Himachal Pradesh is bestowed with distinctive animal diversity having aesthetic, cultural, commercial and genetic values. Himalayan biodiversity has enriched the aesthetic life of hill people and is admired for adding liveliness to nature. The unique colour shades and designs of the beautiful creatures of the nature have caught the imagination of poets, naturalists, fashion designers, collectors, etc. Products of some animals like honey, wax, musk and skins are commercially valuable. The book enumerates and enlists different animal groups present in the State. It provides updated information on the status, distribution, biological diversity, value, threats and conservation strategies of Protista (Protozoa) as well as that of different animal groups from Mesozoa to Mammalia present in Himachal Pradesh. It will serve as a valuable source of information for all those who are concerned with animal diversity and faunal resources of the country in general and Himalayan region in particular.

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Status of Animal Diversity in Himachal Pradesh (India)

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Preface

Man has been dependent upon the biodiversity for fulfilment of his entire livelihood needs. The ancient Indian literature is replete with references to animal and plant life affecting the lives of human beings on day to day basis. Many of the plants and animals have been domesticated over a period of time. Man has also discovered curative uses of plants and animals found in his immediate vicinity, and has associated religious value to most important of such plants. But degradation of the Himalaya, of which Himachal Pradesh is a part, is having a profound influence on all ecosystems of the region resulting in the loss of biodiversity. It is, therefore, very important to conserve the ecology and biodiversity of this fast deteriorating fragile ecosystem. Several endemic species have evolved in this area. These are particularly adapted to the Himalayan way of life, especially at high altitudes above timber line. There are also many valuable animal resources from scientific and aesthetic points of view, and several of these are threatened due to large scale destruction of their habitats. Many interesting unknown taxa may become extinct before they are even discovered. Considering the ecosystem as a gene bank, if populations of species are reduced, there may be a genetic drift and gene loss which is potentially an important loss.

Himachal Pradesh is bestowed with distinctive fauna having aesthetic, cultural, commercial and genetic values. Beautiful birds like Himalayan Monal, Koklass and Tragopan Pheasants, Red-billed Blue Magpie, Paradise Flycatcher and Himalayan Snow Cock, and Papilionid and Nymphalid butterflies are of great aesthetic value. In fact, they have enriched the aesthetic life of hill people and are admired for adding liveliness to nature. The unique colour shades and designs have caught the imaginations of poets, naturalists, fashion designers, collectors, etc. Products of some animals like honey, wax, musk and skins are commercially valuable. Two species of honeybees, *Apis mellifera* and *Apis cerana* are domesticated for the production of honey and wax. Species of non-mulberry silk moths, *Antheraea mylitta* (Indian Tasar Moth) and *Samia cynthia ricini* (Indian Eri Moth), found in Himachal Pradesh can be exploited for yielding wild silk. Snow trout (*Schizothorax* sp.) and golden mahseer

(Tor putitora) are of fishery importance. Earthworm species, *Eisenia fetida* and *Perionyx excavatus* can be easily reared on various kinds of organic waste materials in the state for the production of vermicompost and vermiprotein. Rhesus macaque, *Macaca mulatta* is of great biomedical importance all over the world.

The hill people rear large number of domesticated animals like cattle, goats, sheep etc for meat and wool production, ploughing fields and collection of dung for use as organic manure. Grazing by these animals exerts a great biotic pressure on forests. Often overgrazing leads to ecological problems like formation of gullies in tracks frequented by cattle, abundance of coarse and poor grasses in pastures because of selective feeding, trampling of seedlings and saplings, and soil erosion. Wild animals are hunted by the people for their fur, meat, musk etc. Forests are sometimes set on fire for inducing good growth of grass and mushrooms. Forest fires are very harmful to environment, causing erosion, destroying valuable faunal diversity and hampering regeneration. Human demographic pressure causes shrinkage of forests leading to loss of biodiversity. Increased agricultural and horticultural practices have introduced several exotic taxa in the area.

Keeping in view the above facts, an attempt has been made in the present status report to enumerate and enlist different faunal groups present in Himachal Pradesh. This document provides updated information on the status, distribution, biological diversity, value, threats and conservation strategies of Protista (Protozoa) as well as that of different animal groups from Mesozoa to Mammalia present in Himachal Pradesh. It will serve as a valuable source of information for all those who are concerned with animal diversity and faunal resources of the country in general and Himalayan region in particular. Moreover, efforts have been made to discuss various measures useful for the conservation of endangered species and sustainable utilization of faunal resources.

Authors

Contents

BIODIVERSITY: CONCEPT AND SCOPE

Biological diversity is made up of all species of plants and animals, their genetic material and the ecosystems of which they are a part. The word 'biodiversity' is a contraction of biological diversity. It refers to variety within the living world. The term biodiversity is commonly used to describe the number, variety and variability of living organisms. In general, biodiversity is defined in terms of genes, species and ecosystems, corresponding to three fundamental and hierarchically related levels of biological organization (Melchias, 2001). It is a popular way of describing the diversity of life on earth and includes all life forms and the ecosystems of which they are a part. It is the driving force behind this universe as it supplies us with the basic necessities like food, water, air, place to live, cures our ills, provides raw materials for our industries, beautifies and enriches our physical and spiritual life. The Earth's survival depends on maintaining this diversity of life forms (Kumar and Asija, 2006).

The word biodiversity which is the abbreviated word for Biological Diversity appears to have come into prominence around 1980, when Norse and McManus (1980) first defined it. Its abbreviation into 'biodiversity' was apparently made by Walter G. Rosen in 1985 during the first planning meeting of the 'National Forum on Biodiversity' held at Washington DC in September 1986 (UNEP, 1995). The published proceedings of this meeting in a book entitled *Biodiversity* (Wilson and Peters, 1988) introduced the notion of biodiversity and popularised this word among the scientific community as well as the public. Since then, not only the number of publications on biodiversity, but also of people interested in the subject for one reason or the other has steadily increased (Harper and Hawksworth, 1994). The United Nations Conference on Environment and Development (UNCED) held in 1992 at Rio de Janeiro (Rio Summit or Earth Summit) has also substantially elevated the status of biodiversity (Krishnamurthy, 2003).

The classical definition of biodiversity included in the convention on Biological Diversity, defines biodiversity as the variability among living *inter alia* terrestrial, marine and other aquatic systems and the ecological complexes of which they are part, this includes diversity within species, between species and of

ecosystems. According to Global Biodiversity Strategy, biodiversity is the totality of genes, species and ecosystems in a region. While Huston (1994) views biological diversity, essentially as the coexistence of species on changing landscapes, Wilson (1997) presents biodiversity as all heredity based variation at all levels of organization, from the genes within a single local population or species, to the species comprising all or part of a local community and finally to the communities themselves that compose the various ecosystems of the world. Mallet (1998) argued that diversity of life is fundamentally genetic and one can use a variety of genetic mutations to investigate diversity both within and between species (Gupta, 2003; Ananthakrishnan and Sivaramakrishnan, 2006).

During past twenty years or so biodiversity has attracted attention of various workers expediting fauna and flora of the world. The science considered and needed as the basic science, has grown at an unexpected pace. Several softwares are developed to accommodate the data of faunal and floral biodiversity for the different regions of the globe. Hundreds of terms defining biodiversity have been proposed so far (Ghosh, 1996 a).

Biological diversity is the basis of adaptation and evolution and is basic to all ecological processes. It contributes to research and education, cultural heritage, recreation and tourism, the development of new and existing plant and animal domesticates, and the supply of harvested resources. The intrinsic importance of biological diversity lies in the uniqueness of all forms of life: each individual is different, as is each population, each species, and each association of species (Anonymous, 1988).

LEVELS OF BIODIVERSITY

Theoretically there are three levels of biodiversity but all of them are intervened in such a way that practically it is impossible to separate them. Biodiversity is normally treated in terms of genes, species and ecosystems in correspondence with the three fundamental hierarchical levels of biological organization. Thus, these three diversities are respectively referred as genetic, species and ecosystem diversities.

Genetic Diversity

Genetic diversity refers to the variation of genes and genotypes between and within species. It is the sum total of varied genetic information contained in the genes of individual plants, animals and micro-organisms that inhabit the earth. Diversity within a species gives the ability to adapt or resist changes in environment, climate and agricultural methods or the presence of new pests. This represents variations in genes (DNA or RNA). Ultimately this is due to the variations of sequences of bases in nucleic acids, which constitute the genetic code (Melchias, 2001).

The genetic variations are due to gene and chromosome mutations, and in organisms with sexual reproduction these can be spread by recombination. Other kinds of genetic diversity can be identified at all levels of organizations, including the amount of DNA per cell, chromosome structure and number.

Genetic variation within the species influences the way in which a species Interacts with its environment and enables a population to respond to natural selection. Genetic diversity also provides the potential for subsequent evolutionary change. Biodiversity among organisms ultimately arises at the molecular level involving the sequences of nucleic acid (Kumar and Asija, 2006).

Species Diversity

Species diversity, in its broadest sense refers to the numbers of species occurring in a particular location. Species diversity is often measured with the goal of examining and comparing patterns of species distribution at local and regional levels. These measures are used chiefly for examining particular groups of species rather than the full range of species and interactions found in nature.

Complex spatial pattern of species diversity have often been recognised by dividing species richness into three major components to characterise diversity on different scales. Thus, the species richness is considered as Alpha-diversity, Beta-diversity and Gamma-diversity. The alpha-diversity of species is described as species richness within a community or habitat. The beta-diversity is a measure of the rate and extent of change in species along a gradient from one habitat to others. The gamma-diversity is the richness of species of a range of habitat in a geographical area

which is a consequence of alpha-diversity of the habitats, together with the extent of beta-diversity between them (Krishnamurthy, 2003; Belsare, 2007).

Ecosystem Diversity

Ecosystem diversity is the intricate network of different species present in local ecosystems and the dynamic interplay between them. Measuring ecosystem diversity is difficult because each of the Earth's ecosystems merges into the ecosystems around it. Ecosystem consists of interdependent communities of species and their physical environment. The extent of an ecosystem or habitat is imprecise, a single ecosystem may cover thousands of hectares or just a few. They include major natural systems such as grasslands, mangroves, coral reefs, wetlands and tropical forests as well as agricultural ecosystems that, while depending upon human activity for their existence and maintenance, have characteristic assemblage of plants and animals (Ananthakrishnan and Sivaramakrishnan, 2006).

Ecosystem differs from gene and species in that they explicitly exclude abiotic components (soil, water and climate). The quantitative assessment of diversity of the ecosystem, habitat or community level is problematic. Ecosystem diversity is often evaluated through measures of the diversity of component species. This may involve assessment of the relative abundance of different species as well as consideration of types of species (Melchias, 2001).

Other forms of Biodiversity

The various categories of biodiversity such as forest biodiversity, grassland biodiversity, wetland biodiversity, agro-biodiversity, desert biodiversity, endemic biodiversity, introduced biodiversity and microbial diversity are named in the literature. Agro-biodiversity is the component of biodiversity that is directly related to agriculture. It includes crop plants and their wild relatives, livestock and beneficial organisms such as pollinators, decomposers and predators, which are normally associated with cultivated areas. Endemic biodiversity refers to those forms of life that are exclusive to the given geographical area or ecosystem. For the sake of convenience, endemic biodiversity is often assessed within political boundaries. Introduced biodiversity refers to diversity of micro-organisms, plants and animals

that have been accidentally or deliberately transported by humans to landscapes, countries, regions or continents where they never occurred naturally. Desert biodiversity includes unique species that are found in desert. Microbial diversity refers to the variety in micro-organisms such as viruses, bacteria, yeast, protozoa and certain fungi. Biocultural diversity includes various concepts that flourished in human societies in order to protect biodiversity of nature. These concepts are sacred trees, sacred groves, sacred gardens and traditional systems like Ayurveda, Siddha and Unani etc. Human faith and beliefs played significant role in biodiversity conservation for centuries by using indigenous knowledge systems (Belsare, 2007).

IMPORTANCE OF BIODIVERSITY

Cultural Heritage

Throughout history, societies have put great value on physical features of their environment. In developed and developing countries, a diversity of ecosystems is a source of aesthetic, historic, religious, and ritualistic values. Species diversity assures people of national and state symbols, and many such symbols are protected. Genetic diversity continues in part because of the cultural value of plants and animals. Gardeners around the world share seed material ensuring genetic survival (Melchias, 2001).

Benefits to Agriculture and Harvested Resources

In agriculture, a diversity of ecosystems, species, and genetic material provides increased amounts and quality of yields. In a world where population is rapidly increasing, assuring a continued increase in harvested resources is essential. Diversity in an agroecosystem provides habitat for predators of crop pests and breeding sites for pollinators. Diversity of species can be a buffer against economic failure and can also play an important role in pest management. Further, the use of genetic materials by breeders has attributed to at least 50 percent of the increase in agriculture yields and quality (Ananthakrishnan and Sivaramakrishnan, 2006).

Benefits to Ecological Processes

Knowledge of the relationship between diversity and ecological processes is fragmentary, but it is clear that diversity is crucial to the functioning of all major life

processes, for diversity helps maintain productivity and buffers ecosystems against environmental change. Diversity within ecosystems is essential for protective, productive, and economic benefits. Species diversity is necessary for a stable food web. And diversity of genetic material allows species to adapt to changing environmental conditions (Kumar and Asija, 2006).

Benefits to Recreation and Tourism

Millions of people worldwide derive benefits from recreation and tourism provided by biological diversity. Without diverse ecosystems, countries would lose tremendous amounts of foreign exchange. Without wilderness areas, national parks, or national forests, city dwellers would have no place to "escape" the daily pressures. Species diversity is essential to the millions of wildlife photographers, bird lovers, and plant and animal watchers. And without genetic diversity, horticulturists, gardeners, animal breeders, and anglers would find little enjoyment in their avocations (Belsare, 2007).

Benefits to Research

Research may hold answers to many of the questions facing this complex world. The results of research on the patterns and processes of temperate forests have provided methods for sustainable management of those ecosystems. Knowledge of tropical rain forests will result in similar strategies. Without diversity of species, researchers would not have the needed plant material to develop many vaccines, intravenous fluid, or other medicines. The potential for further advancement has not been fully realized, yet a loss of species diversity will adversely affect future research. Protection of genetic diversity is equally essential, because materials from plants and animals have provided valuable knowledge on viruses, immunology, and disease resistance (Krishnamurthy, 2003).

VALUES AND EVALUATION OF BIOLOGICAL DIVERSITY

Biological diversity benefits everyone, is valued by many (in a variety of ways), but is owned by no one. Thus, its evaluation is fraught with complexity. There are two broad classes of value: economic and intrinsic.

Economic Value

Economic evaluation potentially covers all functional benefits ranging from tangible benefits from harvested resources and breeding materials to spiritual and other cultural benefits. The ability to calculate these values varies, however. In the cases where markets exist, calculations are easily determined (at least $27.4 billion per year in the United States for commercially harvested wild species). In other cases, values are more difficult to calculate, and "shadow prices" may be used to approximate values for such benefits as ecological processes and recreation. For cultural and aesthetic values, economic valuation may be impossible.

Intrinsic Value

Intrinsic evaluation acknowledges that other creatures have value independent of human recognition and estimation of their worth the concept is both ancient and universal.

The Value of Biodiversity
• A network of marine protected areas, with the aim of conserving 20%-30% of the seas and oceans, could cost between $5bn and $19bn, but help to safeguard $70bn to $80bn worth of fish catches, and the provision of marine ecosystem services valued at $4.5 to $6.7 trillion annually.
• The annual economic median value of fisheries supported by mangrove habitats in the Gulf of California has been estimated at $37,500 per hectare of mangrove fringe. The value of mangroves as coastal protection may be as much as $300,000 per kilometre of coastline.
• Nature-based tourism in Africa generates approximately the same amount of revenue as farming, forestry and fisheries combined.
• The national parks of Canada store 4.43 gigatonnes (billion metric tonnes) of carbon, a service worth between $11bn and $2.2 trillion depending on the price of carbon in the market. The protected areas of Mexico store 2.45 gigatonnes of carbon dioxide equivalent-more than five years of Mexico's carbon dioxide emissions in 2004, and valued at $12.2 billion.
• A report in 2003 estimated the total value of annual benefits of the United Kingdom's forests to its people to be around £1 billion. They included recreation (£393 m), biodiversity (£386 m), landscape (£150 m) and carbon sequestration (£94 m). The estimate, carried out by Britain's Forestry Commission, did not include values such as the contribution of forests to the supply and quality of fresh water, the cleansing of pollutants from the air, and reduction of soil erosion.
• The Great Barrier Reef is estimated to contribute nearly 6 billion Australian Dollars to the country's economy, counting only the value of tourism, other recreational activities and commercial fishing.

Source: https://www.cbd.int/2010/biodiversity/ (downloaded on 19.06.2015 at 11:57 IST)

BIODIVERSITY AND BIOTECHNOLOGY

The emergence of modern biotechnology presents an important potential for a productive link between conservation and sustainable utilisation of genetic diversity. Biotechnology can lead to new improved methods of preservation of plant and animal genetic resources, and can accelerate the evaluation of germplasm collections for specific traits; it offers new possibilities for increasing the production of food, medicines, energy, speciality chemicals and other raw materials, and for improving environmental management. Maintenance of a wide genetic base (one of the elements of biodiversity) is essential to the future of biotechnology and the sustainable use of biological resources. The genetic material contained in domesticated varieties of crop plants, trees and animals, their wild relatives, and other wild species which may contain genes useful to these domesticated varieties, is essential for breeding programmes which incorporate genes to improve yields, nutritional quality, flavour, pest and disease resistance, and responsiveness to different soils and climates.

The new biotechnologies may increase the value of the world's biodiversity if they allow increased use of the genetic diversity of both wild and domesticated species, thereby increasing their economic importance. But biotechnology also poses significant ecological and economic risks that could ultimately undermine its potential contribution to the conservation of biodiversity. The introduction of any new organism poses a risk to the environment, and many of the world's known extinctions have been caused primarily by the introduction of exotic species. The release of genetically engineered organisms into the environment thus deserves the most oversight and monitoring (McNeely, 1994).

BIODIVERSITY AND SUSTAINABLE DEVELOPMENT

Biodiversity is a major component to global food security and nutrition. Differences in genetic variations within a species, as represented by livestock breeds or strains of plants, reduce risk from diseases and increase the chances of survival in harsh environment. More than 70,000 plant species are used in traditional and modern medicine. Biodiversity is crucial to human welfare, sustainable

development and poverty reduction. In the long terms, the value of services lost may greatly exceed the short-term economic benefits that are gained from transforming ecosystems. For example, actions to increase food production can lead to reduced water availability in terms of quantity and quality for other users resulting in damage to many services like fisheries, water supply, and protection against natural hazards, seriously affecting people's well-being.

The biological resources of each and every country are important, but not all are equally endowed. In general, a small number of countries lying within the tropics and sub tropics account for a very high percentage of world's biodiversity. The most important food crops, however, appear to have originated in areas that have pronounced seasons. This tends to coincide with arid and semi-arid zones, which include famine-prone countries such as Ethiopia. It makes sense, therefore, to look for sources of certain food crop diversity in such areas (Melchias, 2001). A single Ethiopian barley plant, for example, has yielded a gene that now protects California's annual barley crop from yellow dwarf virus.

The fact that the richest nations are home to the smallest pockets of biodiversity while the poorest are stewards of the richest reservoirs underscores the interdependency of all nations, and the urgency of crafting common strategies for sustaining biodiversity that share both responsibility and benefits. On the eve of the twenty-first century, the challenge for the global community is not to save biodiversity for its own sake, but to ensure that biodiversity is managed and used sustainably and equitably for human development. While it is evident that at present a relatively small proportion of the world's biological diversity is actively exploited by man, other elements of biological diversity may be important for different reasons. They have values which are unused or unknown at present but which could enhance the material well being of mankind if these values were discovered and exploited. They may become useful or vital at some time in the future owing to changing circumstances (Krishnamurthy, 2003).

Thus, biodiversity provides the raw materials, combinations of genes, that produce the plant varieties and animal breeds upon which agriculture depends.

Thousands of different and genetically unique varieties of crops and animal breeds owe their existence to 3000 million years of natural biological evolution and to careful selection and nurturing by our farming and herding ancestors during 12000 or so years of agriculture. Whether they are used in traditional farming systems, conventional or modem breeding or genetic engineering, the genetic resources of plants and animals are a global asset of inestimable value to mankind. As genetic diversity erodes, our capacity to maintain and enhance crop forest and livestock productivity decreases along with the ability to respond to changing conditions. Genetic resources hold the key to increasing food security and improving the human condition.

STATUS OF ANIMAL DIVERSITY

World

Various life forms called biodiversity is the result of 3.5 billion years of evolution. It is estimated that about 8.4 million species exist globally, out of which about 1.82 million species have been described and more than 2,000 new genera and 15,000 new species are added to the zoological literature every year. Throughout the world, of the 1.82 million described species, mammals, birds, reptiles and amphibians comprise 27,298 species, consisting of 4,809 mammals, 9,881 birds, 7,828 reptiles, 4,780 amphibians and 21,725 fishes (Sibley and Monroe, 1990; Uetz and Etzold, 1996; Glaw and Kohler, 1998; Nowak, 1999; Myers *et al.*, 2000). Many new species are being reported regularly while 11,000 floral and faunal species are threatened to extinction in a short period. The World Conservation Union claims two to three species become extinct every hour, mainly due to extensive human intervention in natural ecosystem.

India

India is very rich in terms of biological diversity along with the presence of a large number of endemic species, due to its unique biogeographical location, diversified climatic conditions and enormous ecodiversity and geodiversity. It embraces three major biological realms i.e. Indo-Malayan, Eurasian and Afro-tropical, and is adorned with 10 biogeographical zones and 26 biotic provinces. This

country recognised as one of the twelve mega-diversity countries of the world with two biodiversity hot spots, the North-East Region and the Western Ghats, of a total of 18 such sites identified throughout the globe. Around 1,27,000 species of plants, animals and micro-organisms have been reported so far from India, of which the animal species is about 89, 500 including protozoa which constitute the major share and comprise 7.28% of the total world animal species (Arora and Kumar, 1996; Alfred *et al.*, 1998).

India is quite rich in terms of biological diversity because it possesses diversified ecosystems, varied climatic conditions and enormous eco and geo-diversity. Our country is very rich in terms of not only species diversity but is blessed with an enormous variety and variability (Genetic Diversity) with in species along with the presence of a large number of endemic species. Around 1,27,000 species of plants, animals and micro-organisms have been reported so far from India, of which the animal species (about 89,500 species) including protozoa constitute the major share and comprise 7.28% of the total world animal species. Out of these, insects alone comprise 68.32% and chordates only 5.70%. As per experts opinion, another 4,00,000 species are yet to be explored and identified, majority of which are expected to be micro-organisms and invertebrates (Alfred *et al.,* 1998).

Himachal Pradesh

Himalayas are the most magnificent complex folded and youngest mountain systems in the world and forms a physical barrier between the high plateaus of Tibet and Central Asia, and the Indian plains. They are about 2500 km long, extending from river Indus in the west to the river Brahmputra in the east. Its locations and great expansion in latitude and altitude offers a wide variety of habitats each supporting its own distinctive type of fauna (Mehta & Julka, 2002).

Himachal Pradesh is mainly a hilly state lying between 30^{o} 22' to 33^{o}12' North latitude and 75^{o} 47' to 79^{o} 04' East longitude in the lap of the northwest Himalayas. The physiography of Himachal Pradesh is almost mountainous with elevations ranging from 350 to 6500 metres above mean sea level and total area of the state is 55,673 sq km. Its northern border is bounded by Tibet, whereas, in the northwest, it

has a common border with Kashmir and the eastern border of the state is common with the hills of Uttarakhand. Average rainfall in the state stands at 1523 mm, although it varies from the minimum of 300 mm at Lahaul and Spiti to a maximum of 4400 mm at Dharamsala. The temperature in the state varies according to elevation. From the end of February, mercury rises gradually till June, which is generally the hottest month in this region. With the onset of monsoons, there is a gradual fall in temperature. When the monsoon ends by middle of September, temperature falls gradually at first and fairly rapidly after November (Mani, 1981; Chauhan, 1998).

Himachal Pradesh is divided by general increase in elevation from west to east and from south to north into following four biogeographical regions viz., Shiwalik or Outer Himalayas, Lower or Lesser Himalayas, Higher or Greater Himalayas, and Trans Himalayas. The Shiwalik rages are the southern most zone of about 40 to 60 km width, comprising several highly eroded low ridges. A zone of medium to high ranges (about 80 km wide) the Lesser Himalaya runs north of the Shiwalik and parallel to the main range. The Great Himalayan ranges lie just north of the Chandrabhaga river in Lahaul-Spiti and Pangi region of Himachal Pradesh. This range is nearly 24 km wide and comprises the Great peaks rising up to an elevation of over 6000 m amsl. Varied physiographic and climatic factors have given rise to diverse natural ecosystems/habitats, namely, forests, grasslands and pastures, river, lake and wetlands, glaciers etc. in this region (Mehta & Julka, 2002).

Table 1: Number of described Animal species in India and Himachal Pradesh

Taxonomic Group	**No. of Species**		
	World	**India (% in India)**	**Himachal Pradesh**
PROTISTA			
Protozoa	31250	2577 (8.24)	89
Total (Protista)	**31250**	**2577 (8.24)**	**89**
ANIMALIA			
Mesozoa	71	10 (14.08)	-
Porifera	4562	486 (10.65)	01
Cnidaria	9916	842 (8.49)	01
Ctenophora	100	12 (12)	01
Platyhelminthes	17500	1622 (9.27)	-
Nemertinea	600	-	-
Rotifera	2500	330 (13.20)	-
Gastrotricha	3000	100 (3.33)	-
Kinorhyncha	100	10 (10)	-

Nematoda	30000	2850 (9.5)	127
Nematomorpha	250	-	-
Acanthocephala	800	229 (28.62)	-
Sipuncula	145	35 (24.14)	-
Mollusca	66535	5070 (7.62)	-
Echiura	127	43 (33.86)	-
Annelida	12700	840 (6.61)	50
Onychophora	100	1 (1)	-
Arthropoda	**987949**	**68389 (6.90)**	
Crustacea	35534	2934 (8.26)	04
Insecta	867391	59353 (6.83)	1544
Odonata	6000	499	77
Lepidoptera (Butterflies)	142500	15000	268
Lepidoptera (Moths)			184
Hemiptera	80000	6500	382
Hymenoptera	120000	10000	319
Dermaptera	2000	320	30
Coleoptera	350000	15500	187
Plecoptera	2100	113	20
Mantodea	2310	162	07
Orthoptera	17250	1750	50
Diptera	100000	6093	14
Ephemeroptera	2200	106	06
Arachnida	73440	(7.9)	107
Pycnogonida	600	(2.67)	-
Pauropoda	360	-	-
Chilopoda	3000	100 (3.33)	-
Diplopoda	7500	162 (2.16)	-
Symphyla	120	4 (3.33)	-
Merostomata	4	2 (50)	-
Phoronida	11	3 (27.27)	-
Bryozoa (Ectoprocta)	4000	200 (5)	01
Endoprocta	60	10 (16.66)	-
Brachiopoda	300	3 (1)	-
Pogonophora	80	-	-
Praipulida	8	-	-
Pentastomida	70	-	-
Chaetognatha	111	30 (27.02)	-
Tardigrada	514	30 (5.83)	-
Echinodermata	6223	765 (12.29)	-
Hemichordata	120	12 (10)	-
Chordata	**48451**	**4952 (10.22)**	921
Protochordata (Cephalochordata+Urochordata)	2106	119 (5.65)	-
Pisces	21723	2546 (11.72)	104
Amphibia	5150	209 (4.06)	17
Reptilia	5817	456 (7.84)	14
Aves	9026	1232 (13.66)	657
Mammalia	4629	390 (8.42)	129
Total (Animalia)	**1196903**	**86874 (7.25)**	**2757**
Total (Protista+Animalia)	**1228153**	**89451 (7.28)**	**2846**

(Sources: Alfred et al., 1998; Anonymous, 2000 a, b; Mehta and Julka, 2002)

Out of total 89,500 animal species of the country, Himachal Pradesh possesses a little more than 7 % of the total fauna. This shows richness of the faunal resources of the state considering its small geographical area which is only about 1.7 % of the country. Invertebrates constitute 88.4 % and vertebrates 11.6 % of the Himachal fauna (Table 1). Insects and other arthropods form a predominant group (4641 species) among invertebrates, whereas vertebrates are dominated by birds comprising about 447 (around 600, revised) species (Anonymous, 2000 a, b; Mehta and Julka, 2002; Mattu and Thakur, 2005; Thakur and Mattu, 2012; Thakur and Kataria, 2012; Negi *et al.*, 2015; Thakur, 2014, 2015; Thakur *et al.*, 2014; Thakur and Negi, 2015).

The insects are by far the largest group among animals and plants in the world. It is commonly believed that 75-80 % of the total animal species on this planet are insects (Ehrlich and Wilson, 1991). Hammond (1992) estimated about 9,50,000 described species of insects, although lower figures of around 7,50,000 (May, 1990) are generally quoted. There is still a large percentage of insects which is yet to be discovered and reported. The beetles alone include some 3,50,000 species (Varshney, 1998).

The insect fauna of India is vast. In an old estimate, Lefroy and Howlett (1909) in the monumental book 'Indian Insect Life' reported 25,700 Indian species. Beeson (1961) estimated 40,000 and Menon (1965) 50,000 Indian species. Roonwal (1989) estimated that insects constitute two-thirds of the total fauna in India and comprise nearly 1,00,000 species, of which about half remain yet to be studied. Varshney (1997) has reported 589 families and 51450 species of insects from India. In a recent estimate, Alfred *et al.* (1998) estimated 59353 species of insects from India belonging to 619 families.

Indian insects belong to 27 orders of which Coleoptera is most dominant with about 15,500 species. Butterflies and Moths with about 15,000 species is another important group. These are followed by Hymenoptera (10,000 spp.), Diptera (6093 spp.) and Hemiptera (6500 spp.). Other orders like Orthoptera (1750 spp.), Trichoptera (812 spp.), Odonata (499 spp.), Thysanoptera (693 spp.), Isoptera (253

spp.) and Dermaptera (320 spp.) constitute a very small fraction of insect fauna (Varshney, 1998).

In Himachal Pradesh, Butterflies and Moths (1250 spp.) form the most dominant group. They are followed by Coleoptera (1100 spp.), Diptera (720 spp.), Hymenoptera (470 spp.) and Hemiptera (368 spp.). These five orders together constitute 89.6 % of Himachal entomofauna. On the other hand, four orders of wingless insects, Thysanura, Protura, Diplura and Collembola are represented by only 22 species, comprising 0.5 % of total insects. Ephemeroptera, Odonata and Plecoptera constitute 23.4 %, 17.9 % and 17.7 % respectively of corresponding Indian fauna. No insects of group Embioptera, Stepsiptera and Mecoptera have been recorded so far from Himachal Pradesh (Anonymous, 2000a, b).

So far there has been no in-depth and standard study of the enumeration of endemic taxa of insects in India. One such attempt was made by Zoological Survey of India (ZSI) in the beginning of this decade, the results of which were published by Ghosh (1996 b). According to him there are about 20717 endemic species of insects in India belonging to 2500 genera. Some insect groups in India are now considered endangered and these have been included in the revised list of 'Schedules' to the Wildlife Protection Act (1972). Some of these insects include dragonflies, damselflies, beetles and butterflies (Varshney, 1998).

The phylum Arthropoda includes a group of animals which, unlike the insects or myriapods, have neither antennae nor mandibles. These are known as chelicerata, of which the class Arachnida makes up the largest part. Of the nine living orders under Arachnida, the Acari comprising the mites and ticks form a most important group. The existence of mites was referred to as early as 850 B.C. by Holmer. The first consolidated list of mites was given in the book 'Systema Naturae' by Linnaeus (1758). Later this group of Arachnids was extensively studied by many workers throughout the world. The earlier record of the study of mites in India was made as far back as 1868 when Peal discovered prostigmatid mites on tea in Assam and named it as red-spider. Later many studies were conducted on taxonomy, ecology,

bionomics, physiology, management etc. of mites in India (Cook, 1967; Prasad, 1974; Gupta, 1988; Evans, 1992; Sanyal, 1998).

Though no attempt has been made by any one to estimate the total number of species from the world, but it is presumed that the total acarine species known from the world is not less than 30,000 The total number of acarine species so far known from India is estimated as 2186 distributed over 643 genera and 207 families (Alfred *et al.*, 1998). Of these, the prostagmatid mites occupied the highest position in respect of number of species and genera. The other suborders in descending order of number of species are Mesostigmata, Cryptostigmata, Astigmata and Metastigmata. Nearly 45 % of the species so far known from India are described as new to science (Sanyal, 1998).

Non-insect invertebrates constitute 12.1 % (693 spp.) of Himachal fauna and Arachnids with 195 species is the largest group (Anonymous, 2000a). Out of these, only 51 species of mites belonging to suborders Prostigmata, Astigmata, Mesostigmata and Metastigmata have been reported from Himachal Pradesh.

The Indian subcontinent has 209 species of Amphibia under 38 genera and 9 families (Chanda, 1998). Whereas, in Himachal Pradesh only 17 species of frogs and toads have been reported (Anonymous, 2000a; Mehta and Julka, 2002).

India harbours a very rich and diverse avifauna. The Indian subcontinent has 1232 species, 2123 subspecies under 78 families, and 20 orders. And India can boast of having 1116 species, 1964 subspecies under the 405 genera and same number of families and orders as above (Ali and Ripley, 1983; Alfred *et al.*, 1998; Kazmierczak, 2000). About 47 species have been designated as threatened (King, 1981; Anonymous, 2000 a, b), of them 2 are suspected to be extinct, namely, the Mountain Quail and Pink headed Duck. Yet another, Jerdon's Courser which was also bracketed with them has recently been rediscovered (Alfred *et al.*, 1998). Recently, Forest Owlet which was also thought to be extinct has been rediscovered after 113 years (Rasmussen, 1998).

The avifauna abridges Palaearctic, Oriental, Ethiopian and Australian zoogeographic regional elements, in addition to its 176 endemic forms. About 350

migrating species and subspecies winter in Indian territory, while some migrate to neighbouring regions from India. Geographical diversity in India, its topographical features, climate, vegetation etc., which is often referred to representing almost every feature of the planet, offer excellent habitats of diverse nature to suit almost all branches of adaptive radiation in birds, and each habitat has been suitably colonized by one form or the other separately or collectively (Saha, 1998; Mehta *et al.,* 2002).

In Himachal Pradesh, a total of 447 species of birds have been reported so far comprising 36.4 % of the Indian bird diversity. They also constitute about 67 % of known vertebrates in Himachal Pradesh. Ecologically, the Himachal fauna is very interesting. About 35.5 % of birds are resident in this state and other parts of the country; 15.7 % are winter visitors from S.E. Asia, Europe, and Siberia; 11.6 % are summer visitors from central India and foothills; 10.4 % are altitudinal migrants; 26.8 % are birds of Himalayan ecosystem and show vertical movements. About 47 % (210 spp.) of birds in Himachal Pradesh are insectivorous and are important agents of bio-control of insect pests of agriculture, horticulture and forests (Anonymous, 2000a). A total of 66 species of birds belonging to 52 genera, 23 families and 10 orders were recorded from Kalatop-Khajjiar Wildlife Sanctuary in Himachal Pradesh. Out of these, 5 species have been reported to be endemic or near endemic (Thakur *et al.,* 2002).

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, 390 species belonging to 180 genera, 42 families and 13 orders are found in the Indian Union. Another 13 orders do not occur in our country (Agrawal, 1998). In Himachal Pradesh this group is represented by 77 (89, revised) species constituting about 20.7 % of the total Indian mammals. Aquatic mammals are not found in this state (Anonymous, 2000a,b; Mehta and Julka, 2002).

METHODOLOGY FOR ANIMAL DIVERSITY STUDIES

DATA COLLECTION PROCEDURE

The following section deals with the details of data collection procedure *viz-a-viz* different taxa. It is a general account, which can be used with minor/major modifications suited for different areas and as per requirement of a study:

1. Mammals

The mammalian populations can be sampled by using a combination of direct and indirect methods. The direct methods utilize sightings of animals as the main data whereas indirect methods rely on quantification of indirect evidences such as pellet groups, scats, pug marks and hoof marks in a predetermined sampling unit. The mammals can be separated into two main groups based on size i.e. large and small mammals since sampling strategies for both groups differ considerably. The large and medium sized mammal community includes species such as elephant, chital, sambar, nilgai, barking deer, Himalayan tahr, musk deer, leopard, tiger etc. The direct evidences of all large and medium sized mammals can be sampled using line transects method (Burnham *et al.* 1980) in an area. The entire procedure of line transect sampling is based on being able to follow a straight transect line or series of straight line segments (Burnham *et al.* 1980). The line transects are established in stratified random design with either vegetation type, habitat type or terrain type as stratification criteria. The line transects are monitored either in morning or evening hours which generally coincide with maximum activity period of animals. Transects are generally walked by a team of observers (a maximum of three) who scan either side of the transect to detect animals. All detection of animal groups are described to a) species, b) number of individuals in group, c) perpendicular distance x_i from transect to the centre of the group, d) sighting distance r_l and e) sighting angle θ_i. The distances are measured using range finders whereas a prismatic compass is necessary for angle measurement. Fig. 1 provides some examples of placement of line transect in an area of interest. Fig. 2 provides schematic diagram of measurements to be taken in field. The investigator should ensure that the following assumptions of line transect theory are not violated:

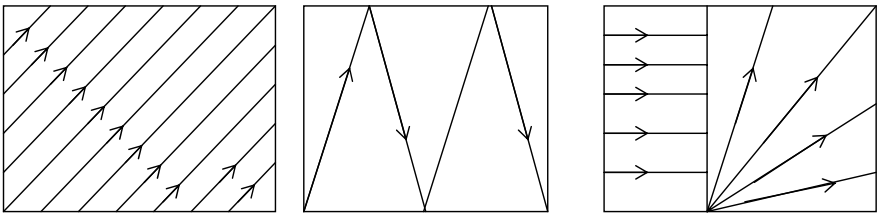

Fig.1. Some examples of placement of line transects in a given area.

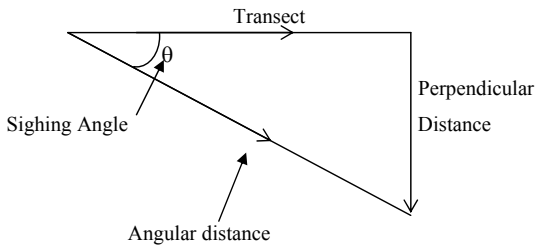

Fig. 2: Measurement required to be taken for each sighting

1. Animals directly on the line transects will never be missed.
2. Animals are fixed at the initial sighting position (they do not move before being sighted) and one is counted twice.
3. No measurement errors and no rounding error occur.
4. Sightings are independent events.

The indirect evidences such as scats, pellet groups can be quantified using plot sampling techniques. The size and shape of the plot varies depending upon the species and community concerned. Generally plots of 10 x 10 m square plots or 10 m circular plots are used for sampling. These plots are established along the line transects at 100 m to 150 m distance intervals. All indirect evidences such as pellet groups; scats can be quantified as to species and their number. The use of indirect evidences for working out relative abundance of a single species or a number of species necessitates that the observer/investigator has considerable experience in distinguishing indirect evidences of different species which generally differ significantly in shape, size and colour.

The small mammal communities are comprised of small cats, civets, mongoose, rodents etc. These groups are one of the most vital groups as far as

management of any landscape unit is concerned. Data on abundance, distribution and diversity of these groups can be collected by using Camera Trap method and by general trapping. The Camera Trap method is a suitable sampling method to study the small cats, civets, and mongoose whereas the rodents are best studied by capture-recapture method using the Sherman Traps. The Camera traps are automatic compact device, which takes photographic evidence of animals if a species happens to pass in front of it. The Camera Traps are deployed systematically in different sampling units such compartments, blocks, beats, sub micro watershed etc. seasonally. A minimum of ten Camera Traps is used for a single trapping exercise. Similarly the Sherman traps can be deployed in different forest compartments for capturing of rodent species. The number of traps to be deployed for sampling depends on the available manpower and funding. A single observer can deploy around 20-30 traps for a single trapping session. The traps are deployed systematically in a line or in a suitable grid system within the predetermined sampling unit such as forest beat, compartment, blocks etc. or different land use categories. The traps are set in either morning hours and checked in evening or they are deployed in evening and checked the following morning.

Apart from above general methods for mammals, following can also be used for different sub groups within mammals:

i) Rodents

Active rodent holes can be observed per unit area and populations can be assessed. “Sherman” traps made of thin G.I. sheet are used for capturing rodents along the trails. Larger rodents can be captured using steel mesh traps of suitable size. To get effective data on population estimates the traps can be deployed systematically either in a line or in a suitable grid system within sampling unit. Traps should be placed inconspicuously camouflaged by vegetation near a trail used by the animal since a highly visible strange object may frighten the animal. In some animals, trap shyness is common. For such cases it is advisable to familiarize the animal with the trap by putting bait in it but not setting the trigger mechanism. Wild animals are

highly susceptible to injury inside a trap. So set traps should be examined at regular intervals.

ii) Mega and Micro-Chiroptera

Bats can be sampled by mist netting or counting them on the roosting sites. For small bats (Micro-Chiroptera) a mist net of 2 X 10m size with average mesh size of 3 cm is suitable for capture. Population can be assessed per unit capture efforts and area sampled. Mist nets should be set between two vertical bamboo poles in a known flight path. In order to reduce the possibility of detecting the net by bats, the mist net should be set against a background of scarce vegetation. Since the bats emerge out from roosts for feeding only after sunset, therefore the nets should be set after sunset and regularly examined at short intervals in order to prevent damage to the net by entangled bats.

iii) Large Carnivores

Population estimates of mammals with distinct body patterns can be obtained using camera traps. In this method special camera with infrared beam are fixed on live trails of the animals and once the animals cut that infrared beam it triggers the camera and animal's picture is captured. In this manner many cameras can be fixed in any given area and population can be assessed. Populations of large carnivores can also be measured using pugmark technique. In this method digital images of the pugmarks are obtained from the wild and then digitized in specific software. After digitization, angles to pad and toe clips are measured and individuals are identified. This technique has been used for estimating tiger population and individual identification in different tiger reserve. The other ways to obtain pugmarks are either plaster cast or tracings. Before tracing pugmarks for individual identification surface texture, slope, thickness of the soil, forest types should be checked and care should be taken to keep these variables constant for all tracings.

iv) Small Carnivores

Populations of nocturnal small mammals like small cats, mongoose, civets etc. can be obtained by employing small cages with bait in the potential habitats. In areas where capture and sighting of small nocturnal animals is difficult, track plots can be

used to get an inference on population estimates. In this method a small area of may be 1x1 meters is cleaned. Fine sand of about 1cm thickness is spread over the clean area and animals are attracted with a bait to walk over the set plot. Number of individual's tracks is measured and population assessed.

v) Ungulates

Estimating ungulates inhabiting higher altitudes needs innovation to established population estimation protocols. Walking transect and even obtaining indirect estimates are very difficult and that is why steep slopes can be scanned with binocular or spotting scopes and total counts of the animal sighted can be made.

Small mammalian collections are preserved by fixing in 10% formalin solution for 24 hrs. They are then either transferred to 4-5% formalin or 70% alcohol for permanent storing. They can also be preserved dry as study skin after proper treatment.

2. Birds

A variety of methods are available to sample bird communities in a landscape unit. The bird communities can be sampled using the "Species Richness Counting" method (MacKinnon & Phillips, 1993) and the "Point Count" method (Reynolds *et al.,* 1980). The "Species Richness Counting" method involves compilation of list of bird species in habitat (Aisha Sultana & Khan, 2000). Each list is comprised of 20 bird species and a species gets listed in the list once only but can be subsequently recorded in second list. The minimum number of lists to be compiled by the Species Richness Counting method would be based on the species accumulation curve. Each area/habitat can be censured till the species accumulation curve reaches the asymptote. The point counts are carried out at a series of locations selected in stratified random design in each area. Points are located at least 500 m apart to maintain independence in simultaneous counts. Point counts are carried out generally in morning hours. At each point, observers are stationed to record detection of different bird species around the point. For each detection, data on following variables are collected a) species and number of individuals, b) number of species and approximate number of individuals for mixed flocks, c) tree species, d) stratum

(upper canopy, middle canopy etc. e) radial distance x_i from the location of the detected bird to the point transect by a range finder. Point counts are carried out for short duration of 20-30 minutes and observer has to be careful for avoiding the double counting.

Data on following habitat variables are also collected a) tree species richness, diversity and cover, b) shrub species richness, diversity and cover, c) ground layer species richness and diversity, d) vertical stratification, e) spatial habitat heterogeneity, f) disturbance such as amount of lopping, cutting, grazing etc, The vegetation at each point is sampled using standard sampling procedures for trees, shrubs and ground layer following Greig Smith (1983). While tree species are counted in 10 m radius circular plot, the shrub species are sampled in 3 m radius circular plots. The data on ground layer species are quantified in four 0.5 m x0.5 m square quadrat. At each sampling point the tree cover is estimated at four locations using a mirror of 20 cm x 20 cm divided into 25 equal grids. At each location, the investigator holds the mirror horizontally at around waistline and number of grids covered more than 50% are counted. The total estimated tree cover equals the total number of grids covered by more than 50% out of a total 100 grids. The cover is then expressed in percentage terms. The shrub cover is estimated by using four m long density board marked at one m interval. The density board is placed at four cardinal locations and the amount of foliage covering each one m interval is recorded. The data on disturbance factors such as lopping, cutting, grazing, cattle abundance are usually collected on ordinal scale of 0 to 4 where 0 represents no cutting or grazing and 4 represents maximum intensity/magnitude of any disturbance factor.

3. Reptiles

The reptiles are best sampled using the general methods described by Ishwar *et al.* (2001). Data on species richness, diversity and abundance of reptiles are collected by using a combination of adaptive cluster sampling, forest transects and stream transects. 5x5 m quadrats are established systematically in different forest compartments/sampling unit. The quadrats (considered as primary quadrat) are searched and in case an animal is sighted, additional quadrats (termed secondary

quadrats) of the same dimension are searched on four sides of the primary quadrats. A gap of 5 m is maintained between primary and secondary quadrats. The sampling continues until quadrats with animals will be surrounded with quadrats without reptiles. In order to minimize the chances of missing animals during sampling, the observers search the quadrat from opposite sides towards the centre. The parameters to be estimated from the data are a) the number of primary quadrats with animals, b) cluster size, d) species richness in a cluster, e) density and f) community composition. In addition to cluster sampling, forests transects and stream transects are monitored for recording abundance of reptiles. Records of casual sightings of reptiles are also be maintained for compiling a species checklist.

Collected voucher specimens are preserved by standard procedure. Small snakes and lizards can be directly preserved in 90% alcohol. For larger specimens, gut content is removed and then immersed in 4-5% formalin solution.

4. Amphibians

The amphibian communities can be sampled using the methods described by Vasudevan *et al.* (2001). Amphibian species are sampled using a combination of adaptive cluster sampling, visual encounters surveys, audio surveys and opportunistic records. The adaptive sampling is done along streams and on forest floors to sample the amphibians. Quadrats of adequate sizes (5 m x 1000 m along the streams and 5 m x 5 m on forests floors) are sampled for recording the amphibian species. The sampling strategy in adaptive clustering will be same as described for reptiles. The primary and secondary quadrats are searched by two observers by carefully turning the leaf litter, rocks, as well as by prodding the cavities on the forest floor to look for amphibian species. Within each quadrat, data on habitat factors such as physiographic variables (elevation, slope, soil moisture and temperature etc), vegetation (canopy cover, shrub density, leaf litter cover etc) and microhabitat factors (rockiness, leaf litter depth etc.) are also collected. Small specimens are directly put in 4% formalin solution. Larger specimens are killed by exposing them to chloroform vapors and then stored in 4% formalin solution.

5. Fishes

There are many methods available for trapping fish. Different kinds of nets and traps are generally employed. Most fish traps work on the principle that it is easier for a fish to enter than to leave. These traps are set on the stream or riverbed against water current so that fishes moving along the water current are trapped. Commonly used types of fish traps include fish- weirs, bag-nets, pot traps, minnow traps etc. All fish traps are highly selective. Aquatic traps can be used with an attractant like light or bait. In lentic water systems, fish diversity and abundance can be estimated by periodic netting using different kinds of nets like drag net.

Fish specimens are preserved in 5-7% formalin soon after catch. Formalin is not suitable for long time preservation of fishes. So after fixation in formalin, the specimens should be gradually transferred to 70% alcohol. For the detailed and in depth information on the preservation methods of different groups of animals, a handbook of Zoological Survey of India (1990) can be consulted.

6. Arthropods

Besides forming the largest component of biodiversity, arthropods are essential for the "ecosystem services" and maintenance of food chain. This warrants their intensive study in biodiversity assessments. Due to their immense diversity, documentation of arthropod fauna of an area is never complete, although a good deal of information can be generated on them by planned and systematic surveys. Following are the methods commonly used for collection of arthropod fauna.

i) Hand picking

Small, soft-bodied insects are best collected by hand with the help of a fine camel hairbrush or a forcep. The brush is dipped in the medium in which the insect is to be preserved and the specimens are collected from soil, litter, vegetation etc. Hand picking needs searching in particular habitat. Insects like leaf miners, aphids, termites, ants, bark inhabiting beetles etc. are best collected by this method.

ii) Sweeping

Sweeping with an insect net yields satisfactory result while collecting insects from herbage. A sweeping net with a 2 feet long handle and 20 inch deep strong cloth

bag gives good results. The disadvantage of sweeping method has mainly been that it does not offer host plant data or specific habitat of an insect species.

iii) Beating

Beating is usually used to dislodge insects from foliage or trees. Usually a long stick is used to beat the plant part with downward strokes and a white cloth is spread over the ground to fetch the falling insects. A net may also be kept on the ground to prevent crawling or jumping.

iv) Aerial netting

Aerial nets are most commonly used to collect free living flying insects like butterflies, dragonflies, wasps and bees, dipterans etc. The length of handle, diameter of the ring, depth of the net may vary on individual collector's preference. Soft-bodied insects like butterflies may be gently removed from the bottom of the bag, after they get trapped in the bag by a rapid twist of handle.

v) Aspirator

Small active insects like leafhoppers, white flies, other Hemiptera and Coleoptera etc. may be collected by a sucking tube or aspirator straight from the plant surface. It is also useful to transfer small insects from sweeping nets. The air is sucked by the rubber tubing, which will draw the insects to the main tube through the glass tube. The lid of the main tube may be removed and the entire content can be transferred to the killing bottle or in to the preservative.

vi) Trapping

Traps are used to collect insects, which may otherwise evade attention of the collector. Various types of traps in use can be grouped into the following categories

i) Traps without bait or light: wind traps; water traps etc.

ii) Traps with bait: Pit fall traps come under this category. The odour of a particular kind of food or sex hormone attracts insects. Baits may include over-ripe fruits, pieces of meat or fish etc. In a pit fall trap, a jar containing bait is placed below the soil level to catch crawling insects like roaches, ground beetles etc. Even this method is quite effective to trap soil arthropods.

iii) Traps with light: Light traps are used to collect insects at night. Simplest form would be to suspend a light source over a broad rimmed funnel, which in turn may be fitted in a glass jar containing poison vapour or other killing agent.

vii) Burlese Funnel

Insects inhabiting leaf litter or subsoil are collected by this method. The leaf litter along with the soil is brought to the laboratory and put in a funnel, which acts as a separator. The simplest form of Berlese funnel is a metal funnel with sieve, inserted inside a can or collecting tube, the material is put on the sieve, which is subjected to continuos heating by an electric bulb. The collecting tube contains preserving fluid like alcohol and the lip of the funnel touches the fluid. Insects or other arthropods in order to evade heat move down through the sieve and fall in the preservative.

Preservation techniques vary according to different groups of insects. However in most cases, after collection they are put into a killing bottle containing agents like benzene. They are relaxed, pinned, dried under electric bulb and permanently stored in insect boxes. Soft-bodied insects like Thysanura, Diplura, Collembola, Protura and many more are preserved in 70% alcohol directly. However, for more detailed information on collection and preservation of insects, Ghosh and Sengupta (1982) can be referred. Other Arthropods (Spiders, Scorpions, Centipedes, Millipedes, Ticks, Mites etc.)

These groups can be collected by any one of the methods described above. They are preserved in 70 % alcohol.

7. Mollusca (Snails & Bivalves), Annelids (earthworms) and other macro soil-fauna

These can be hand picked and preserved in 70 % alcohol. Permanently preserved faunal components should carry well-labelled data. Data label should contain the date of collection, locality, altitude, host plant (wherever applicable), name of the collector or any other relevant information etc.

DATA ANALYSIS

The data collected on each group are comprised of a number of species and their individuals. The data may be used to calculate a) relative abundance/density of a

species or a group of species, b) crude species richness i.e the total number of species present in an area of interest, c) species richness i.e. a refined measure of species richness which takes into account the total number of individuals of all species, and d) species diversity.

The abundance of a species or groups of species may be calculated in the following manner

a) Encounter rates: The encounter rate is a relative abundance index. It is calculated by dividing the number of groups of a species by the length of transect monitored. Thus if an investigator has monitored one line transect of 2 km length 5 times, the investigator has covered a total line length of 10 km. If the investigator has sampled 50 groups of chital, the encounter rate for chital would be 5 chital groups/km. The encounter rates can also be calculated in terms of groups/transect, species/transect, species/point, individuals of a species/point or transect etc. The individual encounter rates may be averaged to calculate mean encounter rates for different species at forest compartment, block, range level or for different land use and cover categories and comparisons between mean values of encounter rates can be made using simple non parametric and parametric statistical tests.
b) Density: The abundance of different species can also be expressed in terms of density i.e. number of individuals of a species per unit area. The estimation of density of species from fixed width transects and plots is easier to calculate using the formulae:

$$\text{Density} = \frac{n}{2xLxy}$$

Where n is the number of individuals of species sampled, L is the length in m or km monitored, y is the width of the transect and 2 stands for both sides of the transect.

Similarly for a circular fixed radius plot, the density is calculated by

$$\text{Density} = \frac{n}{\pi r^2}$$

Where n is the total number of individuals of a species sampled and r is the radius of the circular plot.

The density of a species from line transect sampling is calculated by the formula:

$$\text{Density} = \frac{nf(0)}{2L}$$

Where n is the number of individuals of a species sampled on both side of the transect, f(0) is the value of the probability density function at distance 0, 2 stands for both side of the transect and L is the total length monitored.

The species richness for each sampling unit is calculated by following Margelef's richness index (*RI*) following Magurran (1988):

$$S\text{-}1/\ln N$$

where *S* is the total number of species and *N* is the total number of individuals.

The species diversity (*H*) is calculated by the Shannon-Weiner function following the formulae:

$$H = -\sum pi \times \log pi$$

Where *pi* is the proportion of *ith* species.

The digitized maps of an area may be used to prepare basic layers of different vegetation variables which are of interest from the point of view of faunal diversity. Some of these variables are tree cover, diversity, richness, shrub cover, diversity, richness, distribution of land use types, disturbance factors etc. The spatial relationship between attributes of faunal community (diversity, richness and abundance) and that of habitat variables may be analyzed using GIS software Arc View (Vr. 8.2). The information on presence/absence of different species and their abundance for each group can be used to create a GIS aided data base on distribution and spatial abundance pattern of different species and groups. The information on habitat preferences of each species can also be analyzed to generate the Habitat Suitability Index (HSI) models for selected species/groups which are of utmost conservation significance in an area of interest.

GROUPWISE STATUS AND DETAILS OF ANIMALS IN HIMACHAL PRADESH

Status and details of animal diversity of Himachal Pradesh can be summarised as follows:

INVERTEBRATES

PROTOZOA

Protozoans are single-celled eukaryotic organisms which, are with some exceptions, visible with the aid of a microscope. Some of them play a significant role in the food web as primary consumer in aquatic ecosystems (mainly flagellates and ciliates), contribute in the formation of littoral deposits (foraminifera and rediolaria), humification and mineralisation of leaf litter (rhizopoda and ciliates), natural recovery of putrified sewage water (flagellates and ciliates) etc. Other are being used for environmental biomonitoring particularly in evaluating water quality. There are, however, several well-known parasitic protozoans causing various fatal diseases in man and livestock.

There are about 65,000 species of Protozoans known from the world but more than half of these are fossils. Number of living species is more than 31000 from the world. Of these, a little over 21000 are free living and some 10000 are parasitic. In India 2577 species have been reported so far constituting about 8 % of the total world known species. Of these, 52 % are freeliving and 48 % are parasitic (Das, 1998).

The state of Himachal Pradesh has been inadequately explored for protozoan diversity. There are a few published works by Mukherjee and Das (2000), Chattopadhyay and Das (2003) and Das and Chattopadhyay (2005) on the diversity of this group. Das and Chattopadhyay (2005) have reported 89 species of free living and parasitic protozoans belonging to 2 phyla, 6 classes, 17 orders, 34 families and 50 genera. Of these, 84 are freeliving and 5 are parasitic. The work also includes some of the species viz., *Centropyxis stellata, Campuscus cornuatus, Leptochlamys ampullacea, Litonotus muscorum, Colpoda reniformis* etc reported for the first time from India.

Systematic List of Protozoans found in Himachal Pradesh

A. Freeliving Protozoa

Class : Lobosea
Order : Amoebida
Family : Thecameibidae
1. *Thecamoeba terricola*

Family : Paramoebidae
2. *Mayorella vespertilio*

Order : Testacrealobosea
Family : Arcellidae
3. *Arcella discoides*
4. *Arcella vulgaris*

Family : Microcorycidae
5. *Diplochlamys timida*
6. *Leptochlamys ampullaceal*

Family : Centropyxidae
7. *Centropyxis aculeate*
8. *Centropyxis aerophila*
9. *Centropyxis constricta*
10. *Centropyxis ecornis*
11. *Centropyxis minuta*
12. *Centropyxis platystoma*
13. *Centropyxis spinosa*
14. *Centropyxis sylvatica*
15. *Centropyxis stellata*
16. *Cyclopyxis arcelloides*
17. *Cyclopyxis arcelloides*
18. *Cyclopyxis kahli*
19. *Plagiopyxis callida*
20. *Plagiopyxis minuta*
21. *Trigonopyxis arcula*

Family : Difflugiidae
22. *Difflugia lebes*
23. *Difflugia lobostoma*
24. *Difflugia muriformis*
25. *Difflugia oblonga*
26. *Difflugia rubescens*
27. *Difflugia urceolata*

Family : Nebelidae
28. *Heleopera rosea*
29. *Heleopera sylvatica*
30. *Hyalosphenia papilio*
31. *Nebela collaris*
32. *Nebela wailesi*
33. *Quardulella symmetrica*

Family : Phryganiidae
34. *Phrganella hemispherica*

Class : Filosea
Order : Testaceafilosa
Family : Cyphoderiidae
35. *Campuscus cornuatus*

Family : Euglyphidae
36. *Assulina muscorum*
37. *Corythion dubium*
38. *Euglypha leavis*
39. *Euglypha rotunda*
40. *Euglypha strigosa*
41. *Euglypha tuberculata*
42. *Tracheleuglypha dentate*
43. *Trinema complanatum*
44. *Trinema enchelys*
45. *Trinema lineare*

Phylum : Ciliophora
Class : Kinetofragminophorea
Order : Prostomatida
Family : Holophrydae
46. *Holophrya simplex*

Family : Colepidae
47. *Coleps hirtus*
48. *Coleps inermis*

Family : Trachelidae
49. *Dileptus tenuis*

Family : Didinidae
50. *Didinium nasutum*

Family : Amphilepidae
51. *Amphileptus claparedei*
52. *Hemiophrys procera*
53. *Litonotus fasciola*
54. *Litonotus muscorum*

Order : Trichostomatida
Family : Colpodidae
55. *Colpoda cucullus*
56. *Colpoda steini*
57. *Colpoda reniformis*

Family : Leptopharyngidae
58. *Leptopharynx eurystoma*

Class : Oligohymenophorea
Order : Hymenostomatida
Family : Glaucomidae
59. *Monochilum ovale*

Family : Ophryoglenidae
60. *Ophryoglena flava*

Family : Parameciidae
61. *Paramecium aurelia*
62. *Paramecium caudatum*

Family : Frontoniidae
63. *Frontonia atra*
64. *Frontonia leucas*

Family : Urocentridae
65. *Urocentrum turbo*

Order : Scuticociliatida
Family : Cinetochilidae
66. *Cinetochilum margaritaceum*

Order : Periatrichida
Family : Vorticellidae
67. *Vorticella campanula*

Class : Polyheymenophorea
Order : Heterotrichida
Family : Spirostomatidae
68. *Blepharisma undulans*
69. *Spirostomum ambuguum*

Family : Metopidae
70. *Metopus* sp.

Family : Strobilidiidae
71. *Strobilidium gyrans*

Order : Hypotrichida
Family : Urostylidae
72. *Paraholosticha herbicola*

Family : Oxytrichidae
73. *Oxytricha bifaria*
74. *Oxytricha fallax*
75. *Oxytricha hymenostoma*
76. *Pleurotricha lanceolata*
77. *Stylonychia mytilus*
78. *Stylonychia pustulata*

Family : Euplotidae
79. *Ueplotes patella*
80. *Ueplotes charon*
81. *Ueplotes muscicola*

B. Parasitic Protozoa

Phylum : Sarcomastigophora
Order : Opalinida
Family : Opalinidae
82. *Opalina obtrigonoidea*

Phylum : Ciliophora
Class : Oligohynemophorea
Order : Astomatida
Family : Anoplophryidae
83. *Anoplophrya amaleshi*
84. *Anoplophrya lumbrici*
85. *Anoplophrya marylandensis*
86. *Anoplophrya striata*

(Sources: Das and Chattopadhyay, 2005; Mukherjee and Das, 2000; Chattopadhyay and Das, 2003)

NEMATODA

Nematodes are worm like invertebrates having appendageless and non-segmented body, vary in length from 82 µm to over 8 m, and generally have a cylindrical body while a few may be fusiform, saccate or kidney shaped. They have been divided into five groups on the basis of habitats and feeding habits, viz., vertebrate parasites, invertebrate parasites, plant parasites, microbotrophic, saprophagus or free-living and predacious. The nematode parasites of vertebrates, invertebrates and plants cause significant damages to their hosts, i.e. human beings, livestock and crops. They cause some serious diseases onchocerciasis, ascariasis, filariasis etc in humans. All the nematodes are not enemies. The nematode parasites of insects are considered as good biological control agents of pests. Others maintain natural balance in the soil.

The estimated number of species of nematodes from the world are around 5,00,000 though, there are some 30,000 known species of nematodes from the world and around 3,000 species have so far been reported from India. Of these 3,000

species, more than 1200 are parasitic on vertebrates and invertebrates, and rest are plant parasitic and free-living (Baqri, 1998).

Systematic of nematodes found in Himachal Pradesh

Parasitic nematodes:

1. *Allocreadium singhi* Rai, 1962
2. *Amplicaecum flavescens* Katoch & Kalia, 1993
3. *Ancylostoma (A.) caninum* (Ercolali, 1859)
4. *Ancylostoma quentine* Gupta & Kalia, 1984
5. *Arthrostoma felineum* Cameron, 1927
6. *Arthrostoma pagumae* Gupta & Kalia, 1984
7. *Artyfechinostomum malayanum* (Leiper, 1911)
8. *Bursaphenelchus piniperdae* Fuchs, 1937
9. *Caninum ancylostoma* (Ercolani, 1859)
10. *Coslenchus costatus* (de Man, 1921)
11. *Cosmocercoides barodensis* Rao, 1979
12. *Cosmocercoides bufonis* Karve, 1944
13. *Cosmocercoides duke* (Holl, 1928)
14. *Cosmocercoides fotedari* Arya, 1991
15. *Cosmocercoides kumaoni* Arya, 1991
16. *Cosmocercoides lanceolatus* Rao, 1979
17. *Cosmocercoides multipapillata* Khera, 1958
18. *Cosmocercoides nainitalensis* Arya, 1979
19. *Criconema mutabile* (Taylor, 1936)
20. *Criconemella macrodora* (Taylor, 1936)
21. *Enterobius chabaudi* Kalia & Gupta, 1982
22. *Filenchus filiformis* (Butschli, 1873)
23. *Gireterakis andersoni* Kalia & Gupta, 1989
24. *Gireterakis guptai*
25. *Haemonchus contortus* (Rudolphi, 1803)
26. *Heterakis spurmosa* Schneider, 1866
27. *Homalometron mandiensis*
28. *Indocucullanus fotedari*
29. *Kalicephalus (Schadius) schadi* Ogden, 1966
30. *Longistriata indica* Singh, 1969
31. *Marshallagia* sp.
32. *Meloidogyne incognita* (Kofoid & White, 1919)
33. *Mesocestoides lineatus* (Goeze, 1782)
34. *Monodontus bainae* Kalia & Gupta, 1983
35. *Oesophagostomum (Conoweberia) amarpurense* Chandel & Kalia, 1995
36. *Oesophagostomum (Conoweberia) bifurcum* Creplim, 1849
37. *Oesophagostomum (Conoweberia) kherai* Kalia, 1985
38. *Oesophagostomum (Conoweberia) pachycephalum* Molin, 1861
39. *Oesophagostomum (Conoweberia) tridentatum* Maplestona, 1932
40. *Oesophagostomum (Proteracum) columbianum* (Curtice, 1890)
41. *Oesophagostomum O. amarpurense*
42. *Oxysomatium anurae* Biswas & Chakravarti, 1963
43. *Oxysomatium macintoshii* Travassos, 1931
44. *Oxysomatium mehdii* Ilyas, 1980
45. *Oxysomatium srinagarensis* Fotedar, 1960
46. *Oxysomatium stomatici* Biswas & Chakravarti, 1963
47. *Paratylenchus micoletzkyi* Edward & Misra, 1967
48. *Physaloptera johnsoni* Arya 1978
49. *Physaloptera kherari* Katoch & Kalia, 1990
50. *Physaloptera varani* Parona, 1889

51. *Porrocaecum* sp.
52. *Procamallanus bilaspurensis* Gupta & Duggal, 1973
53. *Psilenchus hilarulus* de Man, 1921
54. *Pterygodermatites (Mesopectines)* sp.
55. *Pterygodermatites (Mesopectines) willmottae* Kalia & Gupta, 1986
56. *Pterygodermatites (Multipectines) affinis* (Jagerskiold, 1904) Quentin, 1969
57. *Quinisulcius capitatus* Siddiqi, 1971
58. *R. (Rhabdochona) moraveci* Katoch & Kalia, 1991
59. *Rhabdias bufonis* (Schrank, 1788)
60. *Rhabdochona (Filochona) ergensi* Moravec, 1968
61. *Rhabdochona (Filochona) oncorhynchi* (Fujita, 1921)
62. *Rhabdochoni (Filochona) andersoni* Katoch & Kalia, 1990
63. *Rhabdochoni soodi* Katoch & Kalia, 1990
64. *Serpinema hamirpurensis*
65. *Seuratum inglise* Gupta & Kalia, 1981
66. *Spirura herpestis* Kalia and Gupta, 1986
67. *Spirura khalili* Katoch & Kalia, 1991
68. *Syphacia (S.) baylisi* Maplestone & Bhaduri, 1942
69. *Syphacia (s.) mandiense*
70. *Syphacia (Syphatineria) quptae*
71. *Syphacia (Syphatineria) suncii*
72. *Thelandros agamae*
73. *Thelandros baylisi* (Chatterji, 1935)
74. *Thelandros himalayana* Karve, 1949
75. *Thelandros taylori* Chatterji, 1935
76. *Trichostrongylus colubriformis* (Giles, 1892)
77. *Trichuris globulosa* (v. Linstow, 1901)
78. *Trichuris ovis* (Abildgaard, 1795)
79. *Trichuris pedetei* Verster, 1960
80. *Trichuris sylvilagi* Tiner, 1950
81. *Trichuris trichiura* (Linnaeus, 1771)
82. *Troglostrongylus brevior* Gerichter, 1948
83. *Trypaloxyuris pitheci* Vevers, 1923
84. *Trypanoxyuris (Trypanoxyuris) pitheci* Kalia & Chandel, 1998
85. *Xiphinema americanum* Cobb, 1913
86. *Xiphinema insigne* Loos, 1949

(Sources: Ahluwalia, 2003; Bhardwaj, 1989; Chandel, 1994; Chauhan, 1993; Chhaila, 1987; Dogra, 2000; Katoch, 1989; Malhotra, 1985; Nayital, 1987; Negi, 2001; Negi, 2002; Sharma, 2004; Soni, 2001; Verma, 2002).

ANNELIDA

Oligochaeta

Earthworms have drawn the attention of philosophers and naturalists since ancient times because of their significant role in decomposition of surface litter, thus increasing the soil fertility by its redistribution and incorporation in the soil. Organic matter is pulverized and subjected to digestive enzymes in their elementary canal. Their castings (excreta) are rich in plant nutrients. Moreover, during unfavourable period, the microbial decomposition of dead worms releases considerable amount of

nitrogen and other nutrients for growing vegetation (Julka, 1988; Julka and Paliwal, 2005).

This phylum includes three classes namely Polychaeta, Oligochaeta and Hirudinea. The group Annelida comprises approximately 12,700 species belonging to 1,470 genera and 128 families in the world. Indian Annelids comprises 3 classes, 80 families, 312 genera and 840 species, forming 6.6 % of the global annelid species. Class Oligochaeta in India is represented by 381 species belonging to 87 genera and 14 families (Julka, 1998). Of these 381 species, 46 have been reported from Himachal Pradesh (Paliwal, 1994; Julka and Paliwal, 1995 & 2005).

Systematic List

Phylum: Naidida
Class : Oligochaeta
Family : Naididae
1. *Nais barbata* Muller
2. *Nais communis* Piguet

Family : Tubificidae
3. *Limnodrilus hoffmeisteri* Claparede

Family : Moniligastridae
4. *Drawida japonica* (Michaelsen)
5. *Drawida nepalensis* Michaelsen

Family : Lumbricidae
6. *Allolobophora parva* Eisen
7. *Aporrectodea c. caliginosa* (Savigny)
8. *Aporrectodea c. trapezoides* (Duges)
9. *Aporrectodea rosea rosea* (Savigny)
10. *Dendrobaena hortensis* (Michaelsen)
11. *Dendrobaena octaedra* (Savigny)
12. *Dendrodrilus rubidus* (Savigny)
13. *Eisenia fetida* (Savigny)
14. *Eiseniella t. tetraedra* (Savigny)
15. *Lumbricus castaneus* (Savigny)
16. *Lumbricus terretris* Linnaeus
17. *Octolasion cyaneum* (Savigny)
18. *Octolasion tyrtaeum* (Savigny)

Family : Ocnerodrilidae
19. *Malabaria levis* (Chen)
20. *Ocnerodrilus occidentalis* Eisen
21. *Thatonia exilis* Gates
22. *Thatonia gracilis* Gates

Family : Acanthodrilidae
23. *Microscolex phosphoreus* (Duges)
24. *Plutellus sadhupulensis* Julka &Paliwal

Family : Octochaetidae
25. *Dichogaster bolanui* (Michaelsen)
26. *Eutyphoes incommodus* (Beddard)
27. *Eutyphoes nicholsoni* (Beddard)
28. *Eutyphoes waltoni* Michaelsen
29. *Lennogaster chittagongensis* (Steph.)
30. *Lennogaster pusillus* (Stephenson)
31. *Lennogaster yeicus* (Stephenson)
32. *Octochaetona beatrix* (Beddard)
33. *Ramiella bishambari* (Stephenson)

Family : Megascolecidae
34. *Amynthas alexandri* (Beddard)
35. *Amynthas corticis* (Kinberg)
36. *Amynthas gracilis* (Kinberg)
37. *Amynthas morrisi* (Beddard)
38. *Metaphire birmanica* (Rosa)
39. *Metaphire anomala* (Michaelsen)
40. *Metaphire houlleti* (Perrier)
41. *Metaphire posthuma* (Vaillant)
42. *Perionyx bainni* Stephenson
43. *Perionyx excavatus* Perrier
44. *Perionyx barotensis* Julka & Paliwal
45. *Perionyx simlaensis* (Michaelsen)
46. *Perionyx sansibaricus* Michaelsen

(Sources: Paliwal, 1994; Julka, 1998; Julka and Paliwal, 1995 & 2005)

ARTHROPODA

ARACHNIDA (MITES)

Mites are characterized by presence of four pairs of legs and an unsegmented abdomen (Krantz, 1978). They are microscopic but the harm they do may be often enormous. Mites are possibly one of the most common groups of arthropods to be found in any conceivable habitat. Mites are also known to act as vectors of certain plant viruses (Ehara, 1966; Mc Murtry *et al.,* 1970; Jeppson *et al,* 1975; Gupta, 1985, 1991). Contrary to the injurious mites, there are some beneficial mites too which act as our friends by predating upon phytophagous mites and small insect pests like aphids, coccids, thrips etc. (Somchoudhury, 1981; Borah and Rai, 1989 and Manjunatha *et al*.,1999) and thus help in biological control.

The existence of mites was referred to as early as 850 B.C. by Homer. Linnaeus in 1758 in his 'Systema Naturae' listed nearly 30 species. Like all organisms, honeybees also suffer from many pests predators and diseases that endanger the life of the individual bee, or damage the colony or cause serious injury to its comb and hive. Most enemies of the bee, however, are of minor importance in comparison to the destruction caused by certain diseases (Mishra, 1995). Pests of honeybees mainly comprise mites, bacteria, virus etc. This may be due to a variety of ecological conditions and more species of honeybees in this subcontinent.

Among the enemies, over 100 different mite species have been found in honeybee colonies. Most of these mites do not feed on the bees themselves, but on the pollen supplies or hive debris. However there are three species of mites, *Acarapis woodi, Tropilaelaps clareae* and *Varroa* sp. which feed upon the bees themselves and can therefore be particularly harmful to honeybee colonies (Bradbear, 1988). Damage caused by these mites may be slight to devasting depending upon honeybee species and their colony build up. Many studies have been conducted on the biology, behaviour and control of parasitic mites abroad (Koeniger and Muzafar, 1988; Delfinado-Baker *et al.,* 1989). Practically a little work has been done on the bioecology of mite pests of Himachal Pradesh.

Table 2: Mite fauna associated with *Apis* spp. in Himachal Pradesh

S.No	Mite species	Order	Family	Honey bees species infested	Mode of living assoiation
1	*Tyrophagus longior* Gervais	Astigmata	Acaridae	*A. mellifera* *A. cerana*	Phoretic
2	*Tyrophagus* sp.	Astigmata	Acardiae	*A. mellifera*	Phoretic
3	*Acarus* sp.	Astigmata	Acardiae	*A. mellifera*	Phoretic
4	*Caloglyphus berlesei* Michael	Astigmata	Acardiae	*A. cerana*	Phoretic
5	*Rhizhoglyphus robini* Claparede	Astigmata	Acaridae	*A. cerana*	Phoretic
6	Astigmatic mite (i)	Astigmata	Acaridae	*A. mellifera*	Phoretic

7	Astigmatic mite (ii)	Astigmata	Acaridae	*A. cerana, A. florea*	Phoretic
8	Astigmatic mite (iii)	Astigmata	Acaridae	*A. mellifera*	Phoretic
9	*Acarapis dorsalis* Morgenthaler	Prostigmata	Tarsonemidae	*A. mellifera*	Ectoparasitic
10	*Acarapis woodi* Rennie	Prostigmata	Tarsonemidae	*A. mellifera*	Endoparasitic
11	*Varroa jacobsoni* Oudemans	Mesostigmata	Varroidae	*A. mellifera*	Ectoparasitic
12	*Tropilaelaps clareae* Delfinado & Baker	Mesostigmata	Laelapidae	*A. cerana*	Ectoparasitic
13	Mesostigmatic mite (i)	Mesostigmata	Laelapidae	*A. mellifera*	Ectoparasitic
14	Mesostigmatic mite (ii)	Mesostigmata	Laelapidae	*A. mellifera*	Ectoparasitic
15	Mesostigmatic mite (iii)	Mesostigmata	Laelapidae	*A. mellifera*	Ectoparasitic
16	Mesostigmatic mite (iv)	Mesostigmata	Laelapidae	*A. mellifera*	Ectoparasitic
17	Mesostigmatic mite (v)	Mesostigmata	Laelapidae	*A. mellifera*	Ectoparasitic
18	*Parasitellus* sp.	Mesostigmata	Parasitidae	*A. mellifera*	Predatory
19	*Macrocheles muscaedomesticae* Scopoli	Mesostigmata	Macrochelidae	*A. cerana*	Predatory
20	*Macrocheles* sp.	Mesostigmata	Macrochelidae	*A. mellifera*	Predatory
21	*Laelaps* sp.	Mesostigmata	Laelapidae	*A. mellifera*	Predatory
22	Ascidae mite	Mesostigmata	Ascidae	*A. cerana*	Phoretic
23	*Neocypholaelaps indica* Evans	Mesostigmata	Ameroseiidae	*A. mellifera*	Phoretic
24	*Neocypholaelaps apicola* Delfinado & Baker	Mesostigmata	Ameroseiidae	*A. cerana*	Phoretic

(Source: Sharma, 2002, Mattu et al., 2003)

Table 3: Mite spp. associated with *Bombus* spp. in Himachal Pradesh

Mite species	Order	Family	Bumble bee species infested	Mode of living/ association
Androlaelaps casalis Berlese	Mesostigmata	*Laelapidae*	*B. tunicatus*	Phoretic
Pneumolaelaps longanalis Hunter and Husband	Mesostigmata	*Laelapidae*	*B. tunicatus*	Phoretic
Mesostigmatic mite (i)	Mesostigmata	*Laelapidae*	*B. tunicatus*	Phoretic
Mesostigmatic mite (ii)	Mesostigmata	-	*B. tunicatus*	Phoretic

(Source: Sharma, 2002)

Table 4: Different honey bee and bumble bee mite pests new to Himachal Pradesh with their taxonomic status

Honeybee Mites

S.No	Mite species	Order	Family	Host bee species
1	*Tyrophagus longior (*Gervais)	Astigmata	Acaridae	*A. mellifera, A. cerana*
2	*Tyrophagus* sp.*	Astigmata	Acaridae	*A. mellifera*
3	*Acarus* sp.*	Astigmata	Acaridae	*A. mellifera*
4	*Caloglyphus berlesei* (Michael)	Astigmata	Acaridae	*A. cerana*
5	*Rhizoglyphus robini* (Claparede)	Astigmata	Acaridae	*A. cerana*
6	Astigmatic mite (i)*	Astigmata	Acaridae	*A. mellifera*

7	Astigmatic mite (ii)*	Astigmata	Acaridae	*A. cerana, A. florea*
8	Astigmatic mite (iii)*	Astigmata	Acaridae	*A. mellifera*
9	*Acarapis dorsalis* (Morgenthaler)	Prostigmata	Tarsonemidae	*A. mellifera*
10	Mesostigmatic mite (I)*	Mesostigmata	Laelapidae	*A. mellifera*
11	Mesostigmatic mite (ii)*	Mesostigmata	Laelapidae	*A. mellifera*
12	Mesostigmatic mite (iii)*	Mesostigmata	Laelapidae	*A. mellifera*
13	Mesostigmatic mite (iv)*	Mesostigmata	Laelapidae	*A. mellifera*
14	Mesostigmatic mite (v)*	Mesostigmata	Laelapidae	*A. mellifera*
15	*Macrocheles muscaedomesticae* (Scopoli)	Mesostigmata	Macrochelidae	*A. cerana*
16	*Macrocheles* sp.*	Mesostigmata	Macrochelidae	*A. mellifera*
17	*Laelaps* sp.*	Mesostigmata	Laelapidae	*A. mellifera*
18	*Parasitellus* sp.	Mesostigmata	Parasitidae	*A. mellifera*
19	*Neocypholaelaps apicola* (Delfinado and Baker)	Mesostigmata	Ameroseiidae	*A. cerana*

Bumble Bee Mites

S.No	Mite species	Order	Family	Host bee species
1.	*Androlaelaps casalis* (Berlese)*	Mesostigmata	Laelapidae	*B.tunicatus*
2.	*Pneumolaelaps longanalis* (Hunter and Husband)*	Mesostigmata	Laelapidae	*B.tunicatus*
3.	Mesostigmatic mite (I)*	Mesostigmata	Laelapidae	*B.tunicatus*
4.	Mesostigmatic mite (ii)*	Mesostigmata	-	*B.tunicatus*

(Source: Sharma, 2002) * mites species new to India

INSECTA

a) Odonata

Odonates commonly known as damsel and dragonflies are amphibiotic insects. They spend a major part of their life cycle in freshwater ecosystem i.e. from oviposition to larval stage. Adults are flying insects, but relatively of short life. Moreover, adults are large predacious insects while larvae are carnivorous and voracious feeders (Prasad, 1998).

This order is represented by 37 families clubbed under 3 suborders namely, Zygoptera, Anisozygoptera and Anisoptera. Approximately 6,000 species and subspecies belonging to 630 genera in 28 families are known from all over the world (Prasad, 1998). This group in India is represented by 499 species and subspecies under 139 genera in 17 families, 32 subfamilies and 7 superfamilies (Prasad and Varshney, 1995). The dragonflies of western Himalayas have been catalogued by

Kumar and Prasad (1981) and Kumar (1995) and reported as many as 162 taxa. Kumar (2005) has reported 77 species of Odonata from Himachal Pradesh.

Syatematic List

Suborder: Zygoptera
Family : Platycnemididae
1. *Copera annulata* (Selys)
2. *Copera marginipes* (Ramb.)
3. *Copera vittata* (Selys)
4. *Coeliccia renifera* (Selys)
5. *Calicnemia eximia* Selys
6. *Calicnemia miles* Laid

Family : Coenagriidae
7. *Ceriagrion cerinorubellum* (Brauer)
8. *Ceriagrion coromandelianum* (Fabr.)
9. *Ceriagrion fallax* Ris
10. *Pseudogrion decorum* (Ramb.)
11. *Pseudogrion rubriceps* Selys
12. *Pseudogrion splenci* Fraser
13. *Pseudogrion laidlawi* Fraser
14. *Coenagrion dyeri* Fraser
15. *Ischnura delicata* (Hagen)
16. *Ischnura forcipata* Morton
17. *Ischnura senegalensis* (Ramb.)
18. *Ischnura rufostigma* Selys
19. *Agriocnemis pygmeae* (Ramb.)

Family : Synlestidae
20. *Megalestes major* Selys
21. *Lestes thoracina* Laid
22. *Lestes viridula* (Ramb.)
23. *Libellago lineata lineata* (Burn.)

Family : Cholorocyphidae
24. *Rhinocypha q. quadrimaculata* (Selys)
25. *Rhinocypha t. trifasciata* Selys
26. *Rhinocypha unimaculata* Selys

Family : Epallagidae
27. *Bayadera indica* (Selys)
28. *Anisopleura comes* Selys
29. *Anisopleura lestoides* Selys

Family : Calopterygidae
30. *Neurobasis chinensis chinensis* (Linn.)

Suborder: Anisoptera
Family : Gomphidae
31. *Ictinogomphus rapax* (Ramb.)
32. *Nepogomphus modstus* (Selys)
33. *Burmagomphus sivalikensis* Laid
34. *Mesogomphus lineatus* (Selys)
35. *Onychogomphus flavum* Selys

Family : Cordulegasteridae
36. *Chlorogomphus olympicus* Fraser
37. *Anotogaster b. basalis* (Selys)
38. *Alligaster* sp.
39. *Cordulegaster b. brevistigma* (Selys)

Family : Aeshnidae
40. *Hemianax ephippiger* (Burm.)
41. *Cephaleschna orbifrons* (Selys)
42. *Aeshna ornithocephala* (Maclac.)
43. *Polycanthagyna erythromelas* (Maclac.)
44. *Anax guttatus* (Burmeister)
45. *Anax immaculifrons* Ramb.
46. *Anax p. parthenope* (Selys)

Family : Libellulidae
47. *Tholymis tillarga* (Fabr.)
48. *Zyxomma petiolatum* Ramb.
49. *Brachydiplex sobrina* (Ramb.)
50. *Palpopleura s. sexmaculata* (Fabr.)
51. *Pantala flavescens* (Fabr.)
52. *Bradinopyga geminate* (Ramb.)
53. *Potamarcha obscura* (Ramb.)
54. *Orthetrum brunneum brunneum* (Fons.)
55. *Orthetrum chrysis* (Selys)
56. *Orthetrum anceps* (Schneider)
57. *Orthetrum c. cancellatum* (Linn.)
58. *Orthetrum japonicum internum* Maclac.
59. *Orthetrum taeniolatum* (Schneider)
60. *Orthetrum chrysostigma luzonicum* (Bra.)
61. *Orthetrum glaucum* (Brauer)
62. *Orthetrum pruinosum neglectum* (Ramb.)
63. *Orthetrum sabina sabina* (Drury)
64. *Orthetrum triangulare* (Selys)
65. *Brachythemis contaminata* (Fabr.)
66. *Crocothemis servilia servilia* (Drury)
67. *Diplacodes nebulosa* (Fabr.)
68. *Diplacodes trivialis* (Ramb.)
69. *Neurothemis fulvia* (Drury)
70. *Neurothemis tullis tullia* (Drury)
71. *Neurothemis i. Intermedia* (Ramb.)
72. *Sympatrum commixtum* (Selys)
73. *Sympatrum hypomelus* (Selys)
74. *Trithemis aurora aurora* (Burm.)
75. *Trithemis festiva* (Ramb.)
76. *Trithemis k. kirby* Selys
77. *Trithemis pallidinervis* (Kirby)
78. *Acisoma panarpoides panarpoides* (Ramb.)
79. *Rhyothemis triangularis* Kirby
80. *Rhyothemis v. variegata* (Linn.)
81. *Tramea basilaris burmeisteri* Kirby
82. *Tramea virginia* (Linn.)

(Sources: Kumar and Prasad, 1981; Kumar, 1995 & 2005)

b) Orthoptera

This is one of the largest orders of the insects and also includes destructive locusts. Over 17,250 species are known to science throughout the world. More than 1,750 species, about 10 % of the total world species, have been recorded from India. The most significant features of this group of insect are its jumping habit with the help of enlarged hind legs, and sound production by its auditory organs. The quantitative concentration of the species varies from season to season and also from one region to other region of the country. However, in India, maximum concentration of all the species have been recorded during monsoon and post monsoon seasons (June to September) when the growth of all types of vegetation in the natural grassfields as well as in the agricultural fields are in optimum conditions (Tandon and Hazra, 1998).

Orthoptera ranks 6th largest order of insects having over 17,250 known species throughout the world. More than, 1750 species that account for over 10 % of the world orthopteran fauna are known from India (Alfred and Ramakrishna, 2004). A number of workers have studied the orthopteran fauna of Himachal Pradesh like Bhowmik and Rui (1982), Julka *et al.* (1982), Bhowmik and Halder (1984), Bhowmik (1985 a & b), Shishodia and Tandon (2000), Mehta *et al.* (2002) and Thakur and Mattu (2006).

Systematic List

Family : Gryllidae

1. *Acanthoplistus birmanus* Saussure
2. *Acheta domesticus* Linnaeus
3. *Gotvendia albipennis* Chopard
4. *Gryllodes sigillatus* (Walker)
5. *Gryllus bimaculatus* De Geer
6. *Gryllus brunneri* Saussure
7. *Gryllus histrio* (Saussure)
8. *Gymnogryllus kashmirensis* Bhowmik
9. *Loxoblemmus detectus* (Serville)
10. *Loxoblemmus equestris* Saussure
11. *Loxoblemmus fascipes* (Walker)
12. *Loxoblemmus macrocephalus* Chopard
13. *Loxoblemmus taicoun* Saussure
14. *Modicogryllus blennus* (Saussure)
15. *Modicogryllus facialis* (Walker)
16. *Platygryllus melanocephalus* (Serville)
17. *Plebeiogryllus guttiventris* (Walker)
18. *Pteronemobius csikii* (Bolivar)
19. *Pteronemobius fascipes* (Walker)
20. *Pteronemobius pantelchopardorum* Shishodia & Varshney
21. *Pteronemobius taprobanensis* (Walker)
22. *Teleogryllus blennus* (Serville)
23. *Teleogryllus occipitalis* (Serville)
24. *Turanogryllus histrio* (Saussure)
25. *Turanogryllus jamuensis* (Bhowmik)
26. *Turanogryllus rufoniger* (Chopard)
27. *Velarifictorus dehradunensis* Tan.&Shis.
28. *Xenogryllus* sp.

Family : Trigonidiidae

29. *Anaxipha longipennis* (Serville)
30. *Trigonidium cicindeloides* Rambur

Family : Phaneropteridae

31. *Elimaea securigera* (Brunner)

32. *Letana despecta* (Brunner)
33. *Himertula kinnaeri* (Uvarov)

Family : Conocephalidae
34. *Conocephalus maculatus* (Le Guillou)
35. *Euconocephalus pallidus* (Radtb.)
36. *Paraconocephalus* sp.

Family : Mecopodidae
37. *Mecopoda elongata* (Linnaeus)

Family : Pseudophyllidae
38. *Onomarchus* sp.

Family : Gryllotalpidae
39. *Gryllotalpa (Gr.) a. africana* (Beauvois)
40. *Gryllotalpa fossor* Scudder

Family : Myrmecophilidae
41. *Myrmecophilus albicinctus* (Chopard)

Family : Tettigonidae
42. *Ducetia japonica* (Thunberg)
43. *Elimaea (Orthilaemaea) securigera* (Brun.)
44. *Isopsera pedunculata* Brunner
45. *Letana despecta* (Brunner)
46. *Letana linearis* Walker
47. *Phneroptera myleocerca* Ragga
48. *Plicigera Himalayana* Uvarov

Family : Eneopteridae
49. *Euscystus hemelytus* (Haan)

Family : Pseudophyllidae
50. *Onomarchus* sp.

Family : Acrididae
51. *Acrida exaltata* (Walker)
52. *Acrida indica* Willemse
53. *Acrotylus humbertianus* Saussure
54. *Aiolopus thalassinus tamulus* (Fabricus)
55. *Aiolopus thalassinus thalassinus* (Fabr.)
56. *Catantops pinguis innotabilis* (Walker)
57. *Catantops simlae* Drury
58. *Ceracris nigri. nigricornis* (Walker)
59. *Ceracris striata* Uvarov
60. *Cholaebora grossa* (Saussure)
61. *Chondracris rosea* (De Geer)
62. *Choroedocus illustris* (Walker)
63. *Choroedocus robustus* (Seville)
64. *Chorthipus (Chor.) indcus* (Uvarov)
65. *Chorthipus (Glyptobothrus) hammerstraeni* (Miram)
66. *Cyrtacanthacris tatarica* (Linnaeus)
67. *Diabolocatantops innotabilis* (Walker)
68. *Dnopherula (Aulacobothrus) luteips* (Wa.)
69. *Eucoptacra praemorsa*
70. *Eucoptarca saturata* (Walker)
71. *Eyprepocnemis a. alacris* (Serville)
72. *Eyprepocnemis rosea* Uvarov
73. *Gasttrimargus a. africanus* (Saussure)
74. *Heteracris nobilis* (Uvarov)
75. *Hieroglyphus banian* (Fabricus)
76. *Holopercna darjeelignesis* (Bolivar)
77. *Holopercna* sp.
78. *Oedaleus abruptus* (Thunberg)
79. *Oedipoda himalayana* Uvarov
80. *Othochtha indica* Uvarov
81. *Oxya fuscovittata* (Marschall)
82. *Oxya h. hyla* Serville
83. *Oxya velox* (Walker)
84. *Pachyacris vinosa*
85. *Pachyacris violascens* (Walker)
86. *Paraconophyma scabra* (Walker)
87. *Patanga succinata* Johansson
88. *Phalaeoba infumata* Brunner
89. *Phalaeoba panteli* Bolivar
90. *Phingonotus longipennis* Saussure
91. *Pusana leavis* (Uvarov)
92. *Scintharista blanchardiana sulphureus*
93. *Scintharista notabills pallips* Uvarov
94. *Sikkimiana darjeelingensis* (Bolivar)
95. *Spathosternum pr. prasiniferum* (Fabr.)
96. *Sphingonotus longipennis (Saussure)*
97. *Sphingonotus octofasciatus* (Serville)
98. *Trilophidia annulata* (Thunberg)
99. *Truxalis sp.*
100. *Tylotropidius varciornis* (Walker)
101. *Xenocatantops h. humilis* (Serville)
102. *Xenocatantops karnyi* (Kirby)

Family : Pyrgomorphidae
103. *Atractomorpha cr. crenulata* (Fabr.)
104. *Chrotogonus (Chr.) tr. trachypterus* (Blanchard)
105. *Aularches miliaris* (Linn.)
106. *Aularches punctatus* Drury
107. *Poikilocerus pictus* (Fabricius)

Family : Tetrigidae
108. *Coptotettix consperus* Hancock
109. *Ergatettix dorsiferus* (Walker)
110. *Erqatettix guentheri* Steinmann
111. *Eucriotettix grandis* (Hancock)
112. *Euparatettix tenuis* Hancock
113. *Hedotettix attenuatus* Hancock
114. *Hedotettix costatus* Hancock
115. *Hedotettix gracilis* (De Haan)
116. *Hedotettix tenuis* Hancock
117. *Pseudotettix histricus* (Stal)
118. *Teredorus frantalis* Hancock

Family : Tridactylidae
119. *Tridactylus thoracicus* Guerin
120. *Xya* sp.

(Sources: Bhowmik and Rui, 1982; Julka et al., 1982; Bhowmik, 1985 a & b; Shishodia and Tandon, 2000; Mehta et al., 2002; Thakur and Mattu, 2006)

c) Dermaptera

Dermapterans generally known as 'earwigs' are nocturnal, hygrophilous and secretive insects. These are medium to moderately large sized, tough bodied with biting and chewing mouth parts, and have a pair of segmented chitinous forceps at the hind end of body (Srivastava, 1998).

Steinmann (1989) has estimated around 2000 species of dermapterans from all over the world, of which, 320 are known from Indian Subcontinent (Srivastava, 1991). Studies on this group from Himachal Pradesh are a few like, Srivastava and Lal (1992) firstly reported 4 species of dermapterans from Himachal Pradesh, Srivastava (2000) reported 7 species belonging to 5 genera from Renuka lake, Sirmour, and further, Srivastava (2005) has enlisted 30 species belonging to 13 genera from the state.

Systematic List

Family : Pygidicranidae
Subfamily : Diplatynae
1. *Haplodiplatys glenis* (Kapoor)
2. *Haplodiplatys rufescens* (Kirby)
3. *Haplodiplatys simlaensis* (Kapoor)
4. *Haplodiplatys chinensis* (Hincks)
5. *Haplodiplatys srivastavai* (Kapoor)

Family : Anisolabididae
Subfamily : Anisolabidinae
6. *Aborolabis pervicina* (Burr)
7. *Euborellia annulipes* (Lucas)
8. *Euborellia compressa* (Borelli)
9. *Euborellia rajasthanensis* Srivastava

Subfamily : Isolaboidinae
10. *Isolaboides burri* (Borelli)
11. *Isolaboides elegans* (Hebard)
12. *Isolaboides immsi* (Burr)

Family : Labiduridae
Subfamily : Nalinae
13. *Nala nepalensis* (Burr)
14. *Nala lividipes* (Dufor)

Subfamily : Labidurinae
15. *Labidura riparia* (Pallas)
16. *Forcipula trispinosa* (Dohrn)
17. *Forcipula quadrispinosa* (Dohrn)
18. *Forcipula indica* Brindle

Family : Chelisochidae
Subfamily : Chelisochinae
19. *Proreus abdominalis* Ramamurthi
20. *Hamaxas singhi* (Kapoor)

Family : Forficulidae
Subfamily : Allodahlinae
21. *Allodahlia macropyga* (Westw.)

Subfamily : Anechurinae
22. *Anechura stoliczkae* (Burr)
23. *Anechura zubovskii* (Semenov)
24. *Anechura nyyari* (Kapoor)

Subfamily : Eudohriniinae
25. *Eudohria metallica* (Dohrn)

Subfamily : Forficulinae
26. *Elaunon bipartitus* (Kirby)
27. *Forficulaplanicollis* (Kirby)
28. *Forficula schlagintweiti* (Burr)
29. *Forficula asketi* (Purohit, Julka & Lal)
30. *Forficula davidi* (Burr)
31. *Forficula Beelzebub* (Burr)

(Sources: Srivastava and Lal, 1992; Srivastava, 2000 & 2005)

d) Mantodea

These insects are popularly known as 'Praying mantis'. They are carnivorous insects. Their body is elongated, specially the prothorax and forelegs are long and spinous for capturing insects. Cannibalism is very frequent among them. Body is generally green or pale brown.

About 432 genera and 2310 species are known from the world, and 162 species, distributed over 6 families, 19 subfamilies and 68 genera are known from India (Hazra and Mukherjee, 1998). A little has been done on the mantid fauna of Himachal Pradesh and is represented by 20 species belonging to 13 genera (Mukherjee and Shishodia, 2000).

Family : Hymenopodidae

1. *Ephestiasula intermedia* Werner
2. *Creobroter laevicollis* (Saussure)

Family : Mantidae

3. *Humbertiella indica* Saussure
4. *Nanomantis lactea* Mukherjee
5. *Mantis indica* Mukherjee
6. *Mantis nobilis* Brunner
7. *Statiella nemoralis* (Saussure)

(Source: Mukherjee and Shishodia, 2000)

e) Coleoptera

The Coleoptera are minute to large (0.6 mm to 15 cm) in size and usually sclerotized insects. The front wings are much thickened, veinless and meeting in the mid-dorsal straight line, and hind wings are membranous with few veins. Mouthparts are of typical biting and chewing type except snout beetles. Beetles comprise the largest insect order not only in the number of described species but also show exceptionally diverse adaptations to wide range of environmental conditions and habits. Their role in the functioning of ecosystems, especially the terrestrial ones is immense (Sengupta and Pal, 1998).

Out of about 8,00,000 described species of insects, Coleoptera alone shares about 3,50,000 species belonging to 177 species under 4 suborders. Of these, 15,500 species belonging to 104 families under 3 suborders are known from India which accounts for about 5 % of all Coleopteran species of the world (Sengupta and Pal, 1998; Alfred and Ramakrishna, 2004). A few attempts have so far been made to study the Coleopteran fauna of Himachal Pradesh (Biswas, 2000; Chandra, 2005).

Systematic List

Family : Gyrinidae

1. *Orectochilus murinus* Regimbart
2. *Orectochilus neglectus* Ochs

Family : Dytiscidae

3. *Laccophilus flexuosus* Aube
4. *Laccophilus parvulus* Aube
5. *Laccophilus sharpi* Regimbart
6. *Hydrovatus* sp.
7. *Hyphoporus elevatus* Sharp
8. *Hydaticus fabriici* Macleay
9. *Sandracottus dejeani* Aube
10. *Sandracottus festivus* (Illiger)

Family : Georyssidae

11. *Georyssus* sp.

Family : Hydrophilidae

12. *Coelostoma* sp.
13. *Hydrochus* sp.
14. *Laccobius* sp.
15. *Helochares crenatus* Regimbart
16. *Sternolophus rufipes* (Fabricium)
17. *Berosus indicum* Motschulsky
18. *Amphiops pedestris* Sharp

Family : Elmidae

19. *Stenelmis* sp.

Family : Byrrhidae

20. *Byrrhus* sp.

Family : Scarabaeidae

Subfamily : Hybosorinae

20. *Hybosorus orientalis* Westw.
21. *Hybosorus illigeri* Reiche
22. *Phaeochorus emarginatus* Cast

Subfamily : Aphodinae

23. *Aphodius parvulus* Harold
24. *Aphodius urostigma* Harold
25. *Aphodius finctarius* Oliv.
26. *Aphodius crenatus* Harold
27. *Aphodius marginellus* (Fabr.)
28. *Aphodius moestus* (Fabr.)

Subfamily : Scarabaeinae

29. *Gymnopleurus opacus* Redtenbacker
30. *Gymnopleurus miliaris* (Fabr.)
31. *Sisyphus indicus* Hope
32. *Heliocopris bucephalus* (Fabr.)
33. *Catharsius molossus* (Linn.)
34. *Catharsius pithecius* (Fabr.)
35. *Catharsius sagax* (Quens.)
36. *Copris sacontala* Redtenbacker
37. *Copris sabinus* Gill
38. *Copris pujnabensis* Gill
39. *Copris repertus* Walk.
40. *Copris sarpedon* Harold
41. *Copris indicus* Gill
42. *Phalops divisus* (Wied.)
43. *Caccobius ultor* (Sharp)
44. *Caccobius vulcanus* (Fabr.)
45. *Caccobius indicus* (Harold)
46. *Caccobius himalayanus* (Jerk.)
47. *Caccobius denticollis* Harold
48. *Caccobius pantherimus* Arrow
49. *Onthophagus marginalis* (Gebl.)
50. *Onthophagus spinifex* (Fabr.)
51. *Onthophagus falsus* Gill
52. *Onthophagus ramosellus* Bates
53. *Onthophagus furcillifer* Bates
54. *Onthophagus gagates* Hope
55. *Onthophagus kuluensis* Bates
56. *Onthophagus bonasus* (Fabr.)
57. *Onthophagus expansicornis* Bates
58. *Onthophagus rubricollis* Hope
59. *Onthophagus productus* Arrow
60. *Onthophagus duporti* Bouc.
61. *Onthophagus ramosus* (Wied.)
62. *Onthophagus sutleinensis* Splich.
63. *Onthophagus lilliputanus* (Lansb.)
64. *Onthophagus lapillus* Arrow
65. *Onthophagus kumaonensis* Arrow
66. *Onthophagus furcicollis* Arrow
67. *Onthophagus concolor* Sharp
68. *Onthophagus pactolus* (Fabr.)
69. *Onthophagus dama* (Fabr.)
70. *Onthophagus mopus* (Fabr.)
71. *Onthophagus tarandus* (Fabr.)
72. *Onthophagus griseosetosus* Arrow
73. *Onthophagus gratus* Arrow
74. *Onthophagus aenescens* (Wied.)
75. *Onthophagus amplexus* Sharp
76. *Onthophagus centricornis* (Fabr.)
77. *Onthophagus atropolitus* d'Orb.
78. *Onthophagus quaestus* (Sharp)
79. *Onthophagus quadridentatus* (Fabr.)
80. *Onthophagus fasciatus* (Bouc.)
81. *Onthophagus tragus* (Fabr.)
82. *Onthophagus catta* (Fabr.)
83. *Onthophagus dubernardi* Bouc.
84. *Liatongus phanaeoides* (Westw.)
85. *Liatongus gagatinus* (Hope)
86. *Liatongus vertagus* (Fabr.)
87. *Liatongus rhinoceros* Arrow
88. *Oniticellus spinipes* Roth.
89. *Oniticellus pallipes* (Fabr.)
90. *Oniticellus pallens* (Oliv.)
91. *Oniticellus cinctus* (Fabr.)
92. *Drepanocerus setosus* (Wied.)
93. *Onitis fulcatus* (Wulf.)
94. *Onitis subopacus* Arrow
95. *Onitis philemon* (Fabr.)

96. *Onitis castaneus* Redtenbacker
97. *Onitis excavatus* Arrow

Subfamily : Sericinae

98. *Serica khaniaris* Mittal
99. *Maladera insanabilis* (Brenske)

Subfamily : Melolonthidae

100. *Apogonia orbitalis* Ritsema
101. *Apogonia nigrescens* Hope
102. *Apogonia setosa* Arrow
103. *Holotrichia stoliczkae* Shrap
104. *Holotrichia problematica* Brenske
105. *Holotrichia anthracina* Branske
106. *Holotrichia semihirta* Frey
107. *Holotrichia sikkimensis* Brenske
108. *Holotrichia serrata* (F.)
109. *Holotrichia longipennis* Blanch.
110. *Holotrichia graditifrons* Bates
111. *Holotrichia nubiliventris* Bates
112. *Holotrichia batillaria* Bates
113. *Holotrichia occipitalis* Bates
114. *Hilyotrogus holoscericeus* Redt.
115. *Cryptotrogus pajni* Mittal
116. *Asactopholis dehradunus* Mittal
117. *Articephala himachali* Mittal
118. *Articephala laguali* Chandra
119. *Articephala planifrons* (Moser)
120. *Idioncycha excisa* Arrow
121. *Hoplosternus nepalensis* Hope
122. *Brahmina crinicollis* Burm.
123. *Brahmina coriacea* Hope
124. *Brahmina cribricollis* (Redt.)
125. *Brahmina culuensis* Moser
126. *Brahmina cupresus* Mittal
127. *Brahmina simlana* Moser
128. *Melolontha aeneicollis* Bates
129. *Melolontha indica* Hope
130. *Melolontha cuprescens* Blanch.
131. *Melolontha furcicauda* Ancey

Subfamily : Rutelinae

132. *Popillia nasuta* Newm.
133. *Popillia cupricollis* Hope
134. *Popillia cynanea* Hope
135. *Popillia clypealis* Ohaus
136. *Popillia simlana* Arrow
137. *Popillia pilosa* Arrow
138. *Mimela horsfieldi* Hope
139. *Mimela passerinii* Hope
140. *Mimela pectoralis* Blanch.
141. *Mimela fulgidivittata* Blanch.
142. *Anomala polita* Blanch.
143. *Anomala rufiventris* Redt.
144. *Anomala lineatopennis* Blanch.
145. *Anomala xanthoptera* Blanch.
146. *Anomala dimidiata* Hope
147. *Anomala stoliczkae* (Sharp)
148. *Anomala rugosa* Arrow
149. *Anomala fuliviventris* Arrow
150. *Anomala chlorosoma* Arrow
151. *Anomala xanthonota* Arrow
152. *Anomala dorsalis* (Fab.)
153. *Anomala cantori* Hope
154. *Anomala bengalensis* Blanch.
155. *Ischnopopillia moorei* Kraatz
156. *Pachyrhinadoretus frontatus* (Burm.)
157. *Tropiorhynchus orientalis* (Newm.)
158. *Adoretus incurvatus* Ohaus
159. *Adoretus lithobaius* Ohaus
160. *Adoretus caliginosus* Burm.
161. *Adoretus duvacauli* Blanch.
162. *Adoretus costopilosus* Ohaus

Subfamily : Dynastinae

163. *Eophileurus perforatus* Arrow
164. *Xylotrupes gideon* (L.)
165. *Phyllogathus dionysius* (F.)
166. *Aliossonotum bindulum* (Fairmaire)
167. *Aliossonotum simile* Arrow
168. *Aryctes nasicornis* (L.)
169. *Heteronychus annulatus* Redt.

Subfamily : Cetoniinae

170. *Heterorrhina nigritarsis* (Hope)
171. *Heterorrhina porphyretica* Westw.
172. *Anatona stillata* (Newm.)
173. *Anatona castanoptera* (Burm.)
174. *Torynorrhina opalina* Hope
175. *Protaetia impavida* (Janson)
176. *Protaetia coenosa* (Westw.)
177. *Protaetia neglecta* (Hope)
178. *Chiloloba acuta* (Wied.)
179. *Clinteria spilota* (Hope)
180. *Clinteria klugi* (Hope)
181. *Glycyphana horsfieldi* (Hope)
182. *Jumnos royeli* (Hope)
183. *Jumnos ruckeri* Saund.
184. *Oxycetonia jucunda* (Fald.)
185. *Oxycetonia versicolor* (F.)
186. *Thaumastopeus pullus* (Billb.)

(Sources: Biswas, 2000; Chandra, 2005)

f) Diptera

Diptera comprising mosquitoes, midges and flies are characterised by piercing and sucking mouth forming proboscis; wingless or with one pair of membranous forewing and hind wings modified like hairs with knobs, called halters. They are fairly homogeneous in general appearance but some flies may be mistaken for some other kind of insects of no near relationship, e.g. Bombylidae, Syrphidae, etc., frequenting flowers as mimics of bees and wasps (Datta, 1998; Alfred and Ramakrishna, 2004).

All Diptera together in intimate association with other animals and variegated flora interact with each other in order to maintain the equilibrium of the nature. Flower visitors help plants perpetuate through pollination, larvae of some dipterans are phytophagous and of others annoy man and livestock. Some are saprophagous, some are vectors of diseases etc (Datta, 1998).

Studies on Dipterans of Himachal Pradesh are scanty, there are a few to quote, like Brunetti (1917) made some contributioons on the dipterans of Shimla, and Parui and Mukherjee (2000) have studied the diversity of dipeterans of Renuka Lake, Sirmour (HP).

Systematic List

Suborder: Nematocera
Family : Tipulidae
1. *Conosia irrorata* (Wiedemann)

Family : Bibionidae
2. *Plecia dispersa* Hardy

Suborder: Brachycera
Family : Stratiomyidae
3. *Oplodontha rubrithorax* (Macquart)
4. *Adoxomyia heminopla* (Wiedemann)

Family : Tabanidae
5. *Tabanus (Tabanus) striatus* Fabr.

Suborder: Cyclorrhapha
Family : Syrphidae
6. *Episyrphus balteatus* (De Geer)
7. *Phytomia (Dolichomerus) crassa* (Fabr.)

Family : Sciomyzidae
8. *Sepedon plumbella* Wiedemann

Family : Muscidae
9. *Musca (Musca) domestica* Linn.
10. *Orthellia timorensis* (Robi.-Desvoidy)
11. *Gymnodia tonitrui* (Wiedemann)
12. *Stomoxys calcitrans* (Linn.)

Family : Calliphoridae
13. *Chrysomya megacephala* (Fabr.)
14. *Parasarcophaga (P.) albiceps (*Meigen)

(Sources: Brunetti, 1917; Parui and Mukherjee, 2000)

g) Lepidoptera

Butterflies and moths have been placed under the order Lepidoptera of class Insecta. This order includes scale-winged insects of holometabolus endopterygote series. This includes bitterflies and moths. The membrs are of great value both for conservation and for environmental planning in local scale (Mondal, 1998).

Hampson (1918) estimated as many as 89 families and subfamilies of Lepidoptera, while Hamlyn (1969) reported about 1,40,000 species comprising 13,000 butterflies and 1,27,000 moths from world (Alfred *et al.,* 1998). A recent estimate shows the occurrence of about 1,42,500 species of Lepidoptera from globe. These estimates for Indian subregion revealed some 15,000 species distributed over 84 families and 18 superfamilies (Mondal, 1998).

i) Rhopalocera (Butterflies)

Out of 84 families and 18 superfamilies of the order available in Indian subregion, the butterflies belong to 5 major families placed under 2 superfamilies, these constitute about 10 % of the total faunal species. A total of 123 species of butterflies are considered as endangered in India (Mondal, 1998). Many workers have studied the butterflies from Himalayas like Moore (1882), Marshall and de Niceville (1882-1890), De Rhe-Philipe (1931), Evans (1932), Talbot (1939, 1947), Wynter-Blyth (1940-46 & 1957), Mani (1986), Thakur *et al.* (2002) and Thakur *et al.* (2006). Arora *et al.* (2005) have compiled a comprehensive list of 288 species of butterflies so far reported till today from Himachal Pradesh.

Systematic List

Family : Papilionidae

1. *Pachliopta aristolochiae*
2. *Atrophaneura philoxenus* (Gray)
3. *Atrophaneura dasarada ravana* (Moore)
4. *Chilasa agestor govindra* (Moore)
5. *Chilasa clytia clytia* (Linn.)
6. *Papilio protenor protenor* Cramer
7. *Papilio polyctor polyctor* Boisduval
8. *Papilio arcturus arius* Rothschild
9. *Papilio polytes romulus* Cramer
10. *Papilio machaon ladakensis* Moore
11. *Papilio machaon punjabensis* Eimer
12. *Papilio demoleus demoleus* Linn.
13. *Papilio machaon asiatica* Menetries
14. *Graphium cloanthus cloanthus* (Westw.)
15. *Graphuim sarpedon luctatius* (Fruhs.)
16. *Parnassius hardwickei hardwickei* (Gray)
17. *Paranassius jacquemonti* Boisduval
18. *Paranassius cashmiriensis* Oberthur
19. *Paranassius s. stoliczkanus* C& R Felder
20. *Paranassius delphius ladakensis* Avinoff
21. *Paranassius delp. mamaievi* Bang-Haas
22. *Paranassius delphius rupshuana* Avinoff
23. *Paranassius simo. simoides* Bang-Haas
24. *Paranassius charltonius* Gray
25. *Pathysa nomius nomius* (Esper)
26. *Pazala eurous cashmirensis* (Rothschild)

Family : Pieridae

27. *Leptosia nina nina* (Fabricius)
28. *Metaporia leucodice soracta* (Moore)
29. *Metaporia agathon* (Gray)
30. *Delias belladona horsfieldi* (Gray)
31. *Delias eucharis* (Drury)
32. *Delias sanaca sanaca* (Moore)
33. *Aporia nabellica* (Boisduval)
34. *Appias lalage* Doubleday
35. *Appias libythea* Fabr.
36. *Baltia butleri butleri* (Moore)
37. *Cepora nerissa phryne* (Fabr.)
38. *Anaphaeis aurota aurota* (Fabr.)
39. *Pieris canidia indica* (Evans)
40. *Pieris brassicae nepalensis* (Doubleday)
41. *Pieris napi ajaka* Moore
42. *Pontia daplidice moorei* (Fabr.)
43. *Ixias marianne* (Cramer)
44. *Ixias pyrene kausala* Moore
45. *Pareronia valeria anais* (Lesson)
46. *Catopsilia crocale* (Cramer)
47. *Catopsilia pyranthe* (Linn.)
48. *Gonepteryx rhamni nepalensis* Doubld.
49. *Gonepteryx mahaguru* Gistel
50. *Eurema brigitta rubella* (Wallace)
51. *Eurema laeta laeta* (Boisduval)
52. *Eurema hecabe fimbriata* (Wallace)
53. *Colias electo fieldi* Menetries
54. *Colias erate erate* (Esper)
55. *Colias ladakensis* C & R Felder
56. *Colias eogene* (C & R Felder)
57. *Colias etrida etrida* (Boisduval)
58. *Synchloe callidice kalora* (Moore)

Family : Danaidae

59. *Danaus chrysippus chrysippus* (Linn.)
60. *Danaus genutia* (Cramer)
61. *Tirumala limniace leopardus* (Butler)
62. *Tirumala hamata septentrionis* (Butler)
63. *Parantica aglea melanoides* Moore
64. *Parantica sita sita* (Kollar)
65. *Euploea core core* (Cramer)
66. *Euploea mulciber mulciber* (Cramer)

Family : Satyridae

67. *Mycalesis perseus blasius* (Fabr.)
68. *Mycalesis mineus mineus* (Linn.)
69. *Mycalesis francisca canatana* Moore
70. *Mycalesis lepcha lepcha* (Moore)
71. *Zophoessa maitrya maitrya* (de Nicev.)
72. *Zophoessa jalaurida jalaurida* de Nicev.
73. *Zophoessa sidonis* (Hewitson)
74. *Zophoessa nicetas* (Hewitson)
75. *Zophoessa golapara goalpara* Moore
76. *Lethe confusa confusa* Aurivillius
77. *Lethe insane insane* (Kollar)
78. *Lethe rohria rohria* (Fabr.)
79. *Lethe verma verma* (Kollar)
80. *Lethe pulaha pondiya* Talbot
81. *Lethe yama buckleyi* Talbot
82. *Maniola pulchella* (C & R Felder)
83. *Maniola davendra davendra* (Moore)
84. *Maniola lupinus cheena* Moore
85. *Lasiommata schakra schakra* (Kollar)
86. *Lasiomata moer. moerula* (C & R Felder)
87. *Rhaphicera moorei moorei* Butler
88. *Orinoma damaris* Gray
89. *Aulocera brahminus* (Blanchard)
90. *Aulocera padma padma* (Kollar)
91. *Aulocera swaha swaha* (Kollar)
92. *Aulocera saraswati* (Kollar)
93. *Callerebia scanda scanda* (Kollar)
94. *Callerebia kalinda kalinda* Moore
95. *Callerebia nirmala nirmala* (Moore)
96. *Callerebia hybrida* Butler
97. *Callerebia annada caeca* (Watkin)
98. *Hipparchia parisatis shiva* (Lecerf)
99. *Hipparchia heu.huebneri* (C & R Felder)
100. *Dallacha Hyagriva* (Moore)
101. *Ypthima sakra nikaea* Moore
102. *Ypthima nareda nareda* (Kollar)
103. *Ypthima asterope mahratta* Moore
104. *Ypthima ceylonica kasmira* Moore
105. *Ypthima lisandra avanta* Moore
106. *Ypthima indecora* Moore
107. *Ypthima baldus baldus* (Fabr.)
108. *Melanitis phedima galkissa* Fruhstorfer
109. *Melanitis zitenius zitenius* Herbst
110. *Melanitis leda ismene* (Cramer)

Family : Nymphalidae

111. *Sephisa dichroa* (Kollar)
112. *Diagora persimilis* (Westwood)
113. *Diagora nicevillei* Moore
114. *Dilipa morgiana* (Westwood)
115. *Dicharragia nesimachus* Boisduval
116. *Euthalia garuda* (Moore)
117. *Euthalia lubetina* (Cramer)
118. *Hestina nama* (Doubleday)
119. *Junonia hierta* (Fabr.)
120. *Junonia orithya* (Linn.)
121. *Junonia lemonias persicaria* (Fruhstorfer)
122. *Junonia almana* (Linn.)
123. *Junonia atlites* (Linn.)
124. *Limenitis trivena* Moore
125. *Melitaea arcesia* Bremer
126. *Stibochiona nicea* (Gray)
127. *Auzakia danava* (Moore)
128. *Athyma opalina* (Kollar)
129. *Athyma selenophora* (Kollar)
130. *Athyma perius* (Linn.)
131. *Athyma asura* (Moore)
132. *Athyma ambica* Kollar
133. *Bassarona patala* (Kollar)
134. *Calinaga buddha* Moore
135. *Charaxes fabius* (Fabr.)

136. *Neptis mahendra* Moore
137. *Neptis hylas astola* Moore
138. *Neptis verburyi* Butler
139. *Neptis sankara* Kollar
140. *Neptis ananta* Moore
141. *Neptis naryana* Moore
142. *Nymphalis xanthomelas* (Den. & Schif.)
143. *Polyura dolon* (Westwood)
144. *Pseudergolis wedah* (Kollar)
145. *Spottea hypselis* (Godart)
146. *Symbrenthia hippoclus* (Cramer)
147. *Symbrenthia niphanda* Moore
148. *Cyrestis thyodamas* Boisduval
149. *Hypolimnas bolina* (Linn.)
150. *Hypolimnas misippus* (Linn.)
151. *Kallima inachus* (Boisduval)
152. *Ariadne merione*
153. *Precis hierta* (Fabr.)
154. *Precis orithya* (Linn.)
155. *Precis lemonias* (Linn.)
156. *Precis almana* (Linn.)
157. *Precis atlites* (Linn.)
158. *Precis iphita* (Cramer)
159. *Cynthia cardui* (Linn.)
160. *Vanessa indica* (Herbst)
161. *Vanessa egea cognata* Moore
162. *Kaniska canace* (Linn.)
163. *Aglais cashmirensis* (Kollar)
164. *Aglais urticae* (Linn.)
165. *Aglais ladakensis* Moore
166. *Argyreus hyperbius* (Johanssen)
167. *Childrena childreni* (Gray)
168. *Fabriciana kamala* (Moore)
169. *Issoria lathonia* (Linn.)
170. *Phalanta phalantha* (Drury)
171. *Ariadne merione* (Cramer)

Family : Acraeidae

172. *Acraea issoria anomala* Kollar
173. *Acraea violae* (Fabr.)

Family : Erycinidae

174. *Abisara echerius* (Stoll.)
175. *Libythea myrrha* Godart
176. *Libythea lepita* Moore
177. *Dodona dipoea* Hewitson
178. *Dodona eugenes* Bates
179. *Dodona durga* (Kollar)

Family : Lycaenidae

180. *Acytolepis puspa gisca* Fruhstorfer
181. *Aricia agestis narira* (Moore)
182. *Albulina galathea* (Blanch.)
183. *Celastrina ladonidas gigas* Hemming
184. *Celastrina argiolus jynteana* deN.
185. *Chilades laius* (Cramer)
186. *Chaetoprocta odata* Hewitson
187. *Chrysozephyrus ataxus* (Doub.)
188. *Chrysozephyrus birupa* Moore
189. *Chrysozephyrus syla* (Kollar)
190. *Creon eleobis* (Godart)
191. *Curetis acuta dentate* Moore
192. *Everes hugelii* race *indica* Gistel
193. *Everes hugelii dipora* (Moore)
194. *Everes argiades diporides* Chapman
195. *Everes lecturnus syntala* Cantlie
196. *Castalius rosimon* (Fabr.)
197. *Euasopa milionia* (Hewitson)
198. *Euasopa ziha* (Hewitson)
199. *Esakiozephyris icana* (Moore)
200. *Esakiozephyris bieti* Oburthur
201. *Freyaria trochilus* Freyer.
202. *Freyeria putli* (Kollar)
203. *Glaucopsyche aeruginosa* Staud.
204. *Heliophorus sena* Kollar
205. *Heliophorus bakeri* Evans
206. *Heliophorus androcles* Hewitson
207. *Heliophorus oda* Hewitson
208. *Horaga onyx* (Moore)
209. *Horaga viola* Moore
210. *Iraota timoleon* (Stoll.)
211. *Jamides bochus* Stoll.
212. *Lampides boeticus* (Linn.)
213. *Leptotes plinius* (Fabr.)
214. *Pseudozizeeria maha* (Kollar)
215. *Euchrysops cnejus* (Fabr.)
216. *Euchysops pandava* (Horsefield)
217. *Catochrysops strabo* (Fabr.)
218. *Spindasis vulcanus* (Fabr.)
219. *Spindasis lilacinus* (Moore)
220. *Spindasis elima* (Moore)
221. *Spindasis nipalicus* Moore
222. *Spindasis ictis* Hewitson
223. *Strymon sassanides* Kollar
224. *Surendra vivarana* Horsfield
225. *Tajuria diaeus* (Hewitson)
226. *Tajuria cippus* (Fabr.)
227. *Tarucus venosus* Moore
228. *Tarucus callinara* Butler
229. *Tarucus nara* Kollar
230. *Tarucus balcanica nigra* Beth. Baker
231. *Thecla ziha* deN.
232. *Udara albocoerulea* Moore
233. *Udara cardia dilecta* Moore
234. *Virachola isocrates* (Fabr.)
235. *Virachola perse* (Hewitson)
236. *Zizeeria karsandra* Moore
237. *Zizula gaika* Trimen
238. *Zizula otis* (Fabr.)
239. *Rapala manea schistacea* (Moore)
240. *Rapala veruna grisea* Moore
241. *Rapala nissa* Kollar
242. *Rapala selira* Moore
243. *Rapala extensa* Evans
244. *Rapala iarbis sorya* (Kollar)
245. *Sinthusa chandrana* (Moore)

246. *Sinthusa nasaka* (Horsfield)
247. *Lycaena phlaeas* (Linn.)
248. *Lycaena kasyapa* (Moore)
249. *Lycaena pavana* (Kollar)
250. *Narathura centaurus* (Fabr.)
251. *Narathura dodonea* (Moore)
252. *Narathura rama* (Kollar)
253. *Oreolyce cardhana* Moore
254. *Panchala ganesa* (Moore)
255. *Panchala alemon* deN. (Moore)
256. *Philotes vicrama* Moore
257. *Polyommatus eros* Schmett
258. *Prosotis nora* Felder
259. *Pratapa ictis* (Hewitson)

Family : Hesperiidae

260. *Achalarus bifasciatus casyapa* Moore
261. *Aeromachus stigma* (Moore)
262. *Badamia exclamationis* (Fabr.)
263. *Bibasis jaina* Moore
264. *Bibasis sena* (Moore)
265. *Tagiades menaka* (Moore)
266. *Tagiades menaka* (Moore)
267. *Taractrocera danna* (Moore)
268. *Taractrocera maevius* (Fabr.)
269. *Telicota oharajja* Evans
270. *Udaspes folius* (Cr.)
271. *Udaspes adrastus* (Cr.)
272. *Coladenia dan* (Fabr.)
273. *Caprona ransonnetti* (Felder)
274. *Sarangesa dasahara* (Moore)
275. *Sarangesa purendra* (Moore)
276. *Spialia galba* (Fabr.)
277. *Suastus gremius* (Fabr.)
278. *Pelopidas mathias* (Fabr.)
279. *Pelopidas assanmensis* W.M. & deN.
280. *Pelopidas conjuncta* Herr. Sch.
281. *Pelopidas sinensis* Mabille
282. *Polytremis eltola* Hewitson
283. *Borbo cinnara* (Moore)
284. *Borbo cinnara* (Wallare)
285. *Celaenorrhinus leucocera* (Kollar)
286. *Choaspes benjaminii* (Guerin)
287. *Hesperia alpina*
288. *Ismene aedipodea aegina* Plotz
289. *Odontoptilum angulata* (Felder)
290. *Parnara guttatus* Bremer & Gray
291. *Udaspes folus* (Cramer)

(Sources: Wynter-Blyth, 1940-46 & 1957; Mani, 1986; Thakur et al., 2002; Thakur et al., 2006; Arora et al., 2005)

ii) Heterocera (Moths)

Moths are easily distinguished from butterflies due to the presence of thread like antennae, wings folded roof-like over the abdomen and nocturnal habits. Hampson (1895, 1896) has described 1017 species of moths (geometrid) from India. Other valuable contributions to the study of moth fauna have been made by Swinhoe (1900). Contributions to the geometrid fauna of Himachal Pradesh have been made by Pajni & Walia (1982, 1983, 1984 a & b, 1985), Walia & Pajni (1987) and Walia (1988, 1994 a & b, 1995, 2000). Walia (2005) has reported 184 species of moths (family: Geometridae) from Himachal Pradesh.

Systematic List

Family : Geomatridae
Subfamily : Geomatrinae

1. *Agathia lycaenaria lycaenaria* (Kollar)
2. *Agathia hilarata hilarata* Guenee
3. *Tanaorhinus recipr. reciprocata* (Walker)
4. *Nixochlora vittata vittata* (Moore)
5. *Ornithospila avicu. avicularia* (Guenee)
6. *Omphacodes directa* (Walker)
7. *Cacochloris uvidula* (Swinhoe)
8. *Geometra flavifrontaria* (Guenee)
9. *Chloroglyphia variegata* (Butler)
10. *Mixocera allbilineata* Walia & Pajni
11. *Hemistola detracta* (Walker)
12. *Hemistola loxaria* (Guenee)
13. *Thetida pallidmarginata* (Walia & Pajni)
14. *Thetidia radiata* Walker
15. *Cosmostola multimaculata* (Panji&Walia)
16. *Heterochroma cristata cristata* (Warren)
17. *Eucyclodes gavissima gavissima* (Walker)
18. *Pingasa p. pseudoterpnaria* (Guenee)

19. *Pingasa ruginaria ruginaria* (Guenee)
20. *Lephophelma e. erionoma* (Swinhoe)
21. *Comibaena cassidara* (Guenee)
22. *Comibaena subhyalina* (Warren)
23. *Rhomborista devaxata* (Walker)
24. *Spaniocentra megaspilaria* (Moore)
25. *Neromia carnifrons carnifrons* (Butler)
26. *Episothalma robustaria* (Guenee)
27. *Hemithea ochrolauta* (Warren)
28. *Hemithea marina* (Butler)
29. *Hemithea himachalensis* Walia
30. *Hemithea aquamarina* Hampson
31. *Pelagodes falsaria* (Prout)
32. *Chlorissa p. pretiosaria* (Staudinger)
33. *Chlorissa albifasciata* Pajni & Walia
34. *Maxates goniaria* (Felder & Rogen.)
35. *Maxates fuscipalpa* (Pajni & Walia)
36. *Idiochlora pudentofimbria* (Prout)
37. *Idiochlora mundaria* (Leech)
38. *Protuliocnemis c. castalaria* (Oberthur)

Subfamily: Sterrhinae

39. *Traminda m. mundissima* (Walker)
40. *Problepsis albidor albidor* Warren
41. *Problepsis vulgaris* Butler
42. *Problepsis deliaria* (Guenee)
43. *Chrysocraspeda faganaria* (Guenee)
44. *Somatina purpurascens* Moore
45. *Somatina anthophilata* Guenee
46. *Somatina omicraria* (Fabricius)
47. *Antitrygodes cuneilinea* (Walker)
48. *Rhodostrophia herbicolens* (Butler)
49. *Rhodostrophia tristrigalis* Butler
50. *Rhodostrophia stigmaticus* Butler
51. *Timandra correspondens* Hampson
52. *Timandra convectaria convectaria* Walker
53. *Chrysocraspeda oleria oleria* (Guenee)
54. *Scopula nigrifrons* Walia
55. *Scopula stigmata* (Moore)
56. *Scopula monosema* Prout
57. *Scopula emissaria emissaria* (Walker)
58. *Scopula k. kashmirensis* (Moore)
59. *Scopula butyrosa* (Warren)
60. *Scopula pulverosa* (Prout)
61. *Scopula pallida* (Warren)
62. *Scopula niveus* Walia
63. *Scopula atriceps* (Hampson)
64. *Scopula attentata attentata* (Walker)
65. *Scopula caesaria caesaria* (Walker)
66. *Scopula ochripennis* Walia
67. *Scopula straminicostalis* Walia
68. *Scopula humilis* (Prout)
69. *Scopula fibulata* (Guenee)
70. *Scopula cleoraria cleoraria* (Walker)
71. *Scopula addictoria* (Walker)
72. *Scopula m. moorei* (Cotes & Swinhoe)
73. *Scopula p. pulchellata* (Fabricius)
74. *Idaea l. leucozona* (Hampson)
75. *Idaea ptyonopoda* (Hampson)
76. *Idaea protensa* (Butler)
77. *Idaea delicatula* (Warren)
78. *Idaea infortunata* (Prout)
79. *Idaea grisescens* (Warren)
80. *Idaea humeraria* (Walker)
81. *Idaea fuscolineata* Walia
82. *Idaea actiosaria* (Walker)
83. *Lophopleps t. triangularis* (Hampson)
84. *Zygophyxia relictata* (Walker)

Subfamily: Desmobasthrinae

85. *Ozola microniaria* Walker

Subfamily: Ennominae

86. *Peratophyga hyalinata hyalinata* (Kollar)
87. *Lomographa distans* (Warren)
88. *Ascotis imprata* (Walker)
89. *Ascotis s. selenaria* (Denis & Schiff.)
90. *Hypomesis infixaria* (Walker)
91. *Scardamia metallaria* Guenee
92. *Scardamia easwarammae* Walia
93. *Isturgia disputaria* (Guenee)
94. *Semiothisa fumosa* (Hampson)
95. *Ligdia coctata* Guenee
96. *Hyperythra lutea* (Stall)
97. *Heterolocha phaenicotaeniata* (Kollar)
98. *Heterolocha bilineata* (Butler)
99. *Heterolocha subtessellata* (Walker)
100. *Heterolocha marginata* (Warren)
101. *Heterostegane urbica urbica* (Swinhoe)
102. *Heterostegane* sp.
103. *Zeheba lucidata* Walker
104. *Pseudopanthera himaleyica* (Kollar)
105. *Sirinopteryx ablunata* (Guenee)
106. *Synegia camptogrammaria* (Guenee)
107. *Abraxas intermedia* Warren
108. *Abraxas leopradina* (Kollar)
109. *Abraxas martaria* Guenee
110. *Abraxas* sp.
111. *Ourapteryx picticaudata* (Walker)
112. *Ourapteryx ebuleata ebuleata* (Guenee)
113. *Thinopteryx crocoptera crocoptera* (Kollar)
114. *Chiasmia pluviata pluviata* (Fabricius)
115. *Chiasmia fidoniata* (Guenee)
116. *Chiasmia azataria* (Swinhoe)
117. *Chiasmia eleonora eleonora* (Cramer)
118. *Chiasmia xanthonora* (Walker)
119. *Chiasmia perfusaria* (Walker)
120. *Chiasmia frugaliata* (Guenee)
121. *Oxymacaria t. temeraria* (Swinhoe)
122. *Abaciscus atmala atmala* (Swinhoe)
123. *Corymica specularia specularia* (Moore)
124. *Corymica arnearia* Walker
125. *Odontopera lentiginosaria* (Moore)
126. *Odontopera obliquaria* (Moore)
127. *Odontopera angularia* (Moore)
128. *Erebomorpha fulguraria fulguraria* Walker

129. *Biston suppressaria suppressaria* (Guenee)
130. *Zamarada baliata* (Felds & Rog.)
131. *Amraica* sp.
132. *Hyposidra talaca successaria* (Walker)
133. *Hyposidra talaca talaca* (Walker)
134. *Astygisa vaxillaria* (Guenee)
135. *Petelia medardaria* Herr.-Schaffer
136. *Luxiaria amasa amasa* Butler
137. *Eutoea h. heteroneurata* (Guenee)
138. *Anonychia grisea* (Butler)
139. *Alcis semialba* (Moore)
140. *Alcis variegata variegata* (Moore)
141. *Psilalsis inceptaria* (Walker)
142. *Ectropis c. crespuscularia* (Dan. & Schiff.)
143. *Dasyboarmia delineata* (Walker)
144. *Menophra subplagiata* (Walker)
145. *Phthonandria a. atrilineata* (Butler)
146. *Chorodra pulverulenta* (Hampson)
147. *Lassaba albidaria albidaria* (Walker)
148. *Gnophus tephrosiaria* Moore
149. *Gnophus accipitraria* Guenee
150. *Ctenognophos eolaria eolaria* (Guenee)
151. *Peratostega deletaria deletaria* (Moore)
152. *Leptomiza calcearia calcearia* Walker
153. *Opthalmitis herbidaria* (Guenee)
154. *Percnia felinaria* Guenee
155. *Antoparcnia belluaria belluaria* (Guenee)
156. *Ourapteryx convergens* Warren
157. *Biston betularia coagnataria* (Guenee)
158. *Minomiza cruentaria cruentaria* (Moore)
159. *Plutodes costatus* (Butler)
160. *Plutodes transmutata* Walker
161. *Opisthograptis lolleri* Warren
162. *Psyra spurcataria* (Walker)

Subfamily : Larentiinae

163. *Photoscotosia m. moniosata* (Walker)
164. *Triphosa dubiosata* (Walker)
165. *Cataclysme c. conturbata* (Walker)
166. *Cidaria* sp.
167. *Laciniodes plurilinearia* (Moore)
168. *Heterothera consimilis* (Warren)
169. *Horisme plurilineata* (Moore)
170. *Docirava* sp.
171. *Docirava aequilineata* (Walker)
172. *Pomasia* sp.
173. *Eupithecia rajata* Guenee
174. *Chalyboclydon marginata* Warren

Family : Sphingidae

175. *Meganoton analis* (Felder)
176. *Psilogramma menephron* (Cramer)
177. *Polyptychus trilineatus* Moore
178. *Nephele didyma* (Fabr.)
179. *Hippotion celerio* (Linn.)
180. *Theretra alecto* (Linn.)
181. *Theretra nessus* (Drury)
182. *Theretra oldenlandie* (Fabr.)

Family : Arctiidae

183. *Argina argus* (Kollar)
184. *Creatonotus transiens* (Walker)
185. *Zadadra distorta* (Moore)
186. *Strysopha torticoides* (Walker)
187. *Cyana gelida* (Walker)
188. *Cyana puella* (Drury)
189. *Hypsa ficus* (Fabr.)
190. *Asota caricae* (Fabr.)

Family : Noctiudae

191. *Anura tirhaca* (Cramer)
192. *Fodina pallula* Guenee
193. *Ischyia manlia* (Cramer)
194. *Spirama retorta* (Linn.)
195. *Chrysodeixiz eriosoma* (Doubleday)
196. *Psimada quadripennis* Walker

Family : Pyralidae

197. *Botyodes asialis* Guenee
198. *Nausinoe pueritia* (Cramer)
199. *Terastia egialealis* (Walker)
200. *Maruca testulalis* (Geyer)

(Sources: Pajni & Walia, 1984 a & b, 1985; Walia & Pajni, 1987; Walia, 1988, 1995, 2000; Walia, 2005)

POLLINATORS

Pollination is the transfer of pollen grains from male to the female part of flower with the help of abiotic and biotic pollen dispersal agents. Wind, water and gravity are the important abiotic agents, whereas, insects, birds, bats and small mammals are the primary biotic agents (Free, 1993). Various insect groups which are of prime significance in pollination of agricultural and horticultural crops are Hymenoptera, Diptera, Lepidoptera, Coleoptera and Thysanoptera (Michener, 1974).

Insects form an important group of biotic pollen dispersal agents of different agricultural and horticultural crops. Among insects, Hymenopterans embrace a vast multitude of pollinating agents and include most efficient pollinators of horticultural crops like honeybees and bumblebees. Beside hymenopterans, various dipterans belonging to families Syrphidae, Calliphoridae, Babionidae and Muscidae and some Lepidopterans also act as pollinators of various temperate fruit crops (Bhalla *et al.,* 1983 a; Verma and Chauhan, 1985; Mishra and Kumar, 1993).

Himachal Pradesh is a principal temperate fruit growing state of the country with apple, cherry, almond, peach, pear, plum, apricot etc. being the important ones. These temperate fruits are mostly self-incompatible or partially self-compatible in nature and need the services of different species of insect pollinators, like honeybees and dipterans for better fruit set. Even self-compatible cultivars of various temperate crops, also need the services of pollinating insects for the transfer of pollen from anther to stigma, so as to get good quality crop.

Many workers have studied the pollinator diversity in Himachal Pradesh, like Mishra *et al.* (1976) studied the pollination in apple. Verma and Chauhan (1985) recorded 44 insect species on apple bloom in Shimla hills. Kumar (1988) recorded 16 species of bees visiting apple bloom at Nauni (Solan, H.P.), whereas, Dashad (1989) observed three species each of *Apis, Halicus* and *Eristalis*; two each of *Bombus* and *Ceratina* and one each of *Xylocopa, Andrena, Episyrphus. Metasyrpus, Orthellia* and *Musca* visiting apple flowers in the same location. Kumar (1997) revealed that apple flowers were visited by 49 species of insects. Recent studies by Talogta (2003) revealed that apple flowers were visited by 42 species of insects belonging to 5 orders and 16 families. Bhalla *et al.* (1983 b) showed that honeybees were predominant among 10 insect species visiting peach, plum and almond blossom at Solan. Others include Singh and Mishra (1986), Thakur (1988), Rana *et al.* (1995) and Kumar (1997).

Systematic list

Order : Hymenoptera
Family: Apidae
1. *Apis cerana*
2. *Apis mellifera*
3. *Apis dorsata*

Family: Bombidae
4.*Bombus tunicatus*
5.*B.haemorrhoidalis*
6. *Bombus* sp.

Family: Vespidae
7.*Vespa mandarina*
8.*Vespa velutina*
9.*Vespa flaviceps*
10.*Vespa magnifica*
11.*Vespa auraria*
12.*Vespa* sp.
13.*Polistes maculipennis*
14. *Polistes* sp.

Family: Halictidae
15. *Halictus dasygaster*
16. *Halictus* sp.

Family: Andrenidae
17. *Andrena* sp.

Family: Xylocopidae
18.*Xylocopa fenestrata*

Family: Formicidae
19. *Camponotus* sp.
20.*Holocomyrmex* sp.

Family: Ceretinidae
21. *Ceratina hieroglyphica*

Family: Tenthridinidae
22. *Athalia* sp.

Family : Ichneumonidae
23. *Fileantha* sp.

Family: Scoliidae
24. *Elis thoracica*

Order: Diptera
Family: Syrphidae
25. *Eristalis tenax*
26. *Eristalis himalayaensis*
27. *Eristalis cerealis*
28. *E. angustimarginalis*
29. *Eristalis arvorum*
30. *Eristalis* sp.
31. *Metasyrphus* sp.
32. *Macrosyrphus* sp.
33. *Episyrphus balteatus*
34. Episyrphus sp.
35. *Scaeva opimius.*
36. *Scaeva* sp.
37. *Melanostoma* sp.
38. *Syrphus* sp.

Family: Muscidae
39. *Musca domestica*
40. *Musca* sp.
41. *Fannia domestica*
42. *Orthelia* sp.

Family: Cordyluridae
43. *Scathophaga stereoraria*

Family: Calliphoridae
44. *Calliphora vicina*
45. *Lucilia* sp.

Family: Sepsidae
46.*Sepsis* sp.

Family: Asilidae
47. *Promachus* sp.

Family: Dolichopodidae
48. *Dolichopus* sp.

Order : Lepidoptera
Family: Pieridae
49. *Pieris canidia*
50. *Pieris* sp.
51. *Delias* sp.
52.*Gonepteryx rhamni*

Family: Nymphalidae
53. *Pyrameis indica*
54. *Vanessa cance*
55. *Vanessa* sp.
56. *Neptis* sp.

Family: Noctuidae
57. *Heliothis* sp.
58. *Plusia* sp.
59. *Agrotis flammatra*
60. *Agrotis* sp.
61. Sphinx moth

Family: Lycaenidae
62. *Heodes* sp.
63. *Heliophorus* sp.

Family: Zyganidae
64. *Zyganea* sp.

Order: Coleoptera
Family: Coccinellidae
65.*Coccinella septumpunctata*
66. *Coccinella* sp.

Family: Chrysomelidae
67. *Altica* sp.

Order : Hemiptera

Family :Cixiidae
68. *Nysius* sp.
69.*Adolenda typicaic*

Order :Thysanoptera
Family: Thripidae
70. *Thrips* sp.

(Sources: Mattu and Chaudhary, 1993; Mattu et al., 1994, 1995, 1996; Rana et al., 1995; Chaudhary et al., 1993; Verma and Jindal, 1997; Verma, 1990, 1992)

MOLLUSCA

Molluscs are soft-bodied animals, a majority of which are covered by a hard calcareous shell. The shell may consist of one, two or many pieces or sometimes may be internal and cartilaginous. It includes the animals popularly known as snails, slugs, mussels, oysters, clams, cuttle fishes, squids, octopuses etc. Globally the estimated number of molluscan species varies from 50,000 to 1,50,000, and most conservative estimates place their number around 66,000. It has been estimated that in India there are some 5,000 species of these molluscans accounting to more than 7 % of the total diversity of Mollusca (Rao, 1998).

Molluscs of Western Himalayas have been studied by a number of workers and some notable include Nevill (1878), Theobald (1878), Godwin-Austin (1899), Hora et al. (1955), Rajagopal and Subha Rao (1968, 1972), Davis et al (1986), Subba and Mitra (1995). Works on molluscs of Himachal Pradesh include those of Rao, (1927), Hora (1928), Bhardwaj and Thakur (1973) Agarwal (1975 a & b, 1976, 1977, 1979), Bhalla and Pawar (1977), Thakur (1980) and Rao and Mitra (2005). These works showed the presence of 71 species and subspecies of freshwater and land molluscs (21 freshwater and 52 land) spread over 30 genera (10 freshwater and 29 land), 21 families (8 freshwater and 13 land, occurring throughout the State. Of the freshwater species, 17 have all India distribution range and rest have restricted distribution. Out of 52 land molluscs, only 4 are cosmopolitan, 6 have all India distribution and as many as 26 have restricted endemic to the western Himalayas. Some high altitude species have also been reported above 3000 m altitude.

Systematic List

Class : Gastropoda
Order : Mesogastropoda
Family : Viviparidae
1. *Bellamya bengalensis f. typica* (Lamarck)
2. *Bellamya b. f. mandiensis* (Kobelt)
3. *Bellamya dissimilis* (Mueller)

Family : Cyclophoridae
4. *Alycaeus strangulatus* (Pfeiffer)
5. *Diplomatina follicula* (Pfeiffer)

Family : Bithyniidae
6. *Digoniostoma cerameopoma*
7. *Digoniostoma pulchella* (Benson)

Family : Thiaridae

8. *Thiara (Melanoides) tuberculata* (Muell.)
9. *Paludomus tanschuaricus* (Gmelin)

Order : Bassommatophora

Family : Lymnaeidae

10. *Lymnaea (Pseudoscuccinae) acuminata f. typica* Lamarck
11. *Lymnaea (P.) acuminata f. rufescens* Gray
12. *Lymnaea (P.) luteola f. australis* Annn. & Rao
13. *Lymnaea (P.) luteola f. ovalis* Gray
14. *Lymnaea (Galba) andersoniana* Nevill
15. *Lymnaea (Radix) auricularia* Linn.
16. *Lymnaea (Radix) persica* Issel
17. *Lymnaea (Radix) stagnalis* (Linn.)

Family : Planorbiae

18. *Gyraulus convexiuxulus* (Hutton)
19. *Gyraulus labiatus* (Benson)
20. *Indoplanorbis exustus* (Deshayes)

Order : Stylommatophora

Family : Pupillidae

21. *Bifidaria huttoniana* (Benson)
22. *Orcula (Sphy.) himalayanum* (Benson)
23. *Pupilla gutta* (Benson)
24. *Pyramidula humilis* (Benson)

Family : Bradybaenidae

25. *Bradybaena radicicola* (Benson)
26. *Plectropis huttoni* (Pfeiffer)

Family : Valloniidae

27. *Vallonia ladakensis* Nevill

Family : Enidae

28. *Cerastus segregatus* (Reeve)
29. *Ena (Serina) kuluensis* (Kobelt)
30. *Ena (Subzebrinus) arcuata* (Kuster)
31. *Ena (Subzebrinus) boysiana* (Reeve)
32. *Ena (Subzebrinus) eremita* (Reeve)
33. *Ena (Subzebrinus) sindica* (Reeve)
34. *Ena (Subzebrinus) vibex* (Kuster)

Family : Clausiliidae

35. *Phaedusa cylindrica* Pfeiffer

Family : Arionidae

36. *Anadenus altivagus* (Theobald)
37. *Anadenus dalhousiensis* Bhatia
38. *Anadenus schlagintweiti* Heynemann

Family : Subulinidae

39. *Allopeas gracile* (Hutton)
40. *Caecilioides balanus* (Reeve)
41. *Coilostele scalaris* Benson
42. *Glessula paupercula* (Blanford)
43. *Glessula tornensis* (Blanford)
44. *Subulina octona*
45. *Bensonia jacquemonti* (V. Mertens)
46. *Bensonia monticola* (Hutton)
47. *Bensonia theobaldiana* Godwin-Austen
48. *Bensonia angelica* (Pfeiffer)
49. *Bensonia convexa* (Reeve)
50. *Kaliella bhasini* Rajagopalainger
51. *Kaliella bullula* (Hutton)
52. *Kaliella fastigiata* (Hutton)
53. *Kaliella nana* (Hutton)
54. *Khasiella chloroplax* (Benson)
55. *Khasiella hyba* (Benson)
56. *Euaustenia cassida* Hutton
57. *Euaustenia theobaldi* (Godwin-Austin)
58. *Macrochlamys glauca* (Pfeiffer)
59. *Macrochlamys kuluensis* (Blanford)
60. *Macrochlamys nuda* (Pfeiffer)
61. *Macrochlamys planuscula* (Hutton)
62. *Macrochlamys vesicula* (Hutton)
63. *Girasia dalhousiae* Godwin-Austin
64. *Syama splendens* (Hutton)
65. *Syama prona* (Nevill)

Family : Succineidae

66. *Succinea crassinulea* Pfeiffer

Family : Streptaxidae

67. *Gulella bicolor* (Hutton)

Family : Limacidae

68. *Kasperia* sp.

Class : Bivalvia

Order : Unionida

Family : Unionidae

69. *Parreysia (P.) favidens* (Benson)

Order : Veneroida

Family : Pisidiidae

70. *Sphaerium (S.) indicum* Deshayes

Family : Corbiculidae

71. *Corbicula striatella* Deshayes

(Sources: Rao, 1927; Hora, 1928; Bhardwaj and Thakur, 1973; Agarwal, 1975 a & b, 1976, 1977, 1979; Bhalla and Pawar, 1977; Thakur, 1980; Rao and Mitra, 2005)

VERTEBRATES

PISCES

Fishes are aquatic cold-blooded vertebrates that have gills for respiration throughout life and limbs, if any, are in the shape of fins and are primarily dependent on water as a medium in which to live. The living fishes are divided into 4 classes, out of which 2 classes, viz., Chondrichthyes (those with cartilaginous skeleton) and Osteichthyes (those with bony skeleton) are represented in India.

As estimated, there are 27,977 valid species of fishes under 62 orders, 515 families and 4,494 genera in the world. Of these 42.72% (11,952 species) are found in freshwaters like lakes and rivers, 12,457 species are secondary freshwater species and the remaining 3,568 species are exclusively marine (Nelson, 2006). Out of a total of 2,500 species of fish in India, 930 are in fresh waters and belong to 326 genera, 99 families and 20 orders (Talwar and Jhingran, 1991).

Some 2546 species of fishes belonging to 969 genera, 254 families and 40 orders are found in the Indian region (Talwar, 1991). Chondrichthyes are represented by 131 species belonging to 67 genera, 28 families and 10 orders, and Osteichthyes by 2415 species in 902 genera, 226 families and 30 orders (Barman, 1998). Jayaram (1999) listed 852 freshwater species of fishes under 272 genera, 71 families and 16 orders, including both primary and secondary freshwater fishes from India, Bangladesh, Myanmar, Nepal, Pakistan and Sri Lanka. Similarly, Menon (1999) listed 446 primary freshwater species under 33 families and 11 orders from the Indian region alone.

Fish fauna of different parts of India has been studied in some details by various workers like Jayaram (1999, 2006), Menon (1999), Ponniah and Gopalakrishnan (2000), Ponniah and Sarkar (2000), Day (1889 a and b) and Vishwanath *et al.* (2007). Sharma and Mehta (2009) reported 19 species of fish belonging to 10 genera and 3 families from Ladakh area of Jammu and Kashmir. Vats and Gupta (2011) reported 64 species belonging to 35 genera and 16 families from northern Haryana.

Himachal Pradesh has overall hilly terrain with a number of rivers, lakes and suitable aquatic habitats. Studies on the fish fauna of Himachal Pradesh started with the arrival of European traders and missionaries somewhere in the beginning of 19th century. Some of important works on fishes include those of McClelland (1839, 1842), Stenidachner (1867), Day (1875-1878), Hora (1927, 1937), Menon (1951, 54, 62, 74, 87, 99), Bhatanagar (1973), Tilak and Husain (1977), Sharma and Tandon (1990), Mehta (2000 a), Johal *et al.* (2002), and Dhanze and Dhanze (2004). Mehta and Sharma (2008) have reported 3 species of fish from Pin Valley National Park. Kumar (2010) revealed the presence of 6 species of fish belonging to 3 orders and 3 families from Kullu Valley. A total of 104 species of fish spread over 48 genera, 14 families and 8 orders are known from Himachal Pradesh. A maximum of 57 species are reported from Sirmour district, followed by 55 from Kangra and 50 from Bilaspur and a minimum of 3 species are known from Lahaul and Spiti district (Mehta and Uniyal, 2005).

Systematic List

Class : Actinopterygii
Order : Osteoglosiiformes
Family : Notopteridae
1. *Notopterus notopterus* (Pallas)
2. *Chitala chaitala* (Hamilton-Buchanan)

Order : Cypriniformes
Family : Cyprinidae
3. *Barilius barila* (Hamilton-Buchanan)
4. *Barilius barna* (Hamilton-Buchanan)
5. *Barilius bendelisis* (Hamilton-Buchanan)
6. *Barilius modestus* (Hamilton-Buchanan)
7. *Barilius shacra* (Hamilton-Buchanan)
8. *Barilius vagra* (Hamilton-Buchanan)
9. *Raiamas bola* (Hamilton-Buchanan)
10. *Brachydanio rerio* (Hamilton-Buchanan)
11. *Rasbora daniconius* (Hamilton-Buchanan)
12. *Danio devario* (Hamilton-Buchanan)
13. *Tor putitora* (Hamilton-Buchanan)
14. *Tor tor* (Hamilton-Buchanan)
15. *Tor chelynoides* (McClelland)
16. *Tor mosal* (Hamilton-Buchanan)
17. *Carassius auratus* (Linnaeus)
18. *Crassius crassius* (Linnaeus)
19. *Catla catla* (Hamilton-Buchanan)
20. *Cirrhinus reba* (Hamilton-Buchanan)
21. *Cirrhinus mrigala* (Hamilton-Buchanan)
22. *Crossocheilus latus latus* (Hamilton-Buch.)
23. *Crossocheilis l. diplocheilus* (Ham.-Buc.)
24. *Cyprinus carpio communis* Linnaeus
25. *Cyprinus carpio specularis* Lacepedes
26. *Cyprinus carpio nudus* Bloch
27. *Gara gotyla gotyla* (Gray)
28. *Garra lamta* (Hamilton-Buchanan)
29. *Ctenopharyngodon idellus* (Valenciennes)
30. *Labeo bata* (Hamilton-Buchanan)
31. *Labeo boga* (Hamilton-Buchanan)
32. *Labeo calbasu* (Hamilton-Buchanan)
33. *Labeo dero* (Hamilton-Buchanan)
34. *Labeo dycocheilus dycocheilus* (McClelland)
35. *Labeo pangusia* (Hamilton-Buchanan)
36. *Labeo rohita* (Hamilton-Buchanan)
37. *Labeo gonius* (Hamilton-Buchanan)
38. *Neolissochilus hexagonolopsis* (McClelland)
39. *Osteobrama cotio cotio* (Hamilt.-Buchanan)
40. *Esomus danricus* (Hamilton-Buchanan)
41. *Puntius phutunio* (Hamilton-Buchanan)
42. *Puntius chola* (Hamilton-Buchanan)
43. *Puntius conchonius* (Hamilton-Buchanan)
44. *Puntius ticto* (Hamilton-Buchanan)
45. *Puntius sarana sarana* (Hamilt.-Buchanan)
46. *Puntiuis sophore* (Hamilton-Buchanan)
47. *Puntius waagenii* (Day)
48. *Puntius tetrarpagus* (McClelland)
49. *Puntius stigma* (Hamilton-Buchanan)
50. *Puntius punjabensis* (Day)
51. *Slamostoma bacaila* (Hamilton-Buchanan)

52. *Chagunius chagunio* (Hamilton-Buchanan)
53. *Schizothorax richardsonii* (Gray)
54. *Diptus maculatus* Steindachner
55. *Hypophthalmichthyes molitrix* (Valenc.)

Family : Cobiitidae
56. *Botia birdi* Chaudhari
57. *Botia dayi* Hora
58. *Botia dario* (Hamilton-Buchanan)
59. *Botia lochachata* Chaudhari
60. *Botia geto* (Hamilton-Buchanan)
61. *Lepidocephalus guntea* (Hamilt.-Buchanan)
62. *Noemacheilus botia* (Hamilton-Buchanan)
63. *Noemacheilus carletoni* Fowler
64. *Noemacheilus corica* (Hamilton-Buchanan)
65. *Noemacheilus horai* Menon
66. *Noemacheilus himachalensis* Menon
67. *Noemacheilus montanus* (McClelland)
68. *Noemacheilus punjabensis* (Hora)
69. *Noemacheilus rupecola* (McClelland)
70. *Noemacheilus nilgiriensis* (Menon)
71. *Triplophysa stoliczkae* (Steindachner)

Order : Siluriformes
Family : Amblycipitidae
72. *Amblyceps mongois* (Hamilton-Buchanan)

Family : Bagridae
73. *Mystus bleekri* (Day)
74. *Mystus vittatus* (Bloch)
75. *Aorichthys aor* (Hamilton-Buchanan)
76. *Aorichthys seenghala* (Sykes)

Family : Siluridae
77. *Wallago attu* (Bloch & Schneider)

Family : Clariidae
78. *Clarias batrachus* (Linnaeus)

Family : Schibeidae
79. *Clupisoma garua* (Hamilton-Buchanan)

Family : Sisoridae
80. *Bagarius bagarius* (Hamilton-Buchanan)
81. *Glyptothorax brevipinnus* Hora
82. *Glyptothorax c. conirostrae* (Steindachner)
83. *Glyptothorax garhwali* Tilak
84. *Glyptothorax gracile* (Gunter)
85. *Glyptothoraxkashmirensis* Hora
86. *Glyptothorax pectinopterus* (McClelland)
87. *Glyptothorax stoliczke* (Steindachner)
88. *Glyptothorax dakpathri* Tilak & Hussain
89. *Gyptosternon reticulatum* McClelland
90. *Pseudecheneis sulcatus* (McClelland)

Order : Order
Family : Salmonidae
91. *Salmo gardnerii gardnerii* Richardson
92. *Salmo trutto fabrio* Linnaeus

Order : Beloniformes
Family : Belonidae
93. *Xenentodon cancila* (Hamilton-Buchanan)

Order : Channiformes
Family : Channidae
94. *Channa gachua* (Hamilton-Buchanan)
95. *Channa marulius* (Hamilton-Buchanan)
96. *Channa orientalis* Block and Schneider
97. *Channa punctatus* (Bloch)
98. *Channa striatus* (Bloch)

Family : Centropomidae
99. *Pseudambasis baculis* (Hamilt.-Buchanan)

Family : Gobidae
100. *Glossogobius giuris* (Hamilton-Buchanan)

Family : Heteropneustidae
101. *Heteropneustes fossilis* (Bloch)

Order : Perciformes
Family : Nandidae
102. *Badius badis* (Hamilton-Buchanan)

Order : Synbranchiformes
Family : Mastacembelidae
103. *Mastacembelus armatus* Lacepede
104. *Macrognathus pancalus* Hamilt.-Buchanan

(Sources: Sharma and Tandon, 1990; Mehta, 2000 a; Johal et al., 2002; Dhanze and Dhanze, 2004; Mehta & Uniyal, 2005)

AMPHIBIA

Amphibians lead a bimodal life i.e. life in water as well as land and are poikilothermic vertebrates with smooth skin. Much of gas exchange in them occurs through their skin whose secretion protects it from desiccation. Three modern orders of Amphibia are Anura, Caudata and Gymnophiona and include animals such as toads, salamanders, caecilians, frogs and toads (Chanda, 1998). They are least harmful creatures in nature as they do not cause any damage to agriculture crops,

fruits and vegetables. Their food mainly consists of small insects and their larvae, algae, snails etc. which are pests of crops and vectors of some diseases. They are found throughout the world from sea level to an altitude of about 3,500 m. They are considered efficient ecological indicators.

Amphibians comprise nearly 6.6% of the total vertebrate life on the earth and they are the least amongst the vertebrates (Lagler *et al*., 1962). Around 3,140 species of amphibians have been estimated in the world (Mehta, 2005). In India, 214 species of Amphibia are known, of which around 66% (167) endemic to the country. India has the third largest amphibian population in Asia. In spite of its broad variety of species, India holds second place on the list of countries having the most number of threatened amphibian species in Asia, with 67 (25%) of its species facing possible extinction.

Works on amphibian fauna of the country is scattered and some of the important contributions are those of Smith (1935), Gruber (1981), Dutta (1997), Chanda (2002) and Dinesh *et al.* (2009). In Himachal Pradesh only 17 species belonging to 4 families has been recorded, which constitute about 8% of the total Indian species. Important contributions to amphibian fauna of different parts of the state is available in the works of Annandale (1907), Boulenger (1920), Kriplani (1952), Dubois (1975), Tilak and Mehta (1983) and Mehta (2000 b, 2005). Mehta (2009) has reported three species of amphibian (*Pseudopidalea latastii*, *Bufo viridis* and *Scutiger occidentalis*) from Indian cold desert Ladakh.

Systematic List

Family : Ranidae

1. *Rana cyanophlyctis* Schneider
2. *Rana limnocharis* (Boie)
3. *Rana tigerina* Daudin
4. *Rana (Tomopterna) breviceps* Schne.
5. *Rana (Paa) minica* Dubois
6. *Rana (Paa) liebigii* Annandale
7. *Rana (Paa) vicinia* Stoliczka
8. *Amolops afgahanus* Gunther
9. *Amolops himalayanus* Boulenger

Family : Rhacophoridae

10. *Polypedates maculates* Gunther

Family : Bufonidae

11. *Bufo melanistictus* Schneider
12. *Bufo stomaticus* Lutken
13. *Bufo andersonii* Boulenger
14. *Bufo himalayanus* Gunther
15. *Bufo viridis* Laurenti

Family : Microphylidae

16. *Microhyla ornata* Dumm. & Bobron
17. *Uperodon systoma* Schneider

(Sources: Dubois, 1975; Tilak and Mehta, 1983; Mehta, 2000 b & 2005)

REPTILIA

Reptiles are cold-blooded vertebrates which breathe by lungs throughout their life and have the body covered by scales. Their skull articulates with the vertebral column by a single median occipital condyle. They were the dominant group of vertebrates during the Mesozoic period and they reached their maximum and most diversified development at that time. 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. These are Crocodylia, Rhynchocephala, Squamata and Testudines. Of these, Crocodilia includes crocodiles, gavials, caimans, and alligators having 23 species. Rhynchocephala having two species is found in New Zealand. Squamata includes lizards, snakes and worm lizards having approximately 9,150 species. Lastly, Testudines consisting of turtles, terrapins and tortoises have about over 300 species.

In India, all the three living orders of reptiles have their representatives- Crocodilia (crocodiles), Testudines (turtles and tortoises) and Squamata (lizards and snakes). The diversified climate, varying vegetation and different types of soil in the country form a wide range of biotopes that support a highly diversified reptilian fauna. India harbours 518 species of reptiles including 3 species of Crocodilia, 34 of Testudines, 202 of lizards and 279 species of serpents belonging to 28 families. Indian reptiles constitute about 6.2 percent of the world reptile fauna and 30 species have been listed as threatened under IUCN Redlist of Threatened Animals (IUCN, 2006).

The monumental works on Indian reptiles are, 'The Reptiles of British India' by Gunther (1864), 'Fauna of British India - 'Reptilia and Batrachia' by Boulenger (1890) and Smith (1931, 1935 and 1943). Further contributions were made by Tiwari and Biswas (1973), Sharma (1977, 1978, 1981, 1998, 2002, 2007), Murthy (1985, 1994, 2010), Das (1991, 1994, 1996, 1997, 2003), Tikedar and Sharma (1992), Das and Bauer (2000), Das and Sengupta (2000), Daniel (2002), Whitaker and Captain (2004), Sharma (2007), Thrope *et al.* (2007), Mukherjee and Bhupathy (2007), Gower and Winkler (2007), Manamendra-Arachchi *et al.* (2007), Das and

Vijayakumar (2009), Giri (2008), Giri and Bauer (2008), Giri *et al.* (2009 a and b), Zambre *et al.* (2009), Haralu (2010), Pook *et al.* (2009), Van Rooijen and Vogel (2009), Mahony (2009, 2010) and Venugopal (2010).

Though, initial efforts on studies of reptiles of Himachal Pradesh started during British period but there is little information on the reptiles from Himachal Pradesh. Smith (1931, 1935, 1943) has recorded the herpetological fauna of British India. A total of 55 species of reptiles belonging to 40 genera and 14 families has been recorded from Himachal Pradesh (Saikia *et al.,* 2007). Mehta (2000 c) reported 14 reptile species of reptiles from Renuka wetland area. Saikia and Sharma (2009) reported 17 species belonging to 10 families from Simbalbara Wildlife Sanctuary including two species of lizards (*Ophisops jerdoni* and *Eurylepis taeniolatus*) and one species of turtle (*Melanochelys trijuga indopeninsularis*) as the first records for the state of Himachal Pradesh (Saikia *et al.,* 2010). Agma rock lizard (*Laudakia tuberculata*) has been reported from Khajjiar area in Chamba District of Himachal Pradesh (Singh and Banyal, 2013).

Systematic List

Order : Testudines
Family : Emydidae
1. *Kachuga kachuga* (Gray)

Family : Gekkonidae
2. *Hemidactylus brooki* Gary
3. *Hemidactylus flaviviridus* Ruppell

Family : Agamidae
4. *Agama tuberculata* Hardwicke & Gray
5. *Calotes versicolor* (Daudin)

Family : Varanidae
6. *Varanus bengalensis* (Daudin)
7. *Varanus flavescens* (Hardwicke & Gray)

Family : Scincidae
8. *Mabuya carinata* (Schneider)
9. *Riopa punctata* (Gmelin)

Order : Serpentes
Family : Typhlopidae
10. *Typhlops porrectus* Stoliczka

Family : Viperidae
11. *Vipera russelli* (Shaw)
12. *Echis carinatus* (Schneider)
13. *Agkistrodon himalayanus* Guenther

Family : Colubridae
14. *Ptyas mucosus* (Linnaeus)

(Sources: Waltner, 1974; Mehta, 2000 c)

AVES

Class Aves of the phylum Chordata includes the fascinating warm-blooded vertebrate creatures which are known as birds. They are characterised by the presence of feathers which serve many purposes like insulating the body and contributing to the flying apparatus of wing and tail (Saha, 1998). Besides being the most tested

scavengers, birds possess a remarkable ability to destroy the vermin, consume insects which otherwise would be hazardous or detrimental to humans, disseminate seeds and above all they are efficient pollinators. Diversity of birds and its population in an ecosystem is the most important indicator of its health as these demonstrate remarkable sensitivity to physical or chemical changes.

Birds evolved about 150 million years ago and their diversification of forms was noticeable sometimes during 60 million years ago. World list of living birds computes about 9026 species under 1800 genera, 182 families and 30 orders (Saha, 1998). India ranks amongst one of the most biodiverse countries in the world. Currently around 1300 species of breeding, staging and wintering birds, spread over 88 families and 22 orders, occupying a wide array of natural, semi-natural and urban habitats are known from India (Manakadan and Pittie, 2001).

Critically Threatened Birds in India	
Migratory Wetland Species	Baer's Pochard (*Aythya baeri*) Siberian Crane (*Leucogeranus leucogeranus*) Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*)
Non-migratory Wetland Species	White-bellied Heron (*Ardea insignis*)
Grassland Species	Bengal Florican (*Houbaropsis bengalensis*) Great Indian Bustard (*Ardeotis nigriceps*) Jerdon's Courser (*Rhinoptilus bitorquatus*) Sociable Lapwing (*Vanellus gregarius*)
Forest Species	Forest Owlet (*Heteroglaux blewitti*)
Scavengers	Indian Vulture (*Gyps indicus*) Red-headed Vulture (*Sarcogyps calvus*) Slender-billed Vulture (*Gyps tenuirostris*) White-backed Vulture (*Gyps bengalensis*)
Practically extinct	Himalayan Quail (*Ophrysia superciliosa*) Pink-headed Duck (*Rhodonessa caryophyllacea*)

Earlier studies on the birds of Himachal Pradesh were initiated during British period because of the presence of the Imperial Summer capital at Shimla as summarised by Ali and Ripley, 1983. Different workers like have undertaken studies on the birds of different parts of the State. Whistler (1926) studied the birds of Kangra district. Jones (1947-48) studied the birds of Shimla and adjoining hills. Ali

(1949) has listed about 225 birds of Western Himalaya. Ganguli (1967) studied the birds of Shimla. Gaston *et al.* (1981 a) has described about Indian ornithology in Himalaya. Khajuria and Sharma (1983) studied the pheasants and their distribution in Western Himalaya. Besides, a number of workers have undertaken studies on different aspects of birds and enriched the knowledge on the ornithology like Gaston and Pandey (1987), Pandey (1989 a & b), Sharma and Pandey (1989), Sharma *et al.* (1990), Singh *et al.* (1990), Mahabal (1992 a & b), Mahabal and Sharma (1992), Suyal (1992), Pandey (1993 a & b), Mahabal (1996, 2000 a & b), Sharma (2001), Thakur *et al.* (2002 & 2003), Mattu and Thakur (2005). Mattu *et al*. (2005) have compiled information on a total of 610 species of birds from different sources. Besten (2004) has recorded 555 species of birds from Kangra District. Mahabal (2005) has reported 447 species of birds belonging to 232 genera spread over 65 families and 17 orders from Himachal Pradesh. The study also represents the district-wise status of the diversity and reveals that maximum diversity was in Kangra district (313) and the least number was from Kinnaur district (40). Some of the recent studies on birds of Himachal Pradesh are reflected in the works of Mehta *et al.* (2002), Besten *et al.* (2004), Pandey *et al.* (2004), Mattu and Thakur (2006), Tak *et al.* (2008), Thakur and Mattu (2011), Thakur and Narang (2012), Thakur and Paliwal (2012), Thakur and Kataria (2012), Thakur (2013, 2014, 2015) and Singh *et al.* (2014).

Systematic List

PODICIPEDIDAE
1. *Tachybaptus ruficollis* Little Grebe
2. *Podiceps grisegena* Red-necked Grebe
3. *Podiceps cristatus* Great Crested Grebe
4. *Podiceps nigricollis* Black-necked Grebe

PHALACROCORACIDAE
5. *Phalacrocorax niger*Little Cormorant
6. *Phalacrocorax fuscicollis* Indian Cormorant
7. *Phalacrocorax carbo* Great Cormorant

ANHINGIDAE
8. *Anhinga melanogaster* Darter

ARDEIDAE
9. *Egretta garzetta* Little Egret
10. *Ardea cinerea* Grey Heron
11. *Ardea purpurea* Purple Heron
12. *Casmerodius albus* Great Egret
13. *Mesophoyx intermedia* Intermediate Egret
14. *Bubulcus ibis* Cattle Egret
15. *Ardeola grayii* Indian Pond Heron
16. *Butorides striatus* Little Heron
17. *Nycticorax nycticorax* Black-crowned Night Heron
18. *Ixobrychus sinensis* Yellow Bittern
19. *Ixobrychus cinnamomeus* Cinnamon Bittern
20. *Dupetor flavicollis* Black Bittern

CICONIIDAE
21. *Mycteria leucocephala* Painted Stork
22. *Ciconia nigra* Black Stork
23. *Ciconia episcopus* Woolly-necked Stork
24. *Ephippiorhynchus asiaticus* Black-necked Stork

THRESKIORNITHIDAE
25. *Pseudibis papillosa* Black Ibis
26. *Platalea leucorodia* Eurasian Spoonbill

ANATIDAE
27. *Dendrocygna javanica* Lesser Whistling-duck
28. *Anser albifrons* Greater White-fronted Goose
29. *Anser anser* Greylag Goose
30. *Anser indicus* Bar-headed Goose
31. *Tadorna ferruginea* Ruddy Shelduck
32. *Tadorna tadorna* Common Shelduck
33. *Anas strepera* Gadwall
34. *Anas Penelope* Eurasian Wigeon
35. *Anas platyrhynchos* Mallard
36. *Anas poecilorhyncha* Spot-billed Duck
37. *Anas clypeata* Northern Shoveler
38. *Anas acuta* Northern Pintail

39. *Anas querquedula* Garganey
40. *Anas crecca* Common Teal
41. *Rhodonessa rufina* Red-crested Pochard
42. *Aythya farina* Common Pochard
43. *Aythya nyroca* Ferruginous Pochard
44. *Aythya fuligula* Tufted Duck
45. *Aythya marila* Greater Scaup
46. *Mergus merganser* Common Merganser

ACCIPITRIDAE

47. *Pernis ptilorhyncus* Oriental Honey-buzzard
48. *Elanus caeruleus* Black-shouldered Kite
49. *Milvus migrans* Black Kite
50. *Haliastur indus* Brahminy Kite
51. *Haliaeetus leucoryphus* Pallas's Fish Eagle
52. *Haliaeetus albicilla* White-tailed Eagle
53. *Ichthyophaga humilis* Lesser Fish Eagle
54. *Gypaetus barbatus*Lammergeier
55. *Neophron percnopterus* Egyptian Vulture
56. *Gyps bengalensis* White-rumped Vulture
57. *Gyps tenuirostris* Slender-billed Vulture
58. *Gyps himalayensis* Himalayan Griffon
59. *Gyps fulvus* Eurasian Griffon
60. *Aegypius monachus* Cinereous Vulture
61. *Sarcogyps calvus* Red-headed Vulture
62. *Circaetus gallicus* Short-toed Snake Eagle
63. *Spilornis cheela* Crested Serpent Eagle
64. *Circus aeruginosus* Eurasian Marsh Harrier
65. *Circus melanoleucos* Pied Harrier
66. *Circus macrourus* Pallid Harrier
67. *Accipiter trivirgatus* Crested Goshawk
68. *Accipiter badius* Shikra
69. *Accipiter virgatus* Besra
70. *Accipiter nisus* Eurasian Sparrowhawk
71. *Accipiter gentiles* Northern Goshawk
72. *Butastur teesa* White-eyed Buzzard
73. *Buteo buteo* Common Buzzard
74. *Buteo rufinus* Long-legged Buzzard
75. *Buteo hemilasius* Upland Buzzard
76. *Ictinaetus malayensis* Black Eagle
77. *Aquila pomarina* Indian Spotted Eagle
78. *Aquila clanga* Greater Spotted Eagle
79. *Aquila chrysaetos* Golden Eagle
80. *Aquila rapax* Tawny Eagle
81. *Aquila nipalensis* Steppe Eagle
82. *Aquila heliaca* Imperial Eagle
83. *Hieraaetus fasciatus* Bonelli's Eagle
84. *Hieraaetus pennatus* Booted Eagle
85. *Spizaetus cirrhatus* Changeable Hawk Eagle
86. *Spizaetus nipalensis* Mountain Hawk Eagle

PANDIONIDAE

87. *Pandion haliaetus* Osprey

FALCONIDAE

88. *Falco naumanni* Lesser Kestrel
89. *Falco tinnunculus* Common Kestrel
90. *Falco chicquera* Red-necked Falcon
91. *Falco amurensis* Amur Falcon
92. *Falco subbuteo* Eurasian Hobby
93. *Falco severus* Oriental Hobby
94. *Falco jugger* Laggar Falcon
95. *Falco cherrug* Saker Falcon
96. *Falco peregrinus* Peregrine Falcon

PHASIANIDAE

97. *Lerwa lerwa* Snow Partridge
98. *Tetraogallus tibetanus* Tibetan Snowcock
99. *Tetraogallus himalayensis* Himalayan Snowcock
100. *Alectoris chukar* Chukar
101. *Francolinus francolinus* Black Francolin
102. *Francolinus pondicerianus* Grey Francolin
103. *Perdix hodgsoniae* Tibetan Partridge
104. *Coturnix coturnix* Common Quail
105. *Coturnix coromandelica* Rain Quail
106. *Coturnix chinensis* Blue-breasted Quail
107. *Perdicula asiatica* Jungle Bush Quail
108. *Arborophila torqueola* Hill Partridge
109. *Tragopan melanocephalus* Western Tragopan
110. *Pucrasia macrolopha* Koklass Pheasant
111. *Lophophorus impejanus* Himalayan Monal
112. *Gallus gallus* Red Junglefowl
113. *Lophura leucomelanos* Kalij Pheasant
114. *Catreus wallichii* Cheer Pheasant
115. *Pavo cristatus* Indian Peafowl

TURNICIDAE

116. *Turnix sylvatica* Small Buttonquail
117. *Turnix tanki* Yellow-legged Buttonquail
118. *Turnix suscitator* Barred Buttonquail

GRUIDAE

119. *Grus antigone* Sarus Crane

RALLIDAE

120. *Rallus aquaticus* Water Rail
121. *Amaurornis akool* Brown Crake
122. *Amaurornis phoenicurus* White-breasted Waterhen
123. *Porzana pusilla* Baillon's Crake
124. *Porzana fusca* Ruddy-breasted Crake
125. *Gallicrex cinerea* Watercock
126. *Porphyrio porphyrio* Purple Swamphen
127. *Gallinula chloropus* Common Moorhen
128. *Fulica atra* Common Coot

JACANIDAE

129. *Hydrophasianus chirurgus* Pheasant-tailed Jacana

ROSTRATULIDAE

130. *Rostratula benghalensis* Greater Painted-snipe

HAEMATOPIDAE

131. *Haematopus ostralegus* Eurasian Oystercatcher

CHARADRIIDAE

132. *Pluvialis apricaria* Eurasian Golden Plover
133. *Pluvialis fulva* Pacific Golden Plover
134. *Pluvialis squatarola* Grey Plover
135. *Charadrius hiaticula* Common Ringed Plover
136. *Charadrius dubius* Little Ringed Plover
137. *Charadrius alexandrinus* Kentish Plover
138. *Charadrius mongolus* Lesser Sand Plover
139. *Charadrius leschenaultii* Greater Sand Plover
140. *Vanellus vanellus* Northern Lapwing
141. *Vanellus malarbaricus* Yellow-wattled Lapwing
142. *Vanellus duvaucelii* River Lapwing
143. *Vanellus indicus* Red-wattled Lapwing
144. *Vanellus gregarious* Sociable Lapwing
145. *Vanellus leucurus* White-tailed Lapwing

SCOLOPACIDAE

146. *Scolopax rusticola* Eurasian Woodcock
147. *Gallinago solitaria* Solitary Snipe
148. *Gallinago nemoricola* Wood Snipe
149. *Gallinago stenura* Pintail Snipe
150. *Gallinago gallinago* Common Snipe
151. *Lymnocryptes minimus* Jack Snipe
152. *Limosa limosa* Black-tailed Godwit
153. *Numenius arquata* Eurasian Curlew
154. *Tringa erythropus* Spotted Redshank
155. *Tringa tetanus* Common Redshank
156. *Tringa stagnatilis* Marsh Sandpiper
157. *Tringa nebularia* Common Greenshank
158. *Tringa ochropus* Green Sandpiper
159. *Tringa glareola* Wood Sandpiper
160. *Xenus cinereus* Terek Sandpiper
161. *Actitis hypoleucos* Common Sandpiper
162. *Calidris minuta* Little Stint
163. *Calidris temminckii* Temminck's Stint

164. *Calidris alpine* Dunlin
165. *Calidris ferruginea* Curlew Sandpiper
166. *Philomachus pugnax* Ruff

RECURVIROSTRIDAE

167. *Ibidorhyncha struthersii* Ibisbill
168. *Himantopus himantopus* Black-winged Stilt
169. *Recurvirostra avosetta* Pied Avocet

PHALAROPOPIDAE

170. *Phalaropus lobatus* Red-necked Phalarope

BURHINIDAE

171. *Burhinus oedicnemus* Eurasian Thick-knee
172. *Esacus recurvirostris* Great Thick-knee

GLAREOLIDAE

173. *Glareola maldivarum* Oriental Pratincole
174. *Glareola lacteal* Small Pratincole

LARIDAE

175. *Larus heuglini* Heuglin's Gull
176. *Larus cachinnans* Caspian Gull
177. *Larus ichthyaetus* Pallas's Gull
178. *Larus brunnicephalus* Brown-headed Gull
179. *Larus ridibundus* Black-headed Gull
180. *Larus minitus* Little Gull
181. *Sterna aurantia* River Tern
182. *Sterna hirundo* Common Tern
183. *Sterna acuticauda* Black-bellied Tern

RYNCHOPIDAE

184. *Rynchops albicollis* Indian Skimmer

PTEROCLIDIDAE

185. *Syrrhaptes tibetanus* Tibetan Sandgrouse
186. *Pterocles exustus* Chestnut-bellied Sandgrouse
187. *Pterocles senegallus* Spotted Sandgrouse

COLUMBIDAE

188. *Columba livia* Rock Pigeon
189. *Columba eversmanni* Yellow-eyed Pigeon
190. *Columba rupestris* Hill Pigeon
191. *Columba leuconota* Snow Pigeon
192. *Columba palumbus* Common Wood Pigeon
193. *Columba hodgsonii* Speckled Wood Pigeon
194. *Columba pulchricollis* Ashy Wood Pigeon
195. *Streptopelia orientalis* Oriental Turtle Dove
196. *Streptopelia senegalensis* Laughing Dove
197. *Streptopelia chinensis* Spotted Dove
198. *Streptopelia tranquebarica* Red Collared Dove
199. *Streptopelia decaocto* Eurasian Collared Dove
200. *Macropygia unchall* Barred Cuckoo Dove
201. *Chalcophaps indica* Emerald Dove
202. *Treron phoenicoptera* Yellow-foot Green Pigeon
203. *Treron sphenura* Wedge-tailed Green Pigeon

PSITTACIDAE

204. *Psittacula eupatria* Alexandrine Parakeet
205. *Psittacula krameri* Rose-ringed Parakeet
206. *Psittacula himalayana* Slaty-headed Parakeet
207. *Psittacula cyanocephala* Plum-headed Parakeet

CUCULIDAE

208. *Clamator jacobinus* Pied Cuckoo
209. *Hierococcyx sparverioides* Large Hawk Cuckoo
210. *Hierococcyx varius* Common Hawk Cuckoo
211. *Cuculus micropterus* Indian Cuckoo
212. *Cuculus canorus* Eurasian Cuckoo
213. *Cuculus saturatus* Oriental Cuckoo
214. *Cuculus poliocephalus* Lesser Cuckoo
215. *Cacomantis merulinus* Rufous-bellied Plaintive Cuckoo
216. *Surniculus lugubris* Drongo Cuckoo
217. *Eudynamys scolopacea* Asian Koel
218. *Phaenicophaeus leschenaultii* Sirkeer Malkoha
219. *Centropus sinensis* Greater Coucal

TYTONIDAE

220. *Tyto alba* Barn Owl

STRIGIDAE

221. *Otus spilocephalus* Mountain Scops Owl
222. *Otus sunia* Oriental Scops Owl
223. *Otus bakkamoena* Collared Scops Owl
224. *Otus scops* Eurasian Scops Owl
225. *Bubo bubo* Eurasian Eagle Owl
226. *Ketupa zeylonensis* Brown Fish Owl
227. *Ketupa flavipes* Tawny Fish Owl
228. *Glaucidium cuculoides* Asian Barred Owlet
229. *Glaucidium radiatum* Jungle Owlet
230. *Athene brama* Spotted Owlet
231. *Asio otus* Long-eared Owl

CAPRIMULGIDAE

232. *Caprimulgus indicus* Grey Nightjar
233. *Caprimulgus macrurus* Large-tailed Nightjar
234. *Caprimulgus asiaticus* Indian Nightjar
235. *Caprimulgus affinis* Savanna Nightjar

APODIDAE

236. *Collocalia brevirostris* Himalayan Swiftlet
237. *Zoonavena sylvatica* White-rumped Needletail
238. *Hirundapus caudacutus* White-thro Needletail
239. *Tachymarptis melba* Alpine Swift
240. *Apus apus* Common Swift
241. *Apus pacificus* Fork-tailed Swift
242. *Apus affinis* House Swift

ALCEDINIDAE

243. *Alcedo atthis* Common Kingfisher
244. *Halcyon smyrnensis* White-throated Kingfisher
245. *Megaceryle lugubris* Crested Kingfisher
246. *Ceryle rudis* Pied Kingfisher

MEROPIDAE

247. *Nyctyornis athertoni* Blue-bearded Bee-eater
248. *Merops apiaster* European Bee-eater
249. *Merops orientalis* Green Bee-eater
250. *Merops persicus* Blue-cheeked Bee-eater
251. *Merops philippinus* Blue-tailed Bee-eater
252. *Merops leschenaulti* Chestnut-headed Bee-eater

CORACIDAE

253. *Coracias garrulous* European Roller
254. *Coracias benghalensis* Indian Roller

UPUPIDAE

255. *Upupa epops* Common Hoopoe

BUCEROTIDAE

256. *Ocyceros birostris* Indian Grey Hornbill

CAPITONIDAE

257. *Megalaima virens* Great Barbet
258. *Megalaima zeylanica* Brown-headed Barbet
259. *Megalaima lineate* Lineated Barbet
260. *Megalaima asiatica* Blue-throated Barbet
261. *Megalaima haemacephala* Coppersmith Barbet

INDICATORIDAE

262. *Indicator xanthonotus* Yellow-rumped Honeyguide

PICIDAE

263. *Jynx torquilla* Eurasian Wryneck
264. *Picumnus innominatus* Speckled Piculet
265. *Dendrocopos canicapillus* Grey-capped Pygmy Woodpecker
266. *Dendrocapus nanus* Brown-capped Pygmy Woodpecker
267. *Dendrocopos auriceps* Brown-fronted Woodpecker
268. *Dendrocopos macei* Fulvous-breasted Woodpecker
269. *Dendrocopos mahrattensis* Yellow-crowned Woodpecker
270. *Dendrocopos hyperythrus* Rufous-bellied Woodpecker
271. *Dendrocopos himalayensis* Himalayan

Woodpecker
272. *Picus chlorolophus* Lesser Yellownape
273. *Picus flavinucha* Greater Yellownape
274. *Picus xanthopygaeus* Streak-throa Woodpecker
275. *Picus squamatus* Scaly-bellied Woodpecker
276. *Picus canus* Grey-headed Woodpecker
277. *Dinopium shorii* Himalayan Flameback
278. *Dinopium benghalense* Black-rumped Flameback
279. *Chrysocolaptes lucidus* Greater Flameback
280. *Mulleripicus pulverulentus* Great Slaty Woodpecker

PITTIDAE

281. *Pitta sordida* Hooded Pitta
282. *Pitta brachyuran* Indian Pitta

ALAUDIDAE

283. *Mirafra cantillans* Singing Bushlark
284. *Mirafra assamica* Bengal Bushlark
285. *Mirafra erythroptera* Indian Bushlark
286. *Eremopterix grisea* Ashy-crowned Sparrow Lark
287. *Melanocorypha bimaculata* Bimaculated Lark
288. *Calandrella brachydactyla* Greater Short-toed Lark
289. *Calandrella acutirostris* Hume's Short-toed Lark
290. *Calandrella raytal* Sand Lark
291. *Galerida cristata* Crested Lark
292. *Alauda arvensis* Eurasian Skylark
293. *Alauda gulgula* Oriental Skylark
294. *Eremophila alpestris* Horned Lark

HIRUNDINIDAE

295. *Riparia riparia* Sand Martin
296. *Riparia diluta* Pale Martin
297. *Riparia paludicola* Plain Martin
298. *Hirundo rupestris* Eurasian Crag Martin
299. *Hirundo concolor* Dusky Crag Martin
300. *Hirundo rustica* Barn Swallow
301. *Hirundo smithii* Wire-tailed Swallow
302. *Hirundo daurica* Red-rumped Swallow
303. *Hirundo fluvicola* Streak-throated Swallow
304. *Delichon urbica* Northern House Martin
305. *Delichon dasypus* Asian House Martin

MOTACILLIDAE

306. *Dendronanthus indicus* Forest Wagtail
307. *Motacilla alba* White Wagtail
308. *Motacilla maderaspatensis* White-browed Wagtail
309. *Motacilla citreola* Citrine Wagtail
310. *Motacilla flava* Yellow Wagtail
311. *Motacilla cinerea* Grey Wagtail
312. *Anthus richardi* Richard's Pipit
313. *Anthus rufulus* Paddyfield Pipit
314. *Anthus campestris* Tawny Pipit
315. *Anthus godlewskii* Blyth's Pipit
316. *Anthus similes* Long-billed Pipit
317. *Anthus sylvanus* Upland Pipit
318. *Anthus trivialis* Tree Pipit
319. *Anthus hodgsoni* Olive-backed Pipit
320. *Anthus cervinus* Red-throated Pipit
321. *Anthus roseatus* Rosy Pipit
322. *Anthus spinoletta* Water Pipit

CAMPEPHAGIDAE

323. *Tephrodornis pondicerianus* Common Woodshrike
324. *Coracina macei* Large Cuckooshrike
325. *Coracina melaschistos* Black-winged Cuckooshrike
326. *Coracina melanoptera* Black-headed Cuckooshrike
327. *Pericrocotus roseus* Rosy Minivet
328. *Pericrocotus divaricatus* Ashy Minivet
329. *Pericrocotus cinnamomeus* Small Minivet
330. *Pericrocotus erythropygius* White-bellied Minivet
331. *Pericrocotus ethologus* Long-tailed Minivet
332. *Pericrocotus flammeus* Scarlet Minivet
333. *Hemipus picatus* Bar-winged Flycatcher-shrike

PYCNONOTIDAE

334. *Pycnonotus melanicterus* Black-crested Bulbul
335. *Pycnonotus jocosus* Red-whiskered Bulbul
336. *Pycnonotus leucogenys* Himalayan Bulbul
337. *Pycnonotus cafer* Red-vented Bulbul
338. *Hypsipetes mcclellandii* Mountain Bulbul
339. *Hypsipetes leucocephalus* Black Bulbul

IRENIDAE

340. *Aegithina tiphia* Common Iora
341. *Irena puella* Asian Fairy Bluebird
342. *Chloropsis aurifrons* Golden-fronted Leafbird
343. *Chloropsis hardwickii* Orange-bellied Leafbird

LANIIDAE

344. *Lanius isabellinus* Rufous-tailed Shrike
345. *Lanius cristatus* Brown Shrike
346. *Lanius vittatus* Bay-backed Shrike
347. *Lanius schach* Long-tailed Shrike
348. *Lanius tephronotus* Grey-backed Shrike
349. *Lanius meridionalis* Southern Grey Shrike

CINCLIDAE

350. *Cinclus cinclus* White-throated Dipper
351. *Cinclus pallasii* Brown Dipper

TROGLODYTIDAE

352. *Troglodytes troglodytes* Winter Wren

PRUNELLIDAE

353. *Prunella collaris* Alpine Accentor
354. *Prunella himalayana* Altai Accentor
355. *Prunella rubeculoides* Robin Accentor
356. *Prunella strophiata* Rufous-breasted Accentor
357. *Prunella fulvescens* Brown Accentor
358. *Prunella atrogularis* Black-throated Accentor

MUSCICAPIDAE: Turdinae

359. *Monticola cinclorhynchus* Blue-capped Rock Thrush
360. *Monticola rufiventris* Chestnut-bellied Rock Thrush
361. *Monticola solitaries* Blue Rock Thrush
362. *Myophonus caeruleus* Blue Whistling Thrush
363. *Zoothera wardii* Pied Thrush
364. *Zoothera citrina* Orange-headed Thrush
365. *Zoothera mollissima* Plain-backed Thrush
366. *Zoothera dixoni* Long-tailed Thrush
367. *Zoothera dauma* Scaly Thrush
368. *Zoothera monticola* Long-billed Thrush
369. *Turdus unicolor* Tickell's Thrush
370. *Turdus albocinctus* White-collared Blackbird
371. *Turdus boulboul* Grey-winged Blackbird
372. *Turdus merula* Eurasian Blackbird
373. *Turdus rubrocanus* Chestnut Thrush
374. *Turdus ruficollis* Dark-throated Thrush
375. *Turdus pilaris* Fieldfare
376. *Turdus viscivorus* Mistle Thrush
377. *Brachypteryx montana* White-browed Shortwing
378. *Luscinia calliope* Siberian Rubythroat
379. *Luscinia pectoralis* White-tailed Rubythroat
380. *Luscinia svecica* Bluethroat
381. *Luscinia brunnea* Indian Blue Robin
382. *Tarsiger cyanurus* Orange-flanked Bush Robin
383. *Tarsiger chrysaeus* Golden Bush Robin
384. *Copsychus saularis* Oriental Magpie Robin

385. *Copsychus malabaricus* White-rumped Shama
386. *Saxicoloides fulicata* Indian Robin
387. *Phoenicurus erythronota* Rufous-backed Redstart
388. *Phoenicurus coeruleocephalus* Blue-capped Redstart
389. *Phoenicurus ochruros* Black Redstart
390. *Phoenicurus erythrogaster* White-winged Redstart
391. *Phoenicurus frontalis* Blue-fronted Redstart
392. *Chaimarrornis leucocephalus* White-capped Water Redstart
393. *Rhyacornis fuliginosus* Plumbeous Water Redstart
394. *Hodgsonius phaenicuroides* White-bellied Redstart
395. *Myiomela leucura* White-tailed Robin
396. *Grandala coelicolor* Grandala
397. *Enicurus scouleri* Little Forktail
398. *Enicurus immaculatus* Black-backed Forktail
399. *Enicurus maculates* Spotted Forktail
400. *Cochoa purpurea* Purple Cochoa
401. *Saxicola torquata* Common Stonechat
402. *Saxicola leucura* White-tailed Stonechat
403. *Saxicola caprata* Pied Bushchat
404. *Saxicola ferrea* Grey Bushchat
405. *Cercomela fusca* Brown Rock-chat
406. *Oenanthe oenanthe* Northern Wheatear
407. *Oenanthe picata* Variable Wheatear
408. *Oenanthe pleschanka* Pied Wheatear
409. *Oenanthe xanthoprymna* Rufous-tailed Wheatear
410. *Oenanthe deserti* Desert Wheatear
411. *Oenanthe isabellina* Isabelline Wheatear

Timalinae

412. *Garrulax albogularis* White-throated Laughingthrush
413. *Garrulax leucolophus* White-crested Laughingthrush
414. *Garrulax striatus* Striated Laughingthrush
415. *Garrulax rufogularis* Rufous-chinned Laughingthrush
416. *Garrulax lineatus* Streaked Laughingthrush
417. *Garrulax variegates* Variegated Laughingthrush
418. *Garrulax erythrocephalus* Chestnut-crowned Laughingthrush
419. *Pellorneum ruficeps* Puff-throated Babbler
420. *Pomatorhinus erythrogenys* Rusty-cheeked Scimitar Babbler
421. *Pomatorhinus schisticeps* White-browed Scimitar Babbler
422. *Pnoepyga albiventer* Scaly-breasted Wren Babbler
423. *Pnoepyga immaculate* Nepal Wren Babbler
424. *Stachyris pyrrhops* Black-chinned Babbler
425. *Dumetia hyperythra* Tawny-bellied Babbler
426. *Macronous gularis* Striped Tit-Babbler
427. *Chrysomma sinense* Yellow-eyed Babbler
428. *Turdoides caudatus* Common Babbler
429. *Turdoides earlei* Striated Babbler
430. *Turdoides malcolmi* Large Grey Babbler
431. *Turdoides striatus* Jungle Babbler
432. *Leiothrix argentauri* Silver-eared Mesia
433. *Leiothrix lutea* Red-billed Leiothrix
434. *Pteruthius flaviscapis* White-browed Shrike Babbler
435. *Pteruthius xanthochlorus* Green Shrike Babbler
436. *Minla cyanouroptera* Blue-winged Minla
437. *Minla strigula* Chestnut-tailed Minla
438. *Alcippe vinipectus* White-browed Fulvetta
439. *Heterophasia capistrata* Rufous Sibia
440. *Yuhina flavicollis* Whiskered Yuhina

Sylviinae

441. *Regulus regulus* Goldcrest
442. *Cisticola juncidis* Zitting Cisticola
443. *Prinia crinigera* Striated Prinia
444. *Prinia buchanani* Rufous-fronted Prinia
445. *Prinia hodgsonii* Grey-breasted Prinia
446. *Prinia flaviventris* Yellow-bellied Prinia
447. *Prinia burnesii* Rufous-vented Prinia
448. *Prinia sylvatica* Jungle Prinia
449. *Prinia socialis* Ashy Prinia
450. *Prinia inornata* Plain Prinia
451. *Tesia castaneocoronata* Chestnut-headed Tesia
452. *Cettia fortipes* Brownish-flanked Bush Warbler
453. *Cettia flavolivacea* Aberrant Bush Warbler
454. *Cettia brunnifrons* Grey-sided Bush Warbler
455. *Locustella naevia* Grasshopper Warbler
456. *Acrocephalus agricola* Paddyfield Warbler
457. *Acrocephalus dumetorum* Blyth's Reed Warbler
458. *Acrocephalus orinus* Large-billed Reed Warbler
459. *Acrocephalus stentoreus* Clamorous Reed Warbler
460. *Acrocephalus melanopogon* Moustached Warbler
461. *Hippolais caligata* Booted Warbler
462. *Orthotomus sutorius* Common Tailorbird
463. *Leptopoecile sophiae* White-browed Tit Warbler
464. *Phylloscopus collybita* Common Chiffchaff
465. *Phylloscopus sindianus* Mountain Chiffchaff
466. *Phylloscopus fuscatus* Dusky Warbler
467. *Phylloscopus fuligiventer* Smoky Warbler
468. *Phylloscopus affinis* Tickell's Leaf Warbler
469. *Phylloscopus griseolus* Sulphur-bellied Warbler
470. *Phylloscopus pulcher* Buff-barred Warbler
471. *Phylloscopus maculipennis* Ashy-throated Warbler
472. *Phylloscopus chloronotus* Lemon-rumped Warbler
473. *Phylloscopus subviridis* Brooks's Leaf Warbler
474. *Phylloscopus humei* Hume's Warbler
475. *Phylloscopus trochiloides* Greenish Warbler
476. *Phylloscopus magnirostris* Large-billed Leaf Warbler
477. *Phylloscopus tytleri* Tytler's Leaf Warbler
478. *Phylloscopus occipitalis* Western Crowned Warbler
479. *Phylloscopus reguloides* Blyth's Leaf Warbler
480. *Phylloscopus neglectus* Plain Leaf Warbler
481. *Phylloscopus inornatus*Yellow-browed Leaf Warbler
482. *Seicercus xanthoschistos* Grey-hooded Warbler
483. *Seicercus burkii* Gold-spectaled Flycatcher-Warbler
484. *Megalurus palustris* Striated Grassbird
485. *Sylvia communis* Greater Whitethroat
486. *Sylvia curruca* Lesser Whitethroat
487. *Sylvia althaea* Hume's Lesser Whitethroat
488. *Sylvia nana* Desert Warbler
489. *Sylvia hortensis* Orphean Warbler
490. *Bradypterus thoracicus* Western Spotted Bush-Warbler

Muscicapinae

491. *Muscicapa striata* Spotted Flycatcher
492. *Muscicapa sibirica* Dark-sided Flycatcher
493. *Muscicapa dauurica* Asian Brown Flycatcher
494. *Muscicapa ruficauda* Rusty-tailed Flycatcher
495. *Ficedula strophiata* Rufous-gorgeted Flycatcher
496. *Ficedula parva* Red-throated Flycatcher
497. *Ficedula subrubra* Kashmir Flycatcher

498. *Ficedula westermanni* Little Pied Flycatcher
499. *Ficedula superciliaris* Ultramarine Flycatcher
500. *Ficedula tricolour* Slaty-blue Flycatcher
501. *Eumyias thalassina* Verditer Flycatcher
502. *Niltava sundara* Rufous-bellied Niltava
503. *Cyornis unicolor* Pale Blue Flycatcher
504. *Cyornis rubeculoides* Blue-throated Flycatcher
505. *Cyornis tickelliae* Tickell's Blue Flycatcher
506. *Culicicapa ceylonensis* Grey-headed Canary Flycatcher

Monarchinae

507. *Hypothymis azurea* Black-naped Monarch
508. *Terpsiphone paradisi* Paradise-flycatcher

Rhipidurinae

509. *Rhipidura hypoxantha* Yellow-bellied Fantail
510. *Rhipidura albicollis* White-throated Fantail
511. *Rhipidura aureola* White-browed Fantail

AEGITHALIDAE

512. *Aegithalos leucogenys* White-cheeked Tit
513. *Aegithalos concinnus* Black-throated Tit
514. *Aegithalos niveogularis* White-throated Tit

REMIZIDAE

515. *Cephalopyrus flammiceps* Fire-capped Tit

PARIDAE

516. *Parus rufonuchalis* Rufous-naped Tit
517. *Parus rubidiventris* Rufous-vented Tit
518. *Parus melanolophus* Spot-winged Tit
519. *Parus dichrous* Grey-crested Tit
520. *Parus major* Great Tit
521. *Parus monticolus* Green-backed Tit
522. *Parus xanthogenys* Black-lored Tit
523. *Sylviparus modestus* Yellow-browed Tit

SITTIDAE

524. *Sitta cashmirensis* Kashmir Nuthatch
525. *Sitta castanea* Chestnut-bellied Nuthatch
526. *Sitta himalayensis* White-tailed Nuthatch
527. *Sitta leucopsis* White-cheeked Nuthatch
528. *Sitta frontalis* Velvet-fronted Nuthatch
529. *Tichodroma muraria* Wallcreeper

CERTHIIDAE

530. *Certhia familiaris* Eurasian Tree-Creeper
531. *Certhia himalayana* Bar-tailed Tree-Creeper

DICAEIDAE

532. *Dicaeum agile* Thick-billed Flowerpecker
533. *Dicaeum erythrorynchos* Pale-billed Flowerpecker
534. *Dicaeum ignipectus* Fire-breasted Flowerpecker

NECTARINIIDAE

535. *Nectarinia asiatica* Purple Sunbird
536. *Aethopyga gouldiae* Mrs Gould's Sunbird
537. *Aethopyga nipalensis* Green-tailed Sunbird
538. *Aethopyga siparaja* Crimson Sunbird
539. *Aethopyga ignicauda* Fire-tailed Sunbird
540. *Arachnothera magna* Streaked Spiderhunter

ZOSTEROPIDAE

541. *Zosterops palpebrosus* Oriental White-eye

EMBERIZIDAE: Emberizinae

542. *Melophus lathami* Crested Bunting
543. *Emberiza leucocephalos* Pine Bunting
544. *Emberiza cia* Rock Bunting
545. *Emberiza citronella* Yellowhammer
546. *Emberiza buchanani* Grey-necked Bunting
547. *Emberiza stewarti* White-capped Bunting
548. *Emberiza striolata* Striolated Bunting
549. *Emberiza fucata* Chestnut-eared Bunting
550. *Emberiza pusilla* Little Bunting
551. *Emberiza melanocephala* Black-headed Bunting
552. *Emberiza schoeniclus* Reed Bunting
553. *Emberiza bruniceps* Red-headed Bunting

FRINGILLIDAE

554. *Fringilla coelebs* Chaffinch
555. *Fringilla montifringilla* Brambling
556. *Serinus pusillus* Fire-fronted Serin
557. *Carduelis spinoides* Yellow-breasted Greenfinch
558. *Carduelis spinus* Eurasian Siskin
559. *Carduelis carduelis* European Goldfinch
560. *Carduelis flavirostris* Twite
561. *Carduelis cannabina* Eurasian Linnet
562. *Callacanthis burtoni* Spectacled Finch
563. *Loxia curvirostra* Red Crossbill
564. *Leucosticte nemoricola* Plain Mountain Finch
565. *Leucosticte brandti* Brandt's Mountain Finch
566. *Carpodacus nipalensis* Dark-breasted Rosefinch
567. *Carpodacus erythrinus* Common Rosefinch
568. *Carpodacus pulcherrimus* Beautiful Rosefinch
569. *Carpodacus rodochrous* Pink-browed Rosefinch
570. *Carpodacus rodopeplus* Spot-winged Rosefinch
571. *Carpodacus thura* White-browed Rosefinch
572. *Carpodacus rhodochlamys* Red-mantled Rosefinch
573. *Carpodacus rubicilloides* Streaked Rosefinch
574. *Carpodacus rubicilla* Great Rosefinch
575. *Carpodacus puniceus* Red-fronted Rosefinch
576. *Pyrrhula nipalensis* Brown Bullfinch
577. *Pyrrhula aurantiaca* Orange Bullfinch
578. *Pyrrhula erythrocephala* Red-headed Bullfinch
579. *Mycerobas icterioides* Black-and-yellow Grosbeak
580. *Mycerobas affinis* Collared Grosbeak
581. *Mycerobas melanozanthos* Spot-winged Grosbeak
582. *Mycerobas carnipes* White-winged Grosbeak
583. *Pyrrhoplectes epaulette* Gold-naped Finch
584. *Amandava amandava* Red Avadavat
585. *Lonchura malabarica* Indian Silverbill
586. *Lonchura punctulata* Scaly-breasted Munia

PASSERIDAE: Passerinae

587. *Passer domesticus* House Sparrow
588. *Passer rutilans* Russet Sparrow
589. *Passer montanus* Eurasian Tree Sparrow
590. *Petronia xanthocollis* Chestnut-shouldered Petronia
591. *Montifringilla adamsi* Tibetan Snowfinch
592. *Pyrgilauda davidiana* Small Snowfinch
593. *Pyrgilauda blanfordi* Plain-backed Snowfinch

Ploceinae

594. *Ploceus philippinus* Baya Weaver
595. *Ploceus benghalensis* Black-breasted Weaver
596. *Ploceus manjar* Streaked Weaver

STURNIDAE

597. *Saroglossa spiloptera* Spot-winged Starling
598. *Sturnus malabaricus* Chestnut-tailed Starling
599. *Sturnus pagodarum* Brahminy Starling
600. *Sturnus roseus* Rosy Starling
601. *Sturnus vulgarisb* Common Starling
602. *Sturnus contra* Asian Pied Starling
603. *Acridotheres tristis* Common Myna
604. *Acridotheres ginginianus* Bank Myna
605. *Acridotheres fuscus* Jungle Myna

ORIOLIDAE

606. *Oriolus oriolus* Eurasian Golden Oriole
607. *Oriolus xanthornus* Black-hooded Oriole
608. *Oriolus traillii* Maroon Oriole

DICRURIDAE

609. *Dicrurus macrocercus* Black Drongo
610. *Dicrurus leucophaeus* Ashy Drongo
611. *Dicrurus caerulescens* White-bellied Drongo
612. *Dicrurus hottentottus* Spangled Drongo

ARTAMIDAE
613. *Artamus fuscus* Ashy Woodswallow
CORVIDAE
614. *Garrulus glandarius* Eurasian Jay
615. *Garrulus lanceolatus* Black-headed Jay
616. *Urocissa flavirostris* Yellow-billed Blue Magpie
617. *Urocissa erythrorhyncha* Red-billed Blue Magpie
618. *Dendrocitta vagabunda* Rufous Treepie
619. *Dendrocitta formosae* Grey Treepie
620. *Pica pica* Black-billed Magpie
621. *Nucifraga caryocatactes* Spotted Nutcracker
622. *Pyrrhocorax pyrrhocorax* Red-billed Chough
623. *Pyrrhocorax graculus* Yellow-billed Chough
624. *Corvus splendens* House Crow
625. *Corvus macrorhynchos* Large-billed Crow
626. *Corvus corax* Common Raven

(Sources: Ali, 1979; Ali and Ripley, 1983; Anonymous 2000 b; Ganguli, 1967; Gaston and Pandey, 1987; Gaston, 1987; Grimmett, et al., 1999; Jones, 1947-1948; Jindal et al., 2013; Kazmierczak, 2000; Lavkumar, 1962; Mahabal and Sharma 1992; Pandey, 1989a & b, Pandey, 1993a & b; Sharma and Pandey, 1989; Sharma et al., 1990; Thakur et al., 2002, 2003, 2006, 2008, 2010, a &b, 2011, 2012, 2014; Whistler, 1926)

MAMMALIA

One of the most fascinating features of the Indian biodiversity is its mammalian fauna, which includes the species as large as whales, elephants, rhinoceroses and tigers, and as small as shrews, mice and bats. The term 'mammals' refers to animals possessing mammary or milk glands producing milk for nourishing their young ones, and another feature include the presence of hairs on the body at least during some period of their life cycle.

The mammalian fauna of the world includes 4629 species belonging to 1135 genera, 136 families and 26 orders (Wilson and Reeder, 1993). Of these, 390 species belonging to 180 genera, 42 families and 13 orders are found in India. Another 13 orders are found in our country. Out of 180 genera, 61 are monotypic and 105 are represented in our country by a single species. Of the 390 species, 175 are threatened with extinction to various levels, and on that basis 75 have been listed in Schedule I, 73 in Schedule II, 8 in Schedule III and 19 in Schedule IV of the Wild Life (Protection) Act 1972 (Agrawal, 1998). Out of 107 species of mammals found in the state, 21 have been included in Schedule I of the Indian Wildlife (Protection) Act, 1972.

The area under protected area network in the form of National Parks and Wildlife Sanctuaries in the State is 12.87 % of the total area. Circumstantial evidences suggest that population level of most of the species have declined during last 100 years mainly due to livestock grazing, forest cutting, roads construction and hunting.

In Himachal Pradesh knowledge on diversity is mainly based on the contributions of Blanford (1888-1891), Hinton and Lindsay (1926), Lindsay (1926, 1929), Pocock (1939, 41), Ellerman and Morrison-Scott (1951), Wynter-Blyth (1950, 1951), Ellerman (1961), Mahajan and Mukherjee (1974), Prater (1980), Gaston *et al.* (1981 b), Rodgers and Panwar (1988), Singh *et al.* (1990), Negi (1992), Cavallini (1992), Pandey (1992), Julka *et al.* (1999), Chakraborthy *et al.* (2005) etc. In the state, this group is represented by 107 species constituting more than 26 % of the total Indian mammals. Aquatic mammals are not found in this state (Anonymous, 2000 a&b; Mehta and Julka, 2002, Mattu *et al.* (2005). Recently, Chakraborty *et al*. (2005) have reported 107 species belonging to 77 genera, 25 families and 9 orders from Himachal Pradesh. The study also enlists some of the factors responsible for the endangerment of mammals of the State like, livestock grazing, forest cutting, road construction, hunting and tourism. Some recent studies on mammalian diversity of Himachal Pradesh include those of Singh and Thakur (2012) and Singh *et al.* (2014).

Systematic list

Order: Insectivora
Family: Soricidae
1. *Soriculus nigrescens* Himalayan Shrew
2. *Crocidura attenuate* Grey Shrew
3. *Suncus murinus* Grey Mask Shrew
4. *Chimarrogale himalayica* Himalayan Water Shrew

Family: Erinaceidae
5. *Hemiechinus collaris* Indian Long eared Hedgehog
6. *Hemiechinus micropus* Pale Hedgehog

Order: Primates
Family: Cercopithecidae
7. *Macaca mulatta* Rhesus Macaque
8. *Semnopithecus entellus* Common Langur

Order: Carnivora
Family: Canidae
9. *Canis aureus* Jackal
10. *Canis lupus* Wolf
11. *Vulpes bengalensis* Indian Fox
12. *Vulpes vulpes* Common Red Fox
13. *Cuon alpines* Indian Wild Dog

Family: Herpestidae
14. *Herpestes edwardsii* Common Indian Mongoose
15. *Herpestes javanicus* Small Indian Mongoose

Family: Viverridae
16. *Peguma larvata* Himalayan Palm Civet
17. *Paradoxuras harmphroditus* Common Palm Civet

18. *Vivvricula indica* Small Indian Civet

Family: Mustellidae
19. *Amblonyx cinereus* Small Clawed Otter
20. *Lutra lutra* Common Otter
21. *Lutrogale perspiciliata* Smooth coated Otter
22. *Mellivora capensis* Honey badger
23. *Martes flavigula* Yellow throated Marten
24. *Martes foina* Beach Marten
25. *Mustella altica* Mountain Weasal
26. *Mustella kathia* Yellow-bellied Weasel
27. *Mustella sibirica* Siberian Weasel

Family: Ursidae
28. *Ursus arctos* Brwon Bear
29. *Ursus thibetarus* Asiatic Black Bear

Family: Hyaenidae
30. *Hyaena hyaena* Striped Hyaena

Family: Felidae
31. *Prionailurus bengalensis* Leopard Cat
32. *Panthera pardus* Leopard
33. *Panthera tigris* Tiger
34. *Felis chaus* Jungle Cat
35. *Uncia uncia* Snow Leopard
36. *Lynx lynx* Lynx

Order: Pholidata
Family: Manidae
37. *Manis crassicaudata* Indian Pangolin

Order: Perissodactyla
Family: Equidae
38. *Equus kiang* Kiang or Tibetan Wild Ass

Order : Artiodactyla
Family: Cervidae
39. *Cervus elaphus hanglu* Kashmir Stag
40. *Ceruvs unicolor* Sambar
41. *Axis axis* Cheetal or Spotted Deer
42. *Axis porcinus*
43. *Muntiacus muntjank* Barking Deer

Family: Moschidae
44. *Moschus chrysogaster* Musk Deer

Family: Bovidae
45. *Bos grunniens* Yak
46. *Boselaphus tragocamelus* Nilgai
47. *Capra sibirica* Himalayan Ibex
48. *Hemitragus jemlahicus* Himalayan thar
49. *Procapra picticauda* Tibetan Gazelle
50. *Gazella benetti* Indian Gazelle or Chinkara
51. *Naemorhedus goral* Goral
52. *Naemorhedus sumatrensis* Serow
53. *Ovis omon* Argali or Nayan
54. *Pseudois nayaur* Bharal

Order: Rodentia
Family: Sciuridae
55. *Marmota himalayana* Himalayan Marmot

56. *Marmota caudate* Long-tailed Marmot
57. *Eupataurus cinereus* Kashmir Flying Squirrel
58. *Hylopetes fimbriatus* Smaller Kashmir Flying Squirrel
59. *Funambulus pennanti* Northern Palm Squirrel
60. *Petaurista petaurista*

Family: Hystricidae
61. *Hystrix indica* Indian Porcupine
62. *Hystrix brachyuran* Hodgson's Porcupine

Family: Muridae
63. *Alticola roylei* Royles Vole
64. *Alticola blanfordi* Altic Vole
65. *Microtus lucurus* Blyth's Vole
66. *Apodemus sylvaticus* Wood Mouse
67. *Apodemus rusiges*
68. *Apodemus wardi* Yellow nacked Field Mouse
69. *Nosekia indica* Short-tailed Bandicoot Rat
70. *Hyperacrius fertilis* Trues Vole
71. *Hyperacrius wynnei* Murees Vole
72. *Pitymys leucurus* Blyths Vole
73. *Tatera indica* Indian Gerbil
74. *Bandicota bengalensis* Leser Bandicoot Rat
75. *Bandicota indica* Greater Bandicoot Rat
76. *Gollunda ellioti* Indian Bush Rat
77. *Millardia meltada* Soft furred Field Rat
78. *Mus booduga* Little Indian Field Mouse
79. *Mus musculus* House Mouse
80. *Mus saxicola* Elliots Spiny Mouse
81. *Mus cervicolor* Fawn-colored Mouse
82. *Mus platythrix* Spiny Field Mouse
83. *Niviventer fluviscens* Chestnut Rat
84. *Niviventer niviventer* White bellied Rat
85. *Cremnomys cutchicus* Kutch Rat
86. *Rattus norvegicus* Norway Rat
87. *Rattus rattus* House Rat
88. *Rattus turkestanicus* Turkestan Rat
89. *Rattus vicerex* Short tailed Turkestan Rat
90. *Vandeleuria oleracea* Indian Long tailed Tree Mouse

Order : Lagomorpha
Family: Leporidae
91. *Lepus nigricollis* Black-naped Hare
92. *Lepus oiostolus* Wooly Hare

Family: Ochotonidae
93. *Ochotona roylei* Royle's Pika
94. *Ochotona ladacensis* Ladak Pika
95. *Ochotona macrotis* Large-eared Pika

(Sources: Alfred et al., 2002; Chakraborty et al., 2005; Mattu et al., 2005)

Chiroptera (Bats)

Dobson's (1873) description of *Vespertilio murinoides* (later synonymised with *Myotis blythii*) from the Chamba area of the state (erstwhile Punjab) is the first

report on the Chiroptera of Himachal Pradesh. Some earlier information on bat fauna of the State is available from the accounts of Blanford (1888-1891), Allen (1908), Dodsworth (1913), Thomas (1915) and Lindsay (1926). Blanford (1888-1891), in his 'Fauna of British India', reported a few species of bats from the present Himachal Pradesh, including *Myotis muricola* from Dalhousie and Shimla, and *Barbastella leucomelas* from Shimla. Allen (1908) reported *Rhinolophus ferrumequinum*, *Scotophilus kuhlii* and *Scotoecus pallidus* from Koolloo valley (Kullu valley). Dodsworth (1913) recorded seven species of bats, namely *Pteropus giganteus*, *Rhinolophus ferrumequinum tragatus, Nyctalus montanus, N. labiatus, Myotis muricola, M. blythii* and *Pipistrellus coromandra* from Shimla and the adjoining hill region. Thomas (1915) reported *Myotis formosus* from Dharamsala and *M. blythii* from Shimla. Lindsay (1926) recorded *Pteropus giganteus* from Kullu and Kangra, *Rhinolophus ferrumequinum tragatus* from Manali, *Pipistrellus javanicus* from Gopalpur (Kangra District), *Nyctalus noctula* from Kangra and Sissu (Lahaul and Spiti District), *Nyctalus leisleri* from Chamba, *Myotis mystacinus* from Chirot, Pattan Valley (Lahaul and Spiti District) and *Myotis muricola* from Chatri (Chamba District) and Samayala from Kangra valley.

A review of the comprehensive work of Bates & Harrison (1997) reveals that 19 species of bats exist in the state. A few other occasional species records from the State include *Plecotus auritus* (Bhat *et al.* 1983) and *Murina tubinaris* (Das, 2003). Saikia *et al.* (2004) added a few more species to the Chiropteran fauna of Himachal Pradesh. Chakraborty *et al.* (2005) revealed the presence of 23 species of bats from Himachal Pradesh. Most recently, Saikia *et al.* (2011) elucidated the presence of 28 species of bats from the State.

Systematic List

Order : Chiroptera
Sub-order : Megachiroptera
Family : Pteropodidae

1. *Rousettus leschenaulti* Fulvous Fruit Bat
2. *Pteropus giganteus* Indian Flying Fox

Sub-order : Microchiroptera
Family : Megadermatidae

3. *Megaderma lyra* Greater False Vampire

Family : Rhinolophidae

4. *Rhinolophus ferrumequinum* Greater Horseshoe Bat
5. *Rhinolophus sinicus* Chinese Horseshoe Bat
6. *Rhinolophus affinis* Intermediate Horseshoe Bat
7. *Rhinolophus luctus* Wooly Horseshoe Bat
8. *Rhinolophus lepidus* Blyth's Horseshoe Bat

Family : Hipposideridae

9. *Hipposideros armiger* Great Himalayan Leaf-nosed Bat

Family : Vespertilionidae

10. *Miniopterus schreibesrsii* Schreiber's Long Fingered Bat
11. *Myotis mystacinus* Whiskered Bat
12. *Myotis blythii* Lesser Mouse-eared Bat
13. *Myotis siligorensis* Himalayan Whiskered Bat
14. *Myotis formosus* Hodgson's Bat
15. *Myotis muricola* Nepalese Whiskered Bat
16. *Pipistrellus tenuis* Indian Pygmy Bat
17. *Pipistrellus coromandra* Coromandel Pipistrelle
18. *Pipistrellus javanicus* Javan Pipisterlle
19. *Pipistrellus dormeri* Dormer's Bat
20. *Pipistrellus ceylonicus indicus* Kellart's Pipistrelle
21. *Scotophilus kuhlii* Asiatic Lesser Yellow House Bat
22. *Plecotus homochrous* Brown Long-eared Bat
23. *Barbastella leucomelas* Eastern Barbastelle
24. *Scotoecus pallidus* Desert Yellow Bat
25. *Nyctalus noctula* Noctule
26. *Nyctalus leisleri* Leisler's Bat
27. *Nyctalus montanus* Mountain Noctule
28. *Murina tubinaris* Scully's Tube Nosed Bat

(Source: Saikia et al., 2011)

MAJOR THREATS TO ANIMALS

The enhanced rate of species extinction shows that the biodiversity cannot support the current pressure that humanity is placing on the planet. Species' extinction rates have increased up to 1,000 times or more the natural rate. We are witnessing the greatest extinction crisis since dinosaurs disappeared from our planet 65 million years ago. These extinctions are irreversible and also pose a serious threat to our health and development. As per estimates, 19,265 species out of the 59,507 so far assessed are threatened with extinction. Of the world's 5,494 mammals, 78 are extinct or extinct in the wild, with 191 critically endangered, 447 endangered and 496 vulnerable species. Moreover, 1,910 of the planet's 6,312 amphibians are in danger of extinction, making them the most threatened group of species known to date.

Threats to biodiversity are mainly due to human activity. Habitat loss and degradation affects 86% of all threatened birds, 86% of the threatened mammals assessed and 88% of the threatened amphibians. Introduction of migrant species that establish and spread outside their normal distribution has also been listed as one of the main reasons for biodiversity loss. Over-exploitation of natural resources like resource extraction, hunting, and fishing for food, pets and medicine have adverse effects on bio-resources. Pollution and diseases like excessive fertilizer use leads to excessive levels of nutrients in soil and water.

The human population of India which is about 17 % of the total humanity of the world is highly disproportionate keeping in view the total land area of the country which is hardly 2% of the world's total land mass (Jairajpuri, 1991). This ever increasing human population has necessitated certain activities like urbanisation, construction of dams and hydro-electric projects, encroachment of land for agriculture, industry, mining, etc. These activities have brought severe imbalances in several ecosystems. Due to these, forest resources of the country have declined to about 22 % of the total geographical area. The other most intimidating factor is the undue exploitation and their parts for trade, medicinal purposes and flesh.

Extinction rates far higher than the normal background rates are resulting in rapid loss of biodiversity. By losing species we are losing potential contributors to future food medicine and valuable links in natural and biological cycles. Although extinction is a natural phenomenon, fossil records show that on an average one species dies out every 100 years. During the last 200 years the rate of extinction has been at least 40 times greater than this. The main causes of extinction are habitat loss and habitat degradation. Changes in land use patterns had a detrimental impact on habitats, which have been fragmented and reduced in extent and diversity (Birdlife International, 2001).

India is situated at the tri-junction of the Afro-tropical, the Indo-Malayan and the Paleo-Arctic realms, which display significant biodiversity. Being one of the 17 identified megadiverse countries, it is home to 8.58% mammalian, 13.66% avian, 7.91% reptilian, 4.66% amphibian and 11.72% fishes. India has some 59,353 insect

species, 2,546 fish species, 209 amphibian species, 456 reptile species, 1,232 bird species and 390 mammal species, of which 18.4 per cent are endemic and 10.8 per cent threatened.

As per the IUCN Red List (2008), India has 413 globally threatened faunal species, being approximately 4.9% of the world's total number of threatened faunal species. These include 53 species of mammals, 69 birds, 23 reptiles and 3 amphibians. India contains globally important populations of some of Asia's rarest animals, such as Asiatic Lion, Bengal Tiger, and Indian White-Rumped Vulture. The Indian White-Rumped Vulture suffered almost extinction situation due to feeding on the carcasses of diclofenac-treated cattle. At least 10 percent of the country's recorded wild flora and possibly the same percentage of its wild fauna are estimated to be in threatened list while many of them are on the verge of extinction.

CONSERVATION MEASURES

There already exist many programmes/acts which if strictly followed, can play an important role in the preservation of wildlife including avifauna of not only urbanized areas but in rural and forested areas too. Wildlife (Protection) Act (1972), National Wildlife Action Plan (1983), National Biodiversity Strategy and Action Plan (NBSAP), Biological Diversity Act, 2002 etc., all envisage objectives which aim at all active protection and development of forest resources, conserving nation's biodiversity and strengthening efforts to protect wild species and varieties. Convention on Biological Diversity (1992) emphasizes various objectives all of which have one thing in common i.e., protection of nature and natural resources.

In India, a network of 668 Protected Areas (PAs) has been established, extending over 1,61,221.57 sq. km. (4.90% of the total geographic area), comprising 102 National Parks, 515 Wildlife Sanctuaries, 47 Conservation Reserves and 4 Community Reserves. In addition, 39 Tiger Reserves and 28 Elephant Reserves have been designated for specie specific management of tiger and elephants (Ministry of Environment and Forests, 2014). UNESCO has designated 5 protected areas as World Heritage Sites. Of the Indian PA network, Himachal Pradesh has 5 National Parks namely Great Himalayan National Park, Pin valley NP, Inderkilla NP,

Khirganga NP and Simbalbara NP. In addition, there are 32 Wildlife sanctuaries in the State of Himachal Pradesh.

Himachal Pradesh has seen a tremendous increase in population in the last decade, due to which natural ecosystems are in great pressure. The future of Himalayan Wildlife therefore, requires immediate involvement of scientific inputs, political will and collective public participation in saving faunal life including that of birds from imminent danger of appalling extinction. Keeping in view the imminent dangers of extinction to birdlife following measures based on the present investigation have been proposed:

1. Protection of domesticated plant and animal species in order to conserve indigenous genetic diversity.
2. Conservation of microorganisms, which help in reclamation of wastelands and revival of biological potential of land.
3. Multiplication and breeding of threatened species through modern techniques of tissue culture and biotechnology.
4. Restriction on introduction of exotic species without adequate investigations.
5. By establishing database at various levels to document support for protecting traditional skills and knowledge for conservation.
6. To establish conservation parks for the rare, endemic document local resources and support for threatened species.
7. Development of National plans, strategies or programmes for conservation and sustainable use of biodiversity and integrating these into relevant sectoral or cross-sectoral plans, programmes and policies.
8. Inventorisation and monitoring of components of biodiversity and of processes adversely impacting it; developing and strengthening of in-situ mechanisms for biodiversity conservation both within and outside protected areas.
9. Development of ex-situ measures for biodiversity conservation, as a complement to in-situ approaches.
10. Restoration of degraded ecosystem and recovery of endangered species.
11. Adopting measures to avoid and minimize adverse impacts on biodiversity.

12. Encourage capacity building in the field of taxonomy, wildlife management and conservation.
13. Strengthen ongoing conservation measures on biodiversity.
14. Encourage propagation and conservation of lower animals like insects and other invertebrates.
15. Maintenance of corridors between different nature reserves for the possible migration of species in response to climate, or any other disturbing factor.
16. Rehabilitation of rural poor/tribals displaced due to creation of protected areas.
17. Protection and sustainable use of genetic resources/germplasm through appropriate laws and practices.
18. Control of over-exploitation through cities and other agencies.
19. Adopting economically and socially sound measures that act as incentives for conservation and sustainable use of components of biodiversity.
20. Facilitating access to genetic resources on mutually agreed terms and prior informed consent, and taking measures for fair and equitable sharing of benefits arising from utilisation of the resources thus transferred.
21. Facilitating access to and transfer of technology, including biotechnology to other parts under fair and most favourable terms.
22. Facilitating exchange of information relevant to biodiversity.
23. Promoting scientific and technical co-operation among Himalayan researchers.
24. Consideration of a protocol for safe transfer, handling and use of living modified organisms resulting from biotechnology.
25. Providing liberal funds for animal biodiversity related programmes and projects.
26. There is a need to undertake these programmes extensively among rural people particularly women, farmers, tribal, graziers and shepherds.
27. Developing educational and public awareness programmes with respect to conservation and sustainable use of biodiversity.

LITERATURE CONSULTED

Agrawal, H.P. 1975 a. A check list of molluscs of Himachal Pradesh, India. Part-I. *Cheetal,* 16 (3): 38-41.

Agrawal, H.P. 1975 b. A check list of molluscs of Himachal Pradesh, India. Part-II. *Cheetal,* 16 (4): 59-60.

Agrawal, H.P. 1976. Aquatic and Amphibious molluscs of Himachal Pradesh, India. *Rec. Zool. Surv. India,* 71: 129-142.

Agrawal, H.P. 1977. New records of land molluscs from Himachal Pradesh, India. *Newsl. Zool. Surv. India,* 3 (6): 345-346.

Agrawal, H.P. 1979. Some land molluscs from Himachal Pradesh. *Indian J. Zootomy,* 18 (2) (1977): 131-135.

Agrawal, V.C. 1998. Mammalia. In: *Faunal Diversity in India* (Ed. Alfred *et al*.). Zoological Survey of India, Calcutta, 459-469 pp.

Ahluwalia, E. 2003. Studies on some Nematodes of Anura in Himachal Pradesh. *M. Phil Dissertation. HP University, Shimla, India.*

Alfred, J.R.B. and Ramakrishna, S. 2004. Collection, Preservation and Identification of Animals. Zoological Survey of India, Kolkata, 310 pp.

Alfred, J.R.B., Das, A.K. and Sanyal, A.K. 1998. *Faunal Diversity in India*. Zoological Survey of India, Calcutta, 497 pp.

Alfred, J.R.B., Sinha, N.K. and Chakraborty, S. 2002. *Checklist of Mammals of India*. Zoological Survey of India, Kolkata, 289 pp.

Ali, S. 1949. *Indian Hill Birds*. Oxford University Press, Bombay, 188 pp.

Ali, S. 1979. *Bird study in India: Its history and its importance*. Indian Council for Cultural Relations, New Delhi.

Ali, S. and Ripley, S.D. 1983. *Handbook of the Birds of India and Pakistan* (Compact Edition). Oxford University Press, New Delhi, 737 pp.

Allen, G.M. 1908. Notes on Chiroptera. *Bulletin of the Museum of Comparative Zoology*, 52: 25-61.

Ananthakrishnan, T.N. and Shivaramakrishnan, K.G. 2006. *Animal biodiversity: patterns and processes*. Scientific Publishers, Jodhpur, 264 pp.

Annandale, N. 1907. The distribution of *Bufo andersonii. Rec. Indian Mus.* 1: 171-172.

Anonymous, 1988. *Technologies to maintain biological diversity*. Science Information Resource Centre, Philadelphia, USA, 334 pp.

Anonymous, 2000 a. *State of the Environment Report- Himachal Pradesh.* State Council for Science, Technology and Environment, Shimla, 285 pp.

Anonymous, 2000 b. *Fauna of Renuka Wetland (Himachal Pradesh).* Zoological Survey of India, Calcutta, 187 pp.

Arora, G.S. and Kumar, A. 1996. Faunal resources in the Western Himalaya. In: *Conservation and management of biological resources in Himalaya* (Eds. Ramakrishnan, P.S. *et al.*). GB PIHED, Almora and Oxford and IBH Publ. Co., New Delhi, 209-232 pp.

Arora, G.S., Mehta, H.S. and Walia, V.K. 2005. Insecta: Lepidoptera (Butterflies). In: *Fauna of Western Himalaya (Part 2)*. Zoological Survey of India, Kolkata, 157-180 pp.

Baqri, Q.H. 1998. Nematoda. In: *Faunal Diversity in India* (Eds. Alfred *et al.*). Zoological Survey of India, Calcutta, 85-92 pp.

Barman, R.P. 1998. Pisces. In: *Faunal Diversity in India* (Eds. Alfred *et al.*). Zoological Survey of India, Calcutta, 418-426 pp.

Bates, P.J.J. and Harrison, D.L. 1997. *Bats of the Indian Subcontinent*. Harrison Zoological Museum, Kent, 268 pp.

Beeson, C.F.C. 1961. *The Ecology and Control of Forest Insects of India and the Neighbouring Countries.* FRI, Dehra Dun, 767 pp.

Belsare, D.K. 2007. *Introduction to Biodiversity*. APH Publ. Corp., New Delhi, 264 pp.

Besten, J.W. Pandey, S. and Thakur, M.L. 2004. Pong Dam Lake Wildlife Sanctuary. In-*Important Bird Areas in India: Priority Sites for Conservation* (Ed.: Islam, M.Z. and Rahmani, A.R.). Indian Bird Conservation Network: BNHS & Birdlife International (UK), 461-462 pp.

Besten, J.W.D. 2004. *Birds of Kangra.* Moonpeak Publishers, Dharamsala and Mosaic Books, New Delhi, 173 pp.

Bhalla, O.P. and Pawar, A.D. 1977. *A survey of insect and non-insect pests of economic importance in Himachal Pradesh.* Deptt. of Entomology-Zoology, College of Agriculture, Chambaghat, Solan. 1-80 pp.

Bhalla, O.P., Dhaliwal, H.S. and Verma, A.K. 1983 a. Insect visitors of mustard bloom (*Brassica campestris* var. sarson) their number and foraging behaviour under mid-hill conditions. *J. Entomol. Res.* 7: 15-17.

Bhalla, O.P., Dhaliwal, H.S. and Verma, A.K. 1983b. Foraging activity of insect pollinators visiting stone fruits. *J. Entomol. Res.* 7: 91-94.

Bhardwaj, A.K. and Thakur, J.R. 1973. Record of snail *Bensonia monticola* Hutton, as pest of beans. *Curr. Sci.* 42 (21): 769.

Bhardwaj, P.C. 1989. Systematic Studies on Nematodes of some wild mammals from District Kullu. *M.Phil. Dissertation. HP Uinversity, Shimla, India.*

Bhat, H.R., Kulkarni, S.M. and Mishra, A.C. 1983. Records of Mesostigmata, Ereynetidae and Pterygosomidae (Acarina) in Western Himalayas, Sikkim and hill districts of West Bengal. *J. Bombay Nat. Hist. Soc.* 80 (1): 91-110.

Bhatanagar, G.K. 1973. On a collection of fish from Bhakra reservoir, Sutlej river and closely associated waters. *J. Inland Fish. Soc. India,* 5: 134-136.

Bhowmik, H.K. 1985 a. Contribution to the gryllid fauna of Western Himalayas (Orthoptera: Gryllidae). *Rec. Zool. Surv. India, Occ. Paper,* no. 73: 1-74.

Bhowmik, H.K. 1985 b. Outline of distribution with an Indian catalogue of index Grasshoppers (Orthoptera: Acridoidea). *Rec. Zool. Surv. India, Occ. Paper,* no. 78: 1-51.

Bhowmik, H.K. and Halder, P. 1984. Preliminary distribution with remarks on little known species of Acrididae (Orthoptera: Insecta) from the western Himalayas, (Himachal Pradesh). *Rec. Zool. Surv. India*, 18 (1&2): 167-191.

Bhowmik, H.K. and Rui, K.N. 1982. Notes on a collection of Orthopterans (Orthoptera: Acrididae) from the Shiwalik Hills. *Rec. Indian Mus*. 17: 48-54.

BirdLife International 2001. *Threatened Birds of Asia: The BirdLife International Red Data Book*. Vol. 1& 2. (Eds. Collar, N.J. *et al.*). BirdLife International, Cambridge, UK, 3038 pp.

Biswas, S. 2000. Aquatic Coleoptera. In: *Fauna of Renuka Wetland*. Zoological Survey of India, Calcutta, 97-103 pp.

Blanford, W.T. 1988-1891. *The fauna of British India including Ceylon and Burma-Mammalia*. Taylor and Francis, London, 617 pp.

Borah, D.C. and Rai, P.S. 1989. Potentiality of *Amblyseius ovalis* as a biological control agent on *Bemisia tabaci*. In: *Progress in Acarology* (Eds. Channabasavanna, G.P. and Viraktamath, P.P.). Oxford and IBH, New Delhi, 375-380 pp.

Boulenger, G.A. 1890. *The fauna of British India including Ceylon and Burma: Reptilia and Batrachia.* London, 541 pp.

Boulenger, G.A. 1920. A monograph of the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana. Rec. Indian Mus*., 20: 1-226.

Bradbear, N. 1988. World distribution of major honeybee diseases and pests. *Bee World* 69: 15-39.

Brunetti, E. 1917. Diptera of the Simla District. *Rec. Indian Mus.,* 13: 59-101.

Burnham, K.P., Anderson, D.R. and Laake, J.L. 1980. *Estimation of density from line transect sampling of biological populations.* The Wildlife Society, USA, 202 pp.

Cavallini, P. 1992. Survey of the Goral, *Nemorhaedus goral* (Hardwiske) in Himachal Pradesh. *J. Bombay Nat. Hist. Soc.* 89: 302-307.

Chakraborty, S., Mehta, H.S. and Pratihar, S. 2005. Mammals. In: *Fauna of Western Himalaya* (Part 2). Zoological Survey of India, Kolkata, 341-359 pp.

Chanda, S.K. 1998. Amphibia. In: *Faunal Diversity in India* (Ed. Alfred *et al*.). Zoological Survey of India, Calcutta, 427- 433 pp.

Chanda, S.K. 2002. *Handbook of Indian Amphibians*. Zoological Survey of India, Kolkata, 335 pp.

Chandel, R. 1994. Taxonomic Studies on Nematodes from some wild mammals from District Bilaspur (Himachal Pradesh). *M.Phil. Dissertation, HP University, Shimla, India.*

Chandra, K. 2005. Insecta: Coleoptera: Scarabaeidae. In: *Fauna of Western Himalaya* (Part 2). Zoological Survey of India, Kolkata, 141-155 pp.

Chattopadhyay, P. and Das, A.K. 2003. Morphology, morphometry and ecology of moss dwelling testate amoebae (Protozoa: Rhizopoda) of North and Northeast India. *Memoirs of the Zoological Survey of India,* 19 (4): 1-113.

Chaudhary, D.K., Mattu, V.K. and Kumar, L. 1993. Role of insects in the pollination of peach and cherry crop. *Poll. Trop*. 1: 224-25.

Chauhan, M. 1993. Studies on Nematodes from some vegetables crops of Shimla and Solan Districts. *M.Phil. Dissertation, HP University, Shimla, India.*

Chauhan, R. 1998. *Himachal Pradesh-A perspective*. Minerva Book House, Shimla.

Chhaila, R.C. 1987. Taxonomical studies on Nematodes from some wild mammals of district Hamirpur, Himachal Pradesh. *M.Phil. Dissertation. HP University, Shimla, India.*

Cook, D.R. 1967. Water Mites from India. *Mem. Amer. Ent. Inst*. 9: 411 pp.

Daniel, J.C. 2002. *The Book of Indian Reptiles*. Bombay Natural History Society, Bombay, 141 pp.

Das, A.K. and Chattopadhyay, P. 2005. Protozoa. In: *Fauna of Western Himalaya, Himachal Pradesh.* Zoological Survey of India, Kolkata, 7-22 pp.

Das, A.K. 1998. Protozoa. In: *Faunal Diversity in India* (Eds. Alfred *et al.*). Zoological Survey of India, Calcutta, 11-19 pp.

Das, I. 1991. A new Species of *Mabuya* from Tamil Nadu state, southern India (Squamata: Scincidae). *Journal of Herpetology,* 25 (3): 342-344.

Das, I. 1994. The reptiles of South Asia, checklist and distribution summary. *Hamadryad,* 19: 15-40.

Das, I. 1996. *Biogeography of the Reptiles of South Asia.* Krieger Publishing Company, Florida, 87 pp.

Das, I. 1997. Checklist of the Reptiles of India with English Common name *Hamadryad,* 22: 32-45.

Das, I. 2003. Growth of Knowledge on the Reptiles of India, with an introduction to Systematics, Taxonomy and Nomenclature. *Journal of the Bombay Natural History Society*, 100 (2&3): 447-501.

Das, I. and Bauer, A.M. 2000. Two new species of *Cnemaspis* (Sauria: Gekkonidae) from southern India. *Russian Journal of Herpetology,* 7 (1): 17-28.

Das, I. and Sengupta, S. 2000. A new species of *Cnemaspis* (Sauria: Gekkonidae) from Assam northeastern India. *Journal of South Asian Natural History,* 5 (1): 17-24

Das, I. and Vijayakumar, S.P. 2009. New species of *Ptychozoon* (Sauria: Gekkonidae) from the Nicobar Archipelago, Indian Ocean. *Zootaxa,* 2095: 8-20.

Dashad, S.S. 1989. Pollination studies on apple (*Malus domestica* Borkh) with particular reference to the role of honey bees. *Ph.D. Thesis, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, H.P. India.*

Datta, M. 1998. Diptera. In: *Faunal Diversity in India* (Ed. Alfred *et al*.). Zoological Survey of India, Calcutta, 284-293 pp.

Davis, G.M., Subba Rao, N.V. and Hoagland, K.E. 1986. In search of *Tricula. Tricula* defined and a new genus described. *Proc. Acad. Nat. Sci., Philad.* 138 (2): 426-442.

Day, F. 1875-1878. *The fishes of India; being a natural history of fishes known to inhabit the sea and freshwater of India, Burma and Ceylon*. (Reprinted in 1958, William Dawson & Co., London), 778 pp.

Day, F. 1889 a. *The Fauna of British Indian including Ceylon and Burma*. *Fishes-I.* Taylor and Francis Ltd. London, 548 pp.

Day, F. 1889 b. *The Fauna of British Indian including Ceylon and Burma. Fishes-II.* Taylor and Francis Ltd. London, 449 pp.

De Rhe Philipe, G.W.V. 1931. The butterflies of Shimla hills. *J. Bombay Nat. Hist. Soc.* 35: 172-184, 415-429, 629-634.

Delfinado-Baker, M., Baker, E.W. and Phoon A.C.G. 1989. Mites associated with bees (Apidae) in Asia with description of new species. *Am. Bee J.* 129: 609-613.

Dhanze, R. and Dhanze, J.R. 2004. Fish diversity of Himachal Pradesh. In: *Fish diversity in protected habitats*. NATCON, Publication, U.P.

Dinesh, K.P., Radhakrishnan, C., Gururaja, K.V. and Bhatta, G.K. 2009. An annotated checklist of Amphibia of India with some insights into the patterns of species discoveries, distribution and endemism. *Records of Zoological Survey of India*, 302: 1-153.

Dobson, G.E. 1873. Description of a new species of *Vespertilio* from northwestern Himalaya. *Journal of the Asiatic Society of Bengal,* 42: 205-206.

Dodsworth, P.T.L. 1913. Notes on some mammals found in Simla districts, the Simla hill states, and Kalka and adjacent country. *Journal of the Bombay Natural History Society*, 22: 726-748.

Dogra, S. 2000. Nematode Parasites of Mammalian host from District Hamirpur, Himachal Pradesh. *M.Phil. Dissertation. HP University, Shimla, India*.

Dubois, A. 1975. Un nouvcau sous-genre (*Paa*) et trios nouvelles especes du genera *Rana.* Remarques sur la phylogenie des Ranides (Amphibiens, Anoures). *Bull. Mus. Natn. Hist. nat.* (3) 324, zool. 231: 1093-1145.

Dutta, S. K. 1997. *Amphibians of India and Sri Lanka (checklist and bibliography*). Odyssey Publishing House, Bhubaneswar, India, 342 pp.

Ehara, S. 1966. A tentative catalogue of predatory mites of phytoseiidae known from Asia with description of five new species from Japan. *Mushi.* 39: 9-30.

Ehrlich, P.R. and Wilson, E.O. 1991. Biodiversity studies: Science and Policy. *Science* 253: 758-762.

Ellerman, J.R. 1961. *The Fauna of India, including Pakistan, Burma and Ceylon: Mammalia, 3 Rodentia.* Part I & II. Govt. of India, New Delhi.

Ellerman, J.R. and Morrison-Scot, T.C.S. 1951. *Checklist of Palaearctic and Indian Mammals, 3 Rodentia.* Part I & II. Govt. of India, Delhi.

Evans, O.G. 1992. *Principles of Acarology*. CAB International, UK. 563 pp.

Evans, W.H. 1932. *The identification of Indian Butterflies* (2nd ed.). Bombay Natural History Society, Bombay, 454 pp.

Free, J.B. 1993. *Insect pollinators of crops*. Academic Press, London.

Ganguli, U. 1967. Birds of Simla in autumn. *Newsletter for Birdwatchers,* 7 (3): 4-6.

Garson, P.J. 1987. Studying Cheer Pheasant in India. *Oriental Bird Club Bulletin* 5: 18-19.

Gaston, A.J. and Pandey, S. 1987. Sighting of Rednecked Grebes (*Podiceps grisegena*) on the Pong Dam Lake, Himachal Pradesh. *J. Bombay Nat. Hist. Soc.* 84 (3): 676-677.

Gaston, A.J., Garson, P.J. and Hunter, M.L. Jr. 1981 a. Present distribution and status of Pheasants in Himachal Pradesh, Western Himalayas. *WPA Journal,* 6: 10-30.

Gaston, G.J., Hunter, M.L. and Garson, P.J. 1981 b. *The Wildlife of Himachal Pradesh Western Himalayas.* Technical Notes. No. 82. School of Forest Resources, USA.

Gaston, T. 1997. Mountain Birds of Himachal Pradesh. *WPA News,* 52: 16-20.

Ghosh, A.K. 1996 a. Faunal diversity. In: *Changing Perspectives of Biodiversity Status in the Himalaya* (Eds. Gujaral, G.S. & Sharma, V.). British Council Division, New Delhi, 43-52 pp.

Ghosh, A.K. 1996 b. Insect Biodiversity in India. *Oriental Insect* 30: 1-10.

Ghosh, A.K. and Sengupta, T. 1982. *Handbook on Insect Collection Preservation and Study*. Zoological Survey of India, Calcutta, 65 pp.

Giri, V.B. 2008. A new rock dwelling *Hemidactylus* (Squamata: Gekkonidae) from Maharashtra India. *Hamadryad,* 32: 25-33.

Giri, V.B. and Bauer, M.A. 2008. A new ground-dwelling *Hemidactylus* (Squamata: Gekkonidae) from Maharashtra with a key to the *Hemidactylus* of India. *Zootaxa,* 1700: 21-34.

Giri, V.B., Bauer, A.M., Vyas, R. and Patil, S. 2009 a. New Species of Rock-Dwelling *Hemidactylus* (Squamata: Gekkonidae) from Gujarat, India. *Journal of Herpetology,* 43 (3): 385-393.

Giri, V.B., Bauer, A.M. and Gaikwad, K.S. 2009 b. A new ground-dwelling species of *Cnemaspis* Strauch (Squamata: Gekkonidae) from the northern Western Ghats, Maharashtra, India. *Zootaxa,* 2164: 49-60.

Glaw, F. and Kohler, J. 1998. Amphibian species diversity exceeds that of mammals. *Herpetol. Rev.,* 29: 11-12.

Godwin-Austen, H.H. 1899. Address of the President. Appendix A. List of shells from Kashmir territory, South of the Pir Panjal and Kajnag ranges including the Murree Hills and Hazara. *Proc. Malac. Soc. Lond.* 3: 259-262.

Gower, D.J. and Winkler, J.D. 2007. Taxonomy of the Indian snake *Xylophis* Beddome (Serpentes: Caenophidia) with description of a new species. *Hamadryad,* 31 (2): 315-329.

Greig Smith, P. 1983. *Quantitative Plant Ecology* (3rd ed). Blackwell Scientific Publications, Oxford.

Grimmett, R., Inskipp, C. and Inskipp, T. 1999. *Pocket Guide to the Birds of the Indian Subcontinent*. Oxford University Press, New Delhi, 384 pp.

Gruber, U. 1981. Notes on the Herpetofauna of Kashmir and Ladakh. *British Journal of Herpetol*ogy, 6: 145-150.

Gunther C.L.C Albert, 1864. *The Reptiles of British India.* Oxford and IBH Publishing Co. New Delhi, 452 pp.

Gupta, R.K. 2003. *Advancements in insect biodiversity*. Agrobios, Jodhpur, 336 pp.

Gupta, S.K. 1985. *Handbook: Plant Mites of India*. Zoological Survey of India, Calcutta, 520 pp.

Gupta, S.K. 1988. *Fauna of India (Acari: Mesostigmata)*. Zoological Survey of India, Calcutta, 350 pp.

Gupta, S.K. 1991. The mites of agricultural importance in India with remarks on their economic status. *Modern Acarology* 1 : 509: 522.

Hamlyn, 1969 (Secondary source: Alfred, J.R.B. *et al.* (ed.). 1998. Lepidoptera. In: *Faunal diversity in India*. Zoological Survey of India, Calcutta. 312-318 pp.)

Hammond, P.M. 1992. Species inventory. In: *Global biodiversity: Status of the earth's living resources*. Chapman and Hall, 17-39 pp.

Hampson, 1918. (Secondary source: Alfred, J.R.B. *et al.* (ed.). 1998. Lepidoptera. In: *Faunal diversity in India*. Zoological Survey of India, Calcutta. 312-318 pp.)

Hampson, G.F. 1895. *Fauna of British India: Moths*, 3, 1-546. Taylor and Francis, London.

Hampson, G.F. 1896. *Fauna of British India: Moths*, 4, 1-594. Taylor and Francis, London.

Haralu, B. 2010. Nagaland concerns and challenges. *Indian Birds,* 6 (2): 56-57.

Harper, J.L. and Hawksworth, D.L. 1994. Biodiversity: measurement and estimation. *Phil. Trans. Roy. Soc.*, London, 345: 5-12.

Hazra, A.K. and Mukherjee, T.K. 1998. Mantodea. In: *Faunal Diversity in India* (Ed. Alfred *et al*.). Zoological Survey of India, Calcutta, 209-214 pp.

Hinton, M.A.C. and Lindsay, H.M. 1926. Bombay Natural History Society's Mammal Survey of India, Burma and Ceylon. Suppl. No. 2 to 41. Collection made by Mr. H. Whistler in Kangra. *J. Bombay Nat. Hist. Soc.,* 31: 403.

Hora, S.L. 1927. On a peculiar fishing implement from Kangra Valley, Punjab. *J. & Proc. Asiat. Soc. Bengal* (N.S.), 22 (1): 81-84.

Hora, S.L. 1928. Hibernation and aestivation in gastropod molluscs. On the habit of a slug from Dalhousie (Westren Himalayas) with remarks on certain other species of Gastropod Molluscs. *Rec. Indian Mus.* 30: 357-373.

Hora, S.L. 1937. Distribution of Himalayan fishes and its bearing on certain palaeogeographical problems. *Rec. Indian Mus.,* 39: 251-259.

Hora, S.L. 1999. *The freshwater fishes of the Indian region.* Narander Publication House, Delhi, 551 pp.

Hora, S.L., Mulik, G.M. and Khajuria, H. 1955. Some interesting features of the aquatic fauna of the Kashmir valley. *J. Bombay Nat. Hist. Soc.*53 (1): 140-143.

Huston, M.A. 1994. *Biological diversity: The coexistence of species on changing landscapes*. Cambridge University Press, 681 pp.

Ishwar, N.M., Chellam, R. and Kumar, A. 2001. Distribution of forest floor reptiles in the rainforest of Kalakad- Mundanthurai Tiger Reserve, South India. *Current Science* 80: 413-418.

IUCN, 2006. *IUCN Red list of threatened species, 2006*. International Union for Conservation of Nature, Switzerland. (www.iucnredlist.org)

IUCN, 2008. *IUCN Red List of Threatened Species, 2008*. IUCN Species Survival Commission. Gland, Switzerland (www.iucnredlist.org).

Jairajpuri, M.S. 1991. Animal resources of India: Protozoa to Mammals-an overview. In: *Animal resources of India.* Zoological Survey of India, Calcutta, i-xxvii.

Jayaram, K.C. 1999. *The freshwater fishes of the Indian region*. Narendra Publishing House, Delhi, 551 pp.

Jayaram, K.C. 2006. *The Catfishes of India*. Narendra Publishing House, New Delhi, 383 pp.

Jeppson, L.R., Keifer, H.H. and Baker, E.W. 1975. *Mites injurious to economic plants*. University of California Press, 614 pp.

Jindal, R., Singh, H. and Sharma, C. 2013. Avian fauna of Pong Dam Wetland-a Ramsar Site. *International Journal of Environmental Sciences* 3 (6): 2236-2250.

Johal, M.S., Tandon, K.K., Tyor, A.K. and Rawal, Y.K. 2002. Fish diversity in different habitats in the streams of lower western Himalayas. *Pol. J. Ecol.* 50 (1): 45-56.

Jones, A.E. 1947-1948. The Birds of Simla and adjacent Hills. *J. Bombay Nat. Hist. Soc*., 47: 117-125, 219-249, 409-432.

Julka, J.M. 1988. *The Fauna of India and the adjacent countries, Megadrile Oligochaeta, Octochaetidae.* Zoological Survey of India, Calcutta, 400 pp.

Julka, J.M. 1998. Annelida. In: *Faunal Diversity in India*. Zoological Survey of India, Kolkata, 123-131 pp.

Julka, J.M. and Paliwal, R. 1995. First record of *Microscolex phosphoreus* and *Malabaria levis* (Oligochaeta: Acanthodrillidae and Ocnerodrillidae) from India. *Megadrilogica,* 6 (6): 60-62.

Julka, J.M. and Paliwal, R. 2005. Annelida: Oligochaeta. In: *Fauna of Western Himalaya* (Part 2). Zoological Survey of India, Kolkata, 53-60.

Julka, J.M., Paliwal, R. and Mehta, H.S. 1999. *Mammals of Himachal Pradesh*. Zoological Survey of India, Solan.

Julka, J.M., Tandon, S.K., Halder, P. and Shishodia, M.S. 1982. Ecological observations on Orthopterans (Orthoptera: Acridoidea) at Solan , H.P. *Oriental Insect*, 16 (1) : 63-75 .

Katoch, S.K. 1989. Taxonimic Studies on Nematodes from some wild mammals from District Mandi (Himachal Pradesh). *M.Phil. Dissertation, HP University, Shimla.*

Kazmierczak, K. 2000. *A Field Guide to the Birds of India, Sri Lanka, Pakistan, Nepal, Bhutan, Bangladesh and the Maldives*. Om Book Service, New Delhi, 352 pp.

Khajuria, H. and Sharma, T.R. 1983. On habits of some high alitutde birds of Indian Western Himalayas. *Proc. Wkshp. High Alt. Ent. & Wildl. Ecol., Zool. Surv. India:* 281-290.

King, W. 1981. *Endangered Birds of the World*. The ICBP Bird Red Data Book. Smithsonian Institute Press, Washington D.C.

Koeniger, N. and Muzaffar, N.1988. Life span of the parasitic honeybee mite *Tropilaelaps clareae* on *Apis cerana*, *Apis dorsata* and *Apis mellifera*. *J. Apic. Res.* 27:207-212.

Krantz, G.W. 1978. *A manual of Acarology*, (2nd ed). Origon State Univ. Book store Inc. Corvallis, 489 pp.

Kriplani, M. 1952. On Indian tadpoles wirh suctorial disc. *Rec. Indian Mus.* 50: 359-366.

Krishnamurthy, KV. 2003. *An Advanced Textbook on Biodiversity*. Oxford and IBH Publ. Co., New Delhi, 260 pp.

Kumar, A. 1995. Odonata. In: *Fauna of Western Himalaya (Part 1)*. Zoological Survey of India, Kolkata, 25-33 pp.

Kumar, A. 2005. Odonata. In: *Fauna of Western Himalaya (Part 2)*. Zoological Survey of India, Kolkata, 75-98.

Kumar, A. 2010. Hydrological conditions of River Beas and its fish fauna in Kullu Valley, Himachal Pradesh, India. *Environment Conservation Journal,* 11: 7-10.

Kumar, A. and Prasad, M. 1981. Field ecology, zoogeography and taxonomy of the Odonata of Western Himalaya, India. *Rec. Zool. Surv. India, Occ. Paper No.* 20: 1-118.

Kumar, J. 1988. Insect pollintors in temperate fruits during bloom. *J. Tree Sci.* 7: 38-40.

Kumar, J., Mishra, R.C. and Gupta, J.K. and Dogra, G.S. 1985. Pollination requirements of some peach cultivars. *Indian Bee J.* 47: 3-6.

Kumar, L. 1997. Foraging ecology and behaviour of *Apis cerana* F. and *Apis mellifera* L. in pollinating apple and cherry flowers. *Ph.D. Thesis, Himachal Pradesh University, Shimla, India.*

Kumar, U. and Asija, M. 2006. *Biodiversity: principles and conservation*. Agrobios, Jodhpur, 234 pp.

Lagler, K.F., John, E.B. and Robert, R.M. 1962. *Ichthyology, the study of fishes*. John Willy and Sons, New York and London, 543 pp.

Lavkumar, K.S. 1962. Bird watching in the Himalayas. *Newsletter for Birdwatchers,* 2 (12): 6-9.

Lefroy, H.M. and Howlett, F.M. 1909. *Indian Insect Life*. Thacker, Spink and Co., Calcutta, 786 pp.

Lindsay, H.M. 1926. Bombay Natural History Society's Mammal Survey of India, Burma and Ceylon. Report No. 44. Kangra and Chamba. *J. Bombay Nat. Hist. Soc.,* 31: 597-606.

Lindsay, H.M. 1929. Scientific results from the Mammal survey No. 48. Indian Shrews. *J. Bombay Nat. Hist. Soc.* 33: 326-340.

Linnaeus, C. 1758. *Systema Naturae* (10th ed, Vol. 1). Holmiae. 823 pages.

Mac Kinnon J. and Philips, K. 1993. *The Birds of Borneo, Sumatra, Java and Bali*. Oxford University Press, Oxford.

Magurran, A.E. 1988. *Ecological Diversity and its Measurements*. Cambridge University Press, Cambridge.

Mahabal, A. 2005. Aves. In: *Fauna of Western Himalaya* (Part 2). Zoological Survey of India, Kolkata, 275-339 pp.

Mahabal, A. 1992 a. Natural distribution of some bird species in Chamba District, Himachal Pradesh. *Newsletter for Birdwatchers,* 32 (5 & 6): 16.

Mahabal, A. 1992 b. Avifauna of Chamba District (Himachal Pradesh). *Pavo,* 34 (1& 2): 7-16.

Mahabal, A. 1996. Bird Survey in Siwalik Himalaya of Himachal Pradesh. *Pavo,* 34 (1 & 2): 7-16.

Mahabal, A. 2000 a. Birds of Talra Wildlife Sanctuary in lower Western Himalaya, H.P. with notes on their status and altitudinal movements. *Zoo's Print Journal,* 15 (10): 334-338.

Mahabal, A. 2000 b. Avifauna. In: *Fauna of Renuka Wetland.* Zoological Survey of India, Calcutta, 169-176 pp.

Mahabal, A. and Sharma, T.R. 1992. Distribution patterns of birds of Kangra Valley (Himachal Pradesh). *Him. J. Env. & Zool.* 6 (2): 85-96.

Mahajan, K.K. and Mukherjee, R.N. 1974. A Checklist of Mammals of Himachal Pradesh. *Hippocampus,* 5: 40-47.

Mahony, S. 2009. A New Species of Gecko of the Genus *Hemidactylus* (Reptilia: Gekkonidae) from Andhra Pradesh, India. *Russian Journal of Herpetology,* 16 (1): 27-34

Mahony, S. 2010. Systematic and taxomonic revaluation of four little known Asian agamid species, *Calotes kingdonwardi* Smith, 1935, *Japalura kaulbacki* Smith, 1937, *Salea kakhienensis* Anderson, 1879 and the monotypic genus *Mictopholis* Smith, 1935. (Reptilia: Agamidae). *Zootaxa,* 2514: 1-23.

Malhotra, A. 1985. Taxonomy of Helminth Parasites from some fresh water fishes (Cyprinidae) in Mandi District. *M.Phil. Dissertation. HP University, Shimla, India.*

Mallet, J. 1998. Species concepts. In: *Encyclopaedia of Ecology and Environmental Management* (Ed. Calow, P). Blackwell Press, 709-711 pp.

Manakadan, R. and Pittie, A. 2001. Standerdised common and scientific names of the birds of the Indian Subcontinent. *Buceros,* 6 (1): 1-38.

Manamendra-Arachchi, K., Batuwita, S. and Pethiyagoda, R. 2007. A taxonomic revision of the Sri Lankan day-geckos (Reptilia: Gekkonidae: *Cnemaspis*), with description of new species from Sri Lanka and southern India. *Zeylanica,* 7 (1): 9-122.

Mani, A. 1981. *The Himalayan aspects of change*. India International Centre, New Delhi.

Mani, M.S. 1986. *Butterflies of Himalaya*. Oxford and IBH Publ. Co., New Delhi.

Manjunatha, M., Hanchinal, S.G. and Kulkarni, S.V. 1999. Mass multiplication of predatory mites and their natural enemies: A review I. Tetranychid enemies: The biological characters and their impact of spray practices. *Hilgardia* 40 (11): 331: 339.

Marshall, G.F.L. and de Niceville, L. 1882-1890. *The Butterflies of India, Burma and Ceylon*, I: 1-321; 1886, 2: 1-332; 1890, 3: 1-503. Taylor and Francis, London.

Mattu, N., Mattu, V.K., Verma, L.R. and Lakhanpal, T.N. 1995. Diversity of plants pollinated by Indian hive bee in Himachal Pradesh, India. In: *Pollination Biology: Environmental Factors and Pollination*. Rajendra Scientific Publishers, Hisar, 91-106 pp.

Mattu, V.K. and Chaudhary, D.K. 1993. Relative abundance and foraging activity of insect pollinators on almond flowers. *Poll. Trop.* 1: 218-221.

Mattu, V.K. and Thakur, M.L. 2006. Bird Diversity and Status in Summer hill, Shimla (Himachal Pradesh). *Indian Forester* 132 (10): 1271-1281.

Mattu, V.K., Chaudhary, D.K. and Kumar, L. 1994. Foraging ecology of *A. cerana* and *A. mellifera* in pollinating stone fruit crops. *Pest Management and Economic Zoology* 2 (1): 35-39.

Mattu, V.K., Mattu, N. and Thakur, M.L. 2005. *Faunal Diversity of Himachal Himalaya* (Publ. No. 5). Institute of Integrated Himalayan Studies (UGC Centre of Excellence), HP University, Shimla, 75 pages.

Mattu, V.K., Sharma, M. and Mattu, N. 2003. Mite Pests of *Apis* spp. in Himachal Pradesh. In: *Frontier Areas of Entomological Research*, EMSI, New Delhi, 316-17.

Mattu, V.K., Sharma, N., Kumar, D. and Kumar, L. 1996. Pollination ecology of stone fruit crops in Himachal Pradesh, India. *Rec. Adv. Biosc. & Ocean*., 75-88.

May, R.M. 1990. How taxonomy as destiny. *Nature* 347: 129-130.

Mc Murtry, J.A., Huffaker, C.B. and Vandevine, M. 1970. Ecology of tetranychid mites and their natural enemies: A review Tetranychid enemies. The biological characters and their impact of spray practices. *Hilgardia* 40 (11): 331-339.

McClelland, J. 1839. Indian Cyprinidae. *Asiat Res.,* 19 (2): 262-450.

McClelland, J. 1842. On the freshwater fishes collection by William Griffith. *Calcutta J. Nat. Hist.,* 2: 560-589.

McNeely, J.A. 1994. Critical issues in the implementation of the convention on Biological diversity. In: *Widening Perspectives on Biodiversity* (Eds. Krattiger, A.F. *et al.*). Natraj Publishers, Dehra Dun, 7-10.

Mehta, H.S, Mattu, V.K. and Thakur, S.K. 2002 a. Orthopteran diversity of Kalatop-Khajjiar wildlife sanctuary, Chamba (H.P.). *Bionotes*, 4 (3): 60.

Mehta, H.S., Thakur, M.L., Paliwal, R, and Tak, P.C. 2002 b. Avian Diversity of Ropar Wetland, Punjab, India. *Ann. For.* 10 (2): 307-326.

Mehta, H.S. 2000 a. Pisces. In: *Fauna of Renuka Wetland*. Zoological Survey of India, Calcutta, 141-149 pp.

Mehta, H.S. 2000 b. Amphibia. In: *Fauna of Renuka Wetland*. Zoological Survey of India, Calcutta, 151-161 pp.

Mehta, H.S. 2000 c. Reptilia. In: *Fauna of Renuka Wetland*. Zoological Survey of India, Calcutta, 163-168 pp.

Mehta, H.S. 2005. *Fauna Western Himalaya (Part-2)*. Zoological Survey of India, Kolkata, 359 pp.

Mehta, H.S. 2009. Fauna of the Indian Cold Desert (Ladakh)-An Overview. ENVIS *Newsletter*, 15: 2-4.

Mehta, H.S. and Julka, J.M. 2002. Mountains: Northwest Himalaya. In: *Ecosystems of India* (Eds. Alfred, *et al.*). Zoological Survey of India, Kolkata, 410 pp.

Mehta, H.S. and Sharma, I. 2008. Pisces. In: *Fauna of Pin Valley National Park*. Zoological survey of India, Kolkata, 75-84 pp.

Mehta, H.S. and Uniyal, D.P. 2005. Pisces. In: *Fauna of Western Himalaya* (part-2). Zoological Survey of India, Kolkata, 255-268 pp.

Melchias, G. 2001. *Biodiversity and Conservation*. Oxford and IBH Publ. Co., New Delhi, 236 pp.

Menon, A.G.K. 1951. Note on fishes in the Indian Museum. XLVII. On two new species of the genus *Nemachilus* from Kangra Valley, Punjab. *Indian Mus.,* 49 (2): 227-230.

Menon, A.G.K. 1954. Fish geography of Himalayas. *Proc. Nat. Inst. Sci. India,* 20 (4): 467-493.

Menon, A.G.K. 1962. A distribution list of fishes of the Himalayas. *J. Zool. Soc. India,* 14 (1): 23-32.

Menon, A.G.K. 1974. *A checklist of fishes of the Himalayan and the Indo-Gangetic plains.* Special publication no. 1. Inland Fisheries Society of India, Barrackpore, India, 136 pp.

Menon, A.G.K. 1987. *Fauna of India and the Adjacent Countries.* Pisces, 4 (I). Homalopteridae. Zoological Survey of India, Calcutta, 259 pp.

Menon, A.G.K. 1999. Checklist of freshwater fishes of India. *Rec. Zool. Surv. India. Occ. Paper,* 175: 366 pp.

Menon, M.G.R. 1965. Systematics of Indian insects. In: *Desert Resources and Technology* (Ed. Singh, A.). Scientific Publishers, Jodhpur. 86 pp.

Michener, C.D. 1974. *The social behaviour of bees*. Harvard Univ. Press, Cambridge, Massacusetts.

Minakshi, 2004. Apiculture and Pollination Ecology of Kiwi and Pear Crops in Himachal Pradesh. *Ph.D. thesis, HP University, Shimla*, 185 pp.

Mishra, R.C. 1995. *Honeybees and their management in India*. ICAR, New Delhi.

Mishra, R.C. and Kumar, J. 1993. Status of research in pollination biology in Himachal Pradesh. In: *Pollination in Tropics.* IUSSI-Indian Chapter, Banglore, India, 279-295 pp.

Mishra, R.C., Dogra, G.S. and Gupta, P.R. 1976. Some observations on insect pollinators of apple. *Indian Bee J.* 38: 20-22.

Mondal, D.K. 1998. Lepidoptera. In: *Faunal Diversity in India* (Ed. Alfred *et al*.). Zoological Survey of India, Calcutta, 311-318 pp.

Moore, F. 1982. List of the Lepidoptera collected by the Rev. J.H. Hocking chiefly in the Kangra district, N.W. Himalayas with description of new genera and species, I. *Proc. Zool. Soc. London*: 234-263.

Mukherjee, D. and Bhupathy, S. 2007. A new species of wolf snake (Serpentes: Colubridae: *Lycodon*) from Anaikatti Hills, Western Ghats, Tamil Nadu, India. *Russian Journal of herpetology,* 14 (1): 21-26.

Mukherjee, R.N. and Das, A.K. 2000. Protozoa. In: *Fauna of Renuka Wetland, Himachal Pradesh.* Zoological Survey of India, Kolkata, 7-9 pp.

Mukherjee, T.K. and Shishodia, M.S. 2000. Mantodea. In: *Fauna of Renuka Wetland.* Zoological Survey of India, Kolkata, 63-66.

Murthy, T.S.N. 1985**.** Classification and distribution of the Reptiles of India. *The Snake,* 17: 48-71.

Murthy, T.S.N. 1994**.** An updated hand list of the reptiles of India. *Cobra,* 17: 17-37.

Murthy, T.S.N. 2010**.** *The Reptile Fauna of India.* B.R. Publishing Corporation, New Delhi.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G.A.B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403: 853-858.

Nayital, A.K. 1987. On Systematics of Helminth Parasites from some wild carnivorous mammals in Kangra District. *M.Phil. Dissertation. HP University, Shimla*.

Negi, R.K., Thakur, M.L. and Banyal, H.S. 2015. Avifauna of Rakchham-Chhitkul Wildlife Sanctuary District Kinnaur, Himachal Pradesh, India. *IOSR Journal of Pharmacy and Biological Sciences*, 10 (2): 18-25.

Negi, S. 2001. Plant Parasitic Nematodes Asscіated with Chir Pine. *M.Phil. Dissertation. HP University, Shimla*.

Negi, S. 2002. Studies on Nematodes of some wild mammals of District Kinnaur, Himachal Pradesh. *M.Phil. Dissertation. HP University, Shimla*.

Negi, S.S. 1992. *Himalayan Wildlife Habitat and Conservation.* Indus Publishing Company, New Delhi.

Nelson, J.S. 2006. *Fishes of the World* (4th Ed). John Wiley and Sons, Inc., 601 pp.

Nevill, G. 1878. Mollusca II. Mollusca from Kashmir and neighbourhood of Mari (Murree) in the Punjab. *Sci. Res. Second Yarkand Mission.* Mollusca, London, 14-21 pp.

Norse, E.A. and McManus, R.E. 1980. Ecology and living resources biological diversity. In: *Environmental quality 1980*. 11th Annual report of the council on environmental quality, Washington DC, 31-80 pp.

Nowak, R. 1999. *Walker's Mammals of the World*. Johns Hopkins Univ. Press, Baltimore, Maryland.

Pajni, H.R. and Walia, V.K. 1982. A study of taxonomy of Indian Geometridae (Lepidoptera), *Symposium on advances in Insect Taxonomy.* Department of Zoology, PAU, Ludhiana, 22-23 pp.

Pajni, H.R. and Walia, V.K. 1983. A report on the family geometridae (Lepidoptera) of Chandigarh and surrounding areas. *Res. Bull. Pb. Univ.* 34 (III-IV): 19-23.

Pajni, H.R. and Walia, V.K. 1984 a. Taxonomic studies on Indian Geometridae I. Genus *Chlorissa* Stephens (Subfamily: Geometriniae). *Entomon,* 9 (1): 30-46.

Pajni, H.R. and Walia, V.K. 1984 b. Taxonomic studies on Indian Geometridae III. Genus *Euchloris* Hubner (Subfamily: Geometriniae). *Uttar Pradesh Journal of Zoology,* 4 (2): 175-178.

Pajni, H.R. and Walia, V.K. 1985. Taxonomic studies on Indian Geometridae IV. On a new species of genus *Chloeres* Truner with comments on the Indian species of this genus. *Geobios New Reports,* 3: 139-141.

Paliwal, R. 1994. Taxonomy and ecology of earthworms of western Himalaya. *Ph.D. Thesis, Ch. Charan Singh University, Meerut (U.P.), 364 pp.*

Pandey, S. 1989a. The Pong Dam Lake Bird Sanctuary, Himachal Pradesh. *Newsletter for Birdwatchers,* 29 (7-8): 3-4.

Pandey, S. 1989b. The birds of Pong Dam Lake Sanctuary. *Tigerpaper* 16 (2): 20-26.

Pandey, S. 1992. Estimation of Density of Ibex, *Capra ibex* Linn. in Pin Valley National Park, Himachal Pradesh. *J. Bombay Nat. Hist. Soc.,* 89: 361-362.

Pandey, S. 1993a. The importance of a man-made reservoir in India for conserving water bird diversity. In: *Wetland and waterfowl Conservation in south and west Asia*. Proc. Int. Symp., Karachi, Pakistan, December 1991. (Eds. Moser, M. & Van Vessem, J.). IWRB, Slimbridge, UK, 95 p.

Pandey, S. 1993b. Changes in water bird diversity due to the construction of Pong Dam Reservoir, Himachal Pradesh, India. *Biol. Conserv.* 66: 125-130.

Pandey, S. Sathyakumar, S. and Thakur, M.L. 2004. Kalatop Khajjiar Wildlife Sanctuary. In-*Important Bird Areas in India: Priority Sites for Conservation* (Ed.: Islam, M.Z. and Rahmani, A.R.). Indian Bird Conservation Network: BNHS & Birdlife International (UK). 445-446 pp.

Parui, P. and Mukherjee, M. 2000. Diptera. In: *Fauna of Renuka Wetland*. Zoological Survey of India, Kolkata, 135-140 pp.

Pocock, R.I. 1939, 1941. *The fauna of British India, including Ceylon and Burma*. Mammalia. Vol. I & II. Taylor and Francis, London

Ponniah, A.G. and Gopalakrishnan, A. 2000. *Endemic Fish Diversity of the Western Ghats*. NBFGR- NATP Publication, 347 pp.

Ponniah, A.G. and Sarkar, U.K. 2000. *Fish Biodiversity of North-East India*. NBFGR- NATP Publication, 228 pp.

Pook C.E., Joger, U., Stumpel, N. and Wuster, W. 2009. When continents collide: Phylogeny, historical biogeography and systematic of the medically important viper genus *Echis* (Squamata: Serpentes: Viperidae). *Molecular Phylogenetics and Evolution,* 53: 792-807.

Prasad, M. 1998. Odonata. In: *Faunal Diversity in India*. Zoological Survey of India, Kolkata, 171-178 pp.

Prasad, M. and Varshney, R.K. 1995. A Checklist of the Odonata of India including data on larval studies. *Oriental Ins.* 29: 385-428.

Prasad, V. 1974. *A catalogue of mites of India*. Indira Acarology Publishing House, Ludhiana, 320 pp.

Prater, S.H. 1980. *The Book of Indian Animals* (3rd ed). Bombay Natural History Society, Bombay.

Rajagopal, A.S. and Subba Rao, N.V. 1968. Aquatic and amphibian molluscs of the Kashmir valley, India. *Proc. Symposium on Mollusca,* Part-I: 95-120.

Rajagopal, A.S. and Subba Rao, N.V. 1972. Some land molluscs from the Kangra valley. *Rec. Zool. Surv. India,* 66 (1-4): 197-212.

Rana, R.S., Verma, L.R. and Mattu, V.K. 1995. Foraging activity and abundance of insect pollinators of plum. In: *Pollination Biology: Environmental Factors and Pollination* (Ed. Sihag, R.C). Rajendra Scientific Publishers, Hisar, 20- 31.

Rao, H.S. 1927. Notes on two species of aestivating gastropod molluscs from the Kangra Valley. *Rec. Indian. Mus.* 29: 50-56.

Rao, K.V. Surya and Mitra, S.C. 2005. Mollusca. In: *Fauna of Western Himalaya (Part 2)*. Zoological Survey of India, Kolkata, 39-51.

Rao, N.V. Subba 1998. *Faunal Diversity in India: Mollusca*. Zoological Survey of India, Kolkata, 103-117 pp.

Rasmussen, P.C. 1998. Forest Owlet (*Athene blewitti*) Rediscovered after 113 Year. *Hiatus, Bird Conservation International*, 8:109.

Reynolds, R.T., Scott, J.H. and Numbaum, R.A. 1980. A variable circular-plot method for estimating bird numbers. *Condor* 82: 309-313.

Rodgers, W.A. and Panwar, S.H. 1988. *Planning a Wildlife Protected Area Network in India*. Vols. I & II. Wildlife Institute of India, Dehra Dun.

Roonwal, M.L. 1989. The Importance of Insect Taxonomy in India. *Hexapoda* 1: 1-2.

Saha, S.S. 1998. Aves. In: *Faunal Diversity in India* (Ed. Alfred *et al*.). Zoological Survey of India, Calcutta, 450-457 pp.

Saikia U. and Sharma D.K. 2009. *Faunal Biodiversity of Simbalbara wildlife Sanctuary*. Zoological Survey of India, Kolkata, 41: 65-79.

Saikia, U., Mehta, H.S. and Sharma, D.K. 2010. New distributional record of Eastern Black Turtle Melanochelys trijuga indopeninsularis from Simbalbara WLS, Sirmour district, H.P. *The Indian Forester*, 136: 273-275.

Saikia, U., Sharma, D.K. and Sharma, R.M. 2007. Checklist of reptilian fauna of Himachal Pradesh India. *Reptile Rap.,* 8: 6-9.

Saikia, U., Sharma, R.M. and Mattu, V.K. 2004. New records of bats from Himachal Pradesh with some ecological notes *The Indian Forester,* 130 (10): 1204-1208.

Saikia, U., Thakur, M.L., Bawri, M. and Bhattacharjee, P.C. 2011. An inventory of the Chiropteran fauna of Himachal Pradesh, northwestern India with some ecological observations. *Journal of Threatened Taxa,* 3: 1637-1655.

Sanyal, A.K. 1998. Acari. In: *Faunal Diversity in India*. Zoological Survey of India, Calcutta, 357- 365 pp.

Sengupta, T. and Pal, T.K. 1998. Coleoptera. In: *Faunal Diversity in India.* Zoological Survey of India, Calcutta, 259-268 pp.

Sharma R.C. 1977. A new lizard of the genus *Riopa* Gray (Scincidae) from Tamil Nadu, India. *Records of the Zoological Survey of India* 73 (1-4): 41-44.

Sharma, A. 2004. Taxonomic Studies on Nematodes from some rats in Sunder Nagar District Mandi (Himachal Pradesh). *M.Phil. Dissertation, HP University, Shimla.*

Sharma, I. and Mehta, H.S. 2009. Fishes of Ladakh. *ENVIS Newsletter,* Zoological Survey of India, Kolkata, 15: 13.

Sharma, L. 2001. Habitat destruction of Western Tragopan in Moral-Kanda. *Mor* 4 (February): 4-5.

Sharma, M. 2002. Biological and Ecological Studies on Mite Pests of *Apis* and *Bombus* spp. *Ph.D. Thesis, HP University, Shimla,* 129 pp.

Sharma, R.C. 1978. A new species of *Phrynocephalus* Kaup (Reptilia: Agamidae) from the Rajasthan desert, India with notes on its ecology. *Bulletin of the Zoological Survey of India,* 1 (3): 291-294.

Sharma, R.C. 1981. *Hemidactylus porbandarensis* a new geckonid lizard from Gujarat India. *Bulletin of the Zoological Survey of India,* 4 (1): 1-2.

Sharma, R.C. 1998. *Fauna of India and the adjacent countries-Reptilia (Testudines and Crocodilia).* Vol. I. Zoological Survey of India, Kolkata, 196 pp.

Sharma, R.C. 2002. *The fauna of India and the adjacent countries-Reptilia (Sauria).* Vol. II. Zoological Survey of India, Kolkata, 430 pp.

Sharma, R.C. 2007. *The fauna of India and the adjacent countries-Reptilia (Serpentes).* Vol. III. Zoological Survey of India, Kolkata, 410 pp.

Sharma, V. and Pandey, S. 1989. Pheasant surveys in the Shimla Hills of Himachal Pradesh, India. *WPA Journal,* 14: 64-78.

Sharma, V., Garson, P.J. and Khera, S. 1990. Status surveys of Cheer and Western Tragopan in Simla Hills of Himachal Pradesh. In: *Pheasants in Asia* (Eds. Hill *et al.*). World Pheasant Association, U.K., 139-141 pp.

Sharma, V.K. and Tandon, K.K. 1990. The fish and fisheries of Himachal Pradesh state of India. *Pb. Fish. Bull.* 14 (1): 41-46.

Shishodia, M.S. and Tandon, S.K. 2000. Orthoptera. In: *Fauna of Renuka Wetland.* Zoological Survey of India, Kolkata, 73-90 pp.

Sibley, C.G. and Monroe, B.L. 1990. *Distribution and Taxonomy of Birds of the World*. Yale University Press, New Haven. 1111 pp.

Singh, J., Thakur, M.L. and Banyal, H.S. 2014. Avifauna of Prashar lake and its surrounding area in Mandi district (Himachal Pradesh), India. *Asian J. Biological Sciences*, 7 (2): 47-56.

Singh, J., Thakur, M.L., Thakur, D.R. and Banyal, H.S. 2014. Mammalian fauna of Prashar lake and its surrounding area in Mandi district (Himachal Pradesh), India. *Asian J. Biological Sciences*, 7(2): 66-71.

Singh, R. and Mishra, R.C. 1986. Flower visiting flies of fruit crops in Himachal Pradesh. *Proc. Indian Nat. Sci. Acad. Biol.* 52: 451-453.

Singh, S., Kothari, A. and Pande, P. (eds.). 1990. Directory of National Parks and Sanctuaries in Himachal Pradesh: Management, Status and Profiles. *Indian Institute of Public Administration, Environmental Studies Division, New Delhi.*

Singh, V. and Banyal, H.S. 2013. Study of Herpetofauna of Khajjiar lake of Chamba district, Himachal Pradesh, India. *International Journal of Plant, Animal and Environmental Sciences*, 3 (2): 1-8.

Singh, V. and Thakur, M.L. 2012. Rhesus Macaque and associated problems in Himachal Pradesh-India. *Taprobanica* 4 (2): 112:116.

Smith, M.A. 1931. *The Fauna of British India, including Ceylon and Burma.* Reptilia and Amphibia, Vol. I. Loricata, Testudines. Taylor and Francis, London, 185 pp.

Smith, M.A. 1935. *The Fauna of British India, including Ceylon and Burma.* Reptilia and Amphibia, Vol. II. Sauria. Taylor and Francis, London, 140 pp.

Smith, M.A. 1943. *The Fauna of British India, Ceylon and Burma including the whole of the Indo-Chinese sub-region.* Reptilia and Amphibia, Vol. III. Serpentes. Taylor and Francis, London, 583 pp.

Somchaudhary, A. K. 1981. Seasonal fluctuation of *Amblyseius delhiensis,* a predator on eggs of cotton jassid. In: *Contribution to Acarology in India (*Ed. Channabasavanna, G.P.). Acarological Society of India, Bangalore, 256 pp.

Soni, K. 2001. Plant Parasitic Nematodes Associated with Kiwi. *M.Phil. Dissertation. HP University, Shimla.*

Srivastava, G.K. 1991. Dermaptera. In: *Animal Resources of India*. Zoological Survey of India, Calcutta, 285-289 pp.

Srivastava, G.K. 1998. Dermaptera. In: *Faunal Diversity in India*. Zoological Survey of India, Calcutta, 197-202 pp.

Srivastava, G.K. 2000. Dermaptera. In: *Fauna of Renuka Wetland.* Zoological Survey of India, Calcutta. 67-71 pp.

Srivastava, G.K. 2005. Dermaptera. In: *Fauna of Western Himalaya (Part 2).* Zoological Survey of India, Kolkata, 103-110 pp.

Srivastava, G.K. and Lal, B. 1992. Studies on some material of Dermaptera from Himachal Pradesh, India. *Rec. Zool. Surv. India,* (1991), 91 (1): 111-125.

Steinmann, H. 1989. *World Catalogue of Dermaptera, Series Entomologica*. Kluwer Academic Publ. The Netherlands and Kiado, Budapest, Hungary, 43: 1-934.

Stenidachner, F. 1867. Ichthyologische Notizen. IV. Sitzungsb. *K. Acad. Wiss. Wien,* 55: 517-534.

Subba Rao, N.V. and Mitra, S.C. 1955. *Fauna of Western Himalaya-Part I. Uttar Pradesh*. Zoological Survey of India, Calcutta, 11-15 pp.

Sultana, A. and Khan, J.A. 2000. Birds of oak forests in the Kumaon Himalaya, Uttar Pradesh, India. *Forktail* 16: 131-146.

Suyal, B.O. 1992. Birds of Sarahan Bushar, Shimla District. *Newsletter for Birdwatchers* 32 (9-10): 14-15.

Swinhoe, C. 1900. *Noctuina, Geometrina and Pyralidinia. Catalogue of Eastern and Australian Lepidoptera Heterocera in the collection of the Oxford University Museum*, Oxford, 540 pp.

Tak, P.C., Sharma, D.K., Thakur, M.L. and Saikia, U. 2008. Birds of Ladakh and analysis of their status. *Rec. Zool. Surv. India*, 108 (Part-2): 27-53.

Talbot, G. 1939. *The Fauna of British India, Butterflies*, 1. Taylor and Francis, London, 600 pp.

Talbot, G. 1947. *The Fauna of British India, Butterflies, 2.* Taylor and Francis, London, 506 pp.

Talogta, S. 2003. Insect pollinator survey of apple bloom in Shimla hills of Himachal Pradesh. *M.Phil. Thesis, Himachal Pradesh Unviersity, Shimla, India.*

Talwar, P.K. 1991. Pisces. In: *Animal Resources of India, Protozoa to Mammalia.* Zoological Survey of India, Calcutta, 577-630 pp.

Talwar, P.K. and Jhingram, A.G. 1991. *Inland fishes of India and adjacent countries*. Oxford publication, New Delhi, 1158 pp.

Tandon, S.K. and Hazra, A.K. 1998. Orthoptera. In: *Faunal Diversity in India*. Zoological Survey of India, Kolkata, 183-188 pp.

Thakur M.L. and Kataria, R.C. 2012. *Status of Vultures in Kangra valley of Himachal Pradesh, India.* LAP-Lambert Academic Publishing GmbH & Co., Saarbrucken, Germany, 103 pp.

Thakur, J.R. 1980. *Bensonia monticola* Hutton, as pest of maize in Himachal Pradesh *Entomologist's Newl. Divn. Ent. Ind. Agri. Res. Inst.* 7 (3) (1977): 18.

Thakur, M.L. 2013. Bird species composition along the altitudinal gradient in Himachal Pradesh (western Himalaya), India. *International Journal of Advanced Biological Research* 3 (4): 556-562.

Thakur, M.L. 2014. Breeding records and recent population trends of Himalayan Griffon (*Gyps himalayensis* Hume) in Himachal Pradesh, India. *American Journal of Research Communication* 2 (3): 141-152.

Thakur, M.L. 2015. Breeding ecology and distribution of White-rumped Vultures (*Gyps bengalensis*) in Himachal Pradesh, India. *Journal of Raptor Research,* 49 (2): 183-191.

Thakur, M.L. and Kataria, R.C. 2012. Breeding records and nest site preference of Indian White-backed Vulture in Kangra valley of Himachal Pradesh, India. *International Journal of Science and Nature* 3 (2): 350-353.

Thakur, M.L. and Mattu, V.K. 2011. Avifauna of Kaza area of Spiti (Himachal Pradesh) India. *International Journal of Science and Nature*, 2 (3): 483-487.

Thakur, M.L. and Mattu, V.K. 2012. *Birds of Himachal Pradesh, India*. LAP-Lambert Academic Publishing GmbH & Co., Saarbrucken, Germany, 369 pp.

Thakur, M.L. and Narang, S.K. 2012. Population status and habitat-use pattern of Indian White-backed Vulture (*Gyps bengalensis*) in Himachal Pradesh, India. *Journal of Ecology and the Natural Environment* 4 (7): 173-180.

Thakur, M.L. and Negi, V. 2015. Status and phylogenetic analyses of endemic birds of the Himalayan Region. *Pakistan J. Zool.*, 47(2): 417-426.

Thakur, M.L. and Paliwal, R. 2012. Avian diversity of Chandigarh (UT). *International Journal of Advanced Biological Research* 2 (1): 103-114.

Thakur, M.L., Mattu, V.K. and Sharma, R.M. 2006. Bird diversity and status in Tara Devi, Shimla, Himachal Pradesh. In: *Biodiversity and Environment* (Eds. Pandey B.N. and Kulkarni G.K.). A.P.H. Pub., New Delhi, 95-113 pp.

Thakur, M.L., Mattu, V.K. and Sharma, R.M. 2012. Avifauna of Mandhala Watershed, Solan (Himachal Pradesh), India. *International Journal of Advanced Biological Research* 2 (1): 120-129.

Thakur, M.L., Mattu, V.K., Hira Lal, Sharma, V., Hem Raj and Thakur, V. 2010 a. Avifauna of Arki Hills, Solan (Himachal Pradesh), India. *Indian Birds* 5 (6): 162-166.

Thakur, M.L., Mattu, V.K., Mattu, N., Sharma, V.N., Bhardwaj, R. and Thakur, V. 2010 b. Bird Diversity in Sarkaghat Valley, Mandi (Himachal Pradesh), India. *Asian Journal of Experimental Biological Sciences* 1 (4): 940-950.

Thakur, M.L., Mattu, V.K., Paliwal, R., Mehta, H.S. and Thakur, V. 2008. Birds of Shahnahar Reservoir, Kangra, Himachal Pradesh, India. *Annals of Forestry* 15 (1): 129-151.

Thakur, M.L., Mattu, V.K., Thakur, V. and Kataria, R. 2014. Avifauna of Shimla area of Himachal Pradesh, India. *International Journal of Science and Nature* 5 (3): 505-51.

Thakur, M.L., Mattu, V.K., Thakur, V. and Sharma, V. 2011. Avifauna of Nalagarh valley of Himachal Pradesh, India. *Himalayan Studies Journal* 3 (1): 36-48.

Thakur, M.L., Paliwal, R., Tak, P.C. and Mattu, V.K. 2003. Birds of Balh Valley, District Mandi, Himachal Pradesh, India. *Annals of Forestry* 11 (1): 113-126.

Thakur, M.L., Paliwal, R., Tak, P.C., Mehta, H.S. and Mattu, V.K. 2002. Birds of Kalatop- Khajjiar Wildlife Sanctuary, Chamba (HP). *Cheetal* 41 (3 & 4): 29-36.

Thakur, S.K. and Mattu, V.K. 2006. Orthopteran diversity of Pin Valley National Park, Lahaul & Spiti, India. *Zoos' Print Journal* 21 (4): 2225.

Thakur, S.S. 1988. Insect pollination studies on almond. *Ph.D. thesis, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, India*.

Theobald, W. 1878. Notes on the land and freshwater shells of Kashmir, more particularly of the Jhelum and the hills of Jammu, *J. Asiat. Soc. Beng.* 47 (2): 141-149.

Thomas, O. 1915. Scientific results from the mammal survey No. 10: The Indian bats assigned to the genus *Myotis*. *Journal of the Bombay Natural History Society*, 23: 607-612.

Thorpe, R.S., Pook, C.E. and Malhotra, A. 2007. Phylogeography of the Russell's viper (*Daboia russelii*) complex in relation to variation in the colour pattern and symptoms of envenoming. *The Herpetological Journal,* 17 (4): 209-218.

Tikedar, B.K. and Sharma, R.C. 1992. *Handbook of Indian Reptiles*. Zoological Survey of India, Kolkota, 250 pp.

Tilak, R. and Husain, H. 1977. A checklist of fishes of Himachal Pradesh. *Zool. Jb. Syst. Bd.* 104, S. 265-301.

Tilak, R. and Mehta, H.S. 1983. On a collection of amphibians of the Sirmour District (Himachal Pradesh). *Res. Bull. (Sci.) Panjab Univ.* 34: 157-166.

Tiwari, K. and Biswas, S. 1973. Two new reptiles from the Great Nicobar Island. *Journal of Zoological Society of India,* 25 (1&2): 57-63.

Uetz, P. and Etzold, T. 1996. The EMBL/EBI reptile database. *Herpetological Review,* 27: 175.

UNEP, 1995. *Global biodiversity assessment*. Cambridge University Press, Cambridge.

Van Rooijen, J. and Vogel, G. 2009. A multivariate investigation into the population systematics of *Dendrelaphis tristis* (Daudin, 1803) and *Dendrelaphis schokari* (Kuhl, 1820): revalidation of *Dendrophis chairecacos* Boie, 1827 (Serpentes: Colubridae). *The Herpetological Journal,* 19: 193-200.

Varsheny, R.K. 1998. Insecta. In: *Faunal Diversity in India*. Zoological Survey of India, Calcutta, 146-157 pp.

Varshney, R.K. 1997. Index Rhopalocera Indica. Part III. Genera of butterflies from India and neighbouring countries (Lepidoptera (C) Lycaenidae). *Oriental Insects* 31 (1): 83-138.

Vasudevan, K., Kumar, A. and Chellam, R.. 2001. Structure and composition of rain forest amphibian communities in Kalalad-Mundunthurai Tiger Reserve. *Current Science* 80: 406-412.

Vats, R. and Gupta S.K. 2011. Icthyofauna of four district of northern Haryana. *Journal of Arts, Science and Commerce*, 4: 1-7.

Venugopal, P.D. 2010. An updated and annotated list of Indian lizards (Reptilia: Sauria) based on a review of distribution records and checklists of Indian reptiles. *Journal of Threatened Taxa*, 2: 725-738.

Verma, L.R. 1990. *Beekeeping in Intergrated Mountain Development*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 367 pp.

Verma, L.R. 1992. *Honeybees in Mountain Agriculture*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 274 pp.

Verma, L.R. and Chauhan, P. 1985. Distribution, abundance and diversity of insect pollinators in apple orchards of Shimla hills. *Indian J. Ecol.* 12: 286-292.

Verma, L.R. and Jindal, K.K. 1997. *Fruit Crops Pollination*. Kalyani Publishers, Ludhiana, 405 pp.

Verma, P. 2002. Studies on Nematodes from wild lizards. *M.Phil. Dissertation. HP University, Shimla.*

Vishwanath, W., Lakra, W.S. and Sarkar, U.K. 2007. *Fishes of North East India*. National Bureau of Fish Genetic Resources Publication, 264 pp.

Vyas, R., Giri, V. and Bauer, A.M. 2006. First record of *Hemidactylus persicus* Anderson 1872 (Squamata: Sauria: Gekkonidae) from the Republic of India with notes on its distribution. *Hamadryad,* 30 (1&2): 209-211.

Walia, V.K. 1988. Studies on Geometridae (Lepidoptera) of North-west India (Subfamily Geometrinae). *Res. Bull. Pb. Univ.* 39 (I-II): 101-107.

Walia, V.K. 1994 a. On a new species of genus *Scardamia* Guenee (Subfamily Boarmiinae). *UP Journal of Zoology,* 14 (1): 29-32.

Walia, V.K. 1994 b. On a new species of genus *Gelasma* Warren (Subfamily Geometrinae). *UP Journal of Zoology,* 14 (2): 176-178.

Walia, V.K. 1995. Record of a new species under genus *Idaea* Treitschke (Sterrhinae: Geomatridae: Lepidoptera). *Ann. Entomol.* 13 (1): 39-41.

Walia, V.K. 2000. On a new species of genus *Hemithea* Duponchel (Geometrinae: Geometridae: Lepidoptera). *Geobios,* 27: 191-193.

Walia, V.K. 2005. Insecta: Lepidoptera: Geometridae (Moths). In: *Fauna of Western Himalaya (Part 2)*. Zoological Survey of India, Kolkata, 181-190 pp.

Walia, V.K. and Pajni, H.R. 1987. Studies on the Geometridae (Lepidoptera) of North-west India. Subfamily Scopulinae. *Res. Bull. Pb. Univ.* 38 (III-IV): 9-14.

Waltner, R.C. 1974. Geographical and altitudinal distribution of amphibians and reptiles in the Himalayas. *Cheetal* 16 (1): 17-25; 16 (2): 28-36; 16 (3): 14-19; 16 (4): 12-17.

Whistler, H. 1926. The birds of Kangra District, Punjab. *Ibis* 12: 521-581, 724-783.

Whitaker, R. and Captain, A. 2004. *Snakes of India: The Field Guide*. Draco Books. Chengalpattu, Tamil Nadu, 479 pp.

Wildlife (Protection) Act 1972. *Ministry of Environment and Forests, Govt. of India*, Amendment 1991.

Wilson, D.E. and Reeder, D.M. (eds.) 1993. *Mammal Species of the World: A Taxonomic and Geographic Reference*. Smithsonian Institute Press, Washington and London.

Wilson, E.O. 1997. Introduction. In: *Biodiversity II* (Eds. Reaka-Kudla, *et al.*). J. Henry Press, Washington, D.C. 133 pp.

Wilson, E.O. and Peters, F.M. 1988. *Biodiversity*. National Academy Press, Washington DC.

Wynter-Blyth, M.A. 1940-46. A list of the butterflies of the Shimla hills. *J. Bombay Nat. Hist. Soc.* 41: 716-741; 1945, 45: 256-257; 1946, 46: 735-736.

Wynter-Blyth, M.A. 1950-51. A Naturalist in the north-west Himalaya. *J. Bombay Nat. Hist. Soc.* 50: 344-354; 559-572.

Wynter-Blyth, M.A. 1957. *Butterflies of the Indian Region.* Bombay Natural History Society, Bombay, 523 pp.

Zambre, A., Sheth, C., Dalvi, S. and Kulkarni, N. 2009. First Record of *Protobothrops jerdoni xanthomelas* (Gunther, 1889) from Eaglenest Wildlife Sanctuary, India. *Journal of the Bombay Natural History Society*, 106 (2): 211-213.

Zoological Survey of India, 1990. *Handbook on Collection and Preservation of Animals*. Zoological Survey of India, Kolkata, 236 pp.