

## CHAPTER V

### FAUNA

#### 1. *Faunal and Zoogeographical Characteristics*

IN THE LAST EDITION of *The Imperial Gazetteer of India* (1907), the chapter on Zoology dealt only with the "principal Vertebrate animals of India"; and the Invertebrates were not dealt with at all. Since then, there has been a large accumulation of data on Indian fauna, particularly the invertebrates; in the number of species and varieties, the invertebrates comprise the bulk of our fauna. The present account includes both the vertebrates and invertebrates; a brief review of the faunal characteristics of India; game animals and the preservation of wild life; and the basic ecological balance between man and wild life. A number of the smaller invertebrate phyla, such as Bryozoa, Rotifera, Phoronida, Brachiopoda and Chaetognatha have had to be omitted.

Before we go into the characteristics of Indian fauna, it would be appropriate to say a word on the geographical, physical and climatic background. India lies in the subtropical belt between latitudes  $8^{\circ} 4' N.$  and  $37^{\circ} 6' N.$  and longitudes  $68^{\circ} 7' E.$  and  $97^{\circ} 25' E.$  Its land area exceeds 3 million sq. km. That includes, in addition to the main land-mass of India, the islands in the Bay of Bengal (the Andamans and the Nicobars) and the Arabian Sea, (the Laccadive, Minicoy and Amindivi Islands). Faunistically however, Pākistān, Nepāl, Burma and Ceylon are inseparable from India, and the entire "Region" has to be treated as a single unit.

The physical and climatic characteristics of the area vary enormously, and many different kinds of habitats are found. The elevation varies from the plains to the highest mountains in the world. The air temperatures vary from tropical, uniformly high ones to extremes of heat and cold. The vegetation changes from tropical evergreen forests to arid desert tracts. While the continental land-mass of North India and Burma, including the Himālayas, have only recently (speaking geologically) emerged from the sea, most of the peninsular portion is of great antiquity and there is no evidence of its ever having been under the sea.

The fauna of this Region, extremely varied as it is, comprises all the major groups of the animal kingdom. Nearly 76,000 species of animals have been listed here and they form 8·2 per cent of the known living world species (c. 920,000) (Roonwal, 1959). While the vertebrate fauna of India is well known, and there is little possibility of new species being discovered except in certain mammals (smaller rodents and bats) and Amphibia, at least one-half of the invertebrate fauna still remains to be discovered.

The region has certain specialized faunas—animals in certain environments have developed special adaptations. For instance, fishes living in torrential streams have developed suckers with which to hold on to the rocks; and cave-dwelling insects have lost their eyes and developed extra-long feelers. Thus we have what may be called cave fauna, desert fauna, torrential stream fauna, river fauna, mangrove-swamp fauna, estuarine fauna, backwaters fauna, pond and lake faunas, littoral or beach fauna, hot-springs fauna and relict fauna. The last named is of unusual interest. We have in the Abor country in the North East Frontier Agency an ancient Arthropod, the Onycophoran *Typhloperipatus williamsoni* Kemp—a small, soft-bodied, slug-like, primitive Arthropod which has remained unchanged through millions of years.

In 1858 Sclater divided the world into six zoogeographical regions. These were so well based that they are substantially accepted today. The regions were :

*Creatio palaeogeana* :

1. Regio palaeartica
2. Regio aethiopica
3. Regio indica
4. Regio australiana

*Creatio neogeana* :

5. Regio nearctica
6. Regio neotropica

Later authorities have made subdivisions of Sclater's major regions, and the following broad classifications as given by Beaufort (1951) may be accepted. Three major divisions (Arctogaea, Notogaea and Neogaea) with 7 regions and a number of subregions are recognized as follows :

A. *Arctogaea* :

1. Holarctic region—
  - (a) Palaeartic subregion. (Iceland, Europe, northern tip of Africa, Asia, north of India and excluding Southern Arabia).
  - (b) Nearctic subregion. (North America and Greenland.)

2. Ethiopian region—
  - (a) African subregion. (Africa, excluding the northern tip and Arabia.)
  - (b) Madagascar subregion. (Madagascar.)
3. Oriental (or Indian) region. (Tropical part of Asia, e.g., India except north-western part, Ceylon and east up to Borneo and the Philippines, but excluding Celebes and further east.)

*B. Notogaea :*

4. Australian region.
5. New Zealand region.
6. Oceanic Islands region.

*C. Neogaea :*

7. Neotropical region. (Central and South America.)

While the occurrence of the Palearctic and the Oriental elements in the Indian fauna has been well established, recent evidence shows that small amounts of the African (Ethiopian) and even the South American (Neotropical) elements are also found. A few groups may be taken to illustrate the origins of the Indian fauna.

*Fishes :* Hora (1937) showed that the freshwater fish fauna of India originated in South East Asia. In consequence, the river systems of North India (the southern drainage of the Himālayas), as they arose, were populated from the east. There is a difference between the northern (Central Asian) and southern (North Indian) drainages of the Himālayas. The northern rivers run through broad beds and often expand into lakes and marshes, whereas the southern rivers, fed by more plentiful rain, are torrential; hence special adaptations for holding on to rocks are to be found among fishes in the south. The same genus may occur in the north and the south, but the species are different. The North Indian fauna is more akin to the fauna of South East Asia, and has been prevented from going north to Central Asia by the Himālayan barrier.

Hora (1938) further postulated that the elevated Sātpura area, which in the Miocene times ran diagonally across India to the Himālayas, permitted the dispersal of hill-stream fishes from the Western Ghāts and the hills of South India (examples : *Bhavania*, *Silurus*, *Parapsilorhynchus* and *Thynnichthys*). Beaufort (1951), however, believes that this extension must have occurred earlier, especially in *Thynnichthys*.

Many of the marine fishes of India are believed to have originated in the Malaya Archipelago (Ekman, 1953).

For Amphibia and reptiles, dispersals have been slow and gradual, compared to the birds, mammals and insects, occurring mostly in times of flood and other fortuitous happenings. Past geography and geology—contiguity or otherwise—are more important in understanding present-day distributions in reptiles and Amphibia than in the more active animals.

Smith (1931) states that it is the past contiguity of land areas which explains the existence of numerous species in common between the Malaya Archipelago and the mainland of Asia. The present distribution of the gharial, *Gavialis gangeticus*, and the freshwater turtles, *Chitra* and *Pelochelys*, in river systems which are today not connected, can be explained by their past connections. Similarly, the present-day discontinuous distribution of several species, both in the hills and the lowlands, is explicable on the basis of a former continuous distribution over a large area. Thus, the hill tortoise, *Testudo elongata* Blyth (synonym : *T. parallelus* Annand.), occurs in isolated patches in Vietnam, Burma, Thailand, Chota Nāgpur plateau and Malaya. It is unlikely that the Chota Nāgpur forms crossed the Ganga plains to reach Indo-China, Burma and Malaya. In snakes there is an important element in common with the Neotropical region but absent elsewhere—these are the families Anilidae and the subfamilies Dipsadinae and Xenoderminae of the family Colubridae, and a genus of the Viperidae.

*Birds* : From a recent analysis Moreau (1952) concluded that Africa has been the centre of evolution of the South Asian avifauna. Ripley (1953) has supported this hypothesis and shown that while the Indian avifauna is overwhelmingly Oriental in character and has some Palaearctic element, the African or Ethiopian element is also considerable. Out of 176 endemic species, 17 per cent are Palaearctic, 17 per cent Ethiopian and 62 per cent Indo-Chinese.

*Mammals* : Among Indian mammals there are several genera which are typically Oriental. A few of these are : *Elephas*, *Bubalus*, *Boselaphus*, *Antelope*, *Nemorhaedus*, *Moschus*, *Hylobates*, *Presbytis*, *Loris*, *Nycticebus*, *Neofelis*, *Ailurus*, *Manis*, *Funambulus*, *Ratufa*, *Hadromys*, *Gohunda* and *Rhizomys*. There is also a considerable amount of the Palaearctic and Ethiopian elements. It is interesting to note that typically African animals such as the giraffe and hippopotamus once roamed Northern India and their fossil remains have been found in the Pleistocene fauna of the Siwālik hills.

In conclusion, it may be stated that Indian fauna consists of three principal elements—a large proportion of the Oriental

element, and fair amounts of the Palaearctic and Ethiopian elements. Finally, a small proportion of the Neotropical (South American) element also exists. This is especially evident in the snakes as discussed above, and is also shown by certain insects. For instance, the termite genus *Anoplotermes*, which has hitherto been found mainly in South America, with a few representatives in Africa, has recently been discovered in Assam where it is represented by a single species. (Roonwal and Chhotani, 1959, 1960).

## 2. *Types of Animals Found in India*

All the known major phyla of the animal kingdom, from the microscopic Protozoa to the largest mammals, are represented in the Indian region. Some phyla, like the Rotifera, are represented by only a few species; others, such as fishes, birds and mammals by hundreds; and still others, such as molluscs and insects, by thousands. It is convenient to have two major divisions—the Invertebrata and Chordata (which includes the Vertebrates). Representatives of the various major phyla found in our region will now be briefly reviewed—for want of space the minor phyla are excluded.

### *Division A : THE INVERTEBRATA*

#### (i) PHYLUM PROTOZOA

This includes the tiny, microscopic unicellular (or according to some acellular) creatures with the simplest organization. Our knowledge of these animals in India is still very poor. They are either free-living forms in the soil, in freshwater and marine environments (pelagic as well as benthal) or parasites in the body of both vertebrates and invertebrates. The latter are causative organisms of diseases, such as malaria and amoebic dysentery. Among free-living forms may be mentioned *Amoeba*, *Euglena*, *Paramecium* and *Noctiluca*, the last named being a pelagic marine phosphorescent form which is responsible for the phosphorescence seen in our seas.

(ii) PHYLUM PORIFERA  
(Sponges)

This is a small group of primitive, sessile aquatic animals which live in fresh water as well as in sea-water. Sponges live in small or large "colonies" which assume various shapes—a rounded ball, a cup, stalks with branches and thin encrustations on a substrate. Three classes are recognized, viz., Calcareae (Calcospongiae), Hexactinellida (Triaxonida or Hyalospongiae) and Demospongiae. About 300 species occur in India. Of these, the family Spongillidae (class Demospongiae), with about 25 species and a few subspecies, inhabit fresh water; many of the species belong to the genus *Spongilla*.

(iii) PHYLUM COELENTERATA  
(Polyps, medusae, jelly-fishes, sea-pens, sea-anemones and corals)

This is a group of primitive soft-bodied aquatic (with mostly marine, and a few freshwater) forms which is well represented in the Indian region by about 800 species. Three main classes are recognized :

Cl. 1. Hydrozoa (Hydromedusae) (polyps and medusae) : Two species of freshwater polyps, *Hydra oligactis* and *H. vulgaris*, are found in India. A freshwater medusa, *Limnocnida indica* Annand., is known from the rivers and lakes of Peninsular India. All the remaining members of the class are marine, and among the more common forms may be mentioned *Campanularia nolliformis* and *Laomedea (Obelia) spinulosa*.

Cl. 2. Scyphozoa (Scyphomedusae) (jelly-fishes) : Among the common jelly-fishes of our seas may be mentioned *Aurelia solida* and *Crambionella annandalei*.

Cl. 3. Anthozoa (Anthomedusae) (corals and sea-pens) : This class is well represented in our seas by the Alcyonacea (soft corals, e.g., *Dendronephthya* spp.), the Gorgonacea (horny corals, e.g., *Melitodes ornata*), the Pennatulacea (sea-pens, e.g., *Pennatula indica*), the Madreporaria (stony corals, e.g., *Flabellum stokesi*, *Fungia danai*, etc.)

(iv) PHYLUM PLATYHELMINTHES  
(Flatworms)

This phylum includes worms which are compressed dorsoventrally and possess no body cavity, the space being filled with

undifferentiated parenchymatous cells. They have free-living and parasitic modes of life. Three existing classes are reviewed below.

*Cl. 1. Turbellaria (free-living flatworms) :* Normally free-living, sometimes commensal or parasitic. Available on land, in fresh water and in the sea. Common Indian examples belong to the genera *Planaria*, *Bipalium*, *Pelmatoplana* and *Dolichoplana*.

*Cl. 2. Trematoda (parasitic flatworms) :* Exclusively parasitic worms—some, attaching themselves to the superficial parts of the host, are ectoparasites while others, penetrating the internal parts of the host (both vertebrates and invertebrates) and settling down in some internal organs, are endoparasites.

Three orders are recognized : Monogenea, Digenea and Aspidogastrea.

- (i) Monogenea : It includes ectoparasites only. The genera, *Diclidophora*, *Diplozoon*, *Gyrocotyle* and *Pricea* are commonly found on fishes while *Polystomum* is reported from the frogs.
- (ii) Digenea : It is the largest group among the trematodes and includes endoparasites, some of which cause serious diseases of man and other animals. *Fasciola gigantica* Cobbold and *Fasciola indica* Varma, commonly known as liver-flukes heavily infest bile ducts of sheep, goat, cattle and camel, and cause liver-rot. *Fasciolopsis buski* (Lankester) infests human beings through infected *Trapa* fruits. *Schistosoma haematobium* (Bilharz) occurs in human blood and causes a serious disease "Schistosomiasis". *Schistosoma indicum* Montgomery occurs in cattle, goat, sheep, horse, ass and camel. Amphistomes (*Paramphistomum* and *Cotylophoron*) commonly infest the rumen of cattle, goat and sheep.
- (iii) Aspidogastrea : It is the smallest group, including parasites of vertebrates and invertebrates. Genus *Aspidogaster* is fairly common in India and several forms have been reported: *Aspidogaster indicum* Dayal occurs in the freshwater fish *Barbus*.

*Cl. 3. Cestoda (tapeworms) :* They commonly possess a long tape-like body with head (scolex) bearing, in many forms, an armature of suckers and hooks; the body is divided into numerous segments. In adult stage, they infest the intestines of vertebrate animals. *Taenia solium* Linn, and *Taenia saginata* Goeze commonly parasitize the human intestine. *Echinococcus granulosus* Batsch, the larval form of which is termed "Hydatid cyst", occurs

in the liver of human beings and other mammals. Among the other genera parasitizing cattle, goat and sheep may be mentioned *Avitellina*, *Moniezia* and *Stilesia*.

#### (v) PHYLUM ASCHELMINTHES

This includes vermiform animals either unsegmented or with superficial segmentation. These may be free-living or parasitic in other animals. Six main classes are recognized : Rotifera, Gastrotricha, Kinorhyncha, Priapulida, Nematoda and Nematomorpha.

*Cl. 1. Rotifera* : These are minute animals occurring in ponds and pools and are characterized by the possession of a ciliated trochal disc which serves for locomotion and food collection.

*Cl. 2. Gastrotricha* : This is a small group of minute forms occurring in fresh water. These are unsegmented, worm-like, and bear resemblance to Rotifera.

*Cl. 3. Kinorhyncha* : This class includes minute forms devoid of cilia but more or less spiny. The body consists of 13-14 segments with superficial segmentation. They are found at the bottom of littoral zone in the shallow water of the sea.

*Cl. 4. Priapulida* : This group includes marine animals of moderate size. The body is characterized by the possession of a proboscis introversible into the interior and a distinct trunk.

*Cl. 5. Nematoda (roundworms)* : They include aquatic, terrestrial or parasitic vermiform animals. Genus *Ascaris* is well represented in numerous vertebrate hosts. *Ascaris lumbricoides* Linn. parasitizes the human intestine (of both adults and children). *Ancylostoma duodenale* (Dubini) (hookworm), *Dracunculus medinensis* (Linn.) (guinea-worm), *Enterobius vermicularis* (Linn.) (pin-worm) and *Trichuris trichiura* (Linn.) (whipworm) commonly infect man. *Wuchereria bancrofti* (Cobb) causes "Elephantiasis" (filariasis) in man. *Strongylus equinus* Müller occurs commonly in the alimentary canal of horses and donkeys. Besides these, several genera of soil-inhabiting Nematodes, *Anguillulina*, *Aphelenchoides*, *Aphelenchus* and *Heterodera*, cause severe damage to the crops and are of great economic importance.

*Cl. 6. Nematomorpha (Gordiaceae)* : A small group of animals whose members are both terrestrial and aquatic (freshwater as well as marine). They are elongated and thread-like but normally the entire body rests in irregular coils.



(vi) PHYLUM ACANTHOCEPHALA  
(Spiny-headed worms)

This group includes endoparasitic, elongated worms with protrusible proboscis provided with numerous hooks. *Acanthogyrus* occurs in the alimentary canal of the fish rohu (*Labeo rohita*). *Echinorhynchus gigas* Van Cleave commonly infests the pig. *Moniliformis* is widely represented in terrestrial mammals, chiefly rodents.

(vii) PHYLUM ENTOPROCTA

This group includes small forms (solitary or colonial), either stalked or sessile. The distal end is modified into a lophophore (a cirlet of ciliated tentacles), while the mouth and anus open inside the tentacular cirlet. Genus *Urnatella* is available from freshwater locations.

(viii) PHYLUM ANNELIDA  
(Polychaetes, earthworms and leeches)

This phylum of free-living, annulated worms is divisible into two classes: Chaetopoda and Hirudinea.

Cl.1. Chaetopoda : Has 3 orders, a small one (Archiannelida) and two large ones.

- (i) Archiannelida : A small order consisting of small marine worms occurring on the shore. Three genera, *Polygordius*, *Protodrilus* and *Saccocirrus*, have been recorded from the eastern shores of India.
- (ii) Polychaeta : Worms with numerous bristles on parapodia. About 450 species are known from the Indian region—some are freshwater and brackish-water forms, others marine. Among the former may be mentioned *Lycastis indica* Sthn., and the species of *Dendronereis* and *Nereis*. Among the marine forms are *Aphrodita talpa* Quatr., *Chloeia flava* (Pall.), *Perinereis nuntia* (Savig.) and many others.
- (iii) Oligochaeta (earthworms) : They are worms with only a few small bristles on the body, have no feet or parapodia, and are hermaphrodites. They inhabit mostly freshwater or damp earth. Eight families, 50 genera and about 350 species are known from the Indian region, the largest

family being the Megascolecidae. Among the commonest earthworms of India are *Pheretima posthuma* (L. Vaill.), *Eutyphaeus nicholsoni* (Bedd.), *E. waltoni* Michael. and species of the genera *Megascolex* and *Drawidia*.

Cl.2. Hirudinea (leeches) : The leeches are a small class of which only 4 families and about 50 species occur in India. Three orders are recognized : Acanthobdella (absent in India), Rhynchobdella and Arhynchobdella.

Rhynchobdella : They are leeches which suck blood and juices of the prey by means of a protrusible proboscis. Two families (Ichthyobdellidae and Glossiphonidae) and about 23 species occur in our region.

Arhynchobdella : They are jawed leeches without a proboscis and are either freshwater or terrestrial, never marine. Two families and about 27 species occur in India.

#### (ix) PHYLUM ARTHROPODA

(Millipedes, centipedes, insects, crabs, prawns, spiders, scorpions, ticks, mites, etc.)

This is by far the largest phylum in the animal kingdom and contains over two-thirds of the known species. Economically also it is the most important group. It contains the insects and mites which are serious pests of agriculture and also act as carriers of many serious diseases in man and animals. Of the 12 classes into which this phylum is generally divided, the more important ones are the Xiphosura, Onychophora, Arachnida, Crustacea, Diplopoda, Chilopoda and Insecta.

Cl.1. Xiphosura (Merostomats—king-crabs) : An ancient class of marine animals of which only a few species are now left. The body is covered with a thick, dark brown shield. Two species of king-crabs occur on the east coast of India—*Tachypleus gigas* (Müll.) (syn. *Limulus mollicanus* Lat.) and *Carcinoscorpius rotundicauda* (Lat.).

Cl.2. Onychophora (Peripatus) : They are small, slug-like, terrestrial animals. A single species, *Typhloperipatus williamsoni* Kemp, lives in the Abor hills, North-eastern India. It is a relict species, having survived unchanged for millions of years.

Cl.3. Arachnida (spiders, scorpions, ticks and mites) : This class is divided into 10 orders of which the important ones are Scorpiones, Araneae and Acarina.

Scorpiones (scorpions) : About 90 species of scorpions are known in the Indian region. Among the more common species are *Buthus tamulus* (Fabr.) (all-India), those of the genera *Palamnaeus* (*P. bengalensis* (C. Koch) North India, eastward to Assam) and *Scorpio*.

Araneae (spiders) : A large order with about 16 families and 250 species from our region. All spiders are carnivorous, and most of them spin webs.

Acarina (ticks and mites) : Members of this group include the ticks (larger specimens) and mites (of minute size), many of which, at some stage or other in their life history, are ectoparasites of both vertebrates and invertebrates.

Two families of ticks, the Argasidae and the Ixodidae, with about 11 genera and 41 species, occur in India. They are ectoparasites of mammals (including man), birds and reptiles. Some species are believed to transmit diseases.

Mites are both terrestrial and aquatic. Many species (e.g., those of the family Trombiculidae) are parasitic on vertebrates and serve as vectors of human diseases such as tsutsugamushi disease (scrub typhus). The species *Trombicula deliensis* Walch is common in India; its larvae parasitize rodents, shrews and other mammals. Over 50 species of Trombiculids are known from our region. Little is known about our water mites, although there is no doubt that the fauna is rich.

Cl.4. Crustacea (crabs, prawns, lobsters, barnacles, wood-lice, etc.) : The Crustacea are mostly aquatic animals varying in size from microscopic forms (e.g., *Cyclops* and *Daphnia*) to large crabs and lobsters about half a metre in length. Five subclasses, 20 orders and over 1,000 species are represented in the Indian region.

Subcl (i) Branchiopoda (shrimps) : Without a well developed carapace over body. Four families occur in India. A common form is *Artemia salina* (Linn.) found in saline waters.

Subcl. (ii) Ostracoda : Small (1-2 mm. long) forms occurring in fresh water as well as sea-water. Two orders are found in India.

Subcl. (iii) Copepoda : Both are free-living and marine parasitic forms. Two orders occur in India : Eucopepoda (free-living), the common genera being *Cyclops* and *Calanus*, and Branchiura (mostly parasitic, causing considerable harm to fishes), with *Argulus* as one of our most common genus.

*Subcl. (iv) Cirripedia* : Sessile in the adult stage. Two orders occur : Thoracica includes the common foulers (*Balanus*, *Lepas*) which attach themselves to the bottoms of ships and harbour installations; and Rhizocephala (e.g., *Sacculina*), which attach themselves to the abdomen of marine crabs and undergo extreme degeneration.

*Subcl. (v) Malacostraca* (isopods, prawns, crabs, lobsters) : A large group which includes 10 orders in India and are an important source of food. The large order Isopoda includes the wood-borers which do considerable damage to harbour installations and boats. Some forms (*Nicholsia* sp.) live in deep wells. Amphipoda is also a large order, with 42 families in India, and some of them include harmful wood-borers. Decapoda has 60 families in India and includes the edible prawns, crabs and lobsters. Stomatopoda is a small marine order, with *Squilla* as the common genus.

*Cl. 5. Diplopoda* (millipedes) : Nearly 20 families, 90 genera and 300 species of millipedes occur in the Indian region. They are segmented, cylindrical animals, with a pair of legs in each segment. They inhabit moist soil under stones and logs.

*Cl. 6. Chilopoda* (centipedes) : Somewhat similar to the Diplopoda, but with a flattened body and fewer body-segments. One of our most common genus is *Scolopendra*.

*Cl. 7. Insecta* (insects) : They are small, segmented, six-legged invertebrates, whose body is covered with hard, cuticular shields and they usually possess two pairs of wings for flight. They occur in all situations, but are mostly terrestrial; many forms also occur in fresh water and only a few on the sea-shore. This is the largest group among animals, and nearly 50,000 species are known in the Indian region alone. Many species are harmful pests of agriculture and are carriers of human and animal diseases. A few species, like the honey-bees, lac insects and silk-worms, are useful in human economy. The class is divisible into 29 orders all of which, with one exception (*Grylloblattoidea*), occur in India. The more important orders are dealt with below :

The Apterygote orders : Four small orders are primitively wingless. Among these are the Thysanura (*Lepisma*—silver-fish), and the Collembala (spring-tails).

Ephemeroptera (may-flies) : Small delicate insects. They breed in fresh water.

Odonata (dragon-flies and damsel-flies) : Large, powerful insects with two pairs of long, transparent wings. They are carnivorous and breed in fresh water.

**Orthoptera (*sensu stricto*)** : It includes the families Tettigonidae (long-horned grasshoppers), the Gryllidae (crickets) and the Acrididae (short-horned grasshoppers). The last family includes locusts of which the most destructive species in India is the Desert Locust, *Schistocerca gregaria* (Forsk.) which swarms in cycles, the swarming periods (several years) alternating with similar non-swarming periods.

**Phasmida (stick insects)** : Long-bodied, ungainly insects which often simulate dried twigs in colour, body-shape and position of rest.

**Dermaptera (earwigs)** : A small order of insects characterized by the possession of a pair of powerful forceps at the hind end of the body. Many species show maternal care of the eggs and the young.

**Dictyoptera (cockroaches and mantises)** : It includes two families. The Blattidae includes the cockroaches. Two introduced species occur commonly in our houses—a large one, *Periplaneta americana* (Linn.), and a small one, *Blattella germanica* (Linn.). The Mantidae includes several species of praying mantises.

**Isoptera (termites)** : Nearly 200 species have been found in the Indian region and about 2,000 in the world. They are social insects, with various castes, e.g., workers, soldiers and reproductives (male and female or king and queen), and division of labour. A few species build large earthen mounds which go up to 2-3 metres in height. The common mound-building species in North India is *Odontotermes obesus* (Rambur) and in South India, *O. redemanni* (Wasm.).

**Mallophaga (biting lice or bird lice)** : Wingless, they are external parasites of birds and mammals.

**Siphunculata (Anoplura) (sucking lice)** : Wingless. Are external blood-sucking parasites of mammals. One species, with two forms, commonly occur on man—the Head Louse, *Pediculus humanus capitis* de Geer, and the Body Louse, *P. h. corporis* de Geer. *P. humanus* is responsible for the transmission of several serious diseases—endemic typhus, trench fever, murine typhus and a form of relapsing fever.

**Hemiptera (bugs, plant-lice and scale-insects)** : A large order characterized by sucking mouth-parts. They mostly suck plant-juices (plant-lice or aphids, and scale-insects or coccids), but some are blood-suckers (e.g., the Indian

bedbug, *Cimex rotundatus* Sign.). The lac insect of India, *Laccifer (Tachardia) lacca* (Kerr), whose female secretes the lac, also belongs to this order.

Thysanoptera (thrips) : Small sucking insects which do considerable damage to the host-plant. Some species transmit virus diseases of plants.

Neuroptera (alder-flies, lace-wings and ant-lions) : A moderate-sized order of usually harmless insects. The larvae of the family Chrysopidae are the familiar ant-lions.

Diptera (flies, mosquitoes, gnats) : A large order which has the hind pair of wings reduced and modified into "halteres". It includes many species of great economic importance, as they are carriers of many serious diseases of man and domesticated animals, such as malaria, yellow fever and kala-azar.

Lepidoptera (butterflies and moths) : A large order of often brilliantly coloured insects, the colour being due mainly to the presence of a large number of scales of various colours and patterns on the wings. The butterflies are often brilliantly coloured, day-flying insects which fold the wings when at rest. Moths, which form the bulk of the order, are usually drab-coloured, nocturnal insects which keep their wings spread as they take rest. The moth group contains several serious pests of agriculture.

Siphonaptera (Aphaniptera) (fleas) : A small order of small, wingless insects which are external parasites on warm-blooded vertebrates (birds and mammals). Some of the species transmit serious diseases of human beings. The species which transmits bubonic plague in India is *Xenopsylla cheopis* (Rothschild); it is an ectoparasite on the common rats, *Rattus rattus* and a number of other rodents.

Hymenoptera (bees, wasps, ants and ichneumons) : A large order which contains a number of families (Apidae or bees and Formicidae or ants) which show a highly developed social life and stratification into castes (cf., Isoptera above). The common honey bees of India are : the common species. *Apis indica* Fabr., a smaller, less common species *Apis florea* Fabr., and a third one (of the submontane regions), the rock bee, *Apis dorsata* Fabr. The large black ant, common in houses in North India, is *Camponotus compressus* Fabr. The large (winged individuals about 2 cm. long) Doryline ant whose bite is very painful is *Dorylus* sp.

Coleoptera (true beetles) : This is by far the largest order among insects. Many species are serious pests of our forest trees, agricultural crops and stored grain.

(x) PHYLUM MOLLUSCA

(Slugs, univalves, bivalves, oysters, cuttle-fish and squids)

This is a large phylum, next in size only to the Insecta, and contains about 11,000 species from the Indian region. It is divided into six classes, all of which are represented in India. Some species are economically important—their shells are used for making buttons; the pearl oyster produces the pearl of commerce; and some species are wood-borers and foulers and do serious damage to harbour installations and the bottoms of boats and ships.

Cl. 1. Chitonida (Chitons) : A small class with four Indian families.

Cl. 2. Gastropoda (apple snail, pagoda snail, etc.): A large class with 9 Indian orders and nearly 117 families. Among the common species the following may be mentioned: *Trochus niloticus* Linn. (Indian Ocean), a species commercially important for its shell; *Pila globosa* (Swain.), the large apple snail common in Indian fresh water; and *Lymnaea* and *Indoplanorbis*, common throughout India.

Cl. 3. Scaphopoda : A small class with 2 Indian families. *Dentalium magnificum* Smith is common in the Indian seas.

Cl. 4. Bivalvia (Pelecypoda) (Bivalves): A large order with 55 Indian families. The common species are : *Mytilus viridis* Linn. (South India and the Andamans), *Lamellidens marginalis* (Lea) and species of the genera *Corbicula* and *Martesia* (common throughout India). The Indian pearl oyster, which is the source of our pearl fishery in the Gulf of Manaar, is *Pteria vulgaris* (Schumach.).

Cl. 5. Pteropoda : A Small class, with 5 families in India.

Cl. 6. Cephalopoda (cuttle-fish and octopuses) : A moderate-sized order of marine molluscs, with 19 families in India. The genera commonly met with are: *Nautilus* (pearly nautilus), *Loligo*, *Sepiella* (cuttle-fish) and *Octopus* (octopuses).

(xi) PHYLUM ECHINODERMATA

(Sea-lilies, sea-cucumbers, star-fishes, sea-urchins and brittle stars)

Echinoderms are marine, radially-symmetrical animals and are common in our seas, about 500 species having been found. The

living Echinoderms are divisible into 5 classes, all of which occur in our region.

Cl.1. Crinoidea (sea-lilies and feather-stars) : Among the common shallow-water species is *Tropiometra* sp.; among the deep-sea forms (250-5,000 metres) are *Comastrocrinus springeri* (Clark) of the seas around the Andaman Islands and *Bathycrinus paradoxus* (Clark) of the Bay of Bengal.

Cl.2. Holothuroidea (sea-cucumbers) : They are cucumber-shaped animals. The body-wall of some species contains poisons which are used for catching fish. The species *Holothuria atra* Jäger, *H. scabra*, Jäger and *Stichopus chloronotus* Brdt. are common in the Palk Strait, South India and are edible being made into a soup.

Cl.3. Asteroidea (star-fishes) : Some of the common star-fishes of the Indian waters are : *Astropecten indicus* Döder., *Luidia maculata* Müll. & Trosch. and *Oreaster lincki* Lütken.

Cl.4. Echinoidea (sea-urchins) : They have a semi-round body, covered with spines of various shapes and sizes. Among our common species are *Salmacis bicolor* Agassiz. *Temnopleurus toreumaticus* (Klein), *Lovenia elongata* (Gray) and *Laganum decagonale* (de Blain.).

Cl.5. Ophiuroidea (brittle-stars) : They are small but relatively active Echinoderms. Among the species commonly found in Indian waters are *Ophiocoma scolopendrina* Agsz., *Ophiothela danae* Ver., and *Gargonocephalus levigatus* Koch.

### Division B: THE CHORDATA (Vertebrata partim)

#### (xii) PHYLUM CHORDATA

The Chordata are united by a few but important common characters either throughout life or in some portion of the life-cycle. They are conveniently divided into five subphyla as follows :

1. Hemichorda (acorn worms).
  2. Urochorda (Tunicata) (ascidians).
  3. Acrania (lancelets).
  4. Agnatha (cyclostomes).
  5. Gnathostomata (fishes, amphibia, reptiles, birds and mammals).
- } Vertebrata

The last two subphyla together constitute what are commonly known as vertebrates. Among these, the Gnathostomata are the



animals with which we are most familiar. The bulk of our space will be devoted to this group.

*Subphylum (i) Hemichorda (acorn worms):*

They are marine, worm-like creatures without legs, but the body surface is uniformly ciliated ; the length varies from about 2-250 cm. A few species have been recorded from Indian waters, such as *Saccoglossus bournei* (Menon), *S. madrasensis* Rao and *Glossobalanus minutus*, from the Madras coast and the Gulf of Manaar, and *Glossobalanus* sp. and *Balanoglossus* sp. from Port Okha. The genus *Cephalodiscus* also is known from the Indian Ocean.

*Subphylum (ii) Urochorda (Tunicata) (ascidians or sea-squirts):*

Several orders and families of these forms, some sessile, others pelagic, occur in our seas. Among the sessile ones are the ascidians, the most common Indian forms being members of the genus *Herdmania* of which 4 species are known from our seas—*H. pallida* (Hell.), *ceylonica* (Herdm.), *mauritiana* (v. Dr.) and *ennurensis* (Das). Other sessile genera are *Ascidia*, *Clavellina* and *Botryllus*. Among the pelagic genera of our seas may be mentioned *Pyrosoma* (which emits a phosphorescent light) and *Salpa*.

*Subphylum (iii) Acrania (lancelets):*

The lancelets are small, semi-transparent, lancet-like marine creatures found burrowing in sand near the shore in warm and temperate seas. Two genera, each with several species, *Branchiostoma* (including subgenus *Amphioxus*) and *Asymetron*, occur in Indian seas. The well known European species *Branchiostoma* (*Amphioxus lanceolatus*) has recently been recorded from the Arabian Sea.

*Subphylum (iv) Agnatha (lampreys and hag-fishes) :*

They have been found in the seas of Europe, North America, Chile, Japan, West and South Africa, Australia and New Zealand, but have not been recorded from the Indian seas. Some species also occur in fresh water.

*Subphylum (v) Gnathostomata (chordates with a pair of jaws) :*

This subphylum contains all the remaining vertebrates in addition to the Agnatha mentioned above. Five classes of the living forms are customarily recognized, namely, the Pisces (fishes), Amphibia (frogs, salamanders, etc.), Reptilia (reptiles), Aves (birds) and Mammalia (mammals). But Pisces is now elevated to

a superclass or "series", with 7 classes of which only 4 are living.

Cl. 1. Pisces (fishes) :—The living fish fauna of the Indian region belongs to three subclasses :

Subcl. 1. Elasmobranchii. (cartilaginous fishes—sharks, skates and rays).

Subcl. 2. Holocephali (chimaeras).

Subcl. 3. Teleostomi (true bony fishes).

The Elasmobranchii is represented by 5 orders and 16 families; the Holocephali by one order and 2 families; and the Teleostomi by 34 orders and 183 families. The Elasmobranchii and the Holocephali are entirely marine, though a few species of the former, such as *Dasyatis (Pastinachus) sephen* (Forsk.) and *Pristis microdon* Lath. ascend freshwaters. The Teleostomi are both freshwater and marine. The lung-fishes (class Dipnoi) are totally absent in the Indian region.

In 1889, Day recorded 1,418 species of Indian fishes. Since then, many new species have been discovered and today the number is about 1,650. Of these about 348 (21 percent) are mainly freshwater, and the remaining 1,302 (79 per cent) marine. Among the marine fishes, about 174 (10 per cent of the total) are deep-sea forms.

Fishes are to be found in a wide variety of aquatic habitats—deep and shallow seas; all along the coasts of India, whether rocky, sandy or muddy; in lagoons, backwaters and estuaries; among coral reefs, in lakes, ponds, wells, rivers and mountain torrents. The torrential fishes possess special adaptation, such as suckers, for holding fast to the substratum. The freshwater fish fauna has elements common with the Indo-Malayan and Indo-Chinese regions. The African element is poor but not wanting, for the Chiclids, *Etroplus* spp., are common in South India and Ceylon. The marine forms have a wide distribution and several genera are common to the Indo-Pacific and the Atlantic regions. The distribution of the Indian Elasmobranchii and Holocephali, which are marine, seems to be governed by mean annual isotherms.

Certain fishes are migratory, spending their life in sea and in fresh water alternately. Species which migrate from sea to fresh water for breeding purposes are called *anadromous* fishes, e.g., *Hilsa ilisha* (Ham.), the Indian shad. Species migrating in the reverse direction for breeding are called *catadromous* fishes, e.g., the eel, *Anguilla bengalensis* (Gray & Hardw.).

A short account of the various classes of fishes follows :

Elasmobranchii (cartilaginous fishes): It includes the sharks, skates and rays. They are common in the Indian seas and estuaries. The five orders are: Hexanchiformes, Lamniformes (*Scyliorhtnus*),

Squaliformes (*Centrophorus*, etc), Rajiformes (*Raja*) and Torpediniformes (*Torpedo*, etc.). The large and dreaded gray sharks and tiger sharks (*Carcharhinus* and *Galeocerdo*), the hammer-headed sharks (*Sphyrna*), the saw-fishes (*Pristis*), the sting-rays (*Dasyatis*) which have a spiny whip-like tail, the large eagle-rays or devil-fish (*Myliobatis*), the torpedos and electric-rays (*Torpedo*, *Narcine* and *Bengalichthys*), are common on the Indian coasts as well as in the seas around the Andaman and Nicobar Islands. Some of the sharks, *Carcharhinus gangeticus* (Müll. & Henle), skates, *Pristis microdon* Latham, and rays, *Dasyatis sephen* (Forsk.), ascend larger rivers hundreds of kilometres above the tidal limits. Some classes of people on the Indian coast eat the flesh of sharks and rays, while their dried fins are exported. Some of the sharks, especially *Carcharhinus limbatus* (Müll. & Henle), *C. melanopterus* (Quoy & Gairm.), *Sphyrna blochii* (Cuv.), *S. zygaena* (Linn.) and *Pristis microdon* Lath., are used for extracting "shark-liver oil" for medicinal purposes (particularly as a concentrated source of vitamins A and D); it is said to be superior to the imported cod-liver oil and has replaced the latter.

Holocephali: The chimaeras are poorly represented. A single order, Chimaeriformes, contains two deep-sea species: *Chimaera monstrosa* Linn. and *Harsiotta indica* (Garman) (egg-capsules only).

Teleostomi: The true bony fishes comprise the bulk of the fish fauna of India. Thirty-four orders and 183 families are recognized, all belonging to the subclass Actinopterygii; the other subclass, Crossopterygii (the Coelacanth, *Latimeria Chalumnae* Smith), is wanting in the Indian region. The more prominent Actinopterygii are mentioned below.

The eels (order Anguilliformes) occur in both marine and fresh-water environments and comprise 12 families. Those inhabiting coral reefs or rocky shores have prominent bands and spots. The best known eel genera are *Anguilla* and *Muraena*. The so-called spiny-eels, *Mastacembelus* spp. (Mastacembelidae), are not true eels and belong to the order Mastacembeliformes.

The order Cypriniformes includes the cat-fishes (suborder Siluroidei) and the carps (suborder Cyprinoidei). The cat-fishes, which are scaleless and have well developed feeler-like barbels, mostly inhabit rivers and their estuaries as well as hill-streams. Some of them, such as *Wallago attu* (Bloch. & Schn.), attain a large size (nearly 2 metres in length) and are sometimes called "fresh-water sharks". A few Siluroid genera, such as *Tachysurus*, *Arius* and *Osteogeniosus*, are marine. The carps live exclusively in fresh waters and include some of our most important food-fishes such as the bola, *Barilus bola* (Ham.) the mahseers, *Tor tor* (Ham.)

and other species, the catla, *Catla catla* (Ham.), the mrigal, *Cirrhinus mrigala* (Ham.), the rohu, *Labeo rohita* (Ham.) and the kalbasu, *Labeo calbasu* (Ham.)

The Perciformes is a large order containing nearly 75 families in India and includes the perches, sea bass, groupers and snappers, with many marine genera and a few freshwater ones (e.g., *Ambassis*, *Nandus*, *Badis*, etc.). Many perches are edible, the better known being the bhukti. *Lates calcarifer* (Bloch.), the snappers, *Lutjanus malabaricus* (Bloch, & Sch.) and *L. argentimaculatus* (Forsk.), the rock perches, *Epinephalus maculatus* (Bl.) and *E. Tauvina* (Forsk.) and the pink perches, *Nemipterus bleekeri* (Day) and *N. japonicus* (Bl.).

The cods and haddocks (Gadidae) are poorly represented. The soles (Soleidae) are represented by several species of flat-fishes of the genera *Solea*, *Brachirus*, etc. Common along our coasts are the globe-fishes (Tetraodontidae), the pipe-fishes (Syngnathidae) and the sea-horses (Hippocampidae)

Among the Clupeiformes, the family Clupeidae includes the sardines (*Sardinella* spp.), the Indian herrings such as the popular food-fish hilsa, *Hilsa ilisha* (Ham.) and kannan, *Ilisha indica* (Swn.); the family Synodidae includes the Bombay duck, *Harpodon nehereus* (Ham.); and the family Salmonidae includes a few species of salmons, *Salmo trutta fario* Linn. etc., all of which are introduced species—there are no true salmon and trout indigenous to India.

*Food-fishes* : The common food-fishes are marine, brackish-water and freshwater inhabitants, and belong mainly to the following orders :

Elasmobranchii : Orders Lamniformes (sharks, dog-fishes) and Rajiformes (skates and rays).

Teleostomi : Orders Clupeiformes (sardines, feather-backs, tarpons), Cypriniformes (carps, minnows, cat-fishes), Beloniformes (needle-fishes, half-beaks), Mugiliformes (mulletts, barracudas), Perciformes (perches, mackerels, horse mackerels, hair-tails, sail-fishes, spear-fishes, etc.), Pleuronectiformes (soles, tongue-fishes), Ophiocephaliformes (snake-heads, murrels), Polynemiformes (threadfins), Thunniformes (tunnies, bonitos) and Mastacembeliformes (spiny-eels).

CI. 2. Amphibia (caecilians, frogs, toads, salamanders) :—The Amphibia are cold-blooded vertebrates having a smooth or rough skin rich in glands which keep it moist; scales are generally absent and, if present, they are hidden in the skin. They are a transitional group which lead a dual life (Greek : *amphi*, dual, and *bios*, life). They are neither fully aquatic nor fully terrestrial but have compromised, with the result that they are not particularly

well adapted to either environment. The living forms are divided into three orders, all of which are found in India :

Order Apoda (or Gymnophiona) (The limbless caecilians blindworms).

Order Caudata (or Urodela) (salamanders and newts).

Order Ecaudata (or Anura) (frogs and toads).

In 1890, Boulenger had listed 130 species in the Indian region. Several new species have since been discovered, and about 250 are now known.

(i) Apoda (Gymnophiona) : The caecilians or blindworms (family Caeciliidae) have a slender worm-like body without limbs and girdles, and the tail is either rudimentary or absent. Only 4 genera (*Ichthyophis*, *Uraeotyphlus*, *Herpele*, and *Gegenophis*) and 8 species occur in India. Three genera are found in the Western Ghāts of South India and one in Assam (*Herpele*).

*Ichthyophis glutinosus* (Linn.), is an interesting species, which occurs in Malabār, Eastern Himālayas and Assam, and also in Ceylon, Burma, Thailand and Indonesia. About 40 cm. long and 1.5 cm. in diameter, it is found in soft mud and other damp habitats. The female protects the eggs by coiling herself round the egg-mass.

(ii) Caudata (Urodela) : This order includes the newts and salamanders which are characterized by the possession of a tail in adult life. Out of about 150 world species, only one, the Burmese newt, *Tylototriton verrucosus* Anderson (family Salamandridae) is found in the Indian region. Its range is: Eastern Himālayas (Sikkim and Darjeeling), North Burma (Kakhyen hills) and Yunnan. It is about 15 cm. in length of which the tail makes up one-half; there is a well marked head and two pairs of well developed limbs. It lives on land except in the breeding season when it takes to the water.

(iii) Ecaudata (Anura) : Frogs and toads form the most numerous component of our Amphibian fauna, and comprise six families, viz., the Ranidae, Polypedatidae, Microhylidae, Bufonidae, Hylidae and Pelobatidae.

Ranidae : Some of the most common frogs belong to the largest family, Ranidae, e.g., the bull frog, *Rana tigrina* (Daudin), the water-skipping frog, *R. cyanophlyctis* Schneider and the burrowing frog, *R. breviceps* Schneider. Their tadpoles are variously adapted to lead a life in ponds, streams and torrents. *Staurois afghanus* (Günther), a form occurring in torrential

streams of the Himālayas, has a tadpole which possesses a ventral suctorial disc to be able to adhere to the rocky stones against the force of the current. *Nannabatrachus beddomii* Boul. is the smallest Amphibian known (length *c.* 20 mm.) and occurs in the Tirunelveli hills (South India).

**Polypedatidae** : The family is represented in India by the genera *Rhacophorus* and *Philautus*, and includes the tree-frogs. *Rhacophorus maculatus* (Gray), the chunam frog of Madras, is a medium-sized species (length *c.* 8 cm.) which climbs trees and also frequents houses. In *R. reticulatus* (Günth.) of Ceylon, the female carries its eggs in shallow pits in the skin of the abdomen. The genus *Philautus* is represented by over a dozen species found in Peninsular India, Ceylon and Burma. *P. variabilis* (Günth.) is the common form in Malabār, the Nilgiris and Wynaad.

**Microhylidae** : Members of this family are characterized by the absence of teeth in both jaws, and include terrestrial, aquatic and burrowing, but not arboreal, forms. The fat-frog, *Uperodon systoma* (Schneider) is the burrowing form sometimes found in nests of ants and termites in South India. *Microhyla rubra* (Jerdon) is common in Assam, South India and Ceylon.

**Bufonidae** : This family includes the true toads which are characterized by toothless jaws and diapophyses of the sacral vertebrae dilated. It is represented in India by 3 genera : *Bufo*, *Nectophryne* and *Cophophryne*. The commonest Indian toad, *Bufo melanostictus* Schn., is a large species (length about 17 cm.) ranging from all-India and Ceylon to Malaya and South China. *B. andersonii* Boulenger is a small toad (length about 8 cm.) found in the arid zone from Western Uttar Pradesh, via Rājasthān and Sind to South Arabia.

**Hylidae** : This family is represented by a single species *Hyla annectens* (Jerdon), found in Assam and Upper Burma.

**Pelobatidae** : This family is represented by a single genus, *Megalophrys* (formerly *Leptobrachium*), with four species ranging from Sikkim to Upper Burma, South China, Malaya and Indonesia. *M. monticola* (Günth.) is fairly common in Northern Bengal (Darjeeling), Sikkim and Assam and is also found in Upper Burma and probably also in South China. Its tadpoles have a funnel-shaped mouth which seems to be peculiar to this genus.

Cl. 3. Reptilia (reptiles : crocodiles, turtles, tortoises, lizards, and snakes) :—Reptilia are cold-blooded vertebrates breathing throughout their lives by means of lungs; the body is covered with scales. The group arose from the Amphibians and reached its maximum development in the Mesozoic period several million years ago when they were the dominant creatures on earth. Then they declined. Out of about 19 orders into which the Reptilia are generally divided, only 4 survive today; the others are known only from fossils. Of the four living orders, one viz., Rhynchocephalia, with a single species *Sphenodon punctatus* is confined to New Zealand; the remaining three are more widely spread and their representatives also occur in India.

1. Loricata (or Crocodilia) : Includes the crocodiles, gharials, alligators and caimans.
2. Testudines : Includes the chelonians (tortoises, turtles and terrapins).
3. Squamata : Includes the lizards and snakes.

(i) Loricata (Crocodilia) : This order includes the crocodiles and the gharial. Only three species occur in India. The gharial, with an elongated snout, belongs to the genus *Gavialis*; the other two with broad snouts belong to the genus *Crocodylus*. Alligators do not occur in India.

The gharial, *Gavialis gangeticus* (Gmelin), is a large crocodile which is found in a few rivers and their tributaries—the Indus, Ganga, Mahānadi, Brahmaputra and Kaladan (Arakan, Burma). Probably it also occurs in the Chilka lake in Orissa. It grows to a length of up to 6.5 metres, males being larger than females. Its food mainly consists of fish and birds. Eggs, about 40 or more, are deposited in sand and hatched in March-April.

The marsh crocodile, *Crocodylus palustris* Lesson, is widely spread, occurring from Baluchistān (West Pākistān) in the west to the whole of India, Nepāl, and Ceylon; its occurrence in Burma is doubtful. It is a freshwater crocodile, inhabiting swamps, tanks, lakes and rivers, and grows up to about 4 metres in length. Its food is mainly fish and birds and it may occasionally attack man. Eggs, about 20 or more, are laid in holes in sand in the beginning of the monsoon, and hatch in about 40 days. In some places, it is kept in semi-captivity; in Manga Pir, about 15 km. from Karāchi, a few hundred crocodiles are kept in a tank by a religious hermit and his followers.

The coast or estuarine crocodile, *Crocodylus porosus* Schneider, inhabits the mouths of rivers and canals near the sea, and can swim several kilometres into the open sea ; the muddy deltaic regions are specially suited to it. It is widely distributed from India,

Ceylon and Burma to Malaya, Indo-China, the Philippines, the Solomon and Fiji Islands and the northern coast of Australia. In India it occurs all along the East Coast down to the tip of the Peninsula and up the West Coast as far north as Cochin. It is the largest living reptile known, and reaches a maximum length of c. 10 m. It eats fish, birds and crabs. Some become man-eaters. About 50-60 eggs are laid in crude nests made with leaves and reeds.

The number of crocodiles has been greatly reduced by hunting. All the three species are now protected in India and skins are not allowed to be exported.

(ii) Testudines (Chelonia): This order includes the turtles, tortoises and terrapins, and about 50 species belonging to several genera are known from the Indian region. The leathery turtle or luth, *Dermochelys coriacea* (Linn.) is the largest of all the chelonians, and grows up to over 2 m. in length and about 450 kg. in weight. It is widely distributed in the Tropics but is rare everywhere. It occurs in our region only on the coasts of Ceylon and Kerala. The green or edible turtle, *Chelonia mydas* (Linn.), is common around the Andaman Islands. The hawksbill turtle, *Eretmochelys imbricata* (Linn.), is fairly common on the Indian and Indo-Chinese coasts, and in other tropical and subtropical seas. It provides the "tortoise shell" of commerce. The freshwater tortoises (family Emydidae) are represented in India by about 33 species and 15 genera. Of these, the common three-keeled land terrapin, *Geoemyda trijuga* (Schweigger), is widely distributed all over India, Ceylon and Burma, *Geoclemys hamiltoni* (Gray) occurs in Northern India, *Hardella thurgi* (Gray) lives in the Ganga and the Brahmaputra rivers and *Kachuga tectum* (Gray) in the Indus, Ganga and Brahmaputra rivers and their tributaries. The land tortoises (family Testudinidae) belong to the genus *Testudo*, the common species being the starred tortoise, *T. elegans* Schoepff. found in Rājasthān, Central and Southern India and in Ceylon; in Ceylon it occurs in forests and in dry areas—*T. emys* Schleg. & Müll. occurs from Assam to Burma, Thailand and Malaya and is the largest Asiatic species of *Testudo*. The common freshwater and mud turtles (family Trionychidae) are: *Lissemys punctata* (Bonn.) (the Indus and the Ganga and their tributaries), *Chitra indica* (Gray) (North India, Thailand and Malaya) *Trionyx gangeticus* Cuvier, *T. leithi* Gray and *T. hurum* Gray (river systems of North India).

(iii) Squamata (lizards and snakes): This order includes two suborders—the Sauria (geckos, chameleons, skinks and monitor lizards) and the Serpentes (snakes).



(a) *Sauria* (lizards): Nearly 250 species of *Sauria* are found in Indian limits. The geckos occur everywhere except at high altitudes and in thick forests. The commonest species belong to the genera *Gymnodactylus*, *Cnemaspis* (hilly areas of South India and Ceylon) and *Hemidactylus*. The commonest house-gecko in India and Ceylon is *Hemidactylus brooki* Gray., *H. flaviviridis* Rüppell is the common North Indian lizard. *Ptychozoon kuhli* Stej. is the parachuting lizard of the Nicobar Islands; it is said to parachute from tree top to tree top. Among the ground and flying lizards (family Agamidae) may be mentioned the flying lizards (genus *Draco*) of South India and Assam. The spiny-tailed lizard, *Uromastix hardwickii* Gray, occurs throughout North-west India, as far east as Uttar Pradesh. It also occurs in Sind (West Pākistān). Of the so-called "blood-suckers" (*Calotes* spp.), *C. versicolor* (Daudin) is the common species found in gardens and open jungles all over India, Ceylon, Afghānistān, Indo-China and South China. Since members of the genus *Calotes* change colour, they are often erroneously called chameleons. The true chameleon (family Chamaelionidae) is represented hereby a single species, *Chamaeleon zeylanicus* Laurenti, found in Southern India and Ceylon.

The skinks (family Scincidae) are represented by several species which live in a variety of habitats. The commonest species are *Mabuya carinata* (Schneider) of Central and Peninsular India, *M. beddomii* (Jerdon) of South India and *M. dissimilis* of North India and West Pākistān.

The monitor lizards (family Varanidae) are represented in India by four species of the genus *Varanus*, namely: the yellow monitor, *V. flavescens* (Gray) of North India and West Bengal; the desert monitor, *V. griseus* (Daudin), of North and North-west India and West Pākistān and further west to North Africa; the common monitor, *V. monitor* (Linn.) found throughout India, Burma and Ceylon and the water monitor, *V. salvator* (Laurenti) ranging from India, Ceylon, South East Asia upto North Australia. Several hundred thousand skins, valued at several lakhs of rupees, of these monitors are exported annually from India. In the year 1957-58 about 1,625,021 skins valued at Rs. 31,66,039, were exported. The skins of *V. salvator* are rare and their export is prohibited.

- (b) *Serpentes (Ophidia)* (snakes): Nearly 400 species of snakes occur in the Indian region. Of these about one-fifth are poisonous, and snake-bites annually claim nearly 20,000 to 30,000 human victims, in addition to a large number of cattle.

Among the common snakes of India are the rat-snake or *dhaman*, *Ptyas mucosus* (Linn.) and the common wolf-snake, *Lycodon aulicus* (Linn.). Of the harmless grass-snakes or striped keelbacks, *Natrix* spp., several species occur, the common ones being *N. piscator* (Schneider) and *N. stolata* (Linn.). The sea-snakes (family Hydrophiidae), all of which are very poisonous, are represented by nearly 25 species. Among the species more widely distributed on our coasts are: *Pelamis platurus* (Linn.), the most widely distributed of all sea-snakes, extending from Siberia to Tasmania and the common species of the Indo-Australian seas, and *Enhydrina schistosa* (Daudin), the commonest snake on our coasts.

Among the more deadly land snakes, the kraits and cobras (family Elapidae) may be mentioned. The kraits (genus *Bungarus*) are represented by eleven species. The common Indian krait, *B. caeruleus* (Schneider), occurs throughout North India down to about latitude 18° N. and in Ceylon (rare). Two species of cobras occur, viz., Indian cobra, *Naja naja* (Linn.) and king cobra or Hamadryad, *N. hannah* (Cantor), which grows up to about 4-5 metres (c. 15-18 feet) in length. The vipers (family Viperidae) are represented by over 20 species. The common ones are: Russel's viper, *Vipera russellii* (Shaw), saw-scaled viper, *Echis carinatus* (Schneider) and pit vipers (genus *Trimeresurus*).

Other snakes deserving mention are the worm-snakes, blind snakes [*Typhlops braminus* (Daudin) and other species], the huge pythons (family Boidae), the commonest being the Indian python, *Python molurus* (Linn.), and the sand boa, *Eryx johni* (Russell).

Cl. 4. Aves (birds): As might be expected from the diversity that obtains in the different parts of the Indian subcontinent as regards physiography and ecological conditions, the avifauna is remarkably rich in variety and numbers. The latest comprehensive list, *A Synopsis of the Birds of India and Pakistan* (together with those of Nepāl, Sikkim, Bhutān and Ceylon) by S. Dillon Ripley, enumerates 1,200 species which is about 14% of the world total

of 8,600. Together with their subspecies, or geographical races, the total of Indian forms reaches 2,061, and includes land birds as well as pelagic families such as petrels and shearwaters, normally found only at sea but which are sporadically blown on to our seaboard by heavy monsoon gales. Of this number some 1,750 forms are resident within our boundaries, the rest being migratory. The latter breed outside our territory, mostly in the Palaearctic region, beyond the Himālayas—in Central and Northern Asia, and Eastern and Northern Europe. The migratory forms are found in India only during the winter months; they arrive in autumn, mainly between September and November, and leave for their northern breeding grounds before our hot weather commences, in March-April. Among them are regular winter visitors, both common and rare, and casual vagrants as well as accidental strays.

An analysis of the 180 odd species purely endemic to India shows that the greatest affinity of our avifauna is with the Indo-Chinese subregion, no less than 63% of the endemics belonging to that category. About 17% show Palaearctic affinities, and 16% Ethiopian. The remaining 4% or so are either relict species or of uncertain affinities.

Of the 28 Natural Orders into which the living birds of the world are divided, 20 are represented in the Indian avifauna. The orders are again broken up into lower categories, such as suborders (in some cases), families, subfamilies, genera, species and subspecies or geographical races. The 20 orders that concern us, with some of their characteristics and more prominent components, are listed in the following pages; further information may be obtained from the books mentioned at the end of this chapter.

*Order Gaviiformes*: Divers. Superficially rather duck-like, swimming water birds with the first three toes fully webbed. Bill strong, tapering, pointed. Tail short but well developed. The blackthroated diver (*Gavia arctica*) and the redthroated (*G. stellata*) have occurred as rare vagrants.

*Order Podicipediformes*: Grebes, as typified by the familiar little dabchick (*Podiceps ruficollis*) common on all village tanks and ponds. Bill sharply pointed; wings short; tail rudimentary.

*Order Procellariiformes*: Petrels and shearwaters. Pelagic in habit, normally seen from ships out at sea; occasionally blown inland by gales. Characterized chiefly by the possession of tubular nostrils.

*Order Pelecaniformes*: Tropic-birds, boobies, frigate birds, pelicans, cormorants and darters—all fish-eaters. The first three are pelagic; the others frequent inland waters—*jheels*, reservoirs tidal creeks. The spottedbilled pelican (*Pelecanus philippensis*)

breeds in Andhra Pradesh and elsewhere in Peninsular India; also cormorants of all our three species, and darters or snake-birds.

*Order Ciconiiformes:* Herons, storks, ibises, flamingos. All these families are well represented. The first three nest colonially in mixed heronries, together with cormorants and darters. The colonies are sometimes very populous and densely packed, e.g., the Keoladeo Breeding Waterbird Sanctuary at Bharatpur, Rājasthān. The water of these heronries is heavily saturated with the droppings of these fish-eating birds; through research and scientific exploitation, they could become a source of valuable fertilizer in the form of liquid guano. The Great Rann of Kutch is the only known nesting ground in India of the large flamingo (*Phoenicopterus ruber*). The concentration of breeding birds here has been estimated to be between one-half and one million. This is one of the largest breeding colonies, or "flamingo cities" in the world.

*Order Anseriformes:* Ducks, geese and swans. In this group of popular sporting birds we have 3 species of swan (*Cygnus*), 7 species of geese (*Branta*, *Anser*), and some 33 species of duck and teal. All the swans and geese, and most of the ducks are migratory, and are identical with those found in Europe. The resident species are the large and lesser whistling teals, or tree ducks (*Dendrocygna bicolor* and *D. javanica*), the spotbilled duck (*Anas poecilorhyncha*), the cotton teal (*Nettapus coromandelianus*), the nukta (*Sarkidiornis melanotos*), and the whitewinged wood duck (*Cairina scutulata*). A very interesting endemic species which has become extinct during the last twenty-five years is the pinkheaded duck (*Rhodonessa caryophyllacea*) formerly found in Bihār and Assam.

*Order Falconiformes:* Birds of Prey. Represented by the families Accipitridae (hawks and vultures), Falconidae (falcons), and Pandionidae (osprey). The vultures (8 species) of which the commonest and most widespread is the whitebacked *Gyps bengalensis*, are a beneficial group of carrion feeders which render great service to man as scavengers by speedily disposing the carcasses of domestic animals lying in the precincts of human habitations. They include the lämmergeier or bearded vulture (*Gypaëtus barbatus*) of the High Himālayas which may have a wing span of c. 335 cm. from tip to tip. The osprey (*Pandion haliaetus*), a Palearctic migrant, is a fish hawk of almost world-wide distribution. Interesting forms among the rest are the golden eagle (*Aquila chrysaetos*) found in the Himālayas, and several other eagles in the hills and plains of which perhaps the commonest and most widely ranging are the tawny eagle (*Aquila rapax*) and the crested serpent eagle (*Spilornis cheela*). Besides the vultures and true eagles, this order

includes the hawk-eagles, bazas, the goshawk, sparrow-hawks, the peregrine, luggar, and shahin falcons, the kestrel shikra, several buzzards, harriers, and kites. Many of these are migratory. The dainty little falconets (*Microhierax*), no larger than a shrike, which prey on butterflies and large flying insects captured on the wing, inhabit the open wooded country in the Himālayan foot-hills and Assam. As a group the birds of prey have been unjustly maligned for alleged destruction of game birds and ground game. They are usually classified as vermin and afforded no legal protection. A careful study of the food and feeding habits of many species indicates, however, that by preying on rats and mice and other pests, they act as an important natural check. On balance, they are more beneficial than harmful and deserve strict protection.

*Order Galliformes:* The family that chiefly concerns us is Phasianidae, the so-called Game Birds, which includes pheasants, junglefowl and spurfowl, partridges and quails. They are all predominantly granivorous birds with strong, moderate sized bills, rounded wings, strong, short to moderately long legs (spurred in the males of many species), and stout blunt claws for scratching the ground for food. The group is typified by the red junglefowl, believed to be the ancestor of all our domestic breeds. In many species, such as pheasants and junglefowl, the sexes are differently coloured, the cock being the more showy. In others like the partridges and quails the sexes are usually alike. The peafowl (*Pavo cristatus*) is common, and has become particularly so under the semi-domesticated conditions of the strict protection it enjoys from the local population in Gujarāt, Rājasthān, and some other parts of the country. Where hunted, the bird is excessively shy and wary. The red junglefowl (*Gallus gallus*) is found in Northern and North-eastern India, its range coinciding almost exactly with that of the sal tree (*Shorea robusta*). In the forested tracts of Western and Peninsular India its place is taken by the grey junglefowl (*G. sonnerati*) whose neck feathers with their curious waxy yellow spots are much prized in the U.S.A. for the manufacture of fishing flies. Pheasants are found chiefly in the Himālayas where their hunting affords enjoyable but strenuous sport. Among the commoner species are the chir (*Catreus wallichi*), koklas (*Pucrasia macrolopha*), kalij (*Lophura leucomelana*), monal (*Lophophorus impejanus*), and four species of the tragopan or horned pheasant. The kalij is found in the foot-hills, but the rest range mainly between 1,800 and 4,200 metres elevation. There are other species of pheasants (*Polyplectron*, *Ithaginis*) and related birds such as the snowcock (*Tetrao. gallus*), snow partridge (*Lerwa lerwa*), and several hill partridges (*Arborophila*) and the chukor (*Alectoris*) found in the Himālayas,

besides many species of francolins (*Francolinus*) and quails (*Coturnix*, *Perdicula*) in other parts of the Peninsula. The mountain quail (*Ophrysia superciliosa*) is an enigmatical species, first described in 1846 and found again only twice or thrice thereafter at between 1,500 and 2,100 m. altitude in the Western Himālayas (Mussoorie and Naini Tāl). During the last 50 years or so, no more specimens have turned up in spite of special search by ornithologists.

*Order Gruiformes*: Represented in India by the following families: Turnicidae (button and bustard quails), Gruidae (cranes), Rallidae (rails), Heliornithidae (finfoot), and Otididae (bustards).

The button and bustard quails have barred or spotted plumage and resemble the true quails in appearance, but they possess only 3 toes like the bustards. The females are polyandrous and more brightly coloured than the males. The cranes are typified by the saras (*Grus antigone*), a large grey bird with bare crimson head and long red legs, standing as tall as a man. It is our only resident crane, commonly seen in pairs near about cultivation, particularly in Northern India. Considered sacred and, like the peafowl, protected by the people, it has become tame and confiding. Two other cranes, the common (*Grus grus*) and the demoiselle (*Anthropoides virgo*) visit India in winter in enormous flocks. They do considerable damage in newly sown wheat and gram fields. The birds are much sought after by sportsmen, since they are good for the table, and extremely wary and difficult to circumvent. The beautiful white Siberian crane (*Grus leucogeranus*) is a rare winter visitor in small numbers.

Rails are marsh-haunting birds of small to moderate size, with short tail, rounded wings, and longish bare legs and toes. The whitebreasted waterhen (*Amaurornis phoenicurus*) and moorhen (*Gallinula chloropus*), common in shrubby-bordered tanks and ponds throughout India, are typical examples. They skulk about amongst reeds and marsh plants and seldom show themselves. Some species, e. g., coot (*Fulica atra*), have lobed toes by means of which they can swim with ease. Their flight is weak, but nevertheless they often fly long distances, some of the forms being migratory.

The masked finfoot (*Heliopais personata*) is a rare and curious species which occurs only in Assam and East Pākistān in low jungle swamps and ponds. In appearance it is between a coot and a diver with short legs, scalloped toes, and a comparatively long and heavy pointed yellow bill.

Our bustards include the Bengal florican (*Eupodotis bengalensis*) and the likh (*Sypheotides indica*), both resident species which haunt tall grassland. The houbara (*Chlamydotis undulata*) is a

migratory species that visits the semi-desert areas of Rājasthān, Gujarāt and Kutch, in winter. But our most interesting and spectacular species, and one that is faced with imminent extinction unless rigidly protected, is the resident great Indian bustard (*Choriotis nigriceps*). Like all bustards, it is often the target of poachers in spite of the official ban on its killing, and its numbers are rapidly dwindling. The increasing encroachment of its habitat under population pressure is another cause of its continuing decline.

*Order Charadriiformes:* This large and heterogeneous order contains at least 11 families, represented in India by resident as well as migratory forms. It includes the jacanas, plovers, snipes, sandpipers, avocet, oystercatcher, gulls and terns.

Jacanas, also known as lily-trotters, of 2 species—the pheasant-tailed (*Hydrophasianus chirurgus*) and the bronzewinged (*Metopidius indicus*)—live on vegetation-covered tanks where they run about on the floating singara (*Trapa*) and lotus leaves with the aid of their enormously lengthened spidery toes.

Plovers are typified by the two common lapwings, the redwattled (*Vanellus indicus*)—the well known “Did-he-do-it” (from its calls)—and the yellowwattled (*Vanellus malabaricus*). The best known among the migratory plovers is perhaps the eastern golden plover (*Pluvialis dominica*), with spangled gold and black plumage, which keeps in flocks on moist grassy mudflats and is much prized by sportsmen. Several species of snipe and sandpipers are found in winter. Good shooting is afforded by the fantail and pintail, snipe (*Capella gallinago* and *C. stenura*), and large bags are made when the migrants first arrive, particularly in Kashmir and Bengal. The related snipe-like waders, the greenshank (*Tringa nebularia*) and the redshanks (*Tringa totanus* and *T. erythropus*) along with numerous other species of sandpipers, godwits (*Limosa limosa* and *L. lapponica*), curlew and whimbrel (*Numenius arquata* and *N. phaeocephus*), stints, the avocet (*Recurvirostra avosetta*) and the black-winged stilt (*Himantopus himantopus*) frequent the estuaries, tidal mudflats, and backwaters along the seaboard and inland waters, in winter. The painted snipe (*Rostratula benghalensis*) is a wide-spread resident on marshes, while the rare ibisbill (*Ibidorhyncha struthersii*)—an aberrant sandpiper—lives at altitudes of 1,800 to 4,000 m. in the Himālayas on shingly river beds. The stone curlew or goggle-eyed plover (*Burhinus oedicephalus*) inhabits open, stony semi-desert areas and fallow land, sharing this biotope with the swift-footed Indian courser (*Cursorius coromandelicus*). An enigmatic relation of the last is Jerdon’s, or the double-banded, courser (*Cursorius bitorquatus*), a rare, apparently

resident bird which has been completely lost since it was last seen in Andhra Pradesh in 1900. The collared and small Indian pratincoles (*Glareola pratincola* and *G. lactea*) are found on dry open pastures and shingle beds of the larger rivers in Northern and Peninsular India.

In keeping with our extensive coastline, the gulls and terns are well represented, the former by 8 species and several geographical races, and the latter by at least 20 forms. The gulls commonly seen in harbours and inshore waters are the herring and lesser black-backed gulls (*Larus argentatus* and *L. fuscus*) and the brown-headed and blackheaded species (*L. brunnicephalus* and *L. ridibundus*). All are winter visitors to our area except the brownheaded gull which breeds on upland lakes in Ladākh. Our commonest terns are the gullbilled (*Gelochelidon nilotica*) chiefly of the sea coasts, and the river tern (*Sterna aurantiaca*) the black-bellied (*S. acuticauda*) and the whiskered (*Chlidonias hybrida*) on inland waters. Most of the other terns are met with offshore, commonly following fishing boats. They include the sea terns, the large and lesser crested *Sterna bergii* and *S. bengalensis*. Many species breed within Indian limits on sandy beds of the larger rivers, vegetation covered *jheels*, and rocky offshore islets. Closely allied to the terns is the skimmer (*Rynchops albicollis*) with the peculiar laterally compressed knifeblade bill in which the lower mandible projects beyond the upper. The skimmer is not uncommon on the larger North Indian rivers where it nests on sandbanks.

*Order Columbiformes*: Represented in India by the families Pteroclididae (sandgrouse) and Columbidae (pigeons and doves). Both families include many species that are highly prized as sporting birds and for the table. Pteroclididae contains 7 species of sandgrouse (1 *Syrrhaptes*, 6 *Pterocles*). These birds inhabit open, semi-desert areas and fallow cultivation in large flocks, and have the well known habit of resorting to favourite drinking places at fixed hours. Most of the species are migratory. The one most esteemed by sportsmen is the large imperial sandgrouse (*Pterocles orientalis*) which breeds in Baluchistān and elsewhere beyond our limits and visits Rājasthān and neighbouring semi-desert areas in great abundance in winter.

The family Columbidae contains 6 species of green pigeons (*Treron*), 3 imperial pigeons (*Ducula*), 9 true pigeons (*Columba*), 2 cuckoo-doves (*Macropygia*), and 7 doves (6 *Streptopelia*, 1 *Chalcophaps*). Many of the above species are represented by several geographical races each, and both resident and migratory forms. The frugivorous green and imperial pigeons move about the country-side seasonally, dependent on the ripening of wild



fruits such as nutmegs and the various figs (*Ficus*.) Perhaps the most wide ranging of our fruit pigeons are the green *Treron phoenicopterus* and the imperial *Ducula aenea*. The wild blue rock pigeon (*Columba livia*), the ancestor of all domestic breeds, lives on cliffs in the hills. Its place in the Him layas is taken by the particoloured snowpigeon (*Columba leuconota*) which ranges between 1,500 and 4,200 m. altitude. The rufous turtle dove (*Streptopelia orientalis*) has races breeding in the Himālayas as well as in Peninsular India and are augmented in winter by migratory races from beyond our boundaries. Three other doves, common throughout the area, are the little brown (*Streptopelia senegalensis*), the spotted (*S. chinensis*) and the ring dove (*S. decaocto*). The lovely little emerald dove (*Chalcophaps indica*) occurs in the better wooded areas of the subcontinent.

**Order Psittaciformes:** The family Psittacidae is represented by 12 species of parakeets (*Psittacula*), many of them with geographical races. They are all predominantly green in coloration and have long, pointed tails. All are highly destructive to crops and orchard fruit, and possess few redeeming qualities from the economic point of view. The commonest species are the Alexandrine parakeet (*Psittacula eupatria*), the roseringed (*P. krameri*), the blossom-headed (*P. cyanocephala* and *P. roseata*) in the plains, and the rosebreasted and slatyheaded (*Psittacula alexandri* and *P. himalayana*) from the foot of the Himālayas to 2,500 m. altitude. The bluewinged parakeet (*Psittacula columboides*) inhabits the Western Ghāts. The dainty little lorikeet (*Loriculus vernalis*), short-tailed and of about the size of a sparrow, is found in the well-wooded parts of the country. It has the peculiarity of hanging head downwards, like a bat, when at rest.

**Order Cuculiformes:** The cuckoos have a practically world-wide distribution. Many of the Old World species, in particular, are notorious for their habit of brood-parasitism, i. e., laying their eggs in the nests of other birds and foisting on them the responsibility of hatching the eggs and rearing the young. Typical of the parasitic cuckoos is the well known *Cuculus canorus* of Europe which extends into Kashmir, Punjab and Uttar Pradesh and has a resident race (*bakeri*) in the Eastern Himālayas and Assam hills. It is met with as a vagrant in many parts of the Peninsula. Among our other parasitic cuckoos the commoner ones are the hawk-cuckoo or brainfever bird (*Cuculus varius*), the Indian cuckoo (*C. micropterus*), and the koel (*Eudynamys scolopaceus*). The diminutive brilliantly coloured emerald and violet cuckoos (*Chalcites maculatus* and *C. xanthorhynchus*) are largely parasitic on sunbirds and spiderhunters (Nectariniidae).

Some of our cuckoos are non-parasitic, i. e., they build nests and bring up their own young. Typical examples are the crow-pheasants or coucals (*Centropus*), the malkohas (*Rhopodytes*) and the sirkeer cuckoo (*Taccocua*).

*Order Strigiformes*: The owls are represented by two families, namely, Tytonidae (barn owls), and Strigidae (true owls). The former is characterized by its pinched monkey like facial disc as in the familiar barn or screech owl (*Tyto alba*) of almost world-wide distribution. The true owls have large round heads, and large, staring, forwardly directed eyes. Some species possess erectile horn-like tufts of feathers above the head. They range in size from slightly larger than a sparrow, e.g., the pigmy owlet (*Glaucidium brodiei*), to larger and heavier than a kite, such as the rock horned owl (*Bubo bubo*). The smaller species which include our common spotted owlet (*Athene brama*) and the collared scops (*Otus bakkamoena*) prey on insects, mice and small birds; the larger ones, e. g., the forest eagle-owl (*Bubo nipalensis*), which is a large and powerful creature, hunt small mammals and birds of the size of pheasants and junglefowl.

*Order Caprimulgiformes*: Represented by the two families Podargidae (Frogmouths) and Caprimulgidae (Nightjars). Both consist of concealingly patterned, brownish and greyish, nocturnal or crepuscular birds with soft plumage as in owls, and very wide gapes like clap-nets adapted for capturing beetles and flying insects on the wing. The base of bill and gape are exceptionally wide in the frogmouths, and their Latin name *Batrachostomus* as well as the English are both aptly descriptive. The species *B. moniliger* is found in the southern Western Ghāts and Kerala, while *B. hodgsoni* inhabits the Eastern Himālayas. The great eared nightjar (*Eurostopodus macrotis*) also has a parallel discontinuous distribution in Kerala and the Eastern Himālayas, being represented by the race *bourdilloni* in the former and by *cerviniceps* in the latter. Six species of nightjars of the genus *Caprimulgus*, with several geographical races, occur. Superficially they all look confusingly alike in the field, but may be readily distinguished by their calls.

*Order Apodiformes* includes the swift families, Apodidae (true swifts) and Hemiprocnidae (crested or tree swifts). The house swift (*Apus affinis*), the most familiar representative of the former, is commonly seen near human habitations, building its nests in clusters, or "villages," in the corners of ceilings of ruined as well as inhabited houses. Swifts are noted for their speed and manoeuvrability in flight, perhaps the most renowned in this regard being the Alpine swift (*Apus melba*) which nests in the fissures of cliffs around the Jog Falls in Mysore, and the large

spinetail swifts *Chaetura gigantea* and *C. caudacuta*. Several species of *Collocalia* swiftlets—which build the edible nests of commerce—are found in North-eastern and Southern India, and in the Andaman and Nicobar Islands. The crested tree swift (*Hemiprocne longipennis*) which, unlike the true swifts, possesses the ability of perching like a passerine bird, is seen hawking insects in the air, or perched on the topmost branches of a leafless tree in deciduous forest tracts.

**Order Trogoniformes:** Represented in our area by the family Trogonidae which is restricted to the Tropics of the Old and New Worlds. It contains brilliantly coloured forest-dwelling birds of rather sluggish habits. Three species occur in India: the Malabār trogon (*Harpactes malabaricus*) in the hilly forest tracts of Southern, Western and Central India; the redheaded (*H. erythrocephalus*) in the Eastern Himālayas and Assam; and Ward's trogon (*H. wardi*) in Bhutān and the Mishmi hills. Their diet consists of small fruits, insects and lizards.

**Order Coraciiformes:** Represented by the families Alcedinidae (kingfishers), Meropidae (bee-eaters), Coraciidae (rollers), Upupidae (hoopoes), and Bucerotidae (hornbills).

Our kingfishers comprise 5 genera, namely, *Ceryle* (2 species), *Alcedo* (3 species), *Ceyx* (1 species), *Pelargopsis* (2 species), *Halcyon* (4 species), with numerous geographical races. They are solitary birds, mainly non-migratory, living in the neighbourhood of water—estuary, river, lake, pond—and procuring their fish food by plunging from an overhanging perch or from the air while hovering. Some species, like the whitebreasted kingfisher (*Halcyon smyrnensis*), have become largely independent of water and live on insects, frogs, lizards and other small terrestrial animals.

The bee-eaters, predominantly green coloured, comprise the genera *Merops* (5 species) and *Nyctyornis* (1 species). The handsome bluebearded bee-eater (*Nyctyornis athertoni*) has a scattered distribution in moist forest biotope throughout the country. All the members of the family Meropidae are local or long-distance migrants whose movements are not well understood.

The rollers (family Coraciidae) include the broadbilled roller (*Eurystomus orientalis*), with 5 geographical races, resident in a moist forest biotope, and 2 species of the genus *Coracias* inhabiting drier, more open country. Of the latter, the migratory *C. garrulus*, the race *semenowi* breeds in Kashmir, the resident *C. benghalensis* in the rest of the country. They are brilliantly coloured birds, largely in shades of blue, commonly seen perched on telegraph wires alongside railroads, whence they pounce upon insects and small animals on the ground.

Four races of the hoopoe (*Upupa epops*) occur in India, all of which are more or less locally migratory.

The hornbills (family Bucerotidae) are well represented, particularly in the moist forest tracts. Six genera with 8 species and several geographical races are recognized, the largest and most spectacular of the group being the great pied hornbill (*Buceros bicornis*) of the southern Western Ghâts, Eastern Him layas and Assam. Two smaller pied hornbills, *Anthracoceros malabaricus* and *A. coronatus*, together with the grey hornbill (*Tockus birostris*) occur patchily in the rest of the country. Hornbills are remarkable for their peculiar nesting habits. The female incarcerates herself within a tree hollow whose entrance is then partially walled up with mud and the birds' droppings. Until the eggs hatch and the young are a few days old, the male feeds his imprisoned mate. Then the wall is broken down and she comes out to help the male in feeding the young.

*Order Piciformes:* The woodpecker-like birds comprise the families Capitonidae (barbets), Indicatoridae (honeyguides) and Picidae (woodpeckers)

Barbets are mostly bright coloured but rather dumpy, fruit-eating birds with large heavy bills overhung around the base with well developed stiff bristles. All the 10 Indian species are currently grouped under the genus *Megalaima*. Some of the more prominent among them are the great hill barbet (*M. virens*) of which several races range along the entire length of the Himālayas and in the Assam hills. The green barbet (*M. zeylanica*) inhabits the forested tracts of Peninsular India. The smaller crimsonbreasted barbet or coppersmith (*M. haemacephala*), whose monotonous, ringing *tonk . . . . . tonk* calls are amongst the most familiar bird voices on the country-side, has a very wide distribution in the plains.

The honeyguides (Indicatoridae) have their headquarters in Africa where many species are known. Only one, *Indicator xanthonotus*, occurs in India in the Himālayas and Nāga hills between 1,500 and 2,700 m. altitude. It is a rare bird, about the size of a sparrow, living largely on the larvae of wild bees and the wax of the honeycombs.

The woodpecker family (Picidae) is particularly rich. 15 genera and 32 species are recognized, many of them again with local races. They range in size from that of a jungle crow, e.g., the great black woodpecker (*Dryocopus javensis*) and the Himālayan slaty woodpecker (*Mulleripicus pulverulentus*), to almost smaller than a sparrow, e.g., the diminutive speckled and rufous piculets (*Picumnus innominatus* and *Sasia ochracea*). Woodpeckers live on an insectivorous diet consisting largely of the grubs of wood

boring beetles which they extract from within the trunks and branches of trees by means of their specially adapted bill and tongue. Modern forestry practices recognize the highly beneficial role they play in forest economy.

*Order* Passeriformes: Popularly known as perching birds or song birds, covers more than half of our total avifauna. It embraces a large number of superficially divergent families, all of which have certain well-defined anatomical features, such as the structure of skull and palate, and muscles of the syrinx, i. e., the lower end of windpipe which is the organ of voice production in birds. It is divided into 4 suborders, of which the 3 that concern us are: Eurylaimi containing the broadbills (family Eurylaimidae), the Tyranni containing the Pittas (family Pittidae), and the Passeres (or Oscines of some authors) containing the following heterogeneous array of families:

<i>Family</i>	<i>Genera</i>	<i>Species</i>
Alaudidae (Larks)	9	19
Hirundinidae (Swallows, Martins)	3	12
Laniidae (Shrikes)	1	9
Oriolidae (Orioles)	1	4
Dicruridae (Drongos)	1	9
Artamidae (Swallow-Shrikes)	1	2
Sturnidae (Starlings, Mynas)	6	18
Corvidae (Crows, Magpies, Jays)	8	22
<b>Bombycillidae :</b>		
Subfamily Bombycillinae (Waxwings)	1	1
Hypocoliinae (Hypocolius)	1	1
Campephagidae (Cuckoo-Shrikes, Minivets)	4	14
Irenidae (Fairy Bluebird, Ioras, Leaf Birds)	3	6
Pycnonotidae (Bulbuls)	4	19
<b>Muscicapidae :</b>		
Subfamily Timaliinae (Babblers)	30	122
Muscicapinae (Flycatchers)	7	39
Pachycephalinae (Thickheads, Silky Flycatchers)	1	1
Sylviinae (Warblers)	22	91
Turdinae (Chats, Robins, Thrushes)	19	89
Troglodytidae (Wrens)	1	1
Cinclidae (Dippers)	1	2
Prunellidae (Accentors)	1	7
<b>Paridae :</b>		
Subfamily Parinae (True Titmice)	2	12
Remizinae (Penduline Titmice)	2	2
Aegithalinae (Longtailed Titmice)	1	4

<i>Family</i>	<i>Genera</i>	<i>Species</i>
Sittidae :		
Subfamily Sittinae (True Nuthatches)	1	6
Trichodromadinae (Wall Creeper)	1	1
Salpornitinae (Spotted Creeper)	1	1
Certhidae (Tree Creepers)	1	4
Motacillidae (Pipits, Wagtails)	2	18
Dicaeidae (Flowerpeckers)	1	9
Nectariniidae (Sunbirds, Spiderhunters)	4	14
Zosteropidae (White eyes)	1	2
Ploceidae :		
Subfamily Passerinae (Sparrows)	3	13
Ploceinae (Weaver Birds)	1	4
Estrildinae (Munias)	2	7
Fringillidae :		
Subfamily Fringillinae (Chaffinches)	1	2
Carduelinae (Goldfinches and allies)	14	38
Emberizidae (Buntings)	2	16

An account of these families and subfamilies, and even of a few representative genera and species, would take more space than is available here. The interested reader is referred to the *Synopsis* by Prof. Ripley mentioned earlier. Volumes 1 to 8 of *The Fauna of British India—Birds*, by E. C. Stuart Baker, though out-dated in many respects, is still the best and most complete manual on the subject.

*Cl. 5. Mammalia (mammals):* While our mammalian fauna exhibits great diversity in forms, certain groups are completely absent, such as: the Prototheria or Monotremes (duck-bill, spiny ant-eater) and the Metatheria or Marsupialia (kangaroos, opossums, koalas, etc.) which are peculiar to Australia; the camel\*, giraffe, zebra and hippopotamus amongst the "Ungulates"; and seals, walruses (order Pinnipedia) and Procavias (order Hyracoidea). About 186 genera, 458 species (and 920 subspecies) are found in our region. The more important of the various types of mammals which occur may be referred to briefly.

\*"Large herds of domesticated forms of the one-humped camel, *Camelus dromedarius*, are kept in the North-western India for draught purposes. The species does not occur in the wild state in India or elsewhere."

1. Insectivora (shrews, moles and hedgehogs): About 38 species (and 83 subspecies) occur in the Indian region. Various subspecies of the common tree-shrew, *Tupaia glis*, are to be found, namely, *belangeri* (Wag.) (Burma), *assamensis* Wr. (Assam) and *lepcha* Thorm. (Darjeeling and Bhutān). In the south, *Anathana ellioti* (Water.) is the common form. Of the hedgehogs, two species are common: *Hemiechinus auritus collaris* (Gray) in the dry parts of North and North-western India to West Pākistān and Afghānistān, and *Paraechinus micropus* (Blyth) (Sind, North-western India and Madras). Of the moles, *Talpa micrura* Hodgs. is common in forests in the eastern region (Nepāl, Assam, Burma). Several species of shrews occur. *Suncus murinus* (Linn.) synonym *S. caeruleus* (Kerr.) is the common house shrew all over India. The Himālayan water-shrew, *Chimmarogale platycephala himalayica* (Gray) is found on the banks of streams all along the Himālayas, from Kashmīr to North Bengal and on to Burma, Yunnan and Indo-China.

2. Dermoptera (flying-lemurs or cobegos): This small order of flying-lemurs contains a single genus, *Cynocephalus* (family Cynocephalidae), which ranges from South Burma to the Philippines. A single species, *C. variegatus peninsulae* (Th.), occurs in the Indian region and is confined to Tenasserim (S. Burma).

3. Chiroptera (bats and pipistrelles) : The Indian chiroptera range in size from the large fruit-bats (wing-span *c.* 120 cm.) to the tiny pipistrelles. Nearly 123 species (and 180 subspecies) occur in this region. Two groups are recognizable: suborder Megachiroptera (large bats, all species fruit-eating), and suborder Microchiroptera (small bats, all species insectivorous and carnivorous). The common ones may be mentioned. Among the Megachiroptera, the Indian fruit-bat or flying fox, *Pteropus giganteus* (Brünnich) is a species most commonly seen hanging upside down in hundreds on trees during the day and flying in the evenings, all over India, Ceylon and Burma. Microchiroptera: This includes the rat-tailed bat, *Rhinopoma hardwickei hardwickei* Gray (all-India), the tomb bats (*Taphozous*), the false vampires (*Megaderma*) and the horseshoe bats (*Rhinolophus*), the leaf-nosed bats (*Hipposideros*), the pipistrelles (*Pipistrellus*), and the yellow bats (*Scotophilus*). The false vampire, *Megaderma lyra* Geoff., is common in caves and buildings all over India. The Indian pipistrelle, *Pipistrellus coromandra* (Gray), is widely distributed in India, Ceylon and Burma to South China. *Scotophilus heathi* (Horsf.) is commonly found in temples and old buildings all over India.

4. Primates (gibbons and monkeys): About 21 species and nearly 59 subspecies occur in our region and are divisible into two suborders: Prosimii and Anthropoidea. The Prosimii is represented by a single family, the Lorisidae (lorises), with two genera, *Loris* and *Nycticebus*, and two species—the slender loris, *L. tardigradus* (Linn.) (with 6 subspecies) of Ceylon and South India, and the slow loris, and *N. coucang bengalensis* (Fischer), of Assam, Burma, Indo-China and Thailand. A third species, *N. pygmaeus* Bonh., is found in Indo-China.

The Anthropoidea is represented by two families—the Cercopithecidae (monkeys) and the Pongidae (Hylobatidae) (gibbons). Two genera, namely, *Macaca*, the macaques, and *Presbytis* (synonym *Semnopithecus*), the langur and leaf-monkeys, and 16 species (and 48 subspecies) are found and they form some of the commonest animals to be seen in India both near human habitations and in the open forests.

*Macaca mulatta* (Zimm.), the *bondar* or rhesus macaque, the common pink-faced monkey seen in North India, usually lives in groups. Other common species are: the bonnet macaque, *M. radiata* (Geoff.) and the lion-tailed macaque, *M. silenus* (Linn.) of South India, the crab-eating macaque, *M. irus* (Cuv.) of the Nicobar Islands and Burma, and *M. assamensis* M'Clell. of Assam, North Burma and Indo-China.

*Presbytis* includes the powerful, graceful, black-faced and long-tailed *langur* or Hanuman monkey, *P. entellus* (Duf.), commonly found all over India and Ceylon, with about 14 subspecies. The langurs live in large groups, preferring open rocky areas, and periodically invade houses in neighbouring towns and cities. Other common species are: the John's langur, *P. johni* (Fisch.) of South India, the capped monkey, *P. pileatus* (Blyth) of Assam and Burma with 5 subspecies, and the recently discovered golden langur, *P. geei* Khajuria in the Goālpāra District of Assam.

The Pongidae (Hylobatidae) includes the gibbons. It contains a single genus, *Hylobates*, with three species. The lar gibbon, *H. lar* (Linn.) and the siamang, *H. syndactylus* (Raff.), are confined to Tenasserim (South Burma) extending east to Malaya, etc. The hoolock gibbon, *H. hoolock* (Harlan), is common in the forests of Assam, East Bengal and Upper Burma; it occurs in two phases: a black phase and a pale phase. A fourth species, *H. concolor* (Har.), is extra-limital (Hainan, Indo-China, Thailand).

The higher Simian apes, namely the Gorilla, Chimpanzee and Orang-utan, are not found in our region.

5. Pholidota (pangolins or scaly ant-eaters): This contains a single family, Manidae, with a single genus, *Manis*, and three



species: *M. pentadactyla aurita* Hodgs., the Indian race of the Chinese pangolin, is found in Nepāl, Sikkim, Assam and Burma and further east to South China. *M. crassicaudata* Gray, the Indian pangolin, is found in a large part of India. *M. javanica* Desm., the Malayan pangolin, ranges from Burma and Malaya east to Indonesia.

6. Carnivora (cats, bears, dogs, foxes, jackals, otters, etc.): Seven families, with 41 genera, 65 species and 146 subspecies, occur in our region.

- (i) Canidae: Two races of the wolf occur : The wooly wolf, *Canis lupus chanco* Gray, of Western Himālayas (Kashmīr and Chitrāl) to Turkestān, and the small Indian wolf, *C. l. pallipes* Sykes (all-India; West P kist n to Irāq and North Arabia). The jackal, *Canis aureus* Linn., occurs throughout the region and several races are distinguishable. Four species of the fox, *Vulpes*, are found. The commonest species is the Bengal fox, *V. bengalensis* (Shaw) (all-India). The white-footed fox, *V. vulpes pusilla* Bly., occurs in the desert areas of Western India, Punjab and West Pākistān to South Irāq. Several races of the Indian wild dog, *Cuon alpinus* (Pallas), occur, the most widespread being *C. a. dukhunensis* (Sykes) (all-India, south of the river Ganga).
- (ii) Ursidae (bears): Four genera and four species occur : The snow, red or brown bear, *Ursus arctos isabellinus* Horsf., occurs in the Western Himālayas (Nepāl to Kashmīr) and Afghānistān. The sloth bear, *Melursus ursinus* (Shaw), is the common black bear found throughout India (except the western desert) and Ceylon. The large Himālayan or Asiatic black bear, *Selenarctos thibetanus* (G. Cuv.), ranges from Siberia, Japan, Manchuria, South China to Burma, Assam, west to Nepāl, Kashmīr, Baluchistān and Afghānistān; three races occur within our region. The Malayan bear, *Helarctos malayanus* (Raff.), ranges from Burma east to Malaya, Indonesia and South China.
- (iii) Procyonidae (Pandas): A single species, the lesser or red panda, *Ailurus fulgens* F. Cuv., is found and ranges from Nepāl, Sikkim and North Burma to South China.
- (iv) Mustelidae (martens, weasels, otters): Nine genera and 18 species occur in our region. The commonest otter found all over India is *Lutra lutra* (Linn.), with various races. Another widespread species is *L. perspicillata* Geoff., the smooth-coated India otter, (Sind and all-India east to Sumatra). The martens (*Martes*), stoats

and ermines (*Mustela*), polecats (*Vormela*) and badgers and ratels are fairly well represented.

- (v) Viverridae (civets, linsangs and mongooses): These animals, are common throughout India and 18 species are found. The large Indian civet, *Viverra zibetha* Linn., ranges from Nepāl eastward to South China. The common palm civet or toddy cat, *Pardoxurus hermaphroditus* (Pallas), is familiar throughout the Indian region. The existence of stink glands in civets makes the presence of these animals very unpleasant in the vicinity of human habitations. The mongooses (*Herpestes*) are represented by five species: *H. edwardsi* (Geoff.), *smithi* Gray, *fuscus* Water., *auropunctatus* (Hodg.), and *vitticollis* Benn., the first two being the more common and widespread. (Some authors treat mongooses as a separate family, Herpestidae).
- (vi) Hyaenidae (Hyaenas) : A single species, the striped or Indian hyaena, *Hyaena hyaena hyaena* (Linn.), occurs and ranges from all-India (except Assam), Nepāl, West Pākistān, Afghānistān, Īrān, west to Transcaucasia.
- (vii) Felidae (lion, tiger, cats, cheetah) : Four genera (*Panthera*, *Felis*, *Neofelis*, and *Acinonyx*) and 16 species occur in our region.

*Panthera* is represented by 4 species : *Panthera pardus* (Linn.) is the panther or leopard which ranges widely from Africa to Asia and is divided into several races of which 4 are found in India; the most common is *P. p. fusca* (Meyer) (all-India, West Pākistān, Ceylon, Burma and South China). An all-black variety, which is an aberration, is not uncommon, and more rarely albinos also occur. The ounce or snow-leopard, *P. uncia* (Schreber), ranges from Central Asia to Tibet, and all along the Himālayas from Kashmīr to Sikkim. The tiger, *P. tigris* (Linn.), has also a wide range—from the Asiatic U. S. S. R. (including Ussuri and Amur regions and Siberia) to South China, Northern Afghānistān, Īrān, Nepāl, most of India (except the western desert region and probably Kashmīr), eastward to Burma and via Malaya to Indonesia. Six races are recognized, of which the Indian race is *P. tigris tigris* (Linn.). Sometimes a tiger turns man-eater. The number of human deaths thus caused in India used to be considerable (866 in 1903), but is now much less, due to decrease in the number of tigers and the introduction of safer means of communication. The tiger is the largest of the living cats—a male weighs about 200-225 kg. and a female 160-180 kg. The lion, *P. leo* (Linn.), survives in tropical Africa and Western India (Gīr forest, Kāthiāwār). Two races occur: the African lion, *P. leo leo* (Linn.) (Africa) and the

Asiatic lion *P. leo persica* (Meyer), the latter believed to have a smaller mane. (The belief that the Indian lion is maneless is unfounded). Up to the middle of the nineteenth century, the lion was common all over West Pākistān and North India as far as West Bengal. Until 1860 or so, many existed in Kāthiāwār and Rājasthān. By 1880, they were confined to the Gīr forest (an area of about 1,300 sq. km.) in Kāthiāwār and only about a dozen heads were left—the last remnant of the Asiatic lion. Stringent protection since then has saved them, at least for the time being, and by 1930 their number increased to about 200; the 1955 Census gave their number as 290. In prehistoric times lions existed in Southern Europe (Greece), and in historical times in Syria and Palestine and until about a century ago in Arabia, Irāq and Irān.

Ten species of *Felis* occur in our region. *F. libyca ornata* Gray is the Indian desert cat (North-west and Central India). The common jungle-cat is *F. chaus kutas* Pears. (of North India) and *F. c. kelaarti* Poc. (of South India and Ceylon). The leopard-cat, *F. bengalensis* Kerr, is common all over India and so is the fishing cat, *F. viverrina* Benn. The lynx, *F. lynx isabellina* Bly., is found in Kashmir, while the caracal, *F. caracal schmitzi* Mats., ranges from North-western India and West Pākistān to Arabia and Palestine.

*Neofelis* is represented by the clouded leopard, *N. nebulosa macrosceloides* (Hodgs.), found in the Himālayas up to about 915 m. from Nepāl to Burma.

The cheetah or hunting leopard, *Acinonyx jubatus* (Schr.), ranges from North Africa to West Asia and India. The Asiatic race, *A. j. venaticus* (Griffith), formerly ranged from North India (east to Bengal), West Pākistān and East Africa, but is now extinct in Asia. The cheetah differs from all other cats (Felidae) in the absence of the cutaneous lobes which form the protecting sheath of the claws, but the claws themselves are retractile as in other cats. It is one of the fastest runners known and, being docile, was used in India for catching game such as blackbuck.

7. Proboscidea (elephants): Of a once flourishing group of mammals (fossils are found all over the world except Australia), only two living genera, each with a single species, survive—*Loxodonta africana* Blumenle (African elephant) and *Elephas maximus* Linn. (Indian elephant), the latter having shorter ear-flaps. Several species have, however, been found as fossils in India in the Eocene and more recent formations. The elephant, which is the largest living land mammal of India (and the world), is found in forests all over India (except Kashmir, Punjab and the

western desert), Ceylon, Burma and eastward to Sumatra. Three races occur in our region: *E. maximus indicus* Cuv. (India), *E. m. maximus* Linn. (E. Ceylon) and *E. m. ceylanicus* Blain. (Ceylon). Their numbers in India have declined during the last century, but they are still not uncommon in certain parts. Since elephants can be easily trained, they are used in many places for hauling logs and other work of that kind.

8. Sirenia (dugong): These "fish-like" creatures are represented by a single family, the Dugongidae (Manatidae), with a single species, the dugong, *Dugong dugong* (Müller). It occurs on the shores of the Indian Ocean from East Africa to Australia for about 15 degrees latitude on either side of the Equator, but has been largely exterminated and is now rare. Big specimens may be as much as 2.5 m. in length.

9. Perissodactyla (odd-toed ungulates): Three families and 5 species occur in the Indian region as follows:

- (i) Tapiridae (tapirs): Represented by a single species, the Malayan tapir, *Tapirus indicus* Desm., which ranges from South Burma (Tenasserim) to Malaya and Sumatra.
- (ii) Rhinocerotidae (rhinoceroses): Three species occur: The great Indian one-horned rhinoceros, *Rhinoceros unicornis* Linn., is today confined to small patches in the East Himālayan *tarai* (Nepāl, Bihār, Bengal Duārs, Cooch Behar and Assam), and is becoming rare. In India it is confined to eight sanctuaries (the largest being the Kaziranga Sanctuary in Assam) in which the overall number is 400 rhinos, whereas in Nepāl it is confined to the Rāpti valley (about 300 heads). Five centuries ago, the rhino roamed over large parts of North India, west of the Hindu Kush mountains, along the Himālayan foothills and in Nepāl. By the year 1900 the number was drastically reduced and the Government started sanctuaries in Assam. The lesser one-horned or Javan rhinoceros, *R. sondaicus* Desm., ranged, about a century ago, from the Sikkim *tarai*, Bengal, Assam and Burma east to Thailand, Malaya, Sumatra and Java. It is now extinct except for about two or three dozen heads in the western tip of Java. The Asiatic or two-horned rhinoceros, *Didermocerus sumatrensis* (Fischer), occurred a century ago in Bengal and Assam, but is now extinct in India. A few heads survive in Burma (about 30-50), Indo-China, Malaya and Sumatra.
- (iii) Equidae (horses and asses): A single species, the Asiatic wild ass, *Equus hemionus* Pallas, is found in our region.

It ranges from Turkestan, Mongolia, Tibet, Nepal, Ladakh, Baluchistan, Sind, Kutch and Afghanistan to Syria. Of its several subspecies two occur in our region—the Indian wild ass, *E. h. khur* Less., in Kutch, Baluchistan and South-eastern Iran and the kiang, *E. h. kiang* Moorcr., in Ladakh, Nepal, Sikkim to Kokonor (Central Asia).

10. Artiodactyla (even-toed ungulates): Four families and 37 species occur in our region as follows:

- (i) Suidae (pigs): Two species are found. The first, the wild boar, *Sus scrofa* Linn., has 3 races in our region, as follows: *Sus scrofa cristatus* Wag. (all-India and Ceylon), *S. s. andamanensis* Bly. (Andaman Islands) and *S. s. nicobaricus* Mill. (Nicobars). The second species, the pygmy hog, *S. salvanius* (Hodg.), is found in the Sikkim tarai, Nepal and Bhutan.
- (ii) Tragulidae: The Indian spotted chevrotain or mouse-deer, *Tragulus meminna* (Erxl.), ranges from Peninsular India to Ceylon.
- (iii) Cervidae (deer): Ten species occur and the more common ones are: The musk-deer, *Moschus moschiferus moschiferus* Linn., (Him layas from Kashmir to North Burma); the barking deer, *Muntiacus muntjak* (Zimmer.) (all-India, Ceylon, South China, Burma, to Indonesia); the chital or spotted deer, *Axis axis* (Erxl.) (all-India, Nepal and Ceylon); the sambar, *Cervus unicolor* Kerr (all-India, Ceylon, Nepal, east to the Philippines); the swamp deer or barasingha, *C. duvauceli* Cuv. (North India); the thamin or Eld's deer, *C. eldi* M'Clell. (Manipur, Burma to Indo-China and Hainan); and the Kashmir stag or hangul, *C. elaphus hanglu* Wag. (Kashmir); formerly abundant but now in danger of extinction, only about 550 heads being left.
- (iv) Bovidae (cattle, sheep, goats, antelopes): This is a large family with 22 species in our region. The more common ones are as follows. The four-horned "antelope", *Tetracerus quadricornis* (Blainv.), occurs in Peninsular India north to Madhya Pradesh. The nilgai or blue bull, *Boselaphus tragocamelus* (Pall.) is a large animal which is a pest of crops and ranges all over India, except East Bengal and Malabar. The genus *Bos* has several representatives: the gaur or Indian "bison", *Bos gaurus* H. Smith (Peninsular India in forested areas, Nepal, Assam, Burma, Malaya, Indo-China), the banteng or

tsaine, *Bos banteng* Wag. (Burma and further east) and the yak, *Bos grunniens* Linn. (Ladākh, East Kumaun, Tibet, Central Asia). The yak is domesticated in the Himālayas. The Indian buffalo, water buffalo or arna, *Bubalus bubalis* (Linn.), survives in its wild state in Nepāl, Assam, Madhya Pradesh and Orissa(?). The domesticated animals are used extensively all over India as milch cattle and for draught. The origin of the common humped cattle or zebu, *Bos indicus*, of India is unknown but is believed to be tropical, possibly African; it has no relatives among fossils found in India, and is also markedly different in colour, voice and habits from the European domestic cattle, *B. taurus*.

The antelopes are represented by a few species. The common ones are the blackbuck, *Antelope cervicapra* (Linn.) (all-India) and the chinkara or Indian gazelle *Gazella gazella bennetti* (Sykes) (West P kist n; plains of North India, south to the Krishna river). The "goat-antelopes" are represented by the serow, *Capricornis sumatrensis thar* (Hodgs.) (Kumaun, Nepāl, Sikkim), the goral, *Nemorhaedus goral* (Hardw.) (all along the Himālayas, China and Siberia) and the takin, *Budorcas taxicolor* Hodgs. (Bhutān, east to Assam, North Burma and South China). The sheep and goat occur in the mountainous regions. The urail, *Ovis orientalis vignei* Bl., is found in Ladākh; the bharal or blue sheep, *Pseudois nayaur* (Hodgs.) from Kashmīr to Sikkim, Tibet and South China; the Asiatic ibex, *Capra ibex sibirica* (Pall.), from Kashmīr to Kumaun in India and also in Central Asia, Afghānistān and Siberia; and the *markhor*, *Capra falconeri* (Wag.), in Kashmīr, Punjab, Baluchistān to Afghānistān and Turkestan. The wild goat, *Capra hircus blythi* Hume, occurs only in Sind, Baluchistān and Turkmenia.

11. Lagomorpha (hares and pikas) : This includes two families and 14 species in our region, as follows:

- (i) Leporidae (hares): Two genera and 7 species are found, the common ones being the Indian or black-naped hare, *Lepus nigricollis* F. Cuv., with 8 races (all-India, except Kashmīr and Bengal, Ceylon), the woolly hare, *L. oiostolus* Hodgs. (Kashmīr, Nepāl, Sikkim and China); and the Assam rabbit or "Hispid Hare", *Carpolagus hispidus* (Pearson) (North-east India: Uttar Pradesh, East Bengal, Assam; and Nepāl).
- (ii) Ochotonidae (pikas or mouse-hares): Seven species of pikas (*Ochotona*) occur in the Himālayas and go up to about 4,875 m. altitude.

12. Rodentia (squirrels, marmots, porcupines, jerboas, gerbils, rats, mice and bandicoots): This is the largest order of mammals and comprises 6 families and 47 genera, about 125 species and 318 subspecies in our region. It includes many economically important species, viz., rats and mice (Muridae), which are serious pests of crops and stored food and are also carriers of diseases such as plague. Only a brief mention of the more common species is possible here.

(i) Sciuridae (squirrels and marmots): About 36 species are found in our region. Several species of flying squirrels occur in the forests from Kashmir to Burma, as well as in South India (Kerala) and Ceylon. The limbs on either side are united by a membrane which forms a parachute for descending from tree-tops. The large brown or common giant flying squirrel, *Petaurista petaurista* (Pallas), with several races, is widely distributed (all-India, except western desert, etc.; Ceylon; Burma to Indonesia; Hainan). The small Travancore flying squirrel, *Petinomys fuscocapillus* (Jerd.), occurs in South India (Kerala) and Ceylon. Of the other squirrels, several genera occur. Two species of striped squirrels are among the most common mammals seen in India near human habitations—these are the northern five-striped palm squirrel, *Funambulus pennanti* Wr. (North India, south to Orissa, Southern Madhya Pradesh and Dhārwar; also Nepāl and West Pākistān); and the three-striped or Indian palm squirrel, *F. palmarum* (Linn.) (Peninsular India, South Bihār, Ceylon)—formerly the two species were confused with each other and lumped under *palmarum*. The Indian giant squirrel, *Ratufa indica* (Erxl.), ranges from Peninsular India north to Orissa.

Two species of marmots (*Marmota*) occur in the Himālayas.

- (ii) Hystricidae (porcupines): It has three species of which the most widespread is the Indian crested porcupine, *Hystrix indica* Kerr (all-India; Ceylon; Nepal; West Pākistān; west from Irān, Arabia to Syria; also Central Asia).
- (iii) Dipodidae (jerboas); and (iv) Muscardinidae (dormice). Two species of jerboas occur in Kashmir and Baluchistān. Similarly, two species of dormice occur—one in West Pākistān and another in South India.
- (v) Rhizomyidae (bamboo rats): Four species occur in our region and are found in the eastern parts (Assam and further east).
- (vi) Muridae (rats, mice and bandicoots, hamsters, gerbils and

voles): This is the largest family of the Rodentia in our region, with 28 genera, about 80 species and nearly 200 subspecies. Rats and mice (Murinae) are very common. The common house rat or black rat of India is *Rattus rattus* (Linn.), with several subspecies, the commonest one being *R. r. rufescens* (Gray)—the domestic or commensal form has a grey venter whereas the corresponding field variety in the neighbourhood is white-bellied, the two varieties occurring together extensively. The brown rat, *Rattus norvegicus* (Berken.), is a Central Asian and European species which has spread, through shipping, to our major ports as well as to ports all over the world. The common house mouse of India is *Mus musculus* Linn., with several races. Three species of bandicoots occur: the lesser bandicoot rat, *Bandicoota bengalensis* (Gr. & Hardw.), the large bandicoot rat, *B. indica* (Bech.), and the short-tailed bandicoot rat, *Nesokia indica* (Gr. & Hardw.). All of them are widespread and cause considerable damage to crops.

Of the hamsters (Cricetinae), two species occur: The grey hamster, *Cricetulus migratorius* (Pallas) with 2 or 3 races (Kashmīr and Baluchistān) and the short-tailed Tibetan hamster, *C. alticola* Th. (Kashmīr and Tibet).

Of the jerds and gerbils (Gerbillinae), there are 3 genera (*Gerbillus*, *Tatera* and *Meriones*) in our region. The commonest gerbils are the Indian hairy-footed gerbil, *Gerbillus gleadowi* Murray (West Pākistān, and Gujarāt); the Indian gerbil or antelope-rat, *Tatera indica* (Hardw.) (nearly all-India except East India, Ceylon and Nepāl; also Irāq, Arabia and Syria); and the Indian desert gerbil, *Meriones hurrianae* (Jerd.) (West India, West Pākistān, Afghānistān and Irāq).

Six genera and 10 species of voles (Microtinae) inhabit the Himālayan region from Kashmīr to Tibet.

13. Cetacea (whales, porpoises and dolphins): The cetacea are truly aquatic throughout their lives and live in both fresh waters (rivers and estuaries) and the sea. Six families, with 15 genera, 25 species and 26 subspecies, occur in the Indian region and are briefly discussed below:

- (i) Balaenopteridae (whales and rorquals): Three species of *Balaenoptera* are found in our seas. Of these *B. musculus* (Linn.) (syn. *B. indica* Blyth) is the largest known animal, whether living or extinct, and grows up to 24-27 m. in length.



- (ii) (dolphins): A single species, the Ganga, Platanistidae dolphin or susu, *Platanista gangetica* (Lebeck), is common in the rivers Ganga, Brahmaputra and Indus. It is about 7-8 ft. or 2-2.5 m. and sometimes 12 ft. or 3.6 m. long and is quite blind.
- (iii) Physeteridae (sperm whales): Two species occur in our seas: the pygmy sperm whale, *Kogia breviceps* (Blain.) and the sperm whale, *Physeter catodon* Linn. (syn. *P. monocephalus* Linn.). Both are world-wide in distribution.
- (iv) Ziphiidae (beaked whales): A single species, Cuvier's beaked whale, *Ziphus cavirostris* G. Cuv., occurs in our seas.
- (v) Phocaenidae (porpoises): A single species, the little Indian porpoise, *Neomeris phocaenoides* (G. Cuv.), occurs in our seas, in shallow waters and in tidal creek; it also ascends rivers in China. It is a small black animal, about 110-125 cm. long and 70-80 cm. in girth.
- (vi) Delphinidae (dolphins and killer whales): About 9 genera and 17 species occur in our waters. The Irrawaddy dolphin, *Orcaella brevirostris* (Owen), ranges over the Bay of Bengal and the South-eastern Indian Ocean; the race *O. b. fluminalis* Anders., is found in the Irrawaddy river, Burma, as far north as Bhamo. The Indian pilot whale, *Globicephala macrorhyncha* Gray (synonym *G. indicus* Blyth), was recorded once, in a shoal in the Hooghly river, near Calcutta; it ranges all over the Indian and Pacific Oceans.

### 3. Game Animals and the Preservation of Wild Life

#### Game animals

A century ago wild life in India was plentiful, and so was game. Even half a century back it was not unusual to see herds of blackbuck, chital and gazelle as one sped across the countryside in a railway train. Extension of agriculture to forest lands, excessive hunting, the increase of human population and other factors contributed to the decline of wild life and game. During the two World Wars game was exploited ruthlessly. Foreign soldiers killed game at will and completed the process of decline in the abundance of our wild life.

Several species have either become extinct (e. g., the cheetah or hunting leopard) or are on the verge of extinction, only a few heads being left in the protection of sanctuaries; the Asiatic lion, the rhinoceros, the Kashmir stag and the great Indian bustard are examples. Some game, however, such as ducks, is still plentiful today. The following are some of the common game animals (mammals, birds and fishes):

Mammals: spotted deer or chital, blackbuck, sambar, nilgai (held sacred in certain areas), Indian bison (rare), bears, panther and tiger.

Birds: Ducks and geese (small and large), whistling teals, comb-bill or nukta, brahmīn duck, sheldrake, common teal, pintail, pochard, etc.; black partridge, grey partridge, quails, snipe, red jungle-fowl, grey jungle-fowl and sandgrouse.

Fishes: (i) Marine: Hammer-headed shark, saw-fish, skates, rays, tarpons, sword-fishes, dolphin-fish and spear-fish, (ii) Fresh-water: Indian trout, mahseers (4 species), goonch, pungas cat-fish, garva and bachhwa.

### *Preservation of wild life*

With the rapid decline of wild life, the problem of its preservation has become urgent. The Governments, both the Central and of the States, are very much alive to the need. Sanctuaries for Asiatic lion in its last refuge in Asia (the Gir forest in Gujarāt), and the rhinoceros (in Assam and Northern Bengal) were formed in the early part of the century at the instance of the Government of India. Private scientific societies, such as the Bombay Natural History Society, and more recently the Zoological Society of India, are playing an important role in creating consciousness about wild life preservation among the public. Religious beliefs of certain sections of Hindus, particularly in Rājasthān and Gujarāt, have been responsible for wild life preservation in those areas. The peacock, which has become rare in other parts of India, is still common there due to the protection offered.

In January 1935, the Government of India held an All-India Conference for the Preservation of Wild Life and a policy of protection was formulated. An Indian Board for Wild Life was set up in 1952 by the Government of India and all the States now have similar Boards. These Boards, by propaganda, by the regulation of export of rare animals and the creation of wild life sanctuaries and reserves, help in protection.

Under the Trade Control Order the export from India of the following animals or their parts is totally banned:

<i>English name</i>	<i>Scientific name</i>
(a) BIRDS	
Great Indian bustard	<i>Choriotis nigriceps</i> (Vigors)
Jerdon's courser	<i>Cursorius bitorquatus</i> (Blyth)
Mountain quail	<i>Ophrysia susperciliosa</i> (J. E. Gray)
Pinkheaded duck	<i>Rhodonessa caryophyllacea</i> (Latham)
Whitewinged wood duck	<i>Cairina scutalata</i> (S. Müller)
(b) MAMMALS	
Asiatic lion	<i>Panthera leo</i> (Linn.) (subspecies <i>persica</i> Meyer)
Hunting leopard or cheetah	<i>Acinonyx jubatus</i> (Schreber)
Indian rhinoceroses	<i>Rhinoceros</i> spp.; <i>Didermocerus</i> <i>sumatrensis</i> (Fischer)
Brow-antlered deer (Thamin or Eld's deer)	<i>Cervus eldi</i> Mc Clelland
Hangul (Kashmīr stag, red deer)	<i>Cervus elaphus hanglu</i> Wagner
Pigmy hog	<i>Sus salvanius</i> (Hodgson)
(c) REPTILES	
Crocodiles	All species, including the gharial

About 47 wild life sanctuaries, reserves and national parks exist in India. They vary from tiny areas of about 23 sq. km. to large parks of nearly 1,550 sq. km. Six of them cover an area varying from 427 to 1,510 sq. km. the remaining being smaller. While some of these sanctuaries are meant for the preservation of certain specified species, others are more general in their scope. Among the former may be mentioned the Gir forest (Gujarāt), the Jaldapara sanctuary (West Bengal), and Kaziranga sanctuary (Assam).

These parks and sanctuaries not only preserve our wild life heritage but also serve other vital functions. They preserve the areas of scenic beauty and provide healthy holiday resorts for the masses. They protect the fauna and flora in the natural state and serve as places for the ecological study of wild life in general and special problems such as bird migration. Further, the large forest reserves favourably affect climate and induce more rain.

#### 4. *The Basic Ecological Balance between Man and Wild Life*

In common with other economically developing countries of the world, particularly those of Asia and Africa which have won their independence since the Second World War, a problem India has to face and solve with wisdom is that of Nature Conservation and Wild Life Preservation; in other words, to reconcile the demands of our ever-increasing human population and expanding economy with the undeniable right of wild life to exist. Such reconciliation can be achieved only by a critical, scientific assessment of the basic ecological balance between Man and wild life, or perhaps better, between Man and Nature. The Indian Board for Wild Life, constituted in 1952 for advising the Government of India on matters of policy in this regard, is an eloquent token of official recognition of this necessity. Wild life in India includes not only the mammals and birds that are normally hunted for sport or meat, generally classified as Game, but also all other animals, big and small, that comprise the rich Indian fauna. Judging from the standpoint of Man, some of these may appear to be unimportant, while others are clearly of vital significance to his interests as friends or foes. Whatever their apparent status, all organisms have an important role to discharge in the delicate web of life. Bitter experience in other parts of the world has taught the lesson that it is unwise to resort to seemingly obvious short-cuts and tamper with a life-community by exterminating one member of it, since that may well transform the entire community and bring about results the opposite of those desired. The folly of too simple shortcuts has been demonstrated so often that it seems unnecessary to cite examples here.

This section is concerned only with the larger terrestrial animals of the Indian country-side—mammals and birds—whose existence is increasingly threatened by the rapid growth of industrialization and land exploitation resulting from the successive Five Year Plans. The opening up of vast tracts of country which had been forest, scrub jungle, swamp or waste land, the erection of gigantic multipurpose dams with the submergence of enormous areas that once gave refuge to wild life, the advent of great hydro-electric power generating stations to run the heavy industries, the reservoirs and river valley projects which will irrigate millions of hectares of waste land, are rapidly altering the natural face of the country. Wild life is everywhere being steadily pushed to the wall. Not only are the animals deprived of their natural habitats but their direct persecution and slaughter are intensified by these processes of civilization.

While it is not yet too late to save what is left, it seems essential to take stock of the position and analyze the status of our wild life *vis-à-vis* the human population; that is, the ecological balance between Man and wild life in this country. The all-too-simple remedy offered by some that wild life wherever it conflicts with Man's interests must without question be destroyed, fails to take count of the complex repercussions that are almost certain to follow. In their untampered natural environment, where each species is adapted to fill its own particular niche, organisms adjust themselves to co-exist in a state of ecological equilibrium. It is only when Man appears on the scene to disturb this delicately poised natural balance that he begins subjectively to assess the harmful or beneficial impact of wild life upon his own concerns. A well known instance of such artificial upsetting of the ecological balance is that of the man-eating tigers which became a menace to the country-side in the Ganjam District of Andhra Pradesh, over hundreds of square kilometres. The cause of this sudden calamity was traced to this fact: the forest deer and pig on which the tigers had normally subsisted had been so reduced in numbers by professional poachers and others that, deprived of their natural food, the animals were driven to cattle-lifting, and on to man-eating. In parts of Madhya Pradesh, on the other hand, due to exceptionally heavy shooting pressure on the larger carnivora, deer and wild pig multiplied so much that their depredations made the raising of the crops around forest villages impossible.

Man upsets the balance of nature by reducing or eliminating the appropriate natural habitats as also by introducing new species of plants and animals (along with their attendant pests and diseases) into habitats where they did not exist before. The removal of natural predators, or an unnatural abundance of food encourages certain species to become dominant at the expense of others. The disastrous effects of introducing the mongoose in the West Indies, and of the rabbit in Australia, are too recent to need reminding.

In order to preserve a dwindling rare animal, it is usually not enough to let Nature take its course. Where the reduction in numbers has been due to Man's interference as in the case of our one-horned rhinoceros and the great Indian bustard, complete stoppage of killing and restoration of the natural habitat may prove effective. However, sometimes animals begin to die out unaccountably. When this happens, recovery is difficult and the animals may be regarded as doomed. Our unique indigenous pinkheaded duck (*Rhodonessa caryophyllacea*) appears to have become extinct in this way. Only a critical study of the ecology of the species can provide a clue to the factors that tilted the balance against it.

Even the normal, legitimate activities of Man make his direct or indirect interference with natural environments inevitable, often producing a serious ecological imbalance. Cultivation of his crops introduces an element of unnatural uniformity into a diversified natural environment, as when a forest is cleared or a swamp reclaimed and converted into farm land. Each species of plant may have a set of animals dependent upon it for food. In a tropical mixed forest habitat with its diverse plant species, animal life is much richer in variety. The actual number of individuals of each species may be smaller than in crop land, where there is greater abundance but more uniformity in the food supply. Uniformity of vegetation produces a reduction in the variety of dependent animal species, but a corresponding increase in the number of individuals. With foresight, the judicious utilization of available scientific knowledge and adaptation of modern techniques to local requirements, we can easily tip the man-made ecological imbalance to our own advantage. After a critical study of the life histories and population dynamics of our game animals and game birds, for instance, it should be possible to harvest an artificially induced surplus for augmenting the nation's food supply without depreciation of the national heritage that is our wild life.

In a natural forest the number of deer, pig and other herbivores is regulated by the grazing and browsing available, and also by predatory carnivores. If, for some reason, the population of herbivores increases beyond what the forest can support, the animals will suffer from under-nourishment, and their weakened condition will make them more susceptible to predation and to disease. The excess will thus be automatically killed off and the ecological equilibrium restored. However, when Man interferes with the natural environment and, say, replaces mixed forest by pure stands of a few selected tree species, or by extensive cultivation of some particular crop, he upsets the natural balance and unwittingly invites the herbivores to concentrate from far and near on the lavish supply of the food he thus provides. Released from their natural checks, the animals multiply and may in time become serious pests. That applies to granivorous birds also. Species that are of neutral economic status from Man's viewpoint while in their natural habitat and subjected to the natural controls, may suddenly explode into "plagues" when those checks are relaxed, as by an artificial removal of their predators or the provision of a super-abundant food supply in cultivated areas. This is what we see happening in the case of our sparrows and weaver-birds (family Ploceidae). Quick to profit from the situation, they concentrate in large numbers around paddy, *jowār*, and *bājra* cultivation, often

causing serious damage to the ripening crops. The natural food of these birds is seeds of grass and weeds; where cultivation has not encroached on their native habitats, they live in small scattered flocks and wander about the country-side in search of food. Although the damage caused by weaver birds to food crops in India is nowhere of the same magnitude as by their relatives, the diochs (*Quelea quelea*) in the newly introduced rice cultivation in Equatorial Africa, it is sometimes quite considerable locally. The weaver birds furnish a good example of how a naturally neutral species can rapidly transform its economic status to one of serious harmfulness when Man intervenes to upset the ecological balance.

In recent forestry practices it has been customary to select, encourage and propagate certain tree species—such as teak and sal in the plains, and deodar and other conifers in the Himālayas—calculated to yield the maximum revenue. This frequently leads to the artificial replacement of the original mixed forest by more or less uniform stands. Such “managed” forests result not only in eliminating the unwanted species of trees and shrubs, but with it also the fauna that is directly or indirectly dependent on them. This, and the removal of all dead and decaying trees, results in depriving many birds of the insect food they obtained from the holes and crannies in the wood and under the bark, as also of the hollows in the rotten trunks and boughs which afforded suitable nesting sites. So the birds are forced to move elsewhere. Uniform stands of selected tree species tend to suffer more severely during outbreaks of defoliating or wood-destroying insect plagues. The pests, attracted by the concentrated abundance of the food supply, swarm in these forests as their counterparts do in cultivated crops. The impoverishment of bird life removes the control exercised by the natural predators, and exposes the trees to the full severity of the insects’ ravages. After the first flush of enthusiasm for severely managed forests, intelligent foresters, here as elsewhere, are now beginning to question the economic soundness of that system; and many devices are introduced, such as artificial nest boxes, in an attempt to lure the birds back and thus restore the ecological balance.

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