachypithecus phayeri* (Phayeri's langur localized in the state of Tripura and a few places in North Kachar districts of Assam); *Trachypithecus pileatus* (Capped langur comparatively better distributed than the other species in the northeastern states); *Semnopithecus schistaceus* (restricted to higher elevations including Sikkim); *Macaca arctoides* (Stump tailed macaque); *Macaca nemestriana* and *Nyctecebus coucang*. In north-eastern India, langur (*Semnopethecus entellus*) species is replaced by three other species *viz.*, leaf eating monkeys—the Capped langur, *T pileatus*, Phayre's leaf monkey, *T. phayrei* and Golden langur, *T. geei*. Among these, the Capped langur is widely distributed in north-eastern region of India whereas the other two species are restricted in their distribution. The Hoolock Gibbon is the only ape species found in India. Among the 9 known species of Southeast Asian lesser apes, the hoolock is the largest gibbon after the Siamang. The hoolock is slender bodied tailless ape with long arms; almost double the length of legs. It has a small and round head with a strong white band above the eyebrows. Adult hoolock is sexually dichromatic- they undergo a sequence of color changes from infancy to the sexually dichromatic adults. The male is always black with white band above eyebrows and with large genital tuft. Adult female is golden or buff or brownish buff coloured.

The other mammal species distributed in eastern Himalaya include *Eptesicus tatei* distributed *in* Darjeeling, West Bengal, so far known by only three specimens and

Biswamoypterus biswasi Saha, apart from the holotype there is no second record, the original record being from the Namdhapa Wildlife Sanctuary, Tirap district, Arunachal Pradesh. Flying squirrel (*Hylopetes alboniger*), is wholly arboreal in habit and nocturnal in behaviour, and lives in tree holes and/or under roof of deserted bungalows in forests of West Bengal (Darjeeling and Jalapiguri Dists.), Arunachal Pradesh, Manipur, Meghalya, Nagaland and Sikkim. Great Evening Bat (*Ia io*) is nocturnal in habit and roosts in a natural cave is one of the largest Vespertilionid bats with forearm length in the range between 70.9–77.3 mm, distributed in eastern Himalaya. Malayan sun bear *Helarctos malayanus malayanus* is terrestrial and more arboreal than the other bear species. It is nocturnal, crepuscular and diurnal in habit. It lives in forested hilly regions of northeast India especially in Assam, Mizoram and Arunachal Pradesh. Chinese Pangolin (*Manis pentadactyla*) mainly inhabits subtropical broad leaf forests and tropical wet semi-evergreen and moist forest. They also inhabit hilly countries. Within Indian limits distributed in Meghalaya, Nagaland, Sikkim, Arunachal Pradesh, Assam, Manipur, Tripura, Mizoram and northern parts of West Bengal. A close relationship exists between range of distribution of *Manis pentadactyla* and abundance of termite species *Captotermes formosanus*. Brow-antlered Deer or Sangai (*Cervus eldii eldii*), the Indian subspecies population is confined to the swamps of the Manipur valley. Currently it is restricted to a very small swampy area of the Logtak Lake in Keibul Lamjao National Park (40 Sq. Km. area), Manipur. The Logtak lake is comprised of unique moss of floating organic humus called "phum or " "phumdi" It consists of dead and decaying vegetation, mosses, algae, humus, tall grasses, sedges and reeds. The grassy vegetation on such a floating swamp forms an ideal and favourite habitat for Sangai.

Lutrogale perspicillata (Smooth-coated Otter), *Mustela strigidirosa* (Black-striped Weasel), *Melursus ursinus* (Sloth Bear), *Hystrix brachyura* (Malayan Porcupine), *Rattus sikkimensis* (Sikkim Rat), *Callosciurus pygerythrus* (Irrawaddy Squirrel), are the other ones distributed in the eastern Himalayan range. Red Panda (*Ailurus fulgens fulgens*) is a shy animal and preferring to live in the temperate, subtropical and even tropical forests. It is arboreal and nocturnal in habit. The most favoured habitat is Fir-Jhapra bamboo thickets and feeds on a bamboo sprouts, grasses, roots and fruits. The species distributed in eastern Himalaya in Northeast India and India between Nepal and Bhutan, particularly in Assam, Arunachal Pradesh, Mishimi Hills, Sikkim, Darjeeling District, W. B. Isolated populations found in Meghalaya plateau (Garo and Khasi Hills) Hispid hare (*Caprolagus hispidus)* is a terrestrial and fossorial hare preferring to live in a well drained tall savannahs or thatch scrub jungles interspersed with dense forest predominated by Sal, distributed in Jaldapara (West Bengal), Manas, Goalpara, Kochugaon, Subankhata, Khalingdor, Barandi, Gohpur, Orang, Haltugaon (all last nine localities in Assam), besides some parts of Bihar and Uttar Pradesh in India.

The Sumatran rhino (*Dicerorhinus sumatrensis*) prefers to live in well wooded wet tropical green forests on a hilly tact of Manipur and Nagaland. The distribution of the species was wide extending from eastern India (Assam) to Indonesia through Myanmar. However the species is now struggling for survival in few pockets in the subcontinent due to persistent threats. Sumatran rhino's presence has been reported in Manipur and

Nagaland along India–Myanmar border on some occasions during last 40 years. Indian One Horned rhino (*Rhinocerous unicornis*) prefers swamps, grassland, and savannahs to live. It is also found in wooded jungles up ravines and low hills. One Horned Rhinoceros has been once known to be common and wide spread in occurrence throughout Indo-Gangetic plains along the base of Himalayan ranges and its neighbouring countries but by the end of 17th century it had completely disappeared from much its range except in the northern parts of West Bengal and Assam in India. Sometimes it sporadically wanders in the part of Arunachal Pradesh bordering Assam state. Takin, Goat-antelope (*Budorcas taxicolor*) found mostly in the altitudinal range of 2500-4000 m. However, animals have been recorded at the altitudes as low as 900 m and 1300 m (Schaller, 1985). Takin has been recorded to live in thickly wooded montane forest with under story of *Rhododendron* and bamboo species of about 5 m in height, distributed in conifer forest predominates at 3000 m altitude of eastern Himalaya from Bhutan to North Burma through Mishmi Hills in Arunachal Pradesh.

The Goral (*Naemorhedus goral*) prefers to move on steep slopes with low snow depth and extremely less human disturbance. They are grazers as well as browsers. They feed and show migratory movement in early morning or late evening (crepuscular). However, they show, habit of nocturnal feeding also. They are distributed from Jammu and Kashmir to Arunachal Pradesh through Himachal Pradesh, Uttar Pradesh, Sikkim and northeastern states of India. Malayan Giant Squirrel (*Ratufa bicolor gigantea*) is terrestrial and arboreal in habit and diurnal in behaviour. It remains confined to high trees with nests in narrow branches. It lives in deep forests as well as along the forest fringes. Recorded from Jalpaiguri, Kochbihar and Darjeeling Districts (West Bengal) and Arunachal Pradesh.

Himalayan Red dog (*Cuon alpinus primaeevus*) is known to occur in the entire Himalayan range from Kumaon (Uttaranchal) to Sikkim, West Bengal and Assam and to north Indian states. *Arctictis binturong* distributed in Sikkim and Assam to Arunchal Pradesh and further eastwards to Nagaland and Tripura. Small-toothed palm civet is (*Arctogalidia trivirgata millsi*) distributed possibly from West Bengal (Darjeeling Dist.) to Assam and Arunachal Pradesh in northeast. Hog Badgers (*Arctonyx collaris*) inhabit tropical forests and they frequent stony grounds, small hills, rocky barren terrains with crevices and fissures. They are crepuscular and nocturnal in behaviour found in West Bengal (Darjeeling), Sikkim, Assam, Nagaland, Manipur and Tripura. Asiatic Brush-tailed Porcupine (*Atherurus macrourus*) burrows among rocks in hills, distributed in rainforest (primary, secondary forests, montane forests, scrub montane forests) of Namdapha Biosphere Reserve, Arunachal pradesh, Meghlaya and Khasi Hills. They have been sighted in the fields as well. Bower's Rat (*Berylmys bowersii*) distributed in Dibang Valley (Arunachal Pradesh), Mizoram, Meghalaya, Nagaland and Manipur in India. Golden Cat (*Catopuma temminckii temminckii*) lives in a variety of forest types from tropical rain forest patches to dry deciduous forests of northeast. Marbled cat *Pardofelis marmorata* is reported from Darjeeling District (West Bengal), Sikkim, Namdapha (Arunachal Pradesh) and Manas (Assam). It is also known to occur on the northern side of Arunachal Pradesh adjoining China.

Looking at the distribution pattern of mammalian species, northeast India sustains a diverse assemblage of small carnivores and perhaps the richest region for small carnivores in the entire planet. Equally rich in number are the Ungulates, i.e., nearly 33% of the total elephants found in India are located in northeastern India. Kaziranga, Pabitora and Orang in Assam are the home for the Indian *Rhinoceros* (Ramakantha *et al.*, 2003).

Aves

According to Birdlife International the Eastern Himalaya is considered as the Critical area under Priority, with altitude varying from 300–4000 m, moderate habitat loss and incomplete knowledge on the avian distribution. Several species have particularly small ranges: *Spelaeornis badeigularis* and *Stachyris oglei* are known only from the Lohit and Tirap Frontier divisions of eastern Arunachal Pradesh, *S. badeigularis* from just a single specimen. *Spelaeornis longicaudatus* is restricted to the hills of Meghalaya, southern Assam and western Manipur; *Apus acuticauda* is only known to breed in the Khasi hills in Meghalaya and the Blue mountains in Mizoram, but up to eight individuals were seen around cliffs in south-east Bhutan in May 1996 (B. King *in litt.* 1996). Eleven of the restricted-range species are considered to be threatened, a greater number than in any other Endemic Bird Area (EBA) of this region. They include the species with very small ranges described above, which are particularly vulnerable to habitat loss, and several species which appear to occur at low densities, some of which (e.g. *Tragopan blythii, Lophophorus sclateri*) are subject to hunting pressure (McGowan and Garson 1995). The threatened Grey-sided Thrush *Turdus feae*, a restricted-range species which breeds in the Shanxi mountains (EBA 136), is a non-breeding visitor to the southern part of the Eastern Himalayas (Nagaland, Manipur, Khasi and Chin hills). More widespread threatened species which occur within the EBA include Hume's Pheasant *Syrmaticus humiae*, Wood Snipe *Gallinago nemoricola*, Blyth's Kingfisher *Alcedo hercules*, Rufous-necked Hornbill *Aceros nipalensis* and Beautiful Nuthatch *Sitta formosa* (all classified as Vulnerable).

The following important species of birds whose status has been identified are found distributed from the eastern Himalaya; their range extends in many cases to Chinese and Burmese territories. Critically Endangered species such as *Rhodonessa caryophyllacea* (Pink-headed Duck) originally distributed now extinct or having no records for more than 50 years, *Gyps bengalensis* (White-rumped Vulture), *Gyps tenuirostris* (Slender-billed Vulture). Endangered species includes *Houbaropsis bengalensis* (Bengal Florican), *Cairina scutulata* (White-winged Duck), *Leptoptilos javanicus* (Lesser Adjutant), *Falco cherrugra* (Saker Falcon) and the Vulnerable Species *viz., Francolinus gularis* (Swamp Francolin); *Lophophorus sclateri* (Sclater's Monal), *Perdicula manipurensis* (Manipur Bush-quail), *Tragopan blythii* (Blyth's Tragopan), *Grus antigone* (Sarus Crane), *Heliopais personata* (Masked Finfoot), *Paradoxornis flavirostris* (Black-breasted Parrotbill), *Sitta Formosa* (Beautiful Nuthatch), *Chaetornis striatus* (Bristled Grass-warbler), *Pellorneum palustre* (Marsh Babbler), *Aythya baeri* (Baer's Pochard), *Apus acuticauda* (Dark-rumped Swift), *Rynchops albicollis* (Indian Skimmer), *Gallinago nemoricola* (Wood Snipe), *Columba punicea* (Pale-capped Pigeon), *Aceros nipalensis* Rufous-necked Hornbill), *Aquila hastate* (Indian Spotted Eagle), *Aquila heliaca* (Imperial Eagle),

Distribution of some threatened vertebrate species in the diferent States of Eastern Himalaya Mammal

Species	W.B. (Darjeeling)	Assam	Meghalaya	Manipur	Mizoram	Tripura	Nagaland	Arunachal	Sikkim
Nycticebus coucong	–	+	+	+	+	+	+	+	-
Macaca arctoides	–	+	+	+	+	+	+	-	-
M. nemestrina	–	+	+	+	+	+	+	+	-
Presbytis geei	–	-	-	-	-	-	-	-	-
P. phayrei	–	+	-	-	-	+	-	-	-
P. pileatus	–	+	+	+	+	+	+	+	-
Hylobates hoolock	–	+	+	-	+	+	-	+	-
Helarctos malayanus	–	+	-	-	+	-	-	+	+
Ailurus fulgens	+	-	-	-	-	-	-	+	+
Amblonyx cinereus	+	+	+	-	-	-	-	+	+
Arctonyx collaris	+	+	-	+	+	+	+	+	-
Arctictis binturong	+	-	-	-	-	-	+	+	+
Prionodon pardicolor	-	-	-	-	-	-	-	+	+
Felis marmorata	+	+	+	-	-	-	-	+	+
Felis temmincki	+	+	+	-	-	-	-	+	+
Felis viverrina	-	+	-	+	+	+	+	+	-
Neofelis nebulosa	+	+	+	-	-	-	-	+	+
Panthera pardus	+	+	+	+	+	+	+	+	+
P. tigris	+	+	+	-	+	-	+	+	+
P. uncia	+	-	-	-	-	-	-	+	+
Platanista gangetica	-	+	-	-	-	-	-	-	-
Elephas maximus	+	+	+	+	+	+	+	+	-

Species	W.B. (Darjeeling)	Assam	Meghalaya	Manipur	Mizoram	Tripura	Nagaland	Arunachal	Sikkim
Rhinoceros unicornis	-	+	-	-	-	-	-	-	-
Sus salvanius	-	+	-	-	-	-	-	-	-
Cervus duvauceli	-	+	-	-	-	-	-	-	-
Cervus eldi	-	-	-	+	-	-	-	-	-
Moschus chrysogaster	-	-	-	-	-	-	-	+	+
Bos gauras	+	+	+	-	-	-	-	+	-
Bubalus bubalis	-	+	-	-	-	-	-	+	-
Capricornis sumatraensis	+	-	+	-	+	+	-	+	+
Hemitragus jemlahicus	+	-	-	-	-	-	-	-	+
Equus kiang	-	-	-	-	-	-	-	-	+
Manis pentadactyla	+	+	+	+	+	+	+	+	+
Caprolagus hispidus	-	+	+	-	-	+	-	-	+

Haliaeetus leucoryphus (Pallas' Fish-eagle), *Falco naumanni* (Lesser Kestrel), *Turdus feae* (Grey-sided Thrush), *Pelecanus philippensis* (Spot-billed Pelican). Northeastern states also support some of the rarest, least known and most sought-after birds of the Oriental region. According to one estimate nearly 400 species have been recorded from Kaziranga National Park and 650 species from Arunachal Pradesh. The Assam plain and the Eastern Himalaya have been identified as Endemic Bird Areas by Bird Life International. The eastern Himalayan part of Northeast India supports 22 restricted range bird species such as *Arbophila mandellii, Tragopan blythii, Lophophorus sclateri, Haractes wardi, Apus acuticauda, Brachypteryx hyperythra, Phylloscopus canator, Tickelli hodgsoni, Garrulax virgatus, Garrulax austeni, Speleornis longicaudatus, Speleornis badeigularis, Speleornis caudatus, Sphenocichla humei, Stachyris oglei, Actinodura nipalensis, Actinodura waldeni, Alcippe ludlowi, Yuchina bakeri, Heterophasia gracilis and Heterophasia pulchella.* It is believed that no further records are available in respect of Buff throated wabler since last 50 years, Rufous bellied Eagle (*Hieraetu kienerii*) and *Pavo muticus* are rarely sighted in recent years. India is home to nine species of hornbills and the northeastern region has the highest diversity of hornbill species in the country, with five hornbill species found there. Three of them are endemic to this region. They are the Wreathed hornbill, Brown hornbill, Rufous-necked hornbill. The other two species, the great Indian hornbill and the Oriental pied hornbill also occur in other parts of India. Except the Oriental pied hornbill, all the others are listed under Schedule I of the Wildlife (Protection) Act, 1972. Crosby (1996) describes that north eastern state of India has highest number of avian species (836/1200) in the entire oriental region, of these nearly 24 are globally threatened are restricted to this region. A cross sectional reference collection from different states of this area indicates that as many as 486 species are recorded by the different members/teams of Zoological Survey of India, during various seasons, indicative of the richness of the avian composition.

Reptiles : *Kachuga silhetensis,* Assam Saw-back or roofed aquatic herbivorous turtle is distributed in Garo, Khasi and Naga Hills of northeastern India. *Kachuga tecta* occur in Brahmaputra River. *Cyclemys dentata* is the most active and omnivorous species, juveniles of which are generally aquatic and prefer to live with in the hill streams. Adults are entirely terrestrial and are found in northeast India especially in Assam, Arunachal Pradesh and Meghalaya. *Cyclemys mouhoti* (*Pyxidea mouhotii),* an insufficiently known turtle, the Assam freshwater species found in northeastern states. *Melanochelys tricarinata* commonly known as the three keeled Tortoise or Tricarinate hill turtle found in West Bengal (Jalpaiguri District), Dafla hills and Bisnath plains of Assam. *Trionyx hurum* [*Aspideretses hurum],* Peacock marked soft shelled turtle is found distributed in the lower reaches of Ganges and Brahmaputra river systems. *Geochelone emys* commonly known as Yellow and Black Giant Tortoise/Assam Land Tortoise/Burmese Brown Tortoise/Six-footed Tortoise is slow, docile and considerably large tortoise prefer to live in hilly forested areas where the water facility is abundant. Assam land tortoise is herbivorous, lives on vegetable matter, occasionally feeds on invertebrates and small amphibians. *Hardella thurgi,* Brahminy River Turtle found in Brahmaputra river and its tributaries in Assam, Meghalaya, Tripura, besides in Ganga river system in Bihar and West Bengal.

Species	W. B. (Darjeeling)	Assam	Meghalaya	Manipur	Mizoram	Tripura	Nagaland	Arunachal	Sikkim
Aves									
Bambusiola fytchii	-	+	-	+	+	+	+	+	-
Aviceda jerdoni	+	+	+	+	+	+	+	+	+
A. leuphotes	+	+	+	+	+	+	+	+	+
Eupodotis bengalensis	-	+	-	+	-	-	-	-	-
Grus nigricollis	-	-	-	-	-	-	-	+	-
Ithaginis cruentus	+	-	-	-	-	-	-	+	+
Ciconia ciconia	-	+	-	-	-	-	-	-	-
Batrachostomas hodgsoni	+	+	+?	+?	+?	+?	+	+	+
Buceros bicornis	+	+	+	+	+	+	+	+	-
Buceros bicornis	-	+	-	+	+	+	+	+	-
Aceros nipalensis	+	+	+	+	+	+	+	+	+
Ptilolaemus tickelli	-	+	+	+	+	+	+	+	-
Anthracoceros malabaricus	+	+	+	+	+	+	+	+	+
Syrmaticus humei	-	-	-	-	+	-	-	-	-
Gypaetus barbatus	+	-	-	-	-	-	-	+	+
Falco peregrinus	+	+	+	+	+		+	+	+
Dendrocygna bicolor	-	+	-	+	-	-	-	-	-
Lophophorus sclateri	-	-	-	+	+	-	+	+	-
Pandion haliaetus	+	+	-	+	-	-	-	+	+
Polyplectron bicalcaratum	+	+	+	+	+	+	+	+	+

Species	W. B. (Darjeeling)	Assam	Meghalaya	Manipur	Mizoram	Tripura	Nagaland	Arunachal	Sikkim
Aves									
Tragopan blythi	-	-	+	+	+	+	+	+	-
T. temminckii	-	-	-	-	-	-	-	+	-
Crossoptilion crossoptilion	+	-	-	-	-	-	-	+	+
Cairina scutulata	-	+	-	-	-	-	-	+	-
Reptlia									
Gavialis gangetics	-	+	-	-	-	-	-	-	-
Crocodylus palustris	-	-	-	-	-	-	-	+	-
Trionyx gangeticus	-	+	-	-	-	-	-	-	-
T. hurum	-	+	+	-	-	-	-	-	-
Python molurus	+	+	+	+	+	+	+	+	+
P. reticulatus	-	+	+	+	+	+	+	+	-
Amphibia									
Pleurodeles verrucosus	+	-	+	+	-	-	-	+	+

The serpent diversity in the eastern Himalaya is more or less similar to that of Western Ghats; however, the species composition varies, due to its geographic location in the country. A large number of species of Indo-Chinese sub region are distributed in this area. The family Typhlopidae represented by *Typhlops jerdoni, Typhlops diardi, Typhlops oligolepis,* are restricted to the area. No member of the family Uropeltidae is distributed in the eastern Himalaya. The family Boidae is represented by *Python reticulates* and the Family colubridae by *Pareas macularis, Pareas monticola, Stoliczkaia khasiensis, Elaphae prasina, Elaphae frenata, E. radiata, E. taeniura, E. contoris, Ptyas korros, Zaocys nigromarginatus, Opheodrys doriae, Leopeltis frenatus, L. stoliczkae, Oligodon cyclurus, O. juglandifer, O. albocinctus, O. cinerus, O. erythrorachis, O. melaneus, O.erythrogaster, O. dorsals, Calamaria pavimentata, Dendralaphis cyanochloris, D. gorei, Lycodon jara, L. fasciatus, Dinodon serpentrionalis, D. gammiei, Amphiesma parallela, A. khasiensis, A. modesta, A. peali, A. xenura, Rhabdophis himalayana, R. subminiata, Pseudoxenodon macrops, Trachiscium monticola, T. guntheri, T. tenuiceps, Rhabdops bicolor, Blythia reticulata, Boiga multimaculata, Boiga ochracea, B. gookol, B quincunciata, B. cyanea, B. cynodon, Psammodynastes pulverulentus, Ahaetulla fronticinctus, Ahaetulla prasinus, Bungarus bangaroides, Trimeresurus mucrosqamatus, T moniticola, T.jerdoni, T stegnegeri, T popeorum and T.erythrurus.*

Snake species widely distributed throughout the eastern Himalaya are *Elaphae helena, Ptyas mucosus, Lycodon aulicus, Amphiesma stolata, Xenochrophis piscator, Macropisthodon plumbicolor, Bioga trigonata, Enhydris dussumieri, Enhydris sieboldi, Bungarus fasciatus, Bungarus niger, Ophiophagus Hannah and Viper russeli* (part of eastern Himalaya). Species of snakes also distributed in the Western Himalaya are *Liopeltis ruppi, Sibynophis collaris, Amphiensma platyceps, Xenochrophis cerasogasgter, Trachiscium fuscum, Boiga multifasciata, Callophis macclellandi, Naja naja kauthia, Agkistrodon himalayanus.*

Distribution Analysis of the snakes of eastern Himalaya reveals nearly 74 snakes of which 19 are rare, 23 common and 32 fairly common; of these 9 species are found in western Himalaya, 14 are widely distributed species and 51 species are exclusive to eastern Himalaya.

Following species of lizards distributed in eastern Himalaya in the states of northeast India *viz., Calotes emma; Mictopholis austeniana; Ptyctolaemus gularis; Scincella sikkimense; Varanus salvator* (Eastern Himalayas up to 6000 ft.); *Calotes jerdoni; Calotes maria; Cosymbotus platyurus; Cyrtodactylus gubernatoris; Cyrtodactylus khasiensis; Draco maculatus; Draco norvilli; Gekko gecko; Hemidactylus garnoti; Hemidactylus karenorum; Japalura andersoniana; Japalura planidorsata; Japalura tricarinata; Japalura variegata; Mabuya multifasciata; Mabuya quadricarinata; Ophisaurus gracilis; Oriocalotes paulus; Sphenomorphus boulengeri; Sphenomorphus courcyanum; Sphenomorphus indicum; Sphenomorphus maculatum; Takydromus haughtonianus; Takydromus sexlineatus khasiensis; Takydromus sexlineatus sexlineatus; Tropidophorus assamensis.*

Amphibia : The amphibian species distributed in eastern Himalaya are *Amolops afghanus* (Arunachal Pradesh, Assam, Himachal Pradesh, Meghalaya, Mizoram, Sikkim, Tripura, West Bengal); *Amolops gerbillus* (Arunachal Pradesh, Assam, Meghalaya, West Bengal);

Amolops monticola (North east states and West Bengal); *Amolops himalayanus; Bufo stuarti; Chaparana sikkimensis; Chirixalus cherrapunjiae; Chirixalus shyamrupus; Chirixalus simus; Chirixalus vittatus; Euphlyctis ghoshi; Gegeneophis fulleri; Icthyophis garoensis; Leptobrachium smithii; Limnonectes khasianus; Limnonectes kuhlii; Limnonectes laticeps; Limnonectes mawlyndipi; Limnonectes mawphalangensis; Megophrys boettgeri; Paa annandalii; Paa liebigii; Philautus dubius; Philautus garo; Philautus jerdonii; Philautus kempiae; Philautus micodiscus; Phrynoglossus borealis; Pleurodeles verrucosus; Polypedates taeniatus; Rana alticola; Rhacophorus appendiculatus; Rhacophorus bipunctatus; Rhacophorus bisacculus; Rhacophorus reinwardtii; Rhacophorus tuberculatus; Scutiger mokokchungensis; Theloderma moloch; Xenophrys kempii; Xenophrys lateralis; Xenophrys montana; Xenophrys parva; Xenophrys robusta.* A total of 68 species are on record from northeast India, several new ones are added regularly from this area.

Known Invertebrate diversity in northeastern India

Order	Genera	Species
Collembola	25	53
Odonata	105	245
Plecoptera	11	28
Orthoptera	69	187
Phasmida	—	70
Dermaptera	45	130
Mantodea	60	86
Blattaria	30	54
Isoptera	27	76
Psocoptera	—	43
Hemiptera	343	535
Thysonoptera	65	105
Neuroptera	41	85
Coleoptera	380	815
Mecoptera	3	13
Lepidoptera	295	604
Hymenoptera	210	670
Ephemeroptera	6	11
Other invertebrate groups		
Myriapoda	—	24
Crustacea	51	83
Annelida	32	61
Nematoda	53	85

Order	Genera	Species
Platyhelminthes	63	92
Mollusca	85	287
Rotifera	32	146
Protozoa	69	141
Acarina	—	294
Araneae	29	55

Faunal diversity in Eastern & Western Himalaya from two selected Protected Area

Category	Eastern Himalaya		Western Himlaya	
	Genera	Species	Genera	Species
INSECTA				
Odonata	18	28	5	6
Collembola	6	9	2	14
Orthoptera	36	41	11	14
Dermaptera	5	7	21	24
Coleoptera	105	188	-	-
Lepidoptera	51	136	23	80
Neuroptera	-	-	4	4
Hemiptera	23	24	12	13
Trichoptera	-	-	2	2
Diptera	-	-	19	24
Dictyoptera	9	34	-	-
Mantoidea	10	16	-	-
Hymenoptera	43	63	19	24
Chilopoda	02	03		3
Annelida	05	08		6
Arachnida	08	12		17
Mollusca	04	08		15
VERTEBRATES				
Pisces	08	16		1
Amphibia	06	12		8
Reptilia	12	18		3
Aves		186		175
Mammalia		48		22

(Western Himalaya–Nanda Devi Biosphere, Eastern Himalaya–Namdapha Sanctuary)

Faunal Diversity of North East Indian States

	Meghalaya	Assam	Arunachal	Mizoram	Nagland	Manipur	Tripura
Protozoa	128	61	72	49	59	85	102
Nematodes	34	19	28	21	23	34	87
Rotifera	111	116	26	31	32	39	112
Annelida	49	51	31	36	16	12	24
Mollusca	223	161	112	68	57	127	48
Apterygotes	28	19	27	28	19	35	18
Odonata	151	69	92	58	48	68	35
Orthoptera	69	23	44	35	45	71	58
Dermaptera	49	12	7	12	7	6	14
Isoptera	29	25	44	22	11	22	30
Psocoptera						7	
Hemiptera	516	218	31	31	32	290	206
Coleoptera	766	167	73	81	73	287	283
Hymenoptera	643	244	118	58	25	35	69
Diptera	602	164	271	168	36	91	108
Lepidoptera	586	252	386	212	462	188	135
Trichoptera						114	
Crustacea	60	35	23	25	18	19	56
Arachnida	217	108	123	68	64	93	246
Fishes	165	200	167	84	108	141	134
Amphibia	40	33	39	15	17	14	11
Reptilia	94	42	78	32	62	19	32
Aves	540	312	473	218	428	586	259
Mammalia	139	60	105	37	92	69	44

Source : From available records at ZSI

INVERTEBRATE DIVERSITY IN EASTERN HIMALAYAN STATES

Species diversity of Protozoa in the Eastern Himalaya

State	Number of species of Protozoa			
	Freeliving	Parasitic	Symbiotic	Total
Arunachal Pradesh	43	20	9	72
Manipur	77	8	—	85
Meghalaya	58	58	12	128

State	Number of species of Protozoa			
	Freeliving	Parasitic	Symbiotic	Total
Mizoram	31	8	10	49
Nagaland	22	3	34	59
Sikkim	55	2	23	80
Tripura	45	37	20	102
West Bengal (Darjeeling dist.)	11	72	—	83

Acarine species in different States of Eastern Himalaya (Sanyal 1998)

States	Prostigmata	Astigmata	Mesostigmata	Cryptostigmata	Metastigmata
Arunachal Pradesh	—	—	4	—	12
Assam	20	2	26	11	10
Manipur	33	—	5	5	4
Meghalaya	11	—	25	—	5
Mizoram	—	—	—	—	4
Nagaland	2	—	—	5	4
Sikkim	—	—	—	21	2
Tripura	—	—	10	90	6
Darjeeling, W.B.	72	14	30	104	16

Faunal component restricted to north east India

Group	Species	India	%
Protozoa	102	22	3.9
Acanthocephala	17	22	7.4
Nematoda	87	28	3.0
Platyhelminthes	36	16	2.2
Annelida	28	84	3.3
Rotifera	148	33	44
Crustacea	88		24
Mollusca	48	16	2.8

Faunal resoruce in Tripura–a case study

Geographical area of the state is 10,491 km^2 (0.32% of total land area of the country). The state is geologically fairly young in origin. Geomorphologically there is a succession of hill ranges & valleys, which enjoy typical warm humid & warm climate. The state is

not rich in mineral resources, except for oil and natural gases. Mountain farmers typically combine agriculture, forestry, and livestock in a balanced way. Shifting (Jhum) cultivation is also common in Tripura. Forests cover 52.8% of the total geographic area

SOIL TYPES & WATER RESOURCES

The type and nature of soils also vary vastly in Tripura from deep alluvial to the thin and bare soils of the mountains. The nature of the soil depends upon the rocks, prevailing climatic conditions, topography and vegetation. The soil types are :

- Reddish yellow brown sandy soil
- Red loam and sandy loamy soil
- Older Alluvial soil
- Younger Alluvial soil
- Laterite soil

Water resources are plenty with 11 major rivers originating in the hills and flowing through valleys, lacks significant natural wetlands, however has good no. of "Dighee"

Vertebrate Faunal Resource of Tripura

Group	Species	India	%
Mammals	44	397	11.10
Aves	259	1232	21.02
Reptilia	32	460	7.02
Amphibia	11	240	5.20
Fishes	128	742	17.25
Total	**474**	**3037**	**15.61**

FAUNAL ANALYSIS

Recent publication on the Fauna of Tripura State by Zoological Survey of India indicate 102 species under 47 genera of Protozoa from the state of which 45 free living, 37 parasitic and 20 symbiotic forms. Of these, ZSI recorded one species new to science, 7 species for the first time from India and 93 for the first time from the state. Trematoda of Tripura includes 36 species under 29 genera. Besides, 27 species of free living Nematodes and 60 species of parasitic Nematodes, of which 14 species are new to science and 1 genus new to India have also been recorded. Acanthocephala with 17 species under 9 genera and 4 new species to science were also reported from the state.

Annelida is represented by 5 species of Hirudinea and 19 species of Oligochaeta which 18 species new records to Tripura and 2 species first records to India. Crustacean diversity is comparatively limited with 5 species of Copepoda, 8 species of Prawns, 3 species of

Crabs, 49 species of Cladocera and 4 species of Bryozoa so far known from the state. Molluscan diversity is represented by 30 species of freshwater and 18 species are landforms.

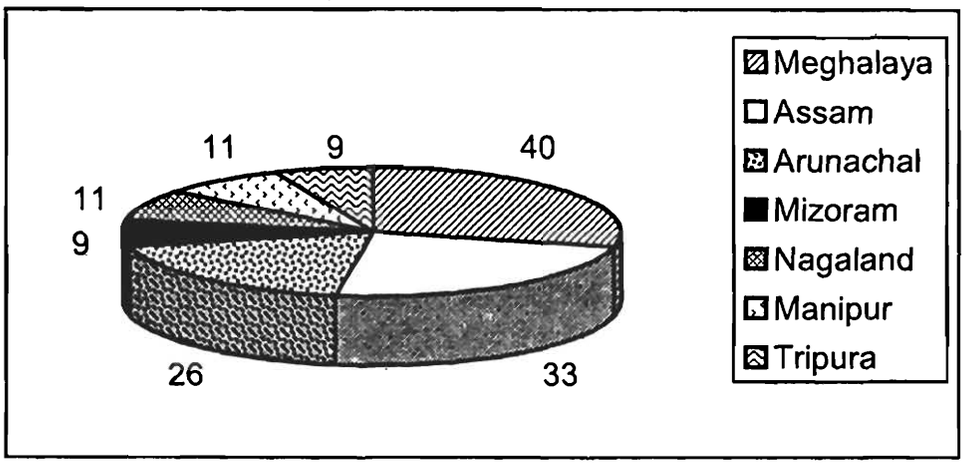
Apterygota is represented by 5 species of Ephemeroptera, 2 species of Thysanura, 11 species of Collembola and 35 species of Odonata. 108 species of Orthoptera (67 species are new records from the state), 14 species of Dermaptera (1 species new to science), 27 species of Isoptera, 5 species of Psocoptera (5 species new records from the state), 10 species of Dictyoptera, 206 species under 143 genera of Hemiptera (111 species are new record to Tripura and 2 species are new to India) have also been reported from Tripura. Thysonoptera is represented by 33 species (11 species new to science), Coleoptera with 283 species under 96 genera (2 species new to science, 1 genus first record from India, 3 species first record from India and rest of species are first record from the state of Tripura). Diptera is known by 108 species under 55 genera with 1 species new to science and 33 species are newly recorded from Tripura. Lepideoptera is represented by 135 species under 106 genera (42 species are new records from Tripura) and Hymenoptera by 69 species under 40 genera with 23 species are newly recorded from Tripura State. Arachnida is represented by 246 species and 131 genera of Acarina (23 species are new to science) and 27 species of Araneae of which 26 species recorded for the first time from Tripura State.

Freshwater fishes represented by 129 species under 78 genera of which 26 species were newly recorded, 8 species are rare and 2 species are vulnerable. 11 species (5 genera) of Amphibia is represented here of which 5 species are new records to Tripura. Reptiles are represented by 32 species under 28 genera of which 16 species are lizards and 16 species snakes. Aves are known by 259 species and subspecies of which 25 species and subspecies were recorded first time from Tripura. The Family Muscicappidae with 27 species and subspecies forms the largest group in the bird fauna of Tripura.

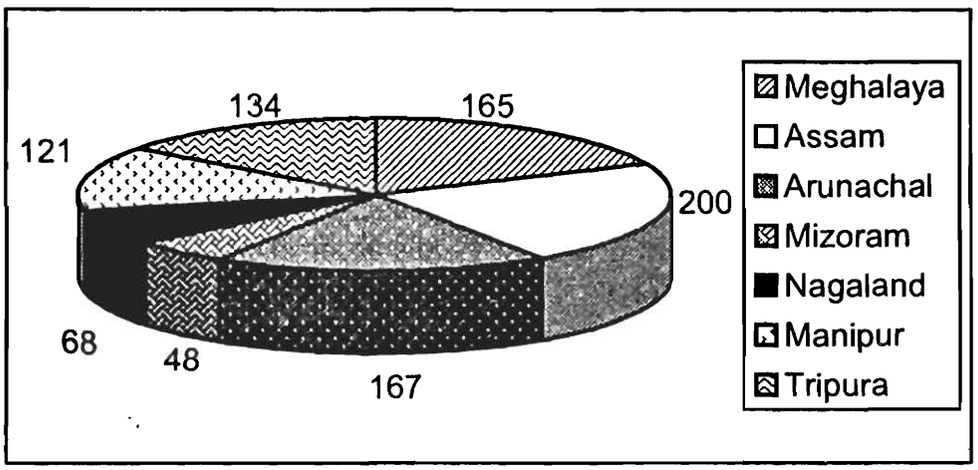
Faunal Diversity in Arunachal Pradesh

The state of Arunachal Pradesh has a predominantly mountainous landscape with nearly 64% of the total area lying above 1200 m, 13% located between 300–1200 m and 8.87% below 300 m (Gopalakrishnan, 1994). The SFRI (2003) has grouped the state physiography into four distinct regions based on the elevation from plain and lower hilly elevation to the snow capped mountains. This includes 1. Siwalik and foot hills with lower hills forming the eastern continuity of the Assam plains. 2. The Sub Himalyan belt including the Siwalik hills upto 1700 m. 3. Lesser Himalaya ranging between 1700–3500m and 4. The Greater Himalayas with snow capped montane areas above 3500 m. The highest point is being located in the Upper Siang district (Namche Borwa peak, 7756 m).

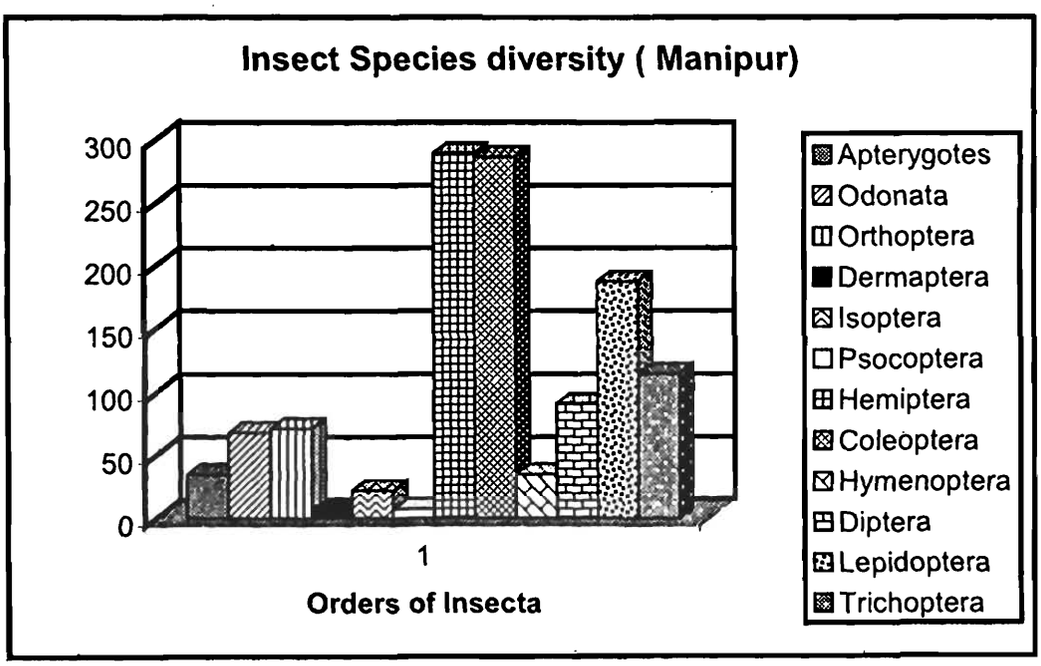
Of the total area of 83,743 km^2, the state has 68,621 km^2 of forest occupying nearly 82% of the total geographic area, i.e., a major part of the state is under forestry. This includes 54,510 km^2 of closed forest, 14,151 km^2 of open forest, but the true picture of recorded forest cover appears to be around 51,540 km^2 comprising 61.5% of the total area of the state (FSI, 1999). Out of this, unclassified forest is 70.25% and the protected forest is



Amphibian diversity



Fish diversity in Northeastern states of India



merely 0.02% (FSI, 1999). Forest tree plantation has remained a low key activity due to rich natural resource. However, plantations started in the early 1950's with native species of *Terminalia myriocarpa*, and subsequently by *Bombax ceiba, Dipterocarpus macrocarpus*, and to little extent with *Tectona grandis*. An area of 9285.48 km^2 representing nearly 11% of the geographic area of the state has been brought under Protected Area Network for conservation and development of biodiversity resource, which includes two National Parks (i. Namdapha NP and ii. Mouling NP), seven Wildlife Sanctuaries (i. Eaglenest WLS, ii. Pakke WLS (earstwhile Pakhui WLS), iii. Itanagar WLS, iv. D Ering Memorial WLS, v. Mehao WLS, vi. Dibang WLS and vii. Kamlang WLS), one Biosphere Reserve (Dihang Dibang Biosphere Reserve), one Orchid Sanctuary (Sessa Orchid Sanctuary), two Proposed Wildlife Sanctuaries (i Kane WLS and ii. Yordi Rabe Supse WLS), two Tiger Reserves (i. Namdapha TR in Namdapha National Park and ii. Pakke Tiger Reserve in Pakke Wildlife Sanctuary) and one Proposed Elephant Reserve in Arunachal Pradesh.

The rich traditional knowledge of tribes is of importance in terms of conservation, as the people have the right to harness the bioresource of the area. The tribe's do not harness entire biodiversity and are selective in gathering animal resource. The tribes also encourage the sacred groves, and never kill birds such as Laughing Thrush and Indian Roller as it is believed to cause epilepsy and graying of hair, when consumed. The tribal area is also the area of highest biological diversity, besides the area of distribution of highly endangered and threatened species of birds such as *Spelaeornis badeigularis* (Mishmi Wren), *Laphophorus sclateri* (Mishmi Monal Pheasant), *Ithaginis cruentus kuseri* (Mishmi Blood Pheasant), *Stachyris oglei* known only from the Lohit and Tirap Frontier Divisions of eastern Arunachal Pradesh, Mammals like *Budorcas taxicolar* (Mishmi Takin), etc.

Arunachal Pradesh forms a complex hill system of Siwalik and Himalayan origin and is crisscrossed by six major rivers and streams flowing from west to east. Besides, a good number of beels in the lower belt and lakes in the middle and higher belts add up to the natural resources of the state. A complete and a comprehensive picture of the fish fauna of the state is undertaken, in the present case reveals the presence of 143 species, under 61 genera, 21 families included in 8 orders. The family Cyprinidae forms the largest group with 65 species followed by Homolopteridae (17 species), Sissoridae (12 species), Bagridae (7 species), Channidae and Cobitidae (6 species each) and the rest with one, two or three species. Of the 50 new records, 12 species are recorded exclusively from the state of Arunachal Pradesh *viz., Barilius jayaramai, Danio (Brachydanio) horai, Garra gravelyi, Garra tirapensis, Puntius stevensonii, Semiplotus modestus, Kryptopterus indicus, Echinoglossus kamengensis, Exostoma berdmorei, Exostoma stuarti, Noemacheilus arunachalensis* and *N. tikadari*. From the present investigation, it is clear that nearly 47 species of fishes share with the other eastern Himalayan states of northeast India. An interesting pattern of distribution of fishes that has been noticed from the recent survey, that the Tirap district adjacent to Myanmar, Assam and Nagaland exhibits highest diversity of fishes with 83 species followed by Changlang (47 species), Lohit (37 speceis), East Kameng (36 species), west Kameng (28 species), East Siang and Lower Subansiri (21 species each), Upper Subansiri (14 spp.),

West Siang (12 spp.), Dibang Valley (4 spp.) and the least in Tawang district with 8 species. From the above studies, it is also clear that the distribution of fishes in the upper stretches of Himalaya are limited as evidenced from the species diversity in Dibang valley, Tawang, West Siang and upper Subansiri districts. Nearly 55 species are hill stream cum torrential forms in the montane areas of the state represented by the distribution of species such as *Erethistoides montana, Euchiloglanis hodgarti, Exostoma berdmorei, Gagata cenia, Botia rostrata, Botia berdmorei.* It is for this reason that **Cold Water fishery** – especially the Trout fishery both Brown and Rainbow Trout variety being cultured for stocking.

The present record of Amphibian diversity from the state is 39 species belonging to 11 genera, 6 families and 2 orders, in comparison to the earlier record of 24 species by Boulenger (1920), Smith (1929), Sarkar and Sanyal (1985) and Chanda (1994). Present study also includes the description of a new species of Amphibian from the state viz., *Philautus sahai* (sp.nov.) and five new records *viz., Megaphrys lateralis, Rana erythraea, Rana nicobarensis, Rana keralensis* and *Rana andersonii* for the first time from India. It is interesting to note that the Salamander (*Trilotriton verrucosus*) was also recorded previously from the Daphabum Scientific Survey Expedition (1969-70) by the scientists of Zoological Survey of India at an altitude of 1248 m in the Lohit district in a hibernating condition. District wise distribution indicates the maximum diversity in Tirap (21 species), East Siang (20 species), West Kameng (9 species), Lower Subansiri (7 species), East Kameng (4 spp.), West Kameng and Changlang (3 species each), Lohit and Dibang Valley (2 species each). As in the case of several other groups such as fishes, the diversity is low in higher stretches and highest in the areas adjacent to Myanmar, Assam and Nagaland i.e., Tirap and East Siang districts. Species such as *Bufo macrotis, Mycrohyla berdmorei, Microxalus borealis, Theloderma moloch, Chiraxalus shyamrupus, Chiraxalus doriae,* and *Rhacophorus naso* (no further addition since the first collection by Annandale, 1912) is restricted to Arunachal Pradesh. As many as 14 species share in common with the distribution in eastern Himalayan states.

Abor expedition by Annandale (1912), Swiss Entomological expedition during 1961, Daphabum expedition in 1969-70, Subansisri expedition during 1974-75 and Namdapha Expedition by a group of scientists from Zoological Survey of India (1981-87) are the starting point in respect of the studies on distribution of reptiles from Arunachal Pradesh. The present study indicates the distribution of 78 species under 46 genera and 12 families of reptiles, of this two species viz., *Ophites laoensis* and *Xenochrophis punctulata* are the first records to the country. The present study also indicative of the restricted distribution of snake (*Boiga gokool*) to the eastern Himalayas and wider distribution of *Trimeresurus monticola* in Southeast Asian countries extending upto Malaysia. The systematic list includes 4 species of testudines, 19 species of lizards and 55 species of snakes.

Among the four testudines recorded, *Pyxidia mouhoutii* is a Malayan element distributed in the state, *Kachuga tecta* becoming vulnerable due to over exploitation, *Kachuga sylhetensis,* endemic to northeastern India distributed in north and south of Brahmaputra River. Species such as Kachuga smithi, Kachuga dhongoka and *Cyclymys dentata* are on record

from the state, but are not collected during the survey. Among the order Squamata, the family Gekkonidae includes *Cyrtodactylus khasiensis, Cosymbotus platyurus, Ptyctolaemus gularis, Mictopholis austeniana, Oriocalotes paulus, Japalura andersoniana, Calotes jerdoni, Sphaenomorphus indicum, S.maculatum, S courcyanum, Scincella sikkimensis, Tarkydromus sexlineatus khasiensis,* which are the eastern Himalayan representatives distributed in the state. Among snakes family Typhlopidae represented by 3 species, Boidae (1 species), Colubridae (42 species), Elapidae (5 species) and Viperidae (4 species).

Species of snakes such as *Pareas monticola, Elaphae taeniura, E cantoris, E porphyracea, E prasina, Ptyas korros, Zaocys nigromarginatus, Leopeltis frenatus, L stoliczkae, Ologodon albocinctus, O. melanozotus, O erythrocharis, Dendolaphis ahaetulla, D. cyanochloris, D. gorei, Ahaetulla prasina, Pseudoxenodon macrops, Amphiesma modesta, Trachyschium monticola, T tenuiceps, Rhabdophis himalayanus, R bicolor, Blythia reticulate, Boiga ochracea, B gokool, B. quincuciata, B cyanodon, Psammodynastes pulverulentus, Bungarus niger, Trimeresurus mucrosquamatus, T monticola, T stejnegeri* are the eastern Himalayan representatives distributed in the state of Arunachal Pradesh. In other words, out of 55 species of snakes, nearly 33 species (60%) are the eastern Himalayan representatives distributed in the state. Besides above, *Elaphae mandarina* restricted to Arunachal Pradesh (recorded in the subcontinent after a lapse of nearly 75 years), *Ophites jara* and *Xenochrophis punctulata* recorded for the first time from Indian subcontinent from the study. *Oligodon (Prox) cinereus* is the other species exclusive to Arunachal Pradesh. Of the 19 species of lizards recorded from the state, distribution in East Siang (17 species) followed by Changlang (9 species), Lohit, East and West Kameng (3 each), Lower Subansiri (2 species) and a lone species from Tirap districts. In contrast, of the 55 species of snakes distributed in the state, again East Siang dominates (26 species), Lower Subansiri (21 species) Changlang (15 species), East Kameng (10 species), Papumpare (9 species), West Siang (6 species), West Kameng (5 species), Lohit (2 species) and a lone species of *Trimeresurus monticola* (Blotched pit viper) from the district of Tirap. In conclusion, it may be said that the distribution of snakes are in the southern and lower elevations along the Brahmaputra River and its tributaries.

Bird collections made by Ogle from the Lohit River Area of Arunachal Pradesh are the first description from the area, which is compiled by Godwin-Austen (1878). Collections made by Baily and Kennedy from Mishmi hills during 1913 were published by Stuart Baker in 1913 as Birds from Mishmi Hills in the Records of Indian Museum. Stevens Publication on the Birds of Upper Assam in BNHS (1914-15) and Bates publication on Birds of Subansiri are important from the point of description of the distributional pattern of birds from the state of Arunachal Pradesh. The ornithological work by Salim Ali, Dillon Ripley (1968–74) is the basis for the present understanding on the diversity and distribution, besides first hand information gathered through various surveys. The present study includes 964 species and subspecies of birds from the state of Arunachal Pradesh divided into four parts the first one includes 473 species authentically collected and reliably sighted in the field by the scientists of the survey, out of this 416 are resident, 42 are winter visitors, 11 are summer visitors and 4 uncertain. The second list of birds includes 282

species and subspecies of birds distributed in the state of Arunachal Pradesh based on further observation and data collected from various sources. Of these, 235 are resident, 42 winter visitors, 3 species are partly resident and partly winter visitor, 1 species each of winter vagrant and summer visitor birds.

Mammals : The order carnivora in India is represented by 7 families, 26 genera and 55 species; of this the state has a share of nearly 13 species under 10 genera. The family Felidae includes 15 species of which the state of Arunachal Pradesh has 9 species thus constituting nearly 60% of the total Indian species. Among them *Panthera tigris, Panthera pardus* are found in the lower elevations and foot hills and are common in Namdapha National Park, Dihang–Dibang Biosphere Reserve, Itanagar WLS, Pakke and Tale WLS. *Neofelis nebulosa* (Groves, 1982 retains still under the genus *Panthera*) and *Uncia uncia* are recorded from the upper stretches of Subansiri, Dibang Valley. Although the *Uncia uncia* has a wide distribution across the Himalayas range, and into the Trans-Himalaya, the population in the Eastern Himalayas especially from Arunachal Pradesh is very important because this high-altitude predator occurs at low densities. Cats such as *Prionilurus bengalensis* (subspecies *charltoni* occurs in India), *Felis chaus* (subspecies *affinis* found in Arunachal Pradesh), *Pardofelis marmorata, Catopoma temminckii* are found distributed in the state while the fishing cat *Prionailurus viverrinus* is comparatively rare and found in marshy areas. Family Canidae represented by 3 genera and 5 species in India, while the state of Arunachal Pradesh accounts for all the five species thus the representation is 100% in the state. The Indian wolf is represented by *Canis lupus pallipes* the common jackal *Canis aureus* a scavenger survive on smaller prey and the Indian wild dog or Dhole (*Cuon alpinus*) distributed in the scrub jungles part of the state. According to Jhonsingh (1985), the wild dog of Arunachal Pradesh is believed to be *Cuon alpinus adjustus*, as this subspecies is found in northern Mayanmar. Of the two species of genera *Vulpes, Vulpes bengalensis* are found in the foot hills and at elevations above 2500 m, and species *Vulpes vulpes* are reported from the area.

The family ursidae represented by 4 genera and 4 species in India, the state is represented by all the two species viz., *Melursus ursinus* (Sloth bear), *Selenarctos thibetanus* (*Ursus thibetanus* according to Corbet and Hall, Himalayan Black bear), and *Helarctos malayanus* (Malayan Sun bear) distributed in Tirap & Changlang adjoining Burma. *Ursus arctos* (Brown bear) is not recorded by the survey however, recently reported by several workers. The monotypic family Ailuridae represented by the Red Panda is a Himalayan species (*Ailurus fulgens*) found in altitude varying from 2800 – 3500 m, records of this are available in old growth subalpine conifer and mixed forests with a bamboo understory and Rhododendron and Oak forests. The family Mustellidae is represented by 7 genera and 15 species are included under 4 subfamilies. The amphibious Otters under subfamily Lutrinae includes *Lutra perspicillata, Lutra lutra* and *Amblyonyx cinerus* (*Aonyx cinera*) but represented by the latter two species in the state. The subspecies of *Amblyonyx cinerus* reported from Arunachal is *concolor*. The subfamily Mustellinae includes martens, weasels and pole cats, represented by 8 species under 3 genera. Arunachal Pradesh has the

distinction of having 2 genera and 2 species of *Martes* (*Martes flavigula* (Indian nominate subspecies is *flavigula)* keeps to forest limits and are not found above tree line, *Mustela strigidirosa* in temperate forests above 1500 m. *Mustela altaica* and *Martes foina is reported in* Tawang and Kameng districts, *Mustela kathaiah* distributed in the districts of Tirap & Changlang adjoining Burma, not included as the representative collections have not been available with the department.

The subfamily Melinae includes badgers represented by 2 genera and 3 species. In Arunachal Pradesh it is fully represented by two species viz., *Arctonyx collaris* (subspecies present in Arunachal is *collaris) and Melogale moschata* (Indian subspecies is *millsi).* The subfamily Mellivorinae represented by a lone species *Mellivora capensis* in India but doubtful in Arunachal. The family Viverridae includes 14 species under 7 genera and 3 subfamily and the state is represented (50%) by 5 species viz., *Viverra zibetha* (Arunachal Pradesh subspecies *zibetha), Viverricula indica, Pardoxurus hermophroditus, Paguma larvata, Arctictis binturong.* The subfamily Herpestrinae includes only one genus *Herpestes* with 6 species. The state represented by *Herpestes urva* and *Herpestes javanicus.*

The order Proboscidia represented by the lone species *Elephas maximus indicus,* the elephant population present in small habitat patches along the north bank of the Brahmaputra River in Arunachal Pradesh is very important from the point of distribution (Sukumar, 1982). The even toed Artyodactyles are represented by four families in Arunachal Pradesh; the family Suidae represented by *Sus scrofa cristatus;* the family Cervidae represented by *Muntiacus muntjak* (subspecies *vaginalis*), *Axis porcinus* (subspecies *porcinus* in Arunachal Pradesh and the genus *Axis* is kept under the genus *Cervus* by Hanacki, 1982); *Cervus unicolor* (subspecies *equines* present in Arunachal) are important prey species distributed in the lower elevations of the state. The family Bovidae represented by *Bos frontalis* (a domesticated stock especially in northeastern Chittagong, Bangla Desh. Honacki, 1982 considers *Bos gaurus* as a synonym of *Bos frontalis*), *Bubalis bubalis* and the *Budorcas taxicolor* especially distributed in the Mishmi hills of Arunachal Pradesh, *Naemorhedus goral, Naemorhedus sumatrensis* are extensively distributed in the state. These large herbivores of Eastern Himalayas especially Arunachal Pradesh play critical ecological roles in maintaining the integrity of the ecosystem. Further more, according to Centre for Education in Northeastern India and BNHS, the landscape includes a variety of ecosystems, from the wetlands and riverine habitat along the Brahmaputra River, and alluvial grasslands and subtropical broadleaf forests, to temperate broadleaf forests, mixed conifer forests, and even alpine habitats in Arunachal Pradesh, the species diversity is high. Some of the Juvenile and sub-adult mammals show seasonal migration especially the tigers disperse from natal areas to establish territories elsewhere, and elephants exhibit seasonal movements along the length of the mountains. In the Higher up the mountain landscape, blue sheep and Takin undertake seasonal migrations from the alpine meadows in the summer to the mixed conifer forests below in the winter. Such ecological phenomenon is also important components of biodiversity that should be included in a conservation strategy.

The order Pholidota represented by two species in India *viz., Manis pentadactyla, Manis crassicaudata,* the former is well distributed in the state. The order Rodentia is the largest order next to Chiroptera, characterized by chisel like incisors in each jaw and in Arunachal Pradesh they are represented by three family, 19 genera and 31 species. The Order includes the lone endemic species Namdapha flying squirrel (*Biswamoyopterus biswasi*) restricted to the temperate broadleaf forests of the Eastern Himalayas. The family Sciuridae includes 10 species including *Biswamoyopterus biswasi;* the family Muridae represented by 19 species and the the family Hystricidae represented by 2 species. Among the members of the order Sciuridae, *Ratufa bicolor gigantia* lives on high trees in dense forests and never comes to ground. The monotypic genus *Belomys* includes only one species *Belomys pearsoni.* The subfamily Arvicolinae under the family Muridae includes *Eothenomys melanogaster,* which according to Wilson and Reeder (1993) did not include India within the scope of distribution of this species. However, Corbet and Hill (1992) on the basis of Hinton (1923), kept the state of Arunachal Pradesh within in its range. Among the subfamily Murinae, *Berlymys bowersi* is a nocturnal fossorial species commonly found in the primary forests and in the highlands above 600 m. *Vandeleuria oleracea,* on the basis of the examination of the material by Agrawal (2000) recognized the *olearacea* species to be distributed in Arunachal Pradesh. On the basis of the collections made Agrawal (2000) confirmed the taxonomic status of *Rattus nitidus,* that there is no difference between the *R. nitidus nitidus* and *R. nitidus obsoletus* and hence the subspecies R *nitidus obsoletus* is considered as the sysonym of *R nitidus nitidus.* The Bamboo rats in Arunachal Pradesh in particular and northeastern Himalyan states is very important as they are related to the flowering seasons of the bamboo shoots belongs to the subfamily Rhizomyinae of Muridae. These rats are heavily built provided with strong claws for digging and have adapted for fossorial habits in the hilly terrains of the state. The subfamily represented by *Cannomys badius.* The family Hystricidae commonly includes porcupines includes two genera and two species viz., *Atherurus macrourus* and *Hystrix brachyura subcristata.*

Insectivores are small, with pointed snout with body covered with closely set fur and short limbs. The family represented by two families Soricidae which includes *Suncus murinus soccatus* and *Suncus murinus griffithi.* Both the species includes a number of genetically distinct populations resembling that of a semi species. The other one is a monotypic genus represented by *Anourosorex squamipes.* The family Talpidae includes animals with short velvety fur represented by a lone species *Euroscaptor micrura* which was earlier treated under the genus *Talpa* by Ellerman and Morrison-Scot (1951), revised by Abe et.al. (1991) as *Euroscaptor.* The family Scandentia represented by a lone species *Tupaia belangeri assamensis.* The state of Arunachal Pradesh is known for the distribution of flying mammals under the order Chiroptera which includes 14 genera and 22 species out of 112 species known from India.

Seven species of primates are distributed in the state including the ape *Bunopithecus hoolock. Trachypithecus geei* (Golden langur); *Trachypithecus pileatus* (Capped langur comparatively better distributed than the other species in the northeastern states); *Semnopithecus schistaceus; Macaca arctoides* (Stump tailed macaque); *Macaca nemestriana; Nyctecebus coucang.*

Altogether, the mammalian fauna of the state is represented by 105 species and subspecies under 58 genera, 25 families and 9 orders, of these 4 species are new records to the state and also includes the lonely endemic species described earlier by the scientists of the Namdapha Biospehre Reserve Expedition party during 1985. Records of several species are also available but as these were not sighted nor any collection made by the scientists of the Survey. These mammals includes *Platenista gangetica, Golunda ellioti, Hemitragus jemlachicus, Taphozous nudiventris, Episticus tatei, Tylonycteris pachypus, Ursus arctos, Psedois nayaur, Caprolagus hispidus, Mustela kathiah, Manis crassicaudata, Sus salvinus* and a few others.

Several species are very significant as they are collected by various expeditions and can be seen from the distribution of the following species: *Soriculus nigriscens,* (First recorded from Mishmi hills by Thomas 1922), *Soriculus leucops (First record by Thomas 1914), Suncus murinus, Suncus etruscus, Crocidura attenuata, Anourosorex squamipes, Chimarrogale himalayica, Tupaia belangeri* (first record by Thomas, 1922), *Callosciurus pygyrythrus (originally recorded by Thomas 1908), Eothenomys melanogaster* (First recorded by Hinton 1923), *Dacnomys millaridii* (First recorded by Thomas 1922 from Mishmi hills), *Ninivneter brahma,* (First recorded by Thomas 1914) and few others.

INVERTEBRATES

No record of free living protozoa exists in the state. Several publications are available on the parasitic protozoa, especially in respect of transmission of malarial parasites, besides several cases of coccidian in the livestock causing severe damage to the bioresource. The present study indicates the distribution of 72 species (43 species of free living, 20 parasites and 9 species are symbionts) distributed in 11 districts, of which 3 species are new records to the country and 62 species are new records to the state. Distribution pattern of protozoans indicates the preponderance of free living in Debang valley, parasitic in Changlang and symbionts in Tirap districts. In comparison to the above, Lower Subansiri dominates in species distribution followed by West Siang, East Siang, Debang Valley, Lohit, Tirap and Changlang. The free living ones are associated with moss plant, parasitic ones are in frogs, toads, birds, livestock and man while the symbionts occur on the termite hosts.

Leeches constitute the major group of annelids recorded from the state, the earliest record dates back to Moquin–Tandon (1826), Moore (1924) and Chandra (1991), presently includes 7 species. The trematode fauna of the state consists of 8 species distributed under 6 genera and 6 sub-families parasitizing the amphibians distributed in 9 districts.

Arthropods are represented by members belonging to Crustacea, Arachnida and Insecta. Wood-Mason (1872), Alcock (1910) and Bott (1972) are the pioneer workers in the systematics of crustaceans from various parts of the country including Arunachal Pradesh. The present exploration includes seven species of palemnoid prawns and six species of potamonid crabs, of which 8 species are first records from the state. Abor Expeditions by Kemp (1911), Pioneering works of Pocock (1900) from Assam frontier, Northeast Arachnid

fauna by Gravely (1911-1925), recently by Tikader (1959-86), Tikader and Bastwade (1983), new description of three species of scorpions from Namdapha Biosphere Reserve are significant contributions in the field of arachnid taxonomy of the northeast India in particular. Besides the distribution of 3 species from the lower foothills of the state, the investigation also includes the description of a new species of scorpion (*Chaerilus dibangvalleycus* sp.nov.) from the family Chelicerilidae and a new species from Scorpiopsidae (*Euscorpios kamengensis* sp.nov.). From among the family Thalyphonidae, the authentic confirmation of the distribution of *Uropoctus asssamensis* from 4 districts of the state are available. Recently, Bastwade (2004) described a new species of Schizomidae (*Schizomus arunachalicus* sp.nov.) and a species of Opalinida (*Gnomulus roingii* sp.nov.) from the state thus totaling 4 new additional species of arachnida. 58 species of spiders are presently found distributed in the state, under 28 genera and 11 families of which 4 species belonging to 4 genera are new to the science (*Storena dibagensis* sp. nov., *Phidippus tirappensis* sp. nov., *Neoscona bomdilaensis* sp. nov., and *Nephila dirangensis* sp. nov) and 25 species are first records from the state and 15 species exclusively from eastern Himalyan states. 21 species of Ixodid mites belonging to 8 genera of a single family are known, of this, 2 species are new records to the state, 7 are restricted to northeastern state, one exclusive restricted to Arunachal Pradesh and the rest are widely distributed in the country. Among the Oribatid mites, 35 species are known from the state belonging to 30 genera and 20 families. All species are reported for the first time from the state of Arunachal Pradesh, besides 3 species which are likely to be new species awaiting confirmation. Of the 35 species, 21 are restricted to the eastern Himalayan foothills.

INSECTS

The eastern Himalayas and hills of Assam and Arunachal Pradesh in the northeast India with tropical evergreen forests form a paradise of maximum number of species and populations of species. The present account is of a small group of insects from the state and when fully explored the diversity of the state in particular and the country in general is likely to go beyond the present day estimate. Though the earliest Collembolan studies in India dates back to the work of Ritter (1911), Imms (1912), Carpenter (1913), Handschin (1920), but the account on Arunachal Pradesh comes from Mitra (1975) from Namdapha Biosphere Reserve. The present contribution enumerates the species description of 27 species under 15 genera and 3 families. Of these, several of them are widely distributed (*Xenylla obscura, Dicranocentrus simplex, Siera indica, Cyphoderus javanus, Tomocerus mitrai, Dicranocentroides flaviscens, D. fasciculatus, Salina indica, S. Montana,* Isomurus balteatus), a few of them are exclusively known from Northeast Indian states (*Lobella kraepilini, Lepidocyrtus caudatus, L. magnificus, L. heterolepis, L. cyaneus, Lepidosira unguserrata, Sinella curviseta, Homidia cingula, Dicranocentroides salmoni, Salina striata, Callyntrura japonica,* while *Lepidocyrtus curvicollis* is known exclusively from Arunachal Pradesh.

The first record of Odonata from Northeastern India dates back 1768 by Linne and Johannson and the earliest record available from Arunachal Pradesh is from Lahiri (1977) and later on by various workers. The present record reveals 92 species and subspecies

distributed over 50 genera, 11 families and 2 suborders. Of these, 65 species are widely distributed, 24 species are having records from northeast India and 3 species are exclusively recorded from Arunachal Pradesh and are known by types. An interesting pattern of distribution of odonates observed, a maximum number of species found in Subansiri district followed by Siang, West Kameng and Dibang valley districts. Among these districts the middle reaches of tree line show maximum diversity than the lower reaches of the state. Another interesting pattern of distribution recorded, as many as 25 species from Tirap district which is adjacent to Myanmar, Assam and Nagaland trijunction.

Records of Acridid insects are known from the work of Hancock (1913), and recently by Tandon *et al.*, (1976), Tandon and Khera (1978) from Arunachal Pradesh. The present survey reveals a sizeable number of acridid insects to the extent of 47 species belonging to 33 genera and 2 families. Among them 29 species are widely distributed, 12 species are restricted to northeastern India while 3 genera (from literature) and 3 species are recorded from Arunachal Pradesh only. Acridid distribution further indicates greater diversity in West Siang (16 species) followed by Upper Subansiri and Debang Valley (15 species each), Lower Subansiri (13 species), West Kameng (11 species), East Siang (4 species), Upper Siang (3 species), East Kameng, Tirap, Papumpare 2 species each and no records from the districts of Tawang and Changlang. Of the 47 species recorded from different districts, *Xenocatantops humilis* distributed in 6 districts, *Stenocatantops splendens* and *Phlaeoba infumata* distributed in 5 districts, *P attenuata* and *Trilophidia annulata* in 4 districts, 10 species in 3 districts, 2 species in 9 districts, 23 species distributed either alone or in places where others have been recorded.

The order Blattaria (Dictyoptera) though well studied by various workers viz., Kirby (1904), Shelford (1910), Hanitsch (1929) and others on the Indian soil, has no comprehensive work from the state. The present study indicates the distribution of 20 species under 14 genera and 6 families, of these 6 species are new records, and the rest are cosmopolitan in their distribution. The distribution of blattids indicate that they are recorded from ten districts of which East Siang and Papumpare dominate followed by Dibang Valley, West Siang, Lower Subansiri, Tirap, Lohit, Upper Subansiri and Changlang districts.

The present investigation includes 73 species belonging to 14 genera of Scarabaeid beetles of the subfamily Coprinae, though the total number of species of coleopterans when completed will be 10 times the present number given in the present fauna of the state. Of these 19 species are new records to the state. The distribution pattern of dung beetles indicates maximum number of species at Changlang, the district adjacent to Myanmar, followed by Papumpare (17 species), Dibang Valley, the lower Dibang showing better distribution than the upper Dibang Valley. The East Siang, West Siang and the Lower Subansiri shows the same pattern of distribution, equally true in case of Upper Siang, Tawang, Lohit and Tirap districts in respect of the species distribution. Least number of species recorded is from East Kameng followed by West Kameng and Upper Subansiri districts.

Dipteran includes 6185 species under 1091 genera and 87 families from India and the largest group of insects next to coleoptera. The present analysis includes only 19 families out of 87 families known from the country, consisting of Syrphidae with 50 species, Bombylidae (9 species), Stratyomyidae (10 species), Tabanidae (24 species), Ailidae (15 species), Empidae (1 sp.), Dolichopodidae (1 sp.), Pipunculidae (2 species), Conopidae (3 species), Tephritidae (26 species), Sciomyzidae (1 sp.), Sepsidae (6 species), Calliphoridae (15 species), Sarcophagidae (15 species), Muscidae (32 species), Tuplidae (23 species), Culicidae (19 species), Simulidae (6 species), Bibionidae (8 species), Sciaridae (5 species) thus totaling 269 species of dipterans from the state.

It may be concluded that the generic representation of the family is nearly 28% while the species representation is only 5.19 from the known dipteran insects, and hence a large scope exist for the unrepresented families of the order Diptera. It is interesting to know four species of syrphids are distributed in the adjacent southeast Asian countries such as Myanmar, Borneo, Jawa and Malaya, 16% of the species are confined to India, 20% to the Oriental Region, 32% extends beyond up to Palaearctic 10% each to Ethiopean and Australian and only one species appears to be cosmopolitan in distribution. The distribution of Bombylids appears to be related to the wet and hilly areas of the Himalayan state of Arunachal Pradesh. Among the 51 species under 5 families of Brachycera, 13 species are confined to Arunachal Pradesh, 4 species to India, 33 species extend up to the boundary of the Oriental Region and a lone species extend beyond up to Japan and Korea. Among the 68 species distributed in 7 families of Cyclorrhapha, a maximum number of species (26) distributed in the district of Tirap which is adjacent to Myanmar, Assam and Nagaland trijunction. 15 species are restricted to Arunachal Pradesh, 49 species are found in Oriental Region and 19 species extend their distribution to Palaearctic region. Of the 32 species of Muscids, 6 species are recorded for the first time from the state, only one species restricted to the Indian soil and the rest extend to Oriental, Palaearctic, Australian, Ethiopian regions of the world. Of the 61 species under five families of Nematocera, 7 species are confined to India, and nearly 44 species extend their range in the Oriental Region and 10 species beyond Oriental Region. It is also interesting to note the families Similiidae and Bibionidae are fully represented at the generic level in the state.

Major concentration of hymenopterous species is in the hilly and densely forested areas of the country and it is estimated that nearly 80–85% of the species remain to be explored from these areas. The present account deals only with two families of Hymenoptera viz., Formicidae and Sphaecidae. 63 species of Formicidae (ants) under 30 genera and 7 subfamilies; 33 species under 20 genera, 8 subfamilies are included in the family Sphaecidae (commonly known as mud daubers and hunting wasps), of which 23 species are recorded for the first time from the state. Among the members of Formicidae, 5 species are exclusively known from Arunachal Pradesh, 12 species from eastern Himalayan states, 4 species share with Andaman and Nicobar group of Islands and the rest are widely distributed in India. District wise distribution indicates maximum in Lower Subansiri (18 species) followed by Papumpare (17 species), West Kameng (12 species), Lohit (11species), Tirap (6 species), Upper Subansiri and East Siang with 5 species

each and lowest recorded is from East Kameng with a lone species. Distribution of 33 species of Sphaecids indicate that 3 species are exclusive to Arunachal Pradesh, 9 species share with the Eastern Himalayan states and the rest are common and widely distributed and some of them extend their range in the Oriental Region, besides India.

FAUNAL RESOURCE IN NAGALAND

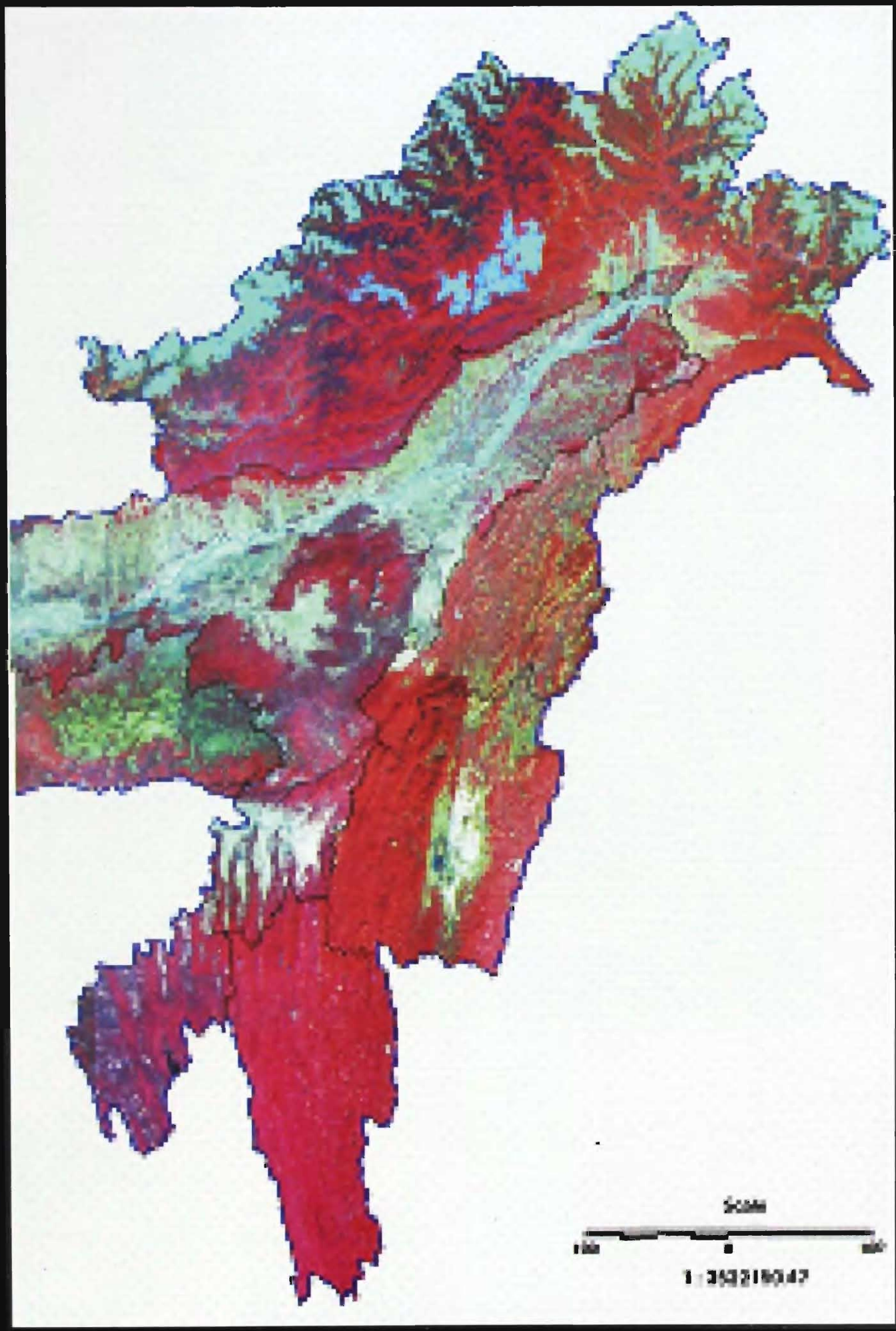
Nagaland, the hilly state of northeastern India approximately lies between 25°6' and 27°4' latitude, North of Equator and between the longitudinal lines 93°20'E and 95°15'E latitude, bounded by Arunachal Pradesh in north, Assam in the west, Myanmar in the east and Manipur in the south has an area of 16,579 km^2. This is predominantly a tribal state with valleys, meandering streams, high mountains, deep gorges and a rich variety of flora and fauna. The state is located at an altitude of 1495 metres above sea-level, the highest Peak: Saramati (3877 metres above sea-level). The Main Rivers are Dhansiri, Doyang, Dikhu, Milak, Zungki and Tizu.

The mammalian fauna of the state owes largely to the Mammal Survey of India, Burma and Ceylon conducted during the 1911 to 1930. Of the total of 397 species of mammals distributed in India, 92 species and subspecies are reported from the Fauna of Nagaland by Zoological Survey of India (2006). The order Scandentia includes *Tupia belangeri assamensis,* order Insectivora includes *Talpa micrura* and *Talpa leucura* (Family: Talpidae) and the family Soricidae includes *Suncus murinus griffithi* and *Suncus murinus soccatus, Crocidura attentuata rubricosa* and *Chimmaragole platycephala himalayica.* The order Chiroptera includes 4 species of megachiroptera and 14 species and subspecies of microchiroptera. Of these *Megaerops niphanae, Taphozous longimanus longimanus, Megaderma lyra lyra, Rhinolophus lepidus lepidus* and *Scotozous savilei* are new records to the state during the investigation.

Primates are represented by all the representatives of northeasten India viz., *Nycticebus coucang bengalensis, Macaca mulatta mulatta, Macaca assamensis assamensis, Macaca arctoides, Prysbytes pileatus pileatus, Presbytes pileatus durga* and *Bunopithecus hoolock.*

The order Pholidota represented by *Manis pentadactyla;* order Carnivora includes canidae represented by *Canis aureus indicus, Vulpes bengalensis* and *Cuon alpinus.* The family Felidae represented by 5 species, three species of *Felis* and two species of *Panthera,* all are common to Eastern Himalayan states. The family Herpestridae includes *Herpestes auropunctatus* and *Herpestes urva.* Family Mustelidae represented by *Martes flavigula, Mustela kathiah, Melogale moschata milisi, Arctonyx collarais, Lutra perspicillata* and *Aonyx cinera concolor.* Family Ursidae represented by *Selenarctos thibetanus;* family Viverridae represented by 5 species *(Viverra zibetha zibetha, Viverricula indica indica, Paradoxurus trivarigata millsi* and *Paguma larvata).*

The order Proboscidia represented by the lone species *Elephas maximus indicus,* the elephant population present in small habitat patches. The even toed Artyodactyles are represented by four families in Arunachal Pradesh; the family Suidae represented by *Sus*



Satelite Map of Northeast India

A close view of Macrophyte-infested Loktak Lake aroung Thanga, Manipur

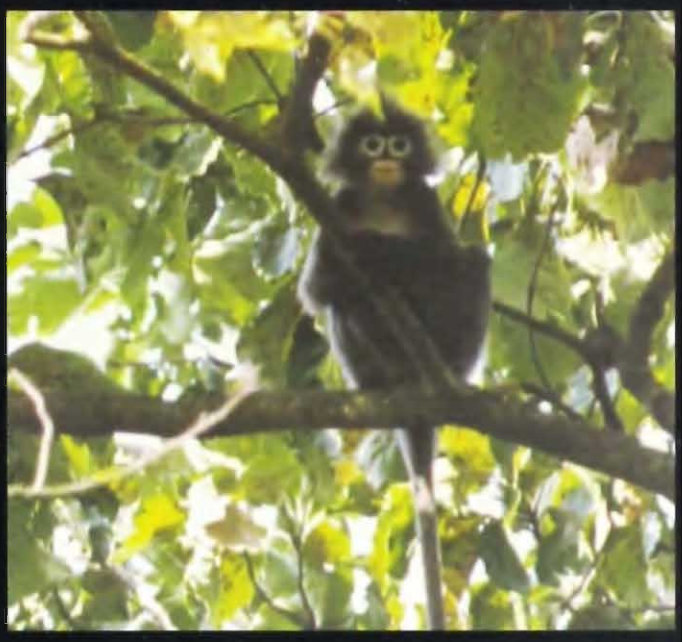
Manas Landscape

Pakke Landscape

Neo Dihing River at Namdhapa

Hoolock Gibbon, *Bunopithecus hoolock*

Capped Langur, *Trachypithecus pileatus*



Phayre's Leaf Monkey, *Trachypithecus phayrei*

Assamese Macaque, *Macaca Assamensis*

Golden Langur, *Trachypithecus geei*

Cephosia biblis tisamena (Red Lacewing)

Pantoporia hordonia hordonia (Common Lascar)

Acetolepis puspa (Common Hedge Blue)

Precis iphita iphita (Chocolate Soldier)

Lebadea martha martha (Knight)

Euploea core coe (Common crow)

Curetis dentata (Angle Sunbeam)

Cirrochroa aoris aoris (Large Yeoman)

scrofa cristatus; the family Cervidae represented by *Muntiacus muntjak vaginalis*. The family Bovidae represented by *Capricornis sumatraensis* and *Bos frontalis* (a domesticated stock especially, *Bos gaurus* a synonym of *Bos frontalis*). The order Lagomorpha represented by a single species *Lepus nigricollis*. The order Rodentia includes the family Sciuridae includes 13 species including; the family Muridae represented by 15 species and the the family Hystricidae represented by 1 species and the family Rhizomyidae represented by 2 species. Among the members of the order Sciuridae, *Belomys pearsoni is the eastern Himalayan representative* a fossorial species lives in dense forests. *Petaurista petaurista yunanens is* is the exclusive representative of the state, *Hylopetes alboniger alboniger*, 3 species and subspecies of *Callosciurus* and 2 species of *Dremomys* are the eastern Himalayan representative. On the basis of the collections made, the family muridae represented by 7 species of *Rattus*, 4 species of *Mus* and 2 species of *Bandicota*. The family Rhizomyidae represented by *Cannomys badius* and *Rhizomys pruinosus*. The family Hystricidae commonly includes porcupines *Hystrix brachyura*. Of the species mentioned above, *Ratuus ratuus arboreus, Bandicota savilei* are recorded for the first time from the state and the the later species *(Bandicota savilei)* has been reported for the first time from the country.

Comprehensive report on the avian fauna initially came from the work of Blyth (1845-1865), Godwin–Austen (1870-1872), Baker (1907-1925), and several others followed by Ali and Ripley (1974), Ripley (1982) and the recent investigation from the scientists of the survey. The list includes 428 species, under 205 genera, 50 families and 16 orders of which the family Muscicappidae with 174 species and subspecies forms the largest representative of the avian fauna of the state. The reptilian fauna was first investigated by John Butler an Anthropologist (1872) who made collections from Naga Hills of the state. The present faunal exploration includes 62 species of which 6 are testudines, 15 species of lizards, 41 species of snakes of which Typhlopidae includes 3 species, Boidae 1 species, Colubridae-30 species, Elapidae- 4 species and Viperidae includes 3 species. Of the above, *Pangshura sylhetensis* and *Manouria emys* the two species are the northeastern representatives. 5 species viz., *Cosymbotus platyurus, Calotes emma, Draco maculatus, Draco norvilli, Plactolaaemus gularis* and *Ophiosaurus gracilis* are new to the state. Nearly 25 species are the northeastern representatives. The amphibia represented by 10 species under 5 genera and 4 families, the species diversity in comparison to other northeastern states is less however, needs further exploration in the unrepresented areas. The report includes 2 species of eastern Himalayan representatives. The fish fauna of Nagaland includes some of the rare description such as *Erythistes hara, E. elonga* and *Danio aequipinnatus* by Day (1889), *Rasbora rasbora* and *Rhynchobdella dhansharii* by Hora (1921), 44 species from Naga hils by Hora and Mukerjee (1935) from Tuzu River and its tributaries, fishes from Naga Hills by Hora (1935) and Menon (1954) are important. The present day diversity of the state is 108 species under 57 genera, 20 families and 7 orders, of these 40 species are recorded for the first time from Nagaland and a rare specimen *Silurus indicus* was also collected from the state.

Invertebrate diversity represented by Protozoa dealing taxonomic account of 59 species from the state which includes 3 species of malarial parasites, 22 species of freeliving and

34 species of symbiotic species. Helminth parasite includes 14 species under 10 genera and 6 families. *Paramphistomum epiclitum, P cervi* from *Bubalis bubalis* host; *Calicophoraon calicophorum, Ceyllonocotyle dawesi, C streptocoelium,* from *Bos indicus, Fischoedirius elongates, F cobboldi,* from Goat, *Diplodiscus amphichrus, Ganeo tigrinum Haematoloechus almorai* are from *Rana cyanophlyctis, Opisthorchis noverca* from pig, *Fasciola gigantica* from cow and buffalo are some of the important findings of the investigation. Only freshwater molluscs are analysed from the state includes 21 species under 16 genera and 9 families. Bivalves are poorly represented by only 4 species. Of the 21 species of gastropods, 11 species are restricted to eastern Himalayan states and the rest are all having wide range of distribution. Three species viz., *Angulyagra microchaetophora* from Dimapur, *Trapezoideus dhanushori* from Dhanushori stream and *Shaerium austreni* from Naga hills are the type localities from the state. 16 species are new records to the state. Oribatid mites includes 16 species under 15 genera and 14 families, includes *Eremobelba indica* and *Allonothrus monensis* are the new species described from the state of Nagaland.

Among apterygotes of Nagaland, the Collembola is known better than the other 3 groups. It is represented by 15 species under 6 genera. Indeed, our knowledge on the Indian apterygote groups is poor and therefore, much more attention requires to be paid in order to reveal the tremendous biodiversity among them. Odonata is an economically and ecologically important group of insects, as they act as predators of flies, mosquitoes and moths besides being a consumer link in the aquatic food chain. The diversity of the group being comparatively better with nearly 48 species distributed over 32 genera, 9 families and 2 suborders. Orthopterans are represented by 11 species of Tettigonids, and Acrididae represented by 34 species under 24 genera and all are first record to the state. *Conocephalus laetus* is a new record to the state as well as to the country. Only seven families of the coleopteran has been analysed in the present context includes 45 species included under 25 genera of which 36 species are new records to the state and one new record to the country. Dipteran fauna of Nagaland is represented by the family Tachinidae (16 species, 14 genera) of which 4 are new species viz., *Dexia prakritiae, Dexia quadristriata, Paradrino pilifacies* and *Phorinia nigra* from Nagaland, 11 species are new records to the state. The Muscidae includes 6 species, all are new records to the state. Family Syrphidae includes 11 species of which Xylota *asamensis* and *Brachypalpus* dives are exclusive to the state. Nearly 36 species under 25 genera are included under 10 families are dealt in the fauna of the state, of which 17 species are new records, 5 species are confined to India, 15 species are distributed in the Oriental region, 4 species extended upto Palearctic and the other 5 species are cosmopolitan in distribution.

The butterflies, besides their aesthetic value, form an important object of display in natural history museums. The ecological significance of this group need not be underestimated, as their immature stages or caterpillars are largely herbivorous and form the primary consumer in the ecosystem. Butterflies are in turn fed upon by higher groups of organism such as amphibians, birds, lizards and other groups and thus form a link in the food web, besides being excellent pollinators. The butterflies and moths are represented

by the following families in the present investigation. The family Nympahlidae includes 138 species and subspecies spread over 62 genera and six subfamilies. Of these, seven species are endemic to Nagaland, 11 species are protected under Wildlife Protection Act, 1972 in Schedule–I (part-4) and 13 species are included under Schedule–II (part-2) and seven species are new records to the state. The family Papilionidae includes 43 species and subspecies in 9 genera. 3 species are included in Shedule–I (part-4) and 9 species under Schedule–II (part-II) of the WPA, 1972.17 species are new records to the state. Butterflies of the family Pieridae and Heperiidae includes 153 species, 3 species of Pieridae and 2 species of Hesperiidae listed in Schedule–II (part-2), 6 species of Hesperidae are included under Schedule–IV. 12 species of the former and 9 species of the later family are new records to the state. The family Geometricae includes 98 species of which 46 are restricted their distributin in India, 44 species are distributed in north India and 37 species to eastern Himalayan states and only 19 species are endemic to Nagaland. Moths belonging to the family Lasiocampidae and Lymantridae include 22 species, of which 10 are new records to the state.The moth family Arctiidae (28 species, 19 genera) and Ctenuchidae (11species, 5 genera) includes 39 species, of which 12 species are new records to the state.

MANIPUR

Manipur is geographically divided into two distinct tracts–hills and plains, the hill ranges running north-south abridging the Patkoi Hill range and the Lushai Hill range of the extended Arakan Yoma, and a central plain—the valley of Imphal roughly 48.27 km long and 31.18 km wide. The hills have an average height of 1,300 m (5,000 ft.); the valley, 660 m (2,500 ft) above sea level. Manipur's hill ranges form parts of the Indo-Burmese Mountain arc, often referred to as the eastern arm of the Himalayas. Though predominantly a hill state, it is watered by the many rivers Imphal, Iril, Thoubal, Irang and Barak, which flow from north to south. At its centre is Lake Loktak into which several rivers drain. Historically, the state of Manipur, was a part of Tethys sea in Archean period and continues to receive sediments of conglomerates and shales, sandstones and limestones of archean rocks. Repeated organic movements accompanied by extensive igneous intrusions occurred in the successive periods that influenced the geologic and tectonic alignments of the region.

Knowledge of the faunal resources of the state is well documented by the explorations conducted by various teams of scientists and naturalists; Erichson's (1834), Blyth (1863), Jerdon (1867), Godwin–Austen, (1868),Dobson (1876), Anderson (1881), Buttler (1885), Cotes & Swinhoe (1887-89), A.O. Hume (1888), Oates (1883-90), Lewis (1888-1894), Elwes (1891-92); Hampson (1892) Sclater (1891), Allen (1905), Distant (1908), Chaudhury (1912), Fruhstorfer (1913), Tytler (1914-15), Hora (1921), Prashad and Amin-ud-Din (1921), Gude (1914) and Preston (1915), Cameron (1930-39), Roepke (1944), Kohls (1948), Kapur (1952), Wynter-Blyth's (1957), W. Pettigrew from Ukhrul during 1908, followed by the work of C.S. Guthrie (1842), McClelland (1844), Barraud (1922), Brunetti (1923), I. M. Puri (1932) and F. Schmid (1960) are some notable naturalists.

The analysis of the faunal exploration and documentation by Zoological Survey of India brought out in two volumes reveal nearly 2601 species belonging to various categories in 1261 genera, 368 families, of which 5 are new to science, 509 species are new records to the state and 28 are new records to the country. Among these faunal groups insects dominate the number with 1220 species followed by birds with 586 species, fishes 141 species and molluscs 127 species.

Species of free living and 8 species of parasitic protozoa are recorded for the first time from the state. It is interesting to note that flagellates, rhizopods and cliates of Lake Kangla, Imphal (10, 17, 20 species respectively) has more or less the same number of species as that of the Loktak lake, Bishenpur (9, 18, 18). Of the 34 species of parasitic nematodes described from the state, the following three species are new to science and the genera; *Soboliphyme* is entirely new to the country : *(Pseudaprocta manipurensis, Soboliphyme manipurensis, Spirura manipuri)*

Records of 52 species of freshwater molluscs and 75 species of land molluscs are available from the state, of which 9 freshwater species and 17 species of land molluscs are recorded for first time from the state, *viz., Bellamya bengalensis, Cipangopaludina lecythis, Angulygra oxytropis, Brotia costula, Paludomus blanfordiana* and *Paludomus conica* among gastropods and *Lamelliedens marginalis, L.corrianus, L. generousu, Paresysa burmanus, P. occata* and *Trapezoideus exolens* among bivalves are available, and are sold in the local markets.

The phylum Arthropoda is remarkable in having the largest number of classes, orders, families, genera and species in India. Crustacea though a major class of the phylum is represented by only 9 species in the state. The Arachnida, another major class is known by 17 families under Acari and 11 families under Aranae represented by 27 and 30 genera and 41 and 52 species respectively.

India by virtue of her very rich evergreen and subtropical vegetation in the Eastern Himalayas and the adjoining areas in the state has a highly rich fauna of coleoptera with 42 families, 188 genera, 335 species. It is evident that the lepidopteron fauna is much more concentrated in the eastern Himalayas as far as the Myanmar border than in the other parts of the country. But the microlepidopterous fauna as well as several families of moths like Casteniidae, Neopseustidae, etc. are poorly known. On the basis of available information, it may be presumed that about 10-15% lepidopterans still await discovery. The present investigation reveals 61 families, 112 genera and 183 species, of which 26 are threatened (Schedule-I = 10 spp., Schedule-II = 16 spp.). Major concentration of hymenopterous species is in the hilly and densely forested areas with 19 genera and 35 species in the state. A great diversity of hemipterous insects is found in the state, with 31 families, 174 genera and 290 species. In fact, aphids attracted much more attention than several other groups. Likewise the other Himalayan belt, Manipur hills exhibit maximum concentration of the dipterous insects both qualitatively and quantitatively with 12 families, 56 genera and 91 species recorded in the state. It is true that the known fauna is far from satisfactory and it is estimated that the number of species still undiscovered, may exceed known ones from the state.

Besides the above major groups, the Orthoptera is ranked below with over 71 species. There are other orders, *viz.*, the Trichoptera with 25 genera and 114 species, Thysanura with single genera and two species, Ephemeroptera with 5 genera and 6 species and Odonata with 41 genera and 68 species. It is extremely difficult at this stage to estimate the actual diversity unless systematic exploration is undertaken all over the state. Several insect orders such as Neuroptera, Phthiraptera, Dermaptera, Siphonaptera, Embioptera, Mecoptera and the Strepsiptera are insignificantly known. The Blattaria are represented by 6 genera and 8 species. The state of Manipur is now represented by 64 genera and 141 species of freshwater fishes, representing 15.16 of the total Indian freshwater fishes of the country. Interestingly all the three living orders of Amphibia *viz.* Gymnophiana, Caudata and Anura are distributed in North-east India, but the state of Manipur is represented by a limited number, 14 species, which is an underestimate to the state. The reptile fauna is equally under represented by 6 genera and 19 species in the state.

The state of Manipur is well represented as far as the aves are concerned, out of total 1232 species and subspecies of birds known from the subcontinent (Alfred *et.al.* 2001), as many as 586 are represented in the state, which accounts nearly 48 percent of the total record. Among them 32 of 138 species are under threat as per IUCN guidelines. One out of nine listed is Critically Endangered (*Gyps bengalensis*), two out of ten species are Endangered (*Cairina scutellata* and *Buceros bicornis*); 17 out of 57 are classified as Vulnerable (*Anas formosa, Aythya baeri, Aquilla clanga, Falco naumanni, Perdicula manipurensis, Tragopan blythii, Syrmaticus humiae, Grus monacha, Grus antigone, Heliopais personata, Gallinago nemoricola, Columba punicea, Aceros nipalensis, Spelaeornis longicaudatus, Turdoides longirostris, Turdus obscurus* and *Sitta Formosa*) and 12 species out of 52 are classified as Near Threatened (Birdlife International, 2001). Important Bird Areas Programme of Bird Life International has also identified Ango Hills, Dzuko, Kailam, Siroi, Yangoupokpi, Bunning Wildlife Sanctuaries, the Loktak and Keibul Lamjo National Park, as conservation sites for birds in the state. 75 species and subspecies under 55 genera and 22 families of mammals are recorded from the state out of 397 species in the country. District wise distribution indicates the mammalian distribution is more concentrated in Imphal district with 36 species, followed by Senapati 28 species and Chandel 24 species. Among primates, two species *Nyctecebus coucang* (Slender Loris) and *Macaca arctoides* (Stump tailed Macaque) are restricted to Chandel district, *Macaca mulatta* and *M. assamensis* in Imphal while the *Bunopithecus hoolock* and *Presbytes pileatus* is restricted to the Senapati district. Of the 75 recorded species from the state, nearly 22 species are conserved under Wildlife Protection Act, 1972, besides including 5 species under Vulnerable, 4 species under Near Threatened (Lower Risk) and 2 with Data Deficient as per the IUCN guidelines. Mention may be made of a lone species of *Cervus eldi eldi* restricted to the state of Manipur and now under protection at Keibul Lamjao National Park, (declared on 28th March, 1977), with an area of 40 km^2.

167 species of fossilised animals, 2 trace fossils and 23 species of calcareous nannofossils are recorded from the state. The major composition of fossils consists of 68 species of foraminifera, 34 species of radiolaria, 4 species of coelenterata, 3 species of bryozoa, 5

species of crustacea, and 37 species of mollusca. The assemblage of microfauna of Ophiolite belt of Ukrul area was referred to late cretaceous age, while the fauna associated with the exotic blocks were of varying age from Paleocene to Upper Eocene.

Loktak Lake : Largest freshwater wetland of Northeast India, designated as the Wetland of International Importance during 1990. Loktak have considerable economic, ecological as well as cultural value to the state of Manipur. The important character feature of the lake is the presence of floating islands covered with vegetation, often called as the "Phumdis" of varying thickness. The largest and the continuous mat of Phumdis are located on the southern part near the Keibul Lamjao National Park, which is the home for the Sangai. Phumdis are locally used by the fishermen community for fishing in the lake, more than 2000 people live on Phumdis. Besides fishing, plant communities present on Phumdis are locally used for medicine, food, fodder as well as fuel. It is also believed that the phumdis play an important role in the ecological processes and functions of the lake, as they provide key nutrient and acts as biological sink to the key nutrients. The lake ecology has been altered by the construction of Ithai barrage across the Manipur River for the storage of water to generate electricity. This has also resulted in rapidly eroding the rich biodiversity of the lake.

CHAPTER–11

ISLAND ECOSYSTEM

Ever since the legendary works of Alfred Russel Wallace and Charles Darwin, islands have held a special place of reverence for evolutionary biologists, their isolation and general inaccessibility often preserves them as natural laboratories for evolutionary studies. Islands surrounded by water have been shown repeatedly to be dynamic and evolving communities regulated by the colonization and extinction of species. Study of species distribution patterns on islands especially the larger islands have more species led to a much better understanding of what controls the number of species that can be supported in a habitat, resulting in "The Theory of Island Biogeography" by Mac Arthur and Wilson, 1967. And according to them, the number of species on an island was the result of two opposing forces : immigration of species from other landmasses which increases species number, and local extinction. Evolutionary production of new species by local speciation will also increase species number, but at a very low rate compared to immigration. Larger islands have a greater shoreline and area available for colonization, so the rate of increase will be higher. They also support larger populations, so the rate of extinction is lower; therefore the larger islands will have more species. Other factors such as habitat diversity and distance from other landmasses will, of course, also affect the species number (P.J. Byrant, 2005).

Biogeographically, islands may be classified as either oceanic or continental. Oceanic islands typically have faunas that are ecologically and taxonomically unbalanced (incomplete). Continental islands generally have a more complete and balanced fauna that fills the available habitats and closely resembles that of the adjacent mainland portion of the continent. Separation of continental island and mainland terrestrial faunas is due to division of pre-existing faunas (vicariance) rather than to over water dispersal (Gibson, 1990*: Geoscience)*. The classification of islands is also continental, volcanic and coral, and each has its own particular kinds of soils. Continental islands are fragments of rock separated off from a big continent. They usually have many kinds of rock, and thus many kinds of soil, rich in fauna. Volcanic islands were built by molten rock (lava) coming up through the earth's crust; the lava either pours out and becomes rock, or is blown out and forms ash or loose sandy material (Two islands of volcanic origin are found here-the Narcondum and the Barren islands in Andaman Group. The former is now apparently extinct while the latter is still active). Coral islands are built of the accumulated skeletons of marine animals (mostly corals) and plants (coralline algae). These skeletal structures are made of calcium carbonate which makes limestone, exemplified by Lakshadweep group of Islands.

Geologically, Oceanic islands have also volcanic foundations, are concentrated in a number of distinctive inter- and intra- plate settings and have commonly experienced a

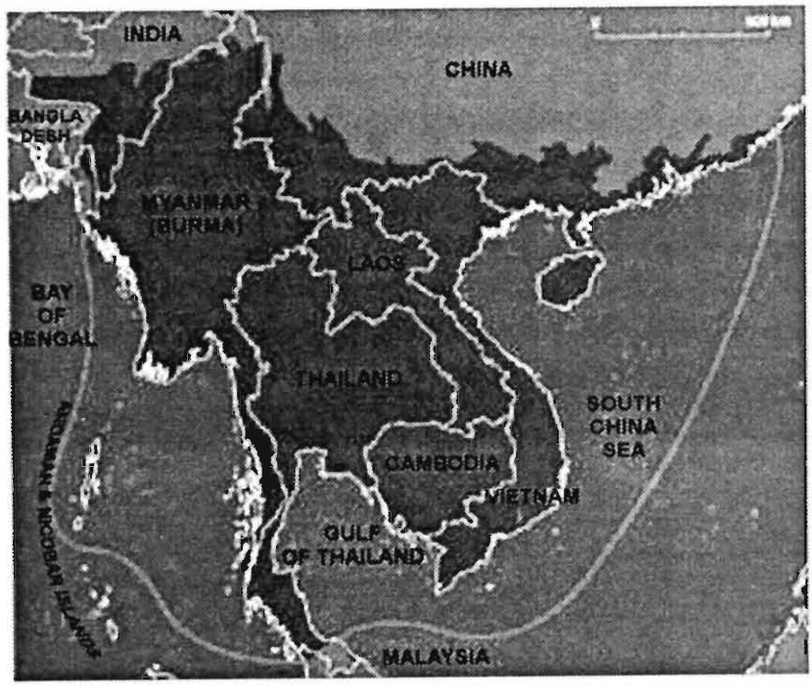
dynamic history involving lateral and vertical displacement. In contrast, Continental islands are pieces of continental crust that have broken off from a big continent and drifted out into the ocean. Because the rock of which they are made has come from a continental area, they can have many kinds of rock of different ages in a very complicated structure. As a result, they have many kinds of soils and may be rich in minerals. Some of the more obviously important environmental features of islands are directly related to the geological factors and include characteristic topographic, climatic and hydrological phenomena. Where as, the upward growth of reef-forming corals at times of relative subsidence have led to the formation of numerous islands of only a few metres elevation, contrasting with the generally steep topography of the volcanic high islands (exemplified by the Lakshadweep group of islands).

Therefore, the study of islands can provide evidence relating to several important questions such as speciation, methods of dispersal, and past events. It seems obvious that the distinctiveness of species on isolated volcanic oceanic islands must be a result of change in species. Distribution patterns indicate the relative dispersal abilities of organisms under past conditions. By comparing the characteristics of faunas from different types of islands, we may be able to improve our understanding of the history of our world (Darlington, P.J. 1966).

BIODIVERISTY OF ANDAMAN & NICOBAR ISLANDS : A CASE STUDY

Andaman and Nicobar groups of tectonically active islands are situated in the Bay of Bengal, mid way between peninsular India and Mayanmar, spreading like a broken necklace in the North-south direction. These islands are located between 6°45" and 13°41" North latitudes, and 92°12" and 93°57" East longitude. The group of Andaman and Nicobar islands are the summits of a submarine mountain range lying on the great tectonic suture zone extending from the eastern Himalayas along the Mayanmar border to the Arakan and finally Sumatra and Lesser Sundas. The northern most part of these islands is isolated from Cape Negrais in Southern Mayanmar by the North Preparis channel and the southern most part is also separated from the Acheen Head of Western Sumatra by the Great channel. There are two more deep channels – (i) the ten degree channel which isolates Andaman islands from Nicobar islands the (ii) the Sombero channel which isolate Great Nicobar from Nicobars and the Nancowrie group. There are more than 3000 islands, islets and rocks in the archipelago while only about 350 of them are of appreciable size. There are in all 349 islands which can be distinguished into two groups geographically. Islands located north of 10° N latitude are known as Andaman group of Islands while islands located south of 10° N latitude are called Nicobar group of islands. There are 325 islands in Andaman group while Nicobar group has 24 islands. Total geographic area of Andaman & Nicobar Islands is 8249 sq. km of which Andaman group of islands cover 6408 km^2, while Nicobar group cover 1841 km^2. Out of total 349 islands in only about 38 islands are inhabited by human beings – 26 in Andaman group and 12 in Nicobar group of islands.

Geologically, these islands belong to a geosynclinal basin. The rocks are highly folded due to frequent tectonic movements in past. The geological formations represent a period of sedimentation from cretaceous to sub-recent period. The surface deposits of gravel beds and raised soil covers are of recent origin i.e., less than 10,000 years. The present configuration of these islands took shape only about 26 million years ago. The physiography of these islands is characterised by undulating topography generally mountainous and intervening valleys. The configuration of the land clearly points to these islands being the visible ridges and summits of sunken range of mountains. Saddle Peak in North Andaman is located at a height of 732 m msl., while villages in Betapur and Diglipur constitute the main flat lands in the Andaman group. The islands in the Nicobar group are surrounded by coral reef and shallow seas with long narrow stretches of sandy beaches. Car Nicobar, Trinket and Katchal are almost flat while the others have hilly terrain. In Little Nicobar and Great Nicobar in the Nicobar group, the land surface is very irregular, cut up by steep hills and valleys. There is no major perennial fresh water river in these islands except Kalpong in North Andaman, Alexendra, Dagmar and Galathea river in Great Nicobar. There are several rainfed streams which dry up during summer. The coastal line of these islands is wavy with large number of bays, lagoons and serpentine creeks, and extends to about 1962 km. At several places tidal creeks penetrate far inside the land and form outlets for fresh water streams.



Location map of Indo Burma Hotspot, which includes Andaman & Nicobar Islands

FOREST COVER

The Andamans and Nicobar islands have tropical evergreen rain forests and tropical semi-evergreen rainforests as well as tropical monsoon moist forests (IUCN, 1986). The tropical evergreen rain forest is only slightly less grand in stature and rich in species than

on the mainland. The dominant species is *Dipterocarpus grandiflorus* in hilly areas, while *Dipterocarpus kerrii* is dominant on some islands in the southern parts of the archipelago. The monsoon forests of the Andamans are dominated by *Pterocarpus dalbergioides* and *Terminalia* spp. 92.2% of the total geographic area of Andaman & Nicobar Islands is under forest cover 1999 (Forest Survey of India, 1999). Dense forests with a crown density of 40% and above, constitute 85.6%, Open forests with crown density less than 40%, constitute 1.7% Mangroves constitute 12.7%. District-wise and Category-wise forest cover

Details of forest cover in A & N Islands (1999 Survey, Area in Sq. km)

District/Category	Dense	Open	Mangrove	Total
Andaman	4,864	90	929	5,883
Nicobar	1,651	35	37	1,723
Total	**6,515**	**125**	**966**	**7,606**

In contrast, the total area recorded as forests as per the Forest Cover Estimation by FSI 2003, is 6964 km^2 which constitute 84.42% of the geographic area of these islands, of this 3,475 km^2 has very dense forests, 2,809 km^2 with moderately dense forest and 680 km^2 of open forest. Category-wise details of recorded forests are given in the following table.

Forest Cover Change Matrix [Andaman And Nicobar]

(Area in Km^2)

2001 Assessment	2003 Assessment				Total 2001
	Dense Forest	Open Forest	Scrub	Non-forest	
Dense Forest	6281	228	0	84	6593
Open Forest	3	321	0	13	337
Scrub	0	0	0	0	0
Non-forest	0	131	1	1187	1319
Total 2003	**6284**	**680**	**1**	**1284**	**8249**
Net Change	**-309**	**343**	**1**	**-35**	

FOREST TYPES

Champion and Seth (1962) classified the vegetation of Andaman & Nicobar Islands into twelve forest types. However, these forest types are not distinctly demarcated and they imperceptibly merge into one another and form an intimate mixture.

1. Giant evergreen forests (1A/C1)
2. Andaman tropical evergreen forests (1A/C2)
3. Southern hilltop evergreen forests (1A/C3)

4. Andaman semi-evergreen forests (2A/C1)
5. Andaman moist deciduous forests (3A/C1)
6. Andaman secondary moist deciduous forests (3A/C1/2S1)
7. Littoral forests (4A/L1)
8. Mangrove (Tidal swamp) forests (4B/TS2)
9. Brakish water mixed forests (4B/TS4)
10. Submontane hill valley swamp forests (4C/FS2)
11. Cane brakes (1/E1)
12. Wet bamboo brakes (I/E2)

The Giant Evergreen Forests the most luxuriant type of multi tier forests occurring in deep alluvial soil near the banks of larger streams. The top canopy is evergreen and the forest mixes with the semi evergreen type. Main species include *Dipterocarpus gracilis, Dinochloa andamanica, Calophyllum soulattri, Artocarpus chaplasha, Amoora wallichii, Messua ferrea* etc.

The Andaman Tropical Evergreen Forests are similar to the giant evergreen forests but not so luxuriant, with more deciduous species. They occur mostly on hilltops. Major species include *Dipterocarpus grandiflorus, Xantho-phyllum andamanicum, Artocarpus chaplasha, Myristica andamanica, Planchoni andamanica, Calamus palustris,* etc.

The Southern hilltop evergreen forests occur on the exposed upper slopes and tops of hills and sometimes on steep slopes lower down. Major species include *Dipterocarpus costatus, Mesua ferrea, Canarium manii, Hopea andamanica* etc.

The Andaman semi-evergreen forests are luxuriant types of forests with many giant trees both of evergreen and deciduous nature. Climbers are often heavy. Occur in valleys, with more economic species in Andaman Islands. Important species include *Dipterocarpus* spp., *Terminalia bilata, Terminalia procera, Pterocarpus dalbergeoides, Pterocymbium tinctorium, Sterculia campanulata, Terminalia bialata, T. procera, Albizzia chinensis, A.lebbek* etc.

The Andaman moist deciduous forests are distributed extensively in Andamans but not so much in Nicobar group of Islands. Top storey is irregular with tall deciduous trees (nearly 40 m height) followed by a second storey which comprise numerous species including some evergreen trees. Important species are *Pterocarpus dalbergioides, Terminalia bialata, T.Manii, T.procera, Pterocymbium tinctorium, Tetrameles nudiflora, Dillenia pentagyna, Canaria euphyllum, Bambus spp.,* etc.

The Andaman secondary moist deciduous forests occur in worked over areas of the primary type. Major species include *Canarium euphyllum, Pterocymbium tincto-rium, Salmalia insignis, Tetrameles nudiflora, Terminalia manii, T. procera, Albizzia lebbek* etc.

The Littoral forests occur all round the coast wherever a fair width of sandy beach

occurs. *Manilkara littoralis* is the most characteristic species of this type in these islands. Other species include *Scavela frutescens, Hibiscus tiliaceus, Morind citrifolia, Terminalia catappa, Pandanus tectorius* etc.

The Mangrove forests (Tidal swamp forests) occupy shores, mouth of tidal creek, sheltered bays and inland channels of these islands. These are salt tolerant species and occupy 966 km^2 area of these islands. Important mangrove species are *Rhizophora mucronata, R.can-delaria, Bruguiera conjugata, B.parviflora B. gymnorhiza, Avicennia officinalis, Ceriops tagal, Kandelia candel, Sonneratia caseolaris, Excoecaria* etc. *R. mucronata* and *R. apiculata* occupy the outer seaward fringe forming clusters, *B. parviflora* and *B. gymnorhiza* abundant in tidal creeks, *Sonneratia* and *Avicenia* species occupy open mudflats while *Ceriops tagal, Kanelia candel, Xylocarpus granulatum, Limnitzera littorea, L. racemosa, Exocoecara agallocha* and *Aegiceras corniculatum* are generally distributed in the creeks.

The Brackish water mixed forests are considered finest development of tidal forests and may be a closed forest of 35 m height. These are found in larger deltas and creeks along the outer periphery and at places where salt water mixes with fresh water. Major species include *Heriteria littoralis, Barringtonia racemosa, B.asiatica, Brownlowia lanceolata, Nypa fruticans, Phoenix paludosa* etc.

The Sub-montane hill valley swamp Forests is an irregular forest of a limited number of mainly evergreen species. Trees are usually low, crowded and branchy. There is often a dense growth of *Calamus*, while *Ficus* and monocotyledons such as *Alpinia* often form the undergrowth.

The Cane brakes are found through out the evergreen and semi-evergreen climaxes and locally in moist deciduous forests. Cane brakes are impenetrable thorny thickets sometimes with a few tall trees. Major species include *Calamus* spp. and sometimes creeping bamboo –*Dixochloa andamanica.*

The Wet Bamboo Brakes are often very dense and occur throughout Tropical evergreen tracts of Andamans. Major species include *Dendrocalamas brandisi, Oxytenthera spp, Bambusa schizostachyoides.*

TAXONOMIC DISTINCTNESS

One of the key observations of Darwin Wallace was that islands tended to host very distinct but limited sets or species–on a given island a spectacular collection of one related group of species would be present and thriving, but many entire families or even higher taxa would be completely absent. This is sometimes called an unbalanced fauna. The distinctness can be very well understood while studying the many faunal groups of the region especially mammals, birds, snakes and even selected species of invertebrates of the region.

Zoo-geographically, Andaman & Nicobar Islands are located in the Indo-Malayan region, which is considered as the "faunistic centre" from which the other subdivisions

of the Indo-Pacific region recruited their fauna (Ekman, 1953). Faunal distribution in these islands is influenced by fauna of both Indo-Chinese and Indo-Malayan regions. According to Smith (1930), Andaman islands exhibits impoverished Bumese fauna and the fauna of Nicobars approximates to Sumatran type. However, absence of Malayan species especially ungulates, carnivores and flying lemurs are noteworthy. Ripley and Beehler (1989) while analysing the breeding behaviour of the birds suggested that the major part of colonization of island birds is along a single route from south western Myanmar via a series of water barriers which acted as filters. They also suggested that the Nicobarese avifauna has higher affinity to the Myanmar than that of Sumatra. It is for this reason rightly, Andaman and Nicobar have been considered as the Indo-Burma Hotspot. Large mammals are absent in both Andaman and Nicobar Islands, except the introduced one. Northern Palm squirrel was not noticed during Boden Kloss's visit to these islands (1902) appears to be recently introduced. According to Darlington, Crab eating macaques, wild pigs, and palm civets were introduced in to these islands. These survived for a long time and evolved as an endemic species. Geographic isolation of these islands has resulted in high degree of endemism. The surrounding seas are equally rich in marine biodiversity, but the endemism is more pronounced in land animals. It is generally assumed that the more distinctive a species is, the older it must be. However, this may not be true. The distinctiveness of species on isolated oceanic islands may be a reflection of the degree of isolation rather than the amount of time involved. Without competitors or predators, aberrant individuals might survive and give rise to a new species able to adapt to a different ecological niche. Such species might be expected to be vulnerable to extinction if competitors or predators were to become established in their habitat. This may help to explain why many island species have become extinct or are endangered as man and his associated animals move in.

Distinctness is also noticed in the form of dwarfism and gigantism, resulted probably as an evolutionary change. Two endemic Serpent eagle species, *Spilornis elgini* and *S. klossi* are distributed in Andaman and Nicobar islands respectively. Both species are having smaller in size and wings than the sister species viz., *Spilornis cheela*. Furthermore, the Nicobar species *Spilornis klossi* is smaller than the Andaman species of *S. elgini*. In comparison to dwarfism, Green Imperial Pigeon *Ducula aenea* and Red cheeked Parakeet, *Psittacula longicauda* the Nicobar species are larger than the Andaman species.

Andaman and Nicobar group of islands are of special significance, in addition to its biodiversity, is the home to several groups of indigenous tribes. Mention may be made of the Great Andamanese, once abundant now restricted to pockets and the current number is estimated to be below 50 persons. The Onge tribes are less than a hundred now. The other tribes of Andamans are the Sentinelese and the Jarawa, with whom the government has initiated the contact process since 1974. The Nicobari and the Shompen tribes are found in Nicobar group of Islands whose number is also less than 500. Besides the indigenous tribes of the island, several settlers from Myanmar and from Chotanagpur belt have settled in the Middle Andamans and Baratang islands respectively. The refugees from East Pakistan have settled in Diglipur area while the settlers from Sri Lanka are

located near Katchal Islands of Nicobar. A large number of other settlers from Andhra Pradesh, West Bengal, Tamilnadu, are also found in the Islands.

Endemic Vertebrates of the Bay Islands occurring in Great Nicobar Biosphere

Species	Common Name	Distribution
Mammals		
Tupaia nicobarica nicobarica	Nicobar Tree shrew	Nicobar
Macaca fuscicularis umbrosa	Nicobar Crabeating Macaque	Nicobar
Sus scrofa nicobarica	Nicobar wildpig	Nicobar
Aves		
Gorsachius melanolophus minor	Nicobar Tiger Bittern	Nicobar
Accipiter badius obsoletus	Katchal Shikara	Nicobar
Spilornis klossi	Great Nicobar Serpent eagle	Nicobar
Spilornis minimus	Nicobar Crested Serpent eagle	Nicobar
Megapodius nicobarensis abbotti	South Nicobar Megapode	Nicobar
Ducula aenia nicobarica	Nicobar Green Imperial Pigeon	Nicobar
Columba palumboides nicobarica	Nicobar Wood Pigeon	Nicobar
Macropygia rufipennis tiwarii	Nicobar Cuckoo Dove	Nicobar
Chalcophaps indica augusta	Nicobar Emarald Dove	Nicobar
Caloenas nicobarica nicobarica	Nicobar Pigeon	Andaman & Nicobar
Psittacula caniceps	Blyth's Nicobar Parakeet	Nicobar
Psittacula longicauda nicobarica	Nicobar Redcheeked Parakeet	Nicobar
Otus scos nicobaricus	Nicobar lesser scops owl	Nicobar
Ninox affinis rexpimenta	Nicobar Hawk Owl	Great Nicobar
Collocalia esculenta affinis	Whitebellied Swiflet	Andaman & Nicobar
Collocalia fuciphaga inexpectata	Andaman Greyrumped Swiflet	Andaman & Nicobar
Ceyx erithacus macrocarus	Andaman Three-toed Kingfisher	Andaman & Nicobar
Pelargopsis capensis intermedia	Nicobar Storkbilled Kingfisher	Nicobar
Halcyon chloris occipitalis	Nicobar Whitecollared Kingfisher	Nicobar
Pitta sordida abbotti	Nicobar Greenbrested Pitta	Nicobar
Oriolus chinensis macrourus	Nicobar Blacknaped Oriole	Nicobar

Species	Common Name	Distribution
Dicrurus paradisius tytleri	Andaman Glossy Stare	Andaman & Nicobar
Gracula religiosa halibrects	Nicobar Hill Myna	Nicobar
Terpsiphone paradise nicobarica	Paradise flycatcher	Andaman & Nicobar
Monarcha azurea nicobarica	Nicobar Blacknaped Monarch	Nicobar
Zoothera citrine albugaris	Nicobar Ground Thrush	Nicobar
Nectarinea jugularis klossi	Nicobar Olivebacked Sunbird	Nicobar
Aethopyga siparaja nicobarica	Nicobar Yellobacked Sunbird	Nicobar
Zosterops palpebrosa nicobarica	Nicobar Whiteeye	Andaman & Nicobar
Reptilia		
Dassia nicobarensis	Nicobarese Tree Skink	Nicobar
Lipnia macrotymphanum	Small eared Island Skink	Nicobar
Dibamus nicobaricum	Nicobar worm lizard	Nicobar
Varanus salvator andamanensis	Andaman water monitor	Andaman & Nicobar
Dendrelaphus picta andamanensis	Andaman painted	Andaman & Nicobar
Bioga wallachi	Bronzeback Tree Snake	Nicobar
Cyrtodactylus adleri	Nicobarese Bent toed Gecko	Great Nicobar
Amphibia		
Polypedates insularis	—	Great Nicobar
Limnonectes shompenorum	—	Great Nicobar

Faunal diversity and endemism in Andaman & Nicobar Islands

Animal Group	No. of species / subspecies	No. of endemics	%Endemism
Terrestrial Fauna			
Mammalia	56	32	57.14
Aves	270	92	30.04
Reptilia	85	23	27.06
Amphibia	18	5	27.67
Fishes (freshwater)	13		

Animal Group	No. of species / subspecies	No. of endemics	%Endemism
Mollusca	110	77	70.00
Arachnida	94	38	45.16
Myriapoda	22	-	-
Insecta	2506	485	21.50
Annelida	30	9	30.00
TOTAL	**3204**	**761**	**23.75**
Marine fauna			
Mammalia	7	-	-
Reptilia	12	-	-
Pisces	1,200	2	0.2
Echinodermata	336	4	0.6
Mollusca	1,010	18	1.9
Sipunculida	2	*	*
Gastrotricha	32	6	18.8
Kinorhyncha	4	2	50.0
Crustacea	607	56	9.2
Polychaeta	186	4	2.2
Anthozoa	326	2	0.6
Porifera	91	-	-
Meiofauna	490	102	21.0
TOTAL	**4,301**	**196**	**4.56**

Insect Fauna of Andaman & Nicobar Islands

Order	Number of						
	Family	Genera	Species	Andaman Islands	Nicobar Islands	Endemic species	%Endemic
1. Collembola	3	8	8	8	-	-	-
2. Ephemeroptera	1	1	1	1	-	1	-
3. Odonata	11	37	59	44	34	11	18
4. Orthopera	11	67	96	73	48	16	16
5. Phasmida	4	4	5	5	1	-	-
6. Dermaptera	6	12	14	9	5	7	50

Order	Number of						
	Family	Genera	Species	Andaman Islands	Nicobar Islands	Endemic species	%Endemic
7. Embioptera	1	1	2	2		2	
8. Blattaria	4	9	15	11	10	1	6.6
9. Mantodia	2	4	5	2	3	2	40
10. Isoptera	3	12	38	26	22	21	55
11. Phithiraptera	2	4	4		4		
12. Hemiptera	47	195	265	225	69	45	16
13. Thysonoptera	2	25	29	29		2	6.8
14. Neuroptera	5	9	13	9	6	3	23
15. Coleoptera	37	368	585	538	117	193	32
16. Siphonoptera	1	1	2	2			
17. Diptera	35	129	259	226	46	47	18
18. Leo\pidoptera	42	529	896	750	268	206	23
19. Trichoptera	8	15	24	23	1	17	70
20. Hymenoptera	28	135	186	155	40	30	16
Total	**253**	**1565**	**2506**	**2138**	**674**	**607**	**24**

A case study on the Faunal richness in Mount Harriet National Park, South Andaman

Groups	No. of Species	Endemic species
Phylum Annelida		
Class Oligochaeta	7	2
Class Hirudinea	2	–
Phylum Arthropoda		
Class Arachnida	2	–
Class Myriapoda	5	1
Class Insecta		
Order Odonata	15	2
Order Orthoptera	17	–
Order Phasmida	2	–
Order Dermaptera	4	–
Order Dictyoptera	2	–
Order Isoptera	8	4

Groups	No. of Species	Endemic species
Order Hemiptera	28	2
Order Coleoptera	53	15
Order Diptera	9	–
Order Lepidoptera	202	48
Order Trichoptera	1	–
Order Hymenoptera	8	–
Phylum Mollusca		
Class Gastropoda	6	5
Phylum Chordata		
Pisces	16	–
Amphibia	8	3
Reptilia	31	12
Aves	91	46
Mammalia	12	9

Fauna of Great Nicobar Islands

Groups	No. of Species	Endemic species
Phylum Annelida		
Class Oligochaeta	04	–
Class Hirudinea	03	–
Phylum Arthropoda		
Class Insecta		
Order Odonata	31	02
Order Orthoptera	15	07
Order Dermaptera	01	–
Order Blattaria	03	–
Order Mantodia	01	01
Order Isoptera	17	08
Order Hemiptera	47	07
Order Coleoptera	46	03
Order Diptera	22	05
Order Siphonoptera	02	–

Groups	No. of Species	Endemic species
Order Lepidoptera	205	59
Order Trichoptera	01	01
Order Hymenoptera	25	07
Phylum Chordata		
Pisces	113	–
Amphibia	10	04
Reptilia	26	07
Aves	71	32
Mammalia	14	12
TOTAL	**659**	**157**

Terrestrials mammals distributed in the Islands are Asian Elephant *Elephas maximus*, a Vulnerable introduced species into the islands, Andaman Wild Pig *Sus scrofa andamanensis* (Insufficiently Known) an endemic known from middle, south and little Andaman Islands and Havelock Island. *Macaca fascicularis umbrosa* (Miller) a Crab eating macaque an endemic and Near Threatened species is known to be distributed in Great Nicobar, Little Nicobar and Catchal Islands, *Crocidura hispida, Crocidura andamanensis* (Andaman spiny shrew), Endemic and Endangered species known to occur only in middle Andaman Islands. The other terrestrial species are, Andaman masked palm civet *(Paguma larvata tytlerii)*, Nicobar tree shrew *(Tupaia nicobarica nicobarica)*, Andaman horse-shoe *bat (Rhinolophus cognatus famulus)*, Lesser short nosed *bat (Cynopterus brachiotis brachysoma)*. Yet another, distributed widely introduced species i.e., *Axis axis* that has become a pest in the Islands. In all the species distribution in the islands are Macaques 2 species with one endemic, 2 species of tree shrews (both endemic), 4 species of terrestrial shrews (4 endemics), 1 species each of jungle cat, palm civet and squirrel, 2 species of wild pigs (both endemic), 2 species of deer, 26 species of bats (11 endemic), and 14 species of small rodents (11 endemics).

Marine mammals abound in the waters of Andaman & Nicobar islands, among them Lower Risk-Near threatened cetaceans distributed in the islands are Common Dolphin *Delphinus delphis*, Melon-headed Whale *Peponocephala electra*; Spinner Dolphin *Stenella longirostris*; Bottle-nosed Dolphin *Tursiops truncatus; Neophocaena phocaenoides*; Minke Whale *Balaenoptera acutorostrata*; Bryde's Whale *Balaenoptera edeni*; Sie Whale *Balaenoptera borealis*; Fin Whale *Balaenoptera physalus*; Pantropical Spotted Dolphin *Stenella attenuata*; Lower Risk-Conservation Dependent species of Hump-Backed or Plumbeous Dolphin *Sousa chinensis* (Endangered); Blue Whale *Balaenoptera musculus* (Critically Endangered); Blainville's Beaked Whale *Mesoplodon densirostris* (Not Listed) found distributed in Nicobar Islands. Pygmy Sperm Whale *Kogia breviceps* (Lower Risk-Near Threatened); Dwarf Sperm Whale *Kogia simus*; Sperm Whale *Physeter macrocephalus*; False Killer Whale *Pseudorca crassidens* and in the Order Sirenia includes Dugong or Sea cow *Dugong dugon* (Critically Endangered) found in the waters of Andaman & Nicobar Islands.

INTRODUCTION OF EXOTICS

A number of animal species have been introduced in these islands from time to time. Cheetal (*Axis axis)* or the spotted deer was the first animal to be introduced in these islands by the Britishers in early part the 20th Century. These deer have multiplied rapidly in absence of any predator. Other animals introduced include Five striped palm squirrel, domestic dog, domestic cat, hog deer, barking deer, domestic goat, leopard, elephant, rats, common mynah, house sparrow, grey patridge, peafowl, giant snail etc. Some of these introduced animals are believed to have caused ecological disturbances but no scientific study has been carried out so far on the impact of introduced fauna on the island ecosystem.

BIRDS

Birds of these islands are significant not only due to their high degree of endemism but also due to their restricted range of distribution of few species. As many as 270 species and sub species of birds are reported to inhabit these islands and of these 92 species and sub-species are endemic. Some important species are Andaman Teal *(Anas gibberifrons albogularis),* Megapode *(Megapodius freycinet,* includes two sub species *M freycient nicobarensis* restricted to Nicobar islands north to Sombero channel and *M freycinet abbotti* distributed in Little and Great Nicobar islands located south of Sombero Channel), Narcondum hornbill *(Rhyticeros narcondami* restricted to Narcondum islands), Nicobar pigeon *(Caloenas nicobarica nicobarica),* Green Imperial Pigeon *(Ducula aenea),* White headed Myna (*Sternus erythropygeus andamanensis, S erythropygeus erythropygeus* and *S. erythropygeus katchalensis* all endemic), Nicobar Parakeet (*Psittacula Caniceps*), Crested serpent eagle *(Spilornis cheela),* White-bellied sea eagle *(Haliaeetus leucogaster),* Edible-nest swiftlet *(Collocalia esculenta),* Emerald dove *(Chalcophaps indica)* etc.

REPTILES

There are 76 terrestrial reptiles. Of these 24 species are endemic. Species distributed in the islands are arboreal, insectivorous and diurnal lizard of *Calotes versicolor, Calotes andamanensis, Calotes mystaceus, Cyrtodactylus rubidus, Cnemaspis kandiana; Dasia olivacea, Gehyra mutilate, Gekko gecko, Gekko smithi, Goniocephalus subcristatus, Hemidactylus frenatus, Lepidodactylus lugubris, Mabuya andamanensis, Mabuya tytleri, Riopa bowringi, Scincella macrotympanum, Phelsuma andamanense, Varanus salvator and the Calotes calotes, Calotes danieli, Calotes cristatellus, Calotes jubatus, Dibamus novae-guineae, Ptychozoon kuhli, Dasia nicobarensis, Mabuya rugifera, Scincella macrotis,* distributed in the Nicobar Islands.

The snake species distributed in Andaman Islands are *Amphiesma stolata, Boiga ochracea, Bungarus andamanensis, Cantoria violacea, Cerberus rhynchops, Chersydrus granulatus, Chrysopelea ornate, Chrysopelea paradise, Dendrelaphis humayuni* (found only in Nicobar group of Islands), *Dendrelaphis pictus andamanensis, Elaphe oxycephala, Elaphe prasina, Hydrophis cyanocinctus, Hydrophis fasciatus, Hydrophis ornatus ornatus, Hydrophis nigrocinctus, Hydrophis*

obscurus, Hydrophis spiralis, Hydrophis stricticollis, Kerilia jerdoni, Laticauda colubrine, Laticauda laticaudata (recorded from Nicobar Islands), *Liopeltis nicobariensis* (Nancowary Haven, Camorta Island), *Lycodon aulicus, Lycodon tiwari, Natrix nicobariensis* (Carmota Island), *Oligodon woodmasoni, Pelamis platurus, Praescutata viperina, Ptyas mucosus, Python reticulates & Sibynophis bistrigatus* (Nicobar Islands), *Trimeresurus albolabris, Trimeresurus cantori, Typhlops andamanensis* (described from single specimen further records are not available), *Typhlops oatesi, Vipera russelli, Xenochrophis piscator, and Xenopeltis unicolor.*

Among turtles *Dermochelys coriacea* a circumglobal species and *Chelonia mydas* (green sea turtle), frequently visits for nesting on the beaches of the of Andaman & Nicobar Islands. These are extremely vulnerable due to hunting pressure in their migrating route, hunted for eggs, cartilage, oil and meat. Stuffed young ones are sold as Curios, Turtle soup is regarded as delicacy. Pollutants especially oil droplets attached to Sargassum kills the young ones. Shrimp trawls are the major threat to the turtles. Included in the Appendix–I of CITES. *Erytmochelys imbricate* (Hawksbill Sea turtle or Tortoise shell turtle) a Circumtropical species nests on the beaches. The species included in Schedule–I under WLP, 1972 and Appendix–I of CITES, however, several countries such as France, Japan are not governed by the convention laid down by CITES. *Caretta caretta* (Loggerhead Sea Turtle) a Cosmopolitan species, nests in the beaches and extremely vulnerable for hunting pressure, hunted for eggs and meat. Included in Appendix-I of CITES. *Dermochelys coriacea* (Leatherback Sea Turtle) a Circumglobal species, Endangered due to the excessive capture for eggs and meat. Adults are used as shark bait, included in Appendix–I of CITES and also as Endangered under the 1973 U S Endangered Species Act. The other freshwater turtle distributed in the islands is *Lessemys punctata punctata* (Lacepede 1788), commonly known as North Indian Flap shelled Turtle. Salt water crocodile (*Crocodylus porosus*), and Water monitor lizard (*Varanus salvator*) are the other reptiles found in the islands.

MARINE LIFE

Due to its long coastal stretch, these islands have a very rich marine biodiversity. They harbour more than 1200 species of fish, 350 species of echinoderms, 1000 species of molluscs and many more lower forms of life. Among vertebrates, dugongs, dolphins, whales, salt water crocodiles, sea turtles, sea snakes etc. are common.

The sea grass community identified in the islands are *Enhalus acoroides; Halophila ovalis, H. ovata; Thalassia hemprichii, Cymodacea roatundata, C. serriulata; Halodule pinifolia, H. uninervis* and *Syringodium isoetifolium* (Das, 1996). The distribution of the sea grasses are important, as the distribution of several marine mammals are directly related by sheltering heterogeneous assemblage forming microniches for herbivores, carnivores, omnivores, detrivores as well as decomposers. Among the species listed above, *C. rotundata* and *T hemprichii* are the dominant species. Mention may be made of dugongs, sea trurtles, herbivore fishes; grazers such as sea urchins dominate in this ecosystem. Among phytoplanktons, as many as 62 species has been found to be distributed in the islands, of which 30 species of chlorophyceae, 10 species of pheophyceae and 22 species of

rhodophyceae (Jagtap, 1992). 13 more species were added by Rao and Mudgal (2002) and with the further elaborative estimation, the present distribution in the Andaman and Nicobar Islands is 182 species (Umamaheshwar Rao, 2002), chlorophyceae dominating (62 species) followed by rhodophyceae (80 species), pheophyceae (39 species), and xanthophyceae (1 species) Andaman sea is oligotgrophic with low primary production and nutrient contents. According to Ramachandra Nair and Pillai (1972, 1983), Jenekaran and Thomas Kiorboe (1991), the productivity ranged from 0.14 (Rutland Island) to 3.60 (Carbyn's Cove), 169.00 (Diglipur) to 1040 mg C/m^2 /day at Port Blair. In comparison,in the Nicobar group of islands, ranged from 0.17 (Campel Bay), 2.35 (Katchall) and 140.00 (Tree Top Jetty) to 1370 mg C/m^2 /day.

Corals and Coral reefs are the most fascinating part of marine ecosystem here. So far 179 species of corals belonging to 61 genera have been reported. Reefs are mostly fringing type on eastern coast and barrier type on the western coast. Important genera include *Acropora, Montipora, Pocillipora, Porites, Favia, Fungia, Goniopora, Millipora and Heliopora.* Coral reefs are important breeding and nursery ground for fish and many other organisms and have been aptly called "The Tropical Rain forests in the Sea"

CHAPTER–12

GLOSSARY

Adaptation : A change in structure, function or form that produces better adjustment of an animal to its environment

Adaptive radiation : Evolutionary divergence of members of one phyletic line into a series of different niches or adaptive zones

Affinity : Likeness especially in relationship

Agamic : A species or generation that does not reproduce sexually

Agamospecies : An asexual species whose members are of common origin

Aggregate : A group of species, other than a subgenus, within a genus or a group of species within a subgenus, or a group of subspecies within a species.

Algorithm : The repitative calculations used in finding the greatest common divisor of two numbers

Allele : The individual member of a gene pair or genes which occupy the same relative position on the homologous chromosomes.

Allochronic species : Species not occuring at the same time level; not contemporary.

Allometry : The study and the measurement of the relative length of a part of an organism in combination with the whole

Allopatric : Population or species which are mutually exclusive, but usually inhabit adjacent geographical regions

Allopatric hybridization : The crossing of individuals belonging to two allopatric populations along a well defined contact zone

Allopatric speciation : Formation of species during geographical isolation

Allotype : A paratype opposite in sex of the holotype (a term not regulated by the Code)

Alpha taxonomy : A taxonomic level concerned with the characterisation and naming of species

Aminoacid : A group of nitrogenous organic compounds that serve as the unit of structure of the proteins

Analogous : Organs having the same function, having the same origin or structure

Ancestor : An early form or type from which the later organisms have derived

Apomorphic : A more derived state in an evolutionary sequence of homologous characters.

Apterous : Having no wings

Apomictic : Parthenogenetic population

Archaean : Belonging to or containing the group of rocks of the Archaeozoic era (the earlier part of the Precambrian era), which ended about 2,500 million years ago.

Archetype : A hypothetical ancestral type constructed by means of elimination of specialized characters.

Artificial classification : Classification based purely on convenient characters without indicating any phylogenetic relationship.

Article : A primary division of a chapter of the Code of Zoological Nomenclature

Author : The person to whom a work or scientific name or a nomenclatural act is atributed

Asexual reproduction : No fusion or union of the nuclei of different gamates

Aspirator : An instrument or apparatus that utilises the vacuum to draw up the small insects

Available name : Scientific name published in accordance with the requirements specified in Article 8–20 of the Code

Bait : Any substance or animal used to lure a particular species

Behaviour : The entire complex of observable, recordable or measurable activities of a living animal

Beta taxonomy : A taxonomic level concerned with the arrangement of species into a natural system of lower and higher taxa

Bibliography : The study of editions, dates, authorship *etc.* of the books and other writings

Bibliographic reference : For nomenclatural purposes, the citation of the name of the author and date of publication of a scientific name, place of publication & journal with number, volume, *etc.*

Binomen : The designation of a scientific name of a species consisting of generic and specific parts

Binominal nomenclature : The Linnaen system of nomenclature of naming of species having both generic and specific components and adopted by the International Congress of Zoology in accordance with International Code of Zoological Nomenclature

Biological classification : The arrangement of animals into taxa on the basis of inferences concerning their genetic relationship

Biological race : Strains of a species which are alike morphologically but differ in some physiological way, such as parasite or saprophyte with particular host requirements or free living organisms with food or habit preferences

Biological species concept : A concept stressing reproductive isolation and the possession of generic programme effecting such isolation (for true species)

Biochemistry : The branch of chemistry that deals with the life processes of plants and animals

Bionomics : The branch of biology that deals with the adaptation of living things to their environment

Biosynthesis : The method of synthesis of complex molecules within the living organism

Biotype : A small area with uniform environment occupied by unified community of organsims

Breeding season : A particular period in which an animal species breeds

Carbohydrates : A group of organic compounds composed of carbon, hydrogen and oxygen only *eg.*, Sugar, startch

Catalogue : An index to taxonomic literature arranged by taxa so as to provide information about the most important taxonomic and nomenclatural references to each taxon covered.

Category : In taxonomy, designates rank or level in a hierarchic classification, or a class, the members of which are all taxa assigned a given rank

Chaetotaxy : The arrangement of bristles or chaetae

Character correlation : Degree of association between two or more variable characters

Character matrix : A table of taxa and characters in which characters are coded to indicate the sequence from ancestral to derive.

Checklist : A skeleton classification of a group listed by taxa for quick reference.

Chromatography : Method of chemical analysis developed from the fact that if a liquid mixture is allowed to trickle through a column of adsorbing material, the components of the mixture is adsorbed in separate layers in the column

Chronological : Pertaining to arrangement of data in order of time of appearance

Clade : A delimitable monophyletic unit formed by the cladogenesis (a mode of evolution consisting of splitting an evolutionary line, such as species, genera and familes and other higher categories)

Cladogram : A branching from a common ancestor, a branching diagram showing the development of a clade

Class : A division of the animal kingdom lower than the sub-kingdom and higher than the order

Classification : A systematic arrangement of animals in series showing their relation or arrangement in structure, life habits, or other characters i.e., delimitation, ordering and ranking of taxa

Cline : A series of form changes, gradient of biotypes, character gradient

Cluster : A group of related or similar species into species groups or higher taxa

Code : An abbreviation of the title of **"the International Code of Zoological Nomenclature"**

Cohort : An indefinite taxonomic group used in different ways by different authoriteis, such as group in rank above a super order, a group between class and order, or group related to families

Commission : The International Commission on Zoological Nomenclature

Complex : Used for number of related taxonomic units, especially those in which taxonomy is difficult or confusing

Compound : Of a word or scientific name formed by the union of two or more basic components, and written as one word.

Congeneric : A species agreeing in all characters of generic value with others compared with it

Conspecific : Indiviudals of the same species

Conserve : To preserve the use of a name as a valid name, by a decision of the Commission using its plenary powers

Contemporaneous species : Species occuring at the same period of time

Continental : Inhabiting large and extensive land masses

Corrigendum : A note published by an author, editor or publisher of a work expressly to cite one or more errors in that work together with correction

Cotype : A term not recognised by the Code, however, used for syntypes or paratype.

Cryptic species : Those which are genetically and sexually distinct but cannot be differentiated on the basis of the observed characterstics

Curating : Care and superintendence of museum containing amimal collections

Cytogenetics : A comparative study of chromosomal mechanics and behaviour in populations and taxa and their effect on inheritance and evolution

Darwinism : An evolutionary theory propounded by Charles Darwin

Data matrix: A tabulation of differences between species or other taxa

Deme : An assemblage of taxonomically closely related individuals, a local population of species, the community of potentially interbreeding individuals at a given locality

Dendrogram : A diagram with branches indicating the relationships of items in a classification

Desiccation : Drying or removal of moisture

Designation : The nomenclatural act of an author or the Commission in fixing, by an express statement, the name bearing type or previously or newly established nominal genus, subgenus, species or subspecies

Designated priority : In cases of simultaneous publication of several names (more than one name for a taxon) the priority established by the first reviser

Differential diagnosis : A statement of important characters which are used for clear cut differentiation of a given taxon from other specifically mentioned equivalent data

Dimorphism : Occurrence of two morphs or phena (morphological types) in a single population

Dip-net : A net used to collect aquatic organisms

Diversity : Multiformity or unlikeness or various kinds

Double citation : Citation of the name of both original author of a species–group name and the person who transferred the taxon to which it applies to another genus, the later authors name is placed after the paranthesis that enclose the name of the original author; in new combinations

Ecology : The scientific study of interrelationship between living organansims and their environment

Ecological race : A local race that owes its most conspicuous attributes to the selective effect of a specific environment

Ecosystem : Any area of nature which includes living organisms and non living substances interacting to produce an exchange of materials between the living and non living parts eg. pond, lake, forest, grassland *etc.* Ecosystem consists of abiotic, producers, consumers and decomposers

Ecotype : All the members of a species that are fit to survive in a particular kind of environment within the total range of the species and no sterility barrier exists between ecotypes of the same ecospecies (Claussen, Keck and Hiesrey, 1945).

Ecospecies : A group of populations so related that they are able to exchange genes freely without loss of fertility or vigor in the offspring

Electrophoresis : The migration of electrically charged solute particles present in a colloidal solution towards the oppositely charged electrode, when the electrodes are placed in the solution and connected externally to a source of electro motive force (EMF).

Elytron : The chitinized fore wings in coleoptera which forms the horny sheath to protect the hind wings when the latter is not in use

Emendation : Any demonstrably intentional change in the original spelling of a available name, other than the mandatory change

Epedaphon : Inhabitants of the soil surface e.g., most ground beetles and scorpions

Epithet : A descriptive name or title

Ethology : The science dealing with the comparative study of animal behaviour

Euedaphon : Inhabitants of the mineral soil *e.g.*, most earthworms, mites and all symphyla

Evolutionary taxonomy : A kind of classification based on evolution of characters

Extant : Taxon having living representation

Extinct : Taxon having no living representation

Family : A taxonomic division consisting of one or more genera aggregating in one or set of characters and so closely related that they are apparently descended from one stem

Fixation : A general term for the determination of a name bearing type whether by original designation or by subsequent designation. Chemical treatment to check biological changes in cells at a particular stage, for histochemical studies

Food chain : Transfer of food energy from the source in plants through a series of organisms, beginning with autotrophs, leading to heterotrophs, which successively depend on each other for food

Form : A term that if published after 1960 denote infrasubspecific rank but before 1961 is to be interpreted according to the Article 45g. It also denotes individual of a species differing, in a stated way, from other individuals within the species (larval forms, male and female forms, ecological forms, seasonal forms)

Gamma taxonomy : A taxonmic level which deals with various biological aspects of taxa, ranging from intraspecific populations to the studies of specification and of evolutionary rates and trends

Genotype : A term not recognised by the Code, formerly used for type species but now should not be used in zoological nomenclature. In heredity, it is the genetic constitution of an individual taxon

Genome : The total chromosomal content of the nucleus of a gamete

Genus : A taxon at the rank of a genus (pl. genera). A taxonomic category that includes one or more species, presumably of one phylogenetic origin and separated from other related genera by distinct characteristics

Geocline : A gradual or continuous change in a character over a considerable area as a result of its adjustment to changing geographical conditions

Geographic speciation : The acquisition of isolating mechanisms by a population during period of geographic (allopatric) isolation

Geographic variation : The differences between spatially separated populations of a species

Habitat : The sum total of environmental conditions of a specific place that is occupied by the organism, by a population or a community

Haltere : Modified and reduced hind wing of dipterous flies; it is sensory and concerned with equilibrium in flight

Hapanotype : One or more preparations of directly related individuals representing different stages in the life cycle together forming a name bearing type in an extant species of protozoa (Article–72c)

Heirarchy : A system of classification based on taxa of decreasing inclusiveness from the kingdom animalia to the smallest distinguishable groups of individuals

Hemiedaphon : Inhabitants of the litter and fermentation layer *e.g.*, many woodlice and millipedes

Hemimetabolous : Insects having incomplete metamorphosis

Holotype : A single specimen designated as the name bearing type of a species or subspecies when it was established or a single specimen on which such a taxon was base

Homonym : In the family, genus of species–group, each of the two or more available names having the same spelling or differing only in suffix denoting different nominal taxa either originally (primary homonym) or subsequently (secondary homonym)

Horizontal classification : Classification based on species which co-exist in time rather than species located on the same evolutionary line

Hybrid : The progeny of two individuals belonging to two different species, however, the progeny of two individuals belonging to two different subspecies of the same species are not hybrids. For treatment of names given to hybrids see articles 1b., 17 and 23h.

Hypodigm : The entire material of a species available to a taxonomist

Ichnotaxa : A taxon based on the fossilised work of an animal

Infrasubspecific : Of a rank, taxon or name: one at a rank lower than that of a subspecies

Incipient species : A population which has not attained all the attributes of reproductive isolation from parent population of a species

Insular : Living or inhabiting an island

Interbreeding : Individuals capable of actual or potential gene exchange by hybridization

Isolating mechanism : Preventing from mating between breeding groups owing to spatial, topographical, physiological, genetic, behavioural or other barriers

Invalid : Of an available name or a nomenclatural act : one that is not valid under the Code

Junior homonym : The more recently published of two or more identical names for the same taxon or different taxa

Junior synonym : The more recently published two or more available names for the same taxon

Karyotype : Group of individuals with same chromosome number and similar linear arrangement or genes in homologous chromosomes

Key : Tabulation of diagnostic characters or taxa in dichotomous couplets facilitating rapid identification

Kingdom : The highest rank in the hierarchical classification. In zoology, the rank consists of the kingdom: Animalia

Lectotype : A syntype designated as the single name bearing type specimen subsequent to the establishment of a nominal species or subspecies

Linnean hierarchy : When in an categorised ranks of taxa each category except the lowest includes one or more subordinate categories

Mark, diacritic : A mark to indicate different pronounciation of a letter or different letter (such as accent)

Microspecies : (Jordanon species) one of the numbers of true breeding morphologically slightly different lines within a complex of largely interbreeding forms

Microtaxonomy : The discrimination of species and their subdivisions : taxonomy at species level

Mimeographing : a method of producing numerous copies of text by means of ink applied through stencil

Monograph : In taxonomy, an exhaustive treatment of a higher taxon in terms of all available information pertinent to taxonomic interpretation; usually include all information full taxonomic details, biology, distribution *etc.*

Monotype : the author bases a nominal species–group taxon on a single Specimen

Monophyletic : of individuals derived in the course of the evolution from a single interbreeding populations or phyletic stock. Opposite of this situation is polyphyletic

Morph species : a group of individuals which are considered to belong to the same species on morphological grounds alone

Multivariate analysis : The simultaneous analysis of several variable characters.

Museum : a building or room for keeping animal specimens or their parts and other objects of Natural History

Name–available : A scientific name that is not excluded under the Article 1b and that conforms to the provision of Articles 10–20. **Collective group name**–a name established expressly for a collective group. As collective groups have no type species their names cannot compete with other genus-group names for priority but they do compete with them for homonymy. **Conserved name**–A name previously unavailable or invalid that the Commission, by the use of its plenary powers, has enabled to be used as a valid name by removal of the known obstacles to the use of the name as the valid

name. Any available name used to replace an older available name is known as **Replacement name. Scientific name** refers to the name that confirms to article 11 b as opposed to a vernacular name. **Species name** or **name of species** refers to the scientific name of a taxon at a rank of a species. An **unavailable name** is the one that does not conform to articles 10–20 or that excluded name under article 1b.

Natural selection : A theory of the mechanisms of evolution which states that the survival of the best adapted forms, with the inheritance of fitness determining characterstics which arise as random variation

Neotype : The single specimen designated as the name bearing type of a nominal species or subspecies for which no holotype or lectotype or syntype or prior neotype is believed to exist

New systematics : The biological or populational approach to systematics

Nomenclature : A system of names and provisions for their formation and use. **Binominal nomenclature**–a system of nomenclature whereby a species, but no other taxon, is denoted by a Binomen. **Zoological nomenclature**–the system of scientific names for Zoological taxa and the provisions for the formation, treatment and use of those names. The principles of binominal nomenclature is the scientific name of a species, not of a taxon at any other rank, is a combination of two names (binomen), the first being the generic name and the second being the specific name (Article–5a)

Nondimensional species : Species lacking dimensions of space and time

Nomen dubium : A descriptive term meaning name of unknown or doubtful application

Nomen novum : equivalent to new replacement name

Nomen nudem : A name that, if published before 1931, fails to conform to Article 12; or if published after 1930 fails to conform the Article 13. A *nomen nudem* is not an available name and the same may be made available later for the same or different concept.

Nomen oblitum : A descriptive term meaning forgotten name, not used in the 3rd edition of the Code., but used in Article 23b in force from 6th November 1961 to 1st January, 1973.

Nomen conservandum : A name preserved by the Commission

Numerical phenetics : The methodology of grouping individuals into taxa on the basis of overall similarity

Ontogeny : The developmental history of an organisms from its initial stages to the adult

Paleontology : The science dealing with the life of past geological periods

Panmictic : Of a randomly interbreeding populations of individuals which mate at random i.e., each individual is equally likely to mate with any individual of the opposite sex

Paralectotype : Each specimen of a former syntype series remaining after the designation of a lectotype (Article–72a and 74f)

Paratype : Each specimen of a series other than the holotype (Article. 72a 73d)

Paraspecies : In palaeontology, isolated parts of animals or fragments when named equally as a species or other taxa

Parantheses : A pair of marks ( ), also known as round brackets

Phenetic : The classification based on appearances of organisms rather than on evolution from a common ancestor

Phenetic ranking : Ranking into categories, based on degree of overall similarity

Parapatry : Non overlapping geographic contact of populations with or without interbreeding

Paraphyletic : Pertaining to a monophyletic group that does not contain all the descendants of that group

Phylogenetic : Evolutionary development of any animal species Phylogenetic tree : A graphic representation showing the descent relations of different organisms

Phylogeny : The evolutionary history of an organism or taxonomic group

Plenary powers : The power of the Commission to suspend the provisions of the Articles 1 to 75 of the Code

Polymorphism : The simultaneous occurrence of several discontinuous phenotypes or genes in a population, the condition having several forms in adult

Population : A group of interbreeding individuals of the same species

Precedence : The order of seniority of available names or nomenclatural acts determined by the Commission

Predictive value : Usefulness of a classification in making predictions on newly employed characters or newly discovered taxa

Prefix : A letter or group of letters attached before the basic part of a word and usually derived words and not as a separate word (*e.g., eu* and *para*)

Principles of coordination : Within the family group or the genus group or the species group, a name established for a taxon at any rank in the group deemed to be simultaneously established with the same author and date for taxa based on the same name bearing type at other ranks in the group

Principles of first reviser : The principle that the relative precedence of two or more names or nomenclatural acts published on the same date or of different original spellings of the same name, is determined by the first reviser

Principles of name-bearing types : The principles that each of the nominal taxon has, actually or potentially, its name bearing type that provides the objective standard of reference by which the application of the names is determined

Principles of priority : The principle that the valid name of a taxon is the oldest available name applied to it

Priority : Seniority fixed by the date of publication

Protein taxonomy : An approach to classify organisms on the basis of the differences in the structure of the protein

Publication : A published work or the issuing of a work conforming the Articles 8&9

Race : Equated with subspecies in taxonomy, in general category of variant individuals within a species and differing slightly in characteristics from the typical members of the species

Rank : The level of a taxon in the zoological hierarchy (Articles 10d, 10e, 42a, & 45a)

Reference, bibliographic : A published citation referring to a publication

Reject : To set aside a work or for the purposes of Zoological Nomenclature (to set aside a name of a taxon in favour of another name)

Rules : The articles of the Code but not titles, recommendations and examples

Revision : In taxonomy, the presentation of new findings or new interpretation integrated with previous knowledge

Semi species : A taxonomic group intermediate between a species and subspecies especially as a result of geographical isolation

Senior synonym : The earliest published of two or more available synonyms for the same taxon

Sequencing : A cladistic method in which sister taxa are given the same categorical rank, the sequence to be determined by the amount of divergence from the ancestral stem species

Sibling species : Reproductively isolated populations that are morphologically similar or identical and frequently sympatric

Species : The rank below the genus group; the basic rank of a zoological nomenclature or a taxon at the rank of a species

Species inquirenda : Doubtfully identified species needing further investigation

Specimen : An individual or a group of individuals derived by vegetative or asexual multiplication from a single individual and forming a single entity. Teratological specimen meaning an abnormal specimen

Strickland code : A code of nomenclature prepared by a committee of the British association for the Advancement of Science under the Secretary ship of H.E. Strickland and first published in 1842

Subjective synonym : Each of the two or more synonyms based on different types but of the same taxon

Subspecies : A geographically defined aggregate of local populations which differs taxonomically from other such subdivisions of the species.

Suffix: A letter or a group of letters added to the stem of a word, such as *–idae* in the family, *-inae* in subfamily or Latin termination such as *–ides* or *–istes* in some generic names

Suppression : The use by the Commission of its plenary powers to rule (1) that work is unpublished or unavailable for nomenclatural purposes (2) that the available name is totally or partially suppressed or (3) that the nomenclatural act is invalid

Sympatric : Two or more populations occupying the same geographical area or of a population existing in a breeding condition within the cruising range of individuals of another population.

Synonym : Each of the two or more scientific names of the same rank used to denote the same taxon. Synonomy is the list of synonyms

Syntype : Each specimen of a type series from which neither a holotype nor a lectotype has been designated (Articles 72a, 73b, 74)

Systematics : "The scientific study of the kinds and diversity of organisms and of any and all relationships among them" (Simpson 1961)

Tautonomy : The use of the same word for the name of a genus and of its included species and or subspecies

Taxon : A taxonomic unit (family, a subgenus or a species). A nominotypical taxon is the taxon at a lower rank within the family group, the genus group or the species group that contains the name bearing type of a divided taxonomic taxon of that group and has exactly same names in genus and species (for *e.g.*, Felinae is the nominotypical subfamily of the family Felidae. In *Felis (Felis) catus* the subgenus *Felis* is the nominotypical subgenus of the genus *Felis*

Taxonomy : The theory and practice of classifying organisms, part of systematics, the study of the kinds and diversity of organisms

Topotype : A term not regulated by the code, for a specimen originating from the type locality of the species or subspecies to which it is thought to belong, whether or not the specimen is a part of the type series

Trinomen : The combination of a generic name, species name and a subspecific name, that together constitute a scientific name of a subspecies (Article-5b). Trinominal

nomenclature : An extension of the binomial system of nomenclature to permit the designation of subspecies by a name consisting of three words

Type : A specimen on which forms the basis for describing a species

Type designation : Determination of the type of a genus under Article 67.5 under the International codes of nomenclature

Type genus : A nominal genus that is the name-bearing type of a nominal family group taxon

Type horizon : The geological stratum that is the name bearing type of nominal species or subspecies was collected

Type host : The host species with which the name bearing type of a nominal species or subspecies was associated

Type locality : The geographical place of capture or collection of the name bearing type of a nominal species or subspecies. If the name bearing type was captured or collected after being transported by boat, vehicle, aircraft, or the other mechanical or human means, the type locality is the place from which it or its wild progenitor, began its unnatural journey

Type method : The method of preserving the identity of a taxonomic category by basing a specimen or as the type

Variety : Heterogeneous group of a taxon usually applied to infraspecific categories, not recognized by the Zoological Commission.

Vertical classification : Classification based on common descent tending to unite ancestral and descendant groups

Vernacular name : Native name of a country or a place for a scientific name and there may be many such names for the same taxon and so causes confusion

Xerography : Any method of producing numerous identical copies based upon an electrostatic process; copies produced in this way are commonly known as xerox copies or photocopies, a method not included within the definition of conventional printing

Zoogeography : The science dealing with the geographical distribution of animals, specifically, the study of the relationship between specific animal form and the region in which they live

Zoologist : Anyone, whether professional or amateur, who studies animals

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