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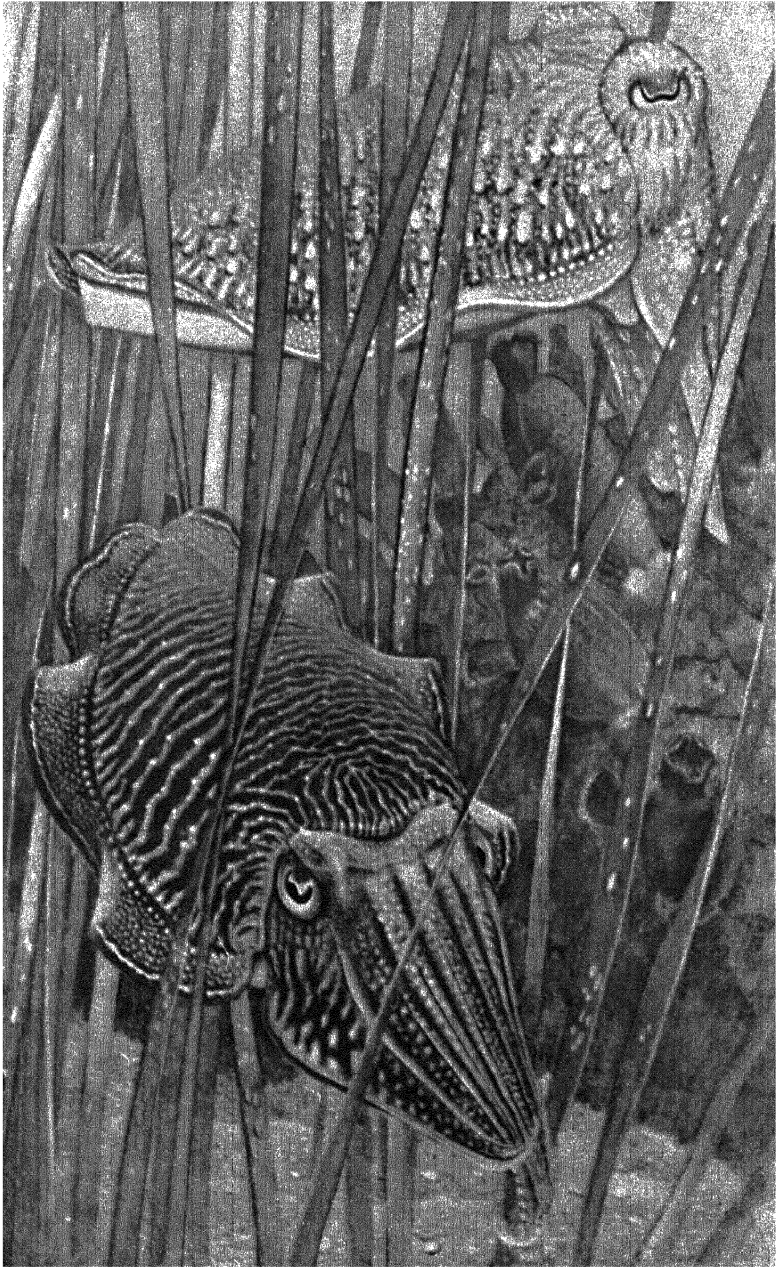
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From a Drawing by Paul A. Robert

WORLD NATURAL HISTORY

By

E. G. BOULENGER

*Director of the Aquarium and ~~Curator~~ of Reptiles in the
Gardens of the Zoological Society of London*

With an Introduction by
H. G. WELLS

*Illustrated by 150 Photographs
and 26 Drawings*

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ERRATA

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Illustration No. 65: for BROWN OWL read BARN OWL.

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By *L. R. Brightwell*

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INTRODUCTION

By H. G. WELLS

THE days in the life of a small boy or girl are so ample and so crowded with events that it is difficult to pick out any of them as cardinal. What, one asks, was the greatest influence upon your mental growth, what book, what teacher, what experiences? To which the truthful answers are a thousandfold. Nevertheless it does seem to me that the day I opened that once popular favourite, Wood's *Natural History*, was in its way exceptional, and that I did come upon something then that made a distinctive, new and fruitful beginning in my thoughts. I was in bed with a broken leg. But the book made me forget my splints. I was absorbed by it. My mind was born anew. I turned over the pages, looking at the plentiful woodcuts, reading here and there, and a multitude of new creatures, in groups and families and regiments, came marching into my imagination. To live and proliferate there.

I had heard of some of them before, and though pictures were not nearly so plentiful in the lives of the young sixty years ago as they are now, I had more or less accurate ideas of what many of these creatures looked like. One of my sources had been a leather-bound iron-mouldy Goldsmith's *Natural History*, a running translation of Buffon in four volumes. This was in the house and I turned it over before I could read. It was bought at a sale, but Wood's *Natural History* came from the Bromley Literary Institute. From Goldsmith I had learnt about beasts like the Tanrec, the Squash, the Cayopolin, the Magot and the Wanderow. Who knows about them now? Goldsmith's sloth and ant-bear were quite unlike any living specimens; his dromedary wore its hump like a bustle and his camelpard was conceived on such a scale that a man on horseback could ride beneath it. Goldsmith himself

never knew of the kangaroo, but in our edition of 1804 an account of Mr. Banks' discovery in New Holland had been inserted. It was described as a sort of Jerboa as big as a sheep and nothing was said about its pouch. That world of Goldsmith's *Natural History* was a world of wonders and marvels, a disorder of strange things. Not so purely marvellous as Pliny's *Natural History* but in the same vein. But Wood's *Natural History* was altogether different. It marked the progress of the better half of a century. All the Australian beasts came into it and the gorilla—quite alarmingly, so that for a time I went upstairs to bed in grievous fear of meeting it.

I had been once to the Zoo and I had seen the Wombwell collection of stuffed animals at the Crystal Palace, mostly monkeys in comic groupings, but now for the first time I realised, as I read, something very important indeed, which Goldsmith had never revealed to me, the orderly arrangement of living things. Hitherto the animals and plants in my mind had been in a state of utter confusion. You could have passed off almost anything upon me as a strange animal or plant, the stranger the better. Now most fascinatingly I realised the existence of elusive threads of resemblance. It came to me, very vaguely at first and none the less excitingly for that, that animals and plants were not any old thing, that they ran into very definite sorts, that there was a subtle grammar about them and that fantasies like the centaur and the griffon in some way offended that grammar and outraged the rules.

In those days, sixty years ago, it would have been considered improper to mention the word Evolution in a book intended for family reading, and so it was left to my childish brain to ask and find out if it could why living things were bound up, so to speak, in these interesting clusters, these classes and orders. Yet I did find out some riddles upon which to exercise myself. Why was the Tasmanian devil an outcast from the cats and why did the Wombat hold himself aloof from the

rats and beavers? I do not think a book with any other arrangement could have awakened my mind to the austere limitation upon variety that characterises our universe, as Wood's *Natural History* did. For just as there is almost measureless empty space between the stars, so there is a whole universe of unfulfilled possibility, between the various elements and between the permitted forms of animal and vegetable life. Nature I perceived wasn't anyhow; there were rules and she kept these rules and played her game within them.

You would imagine there might be anything. But there isn't.

I think this is a rather important thing for a young mind to grasp, and so I welcome in this present *World Natural History* a more brightly illustrated revival of that classic of my childhood, a new rendering of the narrow yet exciting cavalcade of life. How much fuller it is and how much more vivid and certain than Goldsmith or even Wood! The insects are no longer "deservedly placed in the lowest ranks of animated nature", and the cuttlefish, starfish, worms and what you will, no longer constitute the "Zoophytes", "a numerous tribe lately discovered". The cuttlefish indeed, with a look of quite unsated intelligence in his eyes, has worked his way up to the frontispiece of this compendium, leaving all his old associates behind. And the starfish, one gathers now, claims kinship with the vertebrata and ourselves.

A new and better informed generation than was mine will turn over these present pages, and this time they will read about Evolution unconcealed and find a new and keener and more definite interest in tracing cousinship and detecting the subtle intimations that distinguish parallelism from blood relationship. From the outset they will remark that elusive tendency to vary about a defined theme that exercised me so much, and they will have an acuter sense of its significance. This book with its processional order, because of its systematic character, is a necessary supplement to visits to the Zoo,

or to the many discursive descriptions and stories of animals available nowadays. At the Zoo one passes from Eagles to Buffaloes and from Lions and Tigers to Penguins and Humming Birds in a delightful confusion. But this orderly catalogue becomes all the better reading afterwards. After the contrasts of life, the resemblances. One can check back the visit. Did I see the toucan? Did I meet the wart hog? They come in their places here, striking beads upon the strings of heredity. Does the rhinoceros really come next to the hippopotamus, and are the manatees, and the turtles in the Aquarium, fish?

This is a book to read and then browse over and after that to keep for reference. It will become the key to much other reading. Essentially it is a catalogue, though a very explicit, vivid and entertaining one. I think if I were a schoolmaster and I wanted to make a boy into a naturalist I should give him this volume for a beginning and induce him to break up the contents of its neatly arranged classes and orders and drawers and pigeon-holes and rearrange them under regional headings. Then I should send him to the school library to find good descriptive travel books, and he would be a dull young man if he was not presently discussing why it was that the largest cat in the continent of America is the puma, why Old World monkeys are so short of tails and why there is neither giraffe nor okapi nor any real equivalent to these animals in the tall forests of Brazil.

The scientific spirit grows with what it feeds upon, and what it feeds upon is the successful answering of questions. In a little while our incipient naturalist will be planning family trees for the animals and visiting the great skeletons of vanished creatures in the Natural History Museum, in search of intermediate types and missing links. And that will lead him to real comparative anatomy and embryology and general ecology, until he finds himself out of the newspaper world of to-day and amidst the greater realities of life in time. He will see things about him with new and more penetrating eyes.

He will come back to the immediate problem of himself against the universe, mentally enlarged and enlightened. Most intelligent children find animals the most interesting things in existence outside themselves, and they are quite right in that opinion. They are. They are the mirrors which reveal the hidden under-structure of our own nature.

Before I finish this Introduction I am going to make one criticism, which applies not only to this book but to nearly every illustrated book upon natural history I know. There is an ugly but ladylike portrait of the Praying Mantis upon page 228. She might be a religious spinster except for the egg-case beside her. Her mate does not appear in the drawing. He would be ill-advised to appear because his fate is to be eaten by her. This genteel picture, I protest, does her no sort of justice, and no picture I have ever seen of the Praying Mantis does justice to her extreme frightfulness. When she is roused, she is, considering her size, the most awe-inspiring of created beings. I met one once at Chateauneuf near Grasse, she ran and I poked at her with a stick, whereupon she turned, reared herself erect, raised her flat, broad fore-limbs to the side of her head, so that she had the oddest resemblance to a small tin cobra, vibrated her wings in a quite horrid hiss and contrived to frighten me as no living creature has ever frightened me before or since. I could no more have touched that menacing little beast than I could have walked up to a snarling tiger. Some day, someone will really photograph one of these terrifying insects at bay.

Apart from the absence of that one illustration I have found nothing but entirely satisfactory pictures as I have turned and browsed and browsed again upon this volume. Some day when this book appears in a new edition, Mr. Batsford will add another plate, "the Praying Mantis as she really is", and then it will be perfect.

But that little affair of mine with the Praying Mantis

is quite by the way. I commend this clear and stimulating procession Mr. Boulenger has marshalled to the family library with all my heart. It is a book to own. It is a book to give as a present. It is a book to give as a prize. No young gentleman's library, at any rate, should be without it.

H. G. WELLS

THE ANIMAL KINGDOM

LIFE as we know it is represented abundantly by animal and vegetable forms in almost every quarter of the globe, and it is now generally admitted that such forms are the result, not of a sudden and dramatic "creation" but of a long and gradual process, conveniently summed up in the one word "Evolution". Evolution is briefly the succession of one form by another, as the indirect result of such varied factors as food, climatic conditions and geographic environment.

The vast periods of time covered are roughly calculated by studying the rate which the various rock stratas take to form. It is possible to guess within a reasonable margin how long it took to evolve, say, birds from reptiles, but of the earliest evolutionary processes little can be known, since the first forms of life have left no fossil evidence by which to trace them.

Life at its beginning (estimated as well over a thousand million years ago) was probably represented by minute one-celled organisms, mere blobs of jelly that did not even form shells such as those which house the *Foraminifera*, which build up our chalk cliffs. From that period onward, forms of life became, as the result of cellular aggregation, more and ever more complex. At first, life was sexless. Plants and animals were indistinguishable—just as are the simplest known forms of life to-day. The chemical and physiological processes bridging the gulf between such life—and its up-to-date culmination, civilised man—are obviously beyond the scope of the present volume, which is primarily concerned with a brief review of existing animal forms.

A word, however, may be said on the changes, or evolutions, which cause the stream of life to go on in an ascending scale—a scale wherein man, with all his imperfections, must be regarded as the final expression.

Though evolution is more or less placidly accepted by all educated persons, the actual implications of the word are seldom given serious consideration. At the same time something of what evolution means can be appreciated by a glance at our own history, and that of our domestic animals—a matter of only a few centuries. Modern man is a slightly different creature from his ancestors of five centuries ago. Very few modern men can comfortably wear a suit of armour, and the first attempt will prove convincingly that the medieval man was smaller than man is to-day. Moreover, scientists tell us other important changes are taking place in our physical make-up. Our teeth

are tending to become fewer—mainly the result of diet—whilst civilised footwear tends to eliminate the fifth, or “little”, toe.

As for our domestic animals, they represent evolution enormously accelerated by man’s direct intervention and selection. A relatively few centuries have seen us produce from the wolf all those varied, and often unsightly, forms which fill a modern dog show. In less than a century and a half, the ox has been converted from a mere mountain of fat to the compact mass of solid flesh which now feeds half the world. Consideration of such simple facts makes it easier to visualise the ever-changing pageant of life, and to appreciate the true magnificence of those fossil remains which our unscientific forebears explained away as the bones of giants, dragons and other unnatural phenomena.

Only the crudest mentality can placidly accept chaos as the natural order of things, and since the dawn of Greek civilisation there has been a ceaseless struggle to fit the varied spectacle of life into some coherent scheme: in a word to “systematise”.

In view of the fact that well over half a million species of living animals are now recognised, and that the list is added to at the rate of many hundred species annually, the need for systematisation will be fairly obvious. Attempts in this direction have been many from the Middle Ages onwards, but the scheme now universally accepted is founded upon that formulated by Linnaeus, “the father of natural history”, in the 17th century. He realised that the animals found living to-day represented only a small proportion of the number of species which have evolved and passed away, giving place to others, as evolution advanced. He showed also that “fossil” animals and plants bear vital relationships to living forms, and that the two could not be intelligently considered or understood separately.

The manner in which he reduced chaos to order seems remarkably simple, now that it is an accomplished fact. The Animal Kingdom is primarily divided into two sub-kingdoms: the Vertebrates and the Invertebrates. Thus a man, sparrow and fish though very dissimilar in general form will all be seen to have certain features in common. They may vary enormously in length and number of limbs, presence or otherwise of tail, nature of body covering, etc., but one and all possess a backbone, enclosing a central nerve-cord, from which all the rest of a complex nervous system ramifies.

The Vertebrate animals form the first great sub-kingdom. The Vertebrates include all creatures with a central nerve-cord enclosed in a bony, or cartilaginous, canal—the spinal column. Such creatures range from man down to semi-worm-like forms, which are, however, only superficially worm-like, and are actually much more highly constituted.

The Vertebrates are divided into the following classes :

- Class 1. *Mammalia* (Mammals).
 „ 2. *Aves* (Birds).
 „ 3. *Reptilia* (Reptiles).
 „ 4. *Amphibia* (Frogs, Newts, Salamanders).
 „ 5. *Pisces* (Fishes).
 „ 6. *Cephalochordata* (Lancelets).
 „ 7. *Tunicata* (Tunicates and Sea Squirts).
 „ 8. *Hemichordata* (the worm-like Balanoglossus).

The members of the second sub-kingdom, the Invertebrates, are generally arranged as follows :

- Class 1. *Arthropoda* or jointed animals. Crustaceans (crabs, lobsters, etc.), Arachnids (spiders, etc.), Myriopods (centipedes), and Insects.
 „ 2. *Mollusca*. Snails, oysters, cuttle fish, etc.
 „ 3. *Brachiopoda*. Lampshells.
 „ 4. *Echinodermata*. Starfish, sea urchins, etc.
 „ 5. *Bryozoa*. Moss animals.
 „ 6. *Vermes*. Worms.
 „ 7. *Coelenterata*. Corals, sea anemones, jelly fish, etc.
 „ 8. *Porifera*. Sponges.
 „ 9. *Protozoa*, or simplest single-celled animals.

These groups are tolerably well defined. This qualification is advisable, since the march of evolution has been a gradual process, covering an immense period of time and certain forms must necessarily overlap. Animals cannot be arranged with the same ease that buttons are sorted and stitched to their allotted cards. A sub-kingdom is divided into classes, orders, families, genera and species, and these are joined to those immediately preceding or following them by certain intermediary forms—links in the chain of life. Thus, classed with the vertebrate animals are creatures known as sea squirts, which in adult life so nearly resemble molluscs, sponges or even plants that they were classed as such by the earliest naturalists. It is only within comparatively recent times that their close affinity with the backboned animals has been fully established.

Only the most ignorant now clamour for “missing links”, for it is recognised that every creature is a link in the continuous stream of life, the greatest ranking with the least in biological significance.

Every animal bears two scientific names, one denoting the genus, or particular sub-group to which it belongs, and the other the species which tells either of its discoverer, or describes some peculiar feature, such specific name marking it out from every other member of its genus. Some genera contain more than a hundred species.

The growth of education has created the necessity for such names to be generally recognised. Natural history is an international matter, a world movement, and scientists of different nationalities would find communication with one another impossible were not some such universal "code" in circulation. Popular names, though often of local interest, lead to confusion, and even in our own land unscientific fishermen may find themselves at cross-purposes when describing some fish well known to both, yet spoken of by totally different appellations in widely sundered localities.

A species, it must be realised, is devised for the convenience of all. Often species are subdivided into sub-species, varieties, etc. Indeed the dividing line between a sub-species and a mere local variety is a fine one, and must always be matter for controversy.

Scientific nomenclature leaves much to be desired, but it is the best medium which has yet been devised for the common understanding. Frequently a single animal has been honoured with a score of specific names, conferred upon it by different scientists working independently, and unaware of, or indifferent to, each other's activities. To end this confusion, recent years have seen a general overhauling of the entire scheme of scientific nomenclature, and that offered in the following pages may be accepted as enjoying the general approval. It is that adopted in the main by the Zoological Society of London.

Considerably over half a million species of living animals are known to-day. No one book can be expected to deal with such a vast gathering in detail, and the present volume attempts no such impossible task. It purports merely to set forth in a concise manner a *résumé* of the animal world, as a possible incentive for more detailed study.

In a review of the Animal Kingdom, one should perhaps commence at the bottom of the scale. The reverse, however, is generally the accepted procedure, and so, following the usual course, the man-like apes are here given pride of place.

II

MAMMALS

A MAMMAL is a warm-blooded vertebrate, covered with hair, and nourishing its young with milk, generated by lacteal glands or *mammæ*. These features serve to distinguish any and every mammal from all other members of the Animal Kingdom.

Biologically we live in the age of mammals—*i.e.*, a period in earth's history in which mammals are the dominant form of life. To the casual observer, the warm-blooded, hirsute mammals must seem to have "always been". They have figured largely in the written word since the dawn of civilisation, and were portrayed by early man long before the crudest writing was evolved. Yet, in a broad survey of earth's history, the mammals figure as comparative newcomers, and the upstart—man—is a creature only of yesterday.

It is estimated that the mammals had their beginning some seventy million years ago. For many million years prior to that time, when the great land masses known to-day were quite differently disposed, reptiles dominated the earth. The vast continents of America, Europe and Asia were largely covered by sea, and both land and water enjoyed a more universal and genial climate than obtains to-day. In such an environment swarmed those multitudinous and monstrous reptiles whose fossil remains now awaken awe and wonder in the human beholder. The Age of Reptiles was so much longer than any other epoch in earth's history that its sudden termination is the more startling. Cataclysmal upheavals of land and water, coupled with climatic changes, no doubt contributed largely to the downfall of the monster lizards, etc. Many perished in quicksands, other were marooned in sparsely vegetated areas, and in addition it is more than likely that the earliest mammals helped in their annihilation.

Authorities have pointed out that the first mammals, though small and feeble, were more than a match for the Dinosaurs. They dug out and devoured the reptiles' eggs; and in addition their covering of hair made it possible for them to colonise the world, in a manner not possible to reptiles, confined as they were physiologically to the warmer regions only. Early mammals, like early reptiles, show a great similarity of design. Once they had fairly set out to explore, however, no part of the world was wholly closed to them, and adapting themselves to all contingencies they developed at a speed, and with a wealth of variety, never seen in reptiles, either recent or extinct. Like the reptiles, the early mammals often attained vast proportions, and

it may safely be stated that the few thousand species of mammals existing to-day represent a relatively small percentage of the species that have waxed and waned since the first inceptions of the race.

Our great land masses have been stabilised for only a few million years. The mammals once enjoyed a very different distribution from that seen to-day. Land masses rose and sank, and the early flocks and herds were constantly migrating from one continent to another as circumstances allowed. There is abundant evidence, for example, that the bears, now chiefly represented in America, marched to that continent from Asia, the original "cradle" of many important mammals found to-day. Similarly the tapirs, elephants and giraffes manifested themselves in almost every quarter of the globe, being finally restricted to their present habitats at a relatively recent date.

The entire cavalcade of Evolution is a striking instance of "every dog has his day". The mammals, exclusive of man, may well be said to have passed their zenith. Every one of the mammalian groups now recognised was in the past represented by more numerous and infinitely larger forms than now obtain. To-day, the Capybara—a species of huge guinea-pig, about the size of a sheep dog, inhabiting South America—is the largest living rodent. Less than a million years ago, however, beavers ranged as large as oxen, and giant marmots, in order to be able to contend with the carnivores of the period, developed immense unicorn-like horns—a feature unknown in any rodent now living.

One mammal only can be said to dominate the world to-day—Man. All other forms have given way before him, and his ever-increasing potentialities for destruction. The preservation of wild life is a matter of recent times, and in many quarters it is gravely wondered whether or not our new-found zeal for conservation has come too late.

III

THE PRIMATES

Order *Primates*

THE term Primate is applied to such animals as the man-like apes, monkeys and lemurs. One has only to compare the skeleton of a monkey with that of a man to appreciate that our kinship is much more than skin deep. The skeletal structures of man and monkey are almost identical, bone for bone, the chief differences lying in the proportional sizes and minor modifications of the different bones. The differences are reduced to a minimum so far as the man-like apes are concerned, since their tails, like our own, have been literally rubbed out, or at least have atrophied from suppression and disuse. Apart from all anatomical considerations, the primates approximate to ourselves in their mode of life, diet, number and rearing of young, and in their general social economy, *i.e.*, their standards of "civilisation".

It says much for the general advancement of education that one hears no longer people talking nonsense about our having "come from monkeys", or waiting expectantly to be confronted with a "missing link" as they did up to half a century ago. During the last few decades missing links, so called, have been discovered in abundance. The greatest number have emerged, as fossil remains, from Europe and Asia, and it is possible that the latter continent, regarded as the birthplace of the mammals, also saw the dawn of man.

It is not possible to "date" with any accuracy that remote period when anything avowedly a "man" emerged as such, and could be recognised as different from the numerous races of "Ape-men" now known to have existed in Africa, Java and elsewhere. The transition from ape-man to man was no doubt very gradual. The fact is, however, now generally admitted that it was a relatively recent event, and must have covered a period of not much more than a million years. Man is the latest of all the animals, a mere upstart, a mushroom growth of yesterday.

Even with man established as a very distinct and definable entity, the line of demarcation between the highest apes and the lowest man is less apparent than many may suppose. There are to-day, in remote corners of the world, savage tribes that live on more primitive lines than did many of the most advanced flint-working cavemen. There are still people living largely in trees, feeding upon fruits and offal, and but dimly acquainted with the crudest rudiments of clothing, cookery, social laws, or such other purely human prerogatives as tradition, folklore and religious beliefs. Man's meteoric rise to his present position of

highly artificialised civilisation is the most astounding fact which emerges from that age-long chain of events, summed up in the one word "Evolution".

The old saying, "Necessity is the Mother of Invention", is particularly applicable to the evolutionary process. Man's emergence as a clothes-wearing, tool-making animal apparently occurred under climatic conditions demanding activity and resource, and offering few attractions to the mere "lotus eater". The most primitive, and least responsible, humans still exist for the most part only upon sufferance, in the warmest countries, where life goes easily, and little initiative is required in order to subsist. For this reason, probably the bulk of the primates, great or small, still live in warm countries, offering abundant shelter and illimitable supplies of the fruit and various "oddments" characteristic of primate diet.

Geology shows that our earth's history has been one long process of "cooling down", resulting in an insidious but steady restriction of its warm areas to the equatorial and sub-equatorial belts. Up to within some eighteen million years ago (the Miocene period), heat and cold were less sharply defined, and there were, moreover, land areas existent which are now sunk beneath the sea. Ape remains are not traceable before the Miocene, and it is apparent that at that time both man-like apes and monkeys existed in Southern Europe. To-day apes are not found further West than Africa, whilst Malaya marks their Eastern limit.

Travel facilities and the general dissemination of educational literature, reliable pictures, photographs, etc., have now made us all so familiar with the man-like apes that it is difficult to realise the general attitude towards them only two hundred years ago. Representations of new foreign animals were then made at the dictation of the few travellers, who were not always too reliable as eye-witnesses. It is not surprising, therefore, that some of the "first records" of such well-known creatures as the Gorilla, Orang-utan and Chimpanzee, were more exciting than informative. There is now no doubt that many odd stories of fauns, satyrs, wild men and forest devils had their birth in the huge, but usually harmless, apes, and these old beliefs are still remembered in some of the cognomens bestowed upon the beasts by science. The man-like apes are known to-day by the Gorilla, Orang-utan, Chimpanzee and Gibbon. Of the known species, there is some disagreement amongst scientists as to which most nearly approximates to man, *Homo sapiens*. By general consent, however, the Gorilla is allowed pride of place, as much by its imposing size as by its general characteristics.

The Gorilla, *Gorilla gorilla*, is to-day recognised by various

sub-species, which for all practical purposes may be regarded as one.

The Gorilla—a name signifying “wild man”—was first made known to civilisation by a Portuguese captive in Angola. In 1698 he wrote:

“The Pongos differeth not from men but in their legs, for they have no calves. . . . They cannot speake, and have no understanding more than a beast. The people of the countrie when they travaile in the woods, make fires when they sleepe in the night, and in the morning when they are gone, pongoes will come and sit about the fire, till it goeth out; for they have no understanding to lay the wood together. They go many together and kill many negroes that travaile in the woods.”

This description was accepted—and copied—by naturalists and others for the next century and a half until Dr. Thomas S. Savage, a missionary, brought back from the Gaboon some gorilla skulls, and much information, true and false—as for instance that the gorillas absconded with native women. In 1859, the world was startled by the arrival from Central Africa of the explorer Du Chaillu with skins, skeletons, and many stories concerning the greatest of the man-like apes. His tales were hotly disputed by many, though now we know Du Chaillu’s accounts to have been mainly true. Finally, at about the same period, Darwin published his so-called “theory of evolution”, in the development and justification of which the gorilla played an important part. The world generally accepted evolution before it learned the full story of the gorilla. This story—still not entirely complete—has transpired only of recent years. It was not until the animal became known in Zoos, and was later carefully studied by conscientious observers, that the old conceptions of it as a demoniacal monster were finally laid to rest.

The gorilla is the largest ape known, living or extinct, and is confined to the dense jungles of Central Africa. Two races are distinguished, the more delicately constituted lowland gorilla and the hardy mountain breed, which wanders high up the wooded slopes of Mount Mikeno. The latter, like the former, is a dark brown or blackish animal, but with longer hair, and a grey “saddle” mark in the middle of its back. The gorilla is massively built, an adult male standing six feet high and weighing 700 pounds. The creature’s great height is seldom appreciated, since it habitually walks on all fours, and its arm being shorter than the chimpanzee’s, the head is brought nearer to the ground. An adult probably has the strength of five or six men, and this tremendous physique is kept up solely

on a diet of birds, fruit, roots and sugar-cane. Gorillas do some damage to crops, and may become dangerous when disturbed at their pilfering. Normally they are quite inoffensive, and no justification can be found for their one-time persecution. Natives, at all times eager to obtain meat, have killed large numbers, especially in areas where civilisation sought to suppress cannibalism. This reacted disastrously upon the gorillas, whose flesh not unnaturally offered the "next best thing".

Gorillas have their own well-organised social system. There is but one baby at a birth, the youngster remaining some years with "the old people". A family group consists of a big male, or overlord, his several wives and children of various ages and sizes. This party spends a nomadic life, wandering and feeding by day. At night, camp is pitched, but seldom in the same place twice running. The wives and children are "sent up to bed", the overlord seeing them all safely up a selected tree, where they make a rude platform of twigs and branches. There they sleep, the head of the house remaining seated at the foot of the tree, his back to its trunk and his arms folded on his chest.

The old travellers had much to say about the gorilla's demoniacal voice. It can, when fully roused, raise terrible cries which carry for miles, but normally its voice is a dog-like bark. Du Chaillu and others also dwelt upon the gorilla's roaring, at the same time augmenting the intimidating sound by beating its breast, giving the general effect of a war drum working at high pressure. Observation has shown that the gorilla undoubtedly beats its breast, but not necessarily as an intimidating measure. Mok and Moina, an almost adult pair living in the London Zoo, beat their breasts with both open palms to express any intense emotion, pleasurable or otherwise, and often without emitting any vocal sound whatever.

Our knowledge of the gorilla has gone hand in hand with our own civilisation and advancement in education and standards of humanity. The first few gorillas brought to England never prospered for long, and the London Zoo abandoned keeping them until circumstances permitted giving them ideal conditions. Such the Zoo's present examples, Mok and Moina, now enjoy. Their house is illuminated by artificial sunshine, and is perfectly warmed and ventilated. The animals are given ample provision for exercise and enjoy a varied and carefully prepared menu, consisting of fruit and vegetables, eggs, and, in winter, meat. Alcohol and tobacco are tabooed, though it may be mentioned that man-like apes soon acquire a taste for these indulgences if permitted.

As a result of their present conditions, Mok and Moina, received as infants, are now of human stature and thriving with

gusto. Statistics kept at the Berlin Zoo show that a young animal of 30 pounds weight doubles this in a year, and attains 42 stone only six years later. The normal life span of the gorilla, or that of other man-like apes, is not known. Considering, however, that most African natives are middle-aged at thirty and senile at fifty, it is probably considerably less than that of the average white man.

There is to-day probably no animal in the world, not even excepting the dog and horse, enjoying such universal affection as the Chimpanzee, *Pan satyrus*. Until it is of about seven years old the "Chimp" is quite trustworthy, and of a gay, rollicking disposition, in contrast to the gorilla, which even in youth is of a somewhat taciturn and retiring nature. The "chimp's" bare face, large ears, man-like hands and feet and neat black glossy coat, moreover, give it a human appearance that irresistibly captures our fancy and sympathy.

Anatomically, the "chimp" is less stocky than the gorilla, never developing the latter's "paunch". The black hair, unlike that of most black animals, does not whiten with age. The arms are proportionately longer than those of the gorilla, and their strength is enormous. The male chimpanzee is fifty per cent stronger than the female, and grows to a height of 5 feet—a foot more than she. As with other apes and many monkeys, attempts have lately been made to "learn the language" of the chimpanzee. Some authorities have claimed to detect a definite code, or vocabulary, in the various sounds emitted, but the results of their investigations can at present only be described as very inconclusive. Like the gorilla, the chimpanzee thrives mainly upon a vegetarian diet. As regards its private life, much still remains unknown. It is, however, believed that the older animals live in small family groups, but that adolescent "chimps", in the hobbledehoy stage of development, form bands which "racket" through the forest, to the general disturbance. Of the



Chimpanzee: Hand (dorsal), Foot (ventral surface)

chimpanzee as a Zoo exhibit, circus star or household pet stories could be told without end.

The chimpanzee is essentially a social animal, and dreads nothing so much as solitude, the companionship of even a small monkey being preferred to none at all. Of late years many investigators have kept it under careful observation, and even brought it up "on human lines" with their own children. The ape under such conditions not only shows a wonderfully quick intelligence, but in some directions for a time at least even outstrips the mentality of the human infant. After a few years, however, a "slowing down" manifests itself, and after seven years the ape becomes subject to "moods", and is generally less trustworthy.

The chimpanzee is at all ages somewhat hysterical. It has a love of "limelight" which makes it quick to seek human approval, and is highly susceptible to the "atmosphere" of any society in which it finds itself. Some years ago a little Zoo "chimp" used to frequent the writer's house, and was on one occasion present at a luncheon party. His behaviour at table was perfect, handling the service with utmost propriety, and decorously clapping with delight when laughter was general. Towards the close of the meal a large bowl of cherries appeared. This proved too much for his self-control, and the ape plunged both arms to the elbow in the fruit. Human hilarity followed naturally, but the ape did not join in the merriment. Realising that the laughter was "on" and not "with" him, and that he had committed a "social error", he buried his face in his hands, overcome with mortification.

A chimpanzee soon learns to acquire a liking for all the amenities of civilisation. It delights in dressing up, and can learn to steer a car or mount a bicycle after a few lessons. A specimen at the Hamburg Zoo daily used his bicycle to make sallies into the streets and raid fruit stalls, pedalling off at high speed after one of these raids.

All these activities are, of course, largely imitative, but experiment has shown that the "chimp" has reasoning powers far in advance of any other animal. It can "think things out" and couple cause with effect. If, for example, a bunch of fruit is hung just beyond the ape's grasp, and a number of boxes placed nearby, the animal will "put two and two together", piling the boxes into a pyramid until the fruit is within its grasp.

Many animals learn by experience that the at first perhaps painful ministrations of a "vet" are for their benefit, and learn to tolerate such treatment with resignation. The "chimp" not merely tolerates, but learns to collaborate with its well-wishers.

*

A large Zoo chimpanzee whose teeth had become undermined with caries—as the result of unwise feeding in its pre-Zoo days—came under the dentist's hands. On “coming to” from the chloroform, it found itself minus several large molars, and was no doubt in considerable discomfort. Yet after very little initiation it learnt to rinse and gargle with a mouth wash, and was prepared to continue the treatment long after it became unnecessary.

As with the gorilla, only the last few years have shown Zoo authorities just those conditions and requirements necessary for the animals' full prosperity under confinement. As a result, several chimpanzees have been born in these islands, one of them at present living in the Regent's Park Zoo. The infant is in all respects “mothered” much like one of our own species. It is meticulously washed and groomed, its food carefully supervised, and its discipline attended to—sometimes vigorously.

The Orang-Utan, *Pongo pygmaeus*, is next to the gorilla the largest of the man-like apes, but is possibly lower than that animal or the chimpanzee in general development. It has shared all the old legends told of the gorilla and chimpanzee, and any true knowledge of the animal was only possible when the steamship made acquaintanceship with the Far East of common occurrence. The orang is much less man-like than the two preceding apes. Apart from its reddish-brown skin, and long, ragged “auburn” hair, it is distinguished by the great length of the arms, markedly stooping habit, and tardy, almost sloth-like mode of progression. It is also much more truly arboreal than its nearest relatives, having, in common with the gibbon, an extra bony development in its wrist, giving that joint great suppleness. In its every activity, mental and physical, the orang is “lower geared” than the chimpanzee. Docile and quaint as an infant, it acquires a less prepossessing presence with advancing age. The head sags forward, and in adult males the face may acquire huge fleshy side flaps, whilst the throat exhibits an enormous goitre-like development, that hangs down over the chest. The eyes are close together, the ears and nostrils very small, and the upper lip grotesquely big—but readily retractable, to show most intimidating teeth.

The orang appears to be isolated in Borneo and Sumatra, where it keeps to the dense and humid jungles. It is of interest to note that, just as the gorilla shares the almost ebony hue of many native tribes, the orang takes on the more brownish colour of Malay peoples, and like some primitive peoples of that region is essentially a tree dweller. As with the other great

apes, its chief foes—apart from man—appear to be the large cats and snakes.

Unless tempted to raid crops, the orang seldom comes to earth. Like the gorilla, it is a nest—or rather platform—builder, and further has an instinct to protect itself from sun or rain by impromptu parasols, using in captivity newspapers or straw in this connection, though the actual necessity for so doing is usually non-existent. On one occasion only has a captive orang actually built a nest. This occurred some years ago at the London Zoo, when a big orang, "Jacob", broke loose one night from the now demolished ape house. He made for the branches of a tree outside and there constructed, in a few hours, a platform of branches on which he rested till morning. It says much for orang architecture that this structure, crude though it was, withstood the gales of an entire winter.

Few seem to have paid as much attention to the orang's "education" as to the chimpanzee's, but the ape has evidently a deep reserve of potential ingenuity and reasoning power. One at the New York Zoo fashioned a crude wooden key with which to unfasten his cage. Another utilised a piece of scrap iron, left accidentally within his reach by some workmen, to lever his cage bars apart, and actually enlisted the co-operation of a young chimpanzee, his cage companion, the two working together, sometimes in separate "shifts". The orang is much less hysterical and "temperamental" than the chimpanzee, showing great powers of quiet concentration and sustained effort in any piece of work undertaken.

In general mode of life the orang closely follows the manners of both the gorilla and chimpanzee, living in small family communities, feeding by day and sleeping at night. The single young one is "educated" exclusively by the female, and for the first year largely carried on the hip, much as are human infants throughout the East and by many primitive people. The orang-utan's exclusively aboreal life, however, has led to certain peculiarities of its daily routine. It never stays in any one spot for a length of time without constructing the characteristic platform, and even for its afternoon siesta contrives a rude hammock or other support for its weight. It drinks almost exclusively from such reservoirs as rain and dew create in the axils of tree branches. In the Zoo's old ape-house, water-troughs were placed some little distance from the bars of the orang cages, and although provided with a drinking-bowl the orangs spent many hours solemnly dipping straws into the fluid, and then sucking the liquid off.

The orang-utan, quite as much as the gorilla, has earned a reputation for savagery, and this is doubtless justified as regards

adult males. The bulk of such, taken dead or alive, bear the marks of numerous battles, the hands often showing a remarkable shortage of finger-tips. The customary method of attack with all primates is to seize the adversary's hand and then bring it to the mouth.

The orang's principal foes in the wild are probably serpents, since its native jungles teem with these, both harmless and venomous. No doubt it has good cause to dread them, though possibly its fears in this regard—like those of most humans—are as much a result of precept and tradition as of actual first-hand experience. At the Zoo many years ago, the experiment was made of introducing a large, harmless snake to an infant orang, which was known to have never seen a snake of any kind. So far from showing any fear of the snake, the baby ape hailed it as a welcome play-fellow, treating it to such boisterous endearments that the reptile had to be removed, in its own interests.

The Gibbons (Family *Hylobatidae*) are represented by a number of Far Eastern apes, and are regarded as the lowest of the man-like apes since, though undoubtedly akin to the animals already reviewed, they depart furthest from man. They are divided into two groups, all the members of which, however, present the same general make-up.

The principal feature is the extraordinary length of the arms, the fingers touching the ground when the animal stands erect. There is a well-formed thumb, although the hands are used as mere grappling irons rather than tactile organs. In a few species the second and third toes are almost fused together or joined by a web, and the foot exceeds the hand in length. The head is almost globular, and the nose is more bridged than in other anthropoids. The coat is very dense and thick, a seeming anomaly in a creature living in a hot steamy climate, but it must be remembered that tropic nights in the tree-tops can be exceedingly cold, and the fur further serves as a protection against torrential rain, drenching dew and direct sunlight.

The eager, restless brain of a gibbon is reflected in its large, brilliant, and widely separated eyes. Gibbons indeed are very amenable animals, quickly becoming used to human society, and passing with honours many of the intelligence tests often presented to the higher apes.

The most remarkable of the group perhaps is the Siamang, *Symphalangus syndactylus*, of Sumatra and the Malay Peninsula. It is distinguished by the presence of a laryngeal sac, a large bladder-like organ which, when distended with air, may be the size of a grape fruit. It adds remarkable resonance to the voice

—a leading feature of the entire group—and can be heard several miles distant especially at dawn and sunset, the gibbons' favourite times for song.

The gibbons of the genus *Hylobates* are known by the Lar or Agile Gibbon of Sumatra and Siam, *H. lar*, the Hoolock Gibbon, *H. hoolock*, of Assam, and the Concolor Gibbon, *H. concolor*, of Indo-China.

These apes differ only in minor structural features, colour and voice. The song of the Hoolock is described by its name, the ape's vocal efforts consisting in a monotonous, and at times ear-splitting, repetition of "Hoo—lock, Ho—o—o—lock!" Being highly gregarious, and much given to "community singing", gibbons never fail to advertise their presence, wherever they may be. At the Zoo it has been noted that almost anything—a fine day or a party of hilarious visitors—may inspire the gibbon to song. On late evenings, or Saturday afternoon, however, when the band plays or music is relayed by wireless, the gibbons receive a check. Unequal to the task of "shouting down opposition", they relapse, after a few efforts, into sulky silence.

Gibbons are, without exception, the most active of the entire ape and monkey race. Their agility is incomparable to that of any other animal, and this is the more surprising since the animals have no vestige of a tail to serve as a balancing pole. The arms, however, are often made to perform the same function. Thus, a gibbon will run at high speed along a horizontal branch with the arms held grotesquely bent at right angles to the body, as though balancing a pole such as is carried by a human "wire walker". A gibbon's more usual course of progression is, however, by the arms alone, gaining in the process such momentum that it can swing itself thirty feet between one hand-grip and another.

The Family *Cercopithecidae* embraces the whole of the Old World monkeys, including the baboons. Monkeys are primates less obviously akin to man than the anthropoid "apes". The majority have tails of varying length, though several so-called monkeys are quite tail-less. The several hundred species vary greatly in size, colour and internal economy, some of the leaf-eating kinds having stomachs not unlike those of ruminant quadrupeds. The majority are arboreal.

The Baboons are African monkeys that have given up an arboreal life for one in more or less open country, and as a result have "slipped back" to the status and general appearance of ground-dwelling quadrupeds. The chest has become deep and laterally compressed, the tail largely atrophied from disuse,

and the hands blunted and hardened from constant contact with the earth. Since a baboon's food is largely obtained from the earth, the nose has become highly sensitised, the better to search for it, and presents the elongated form characteristic of a wild dog, deer or pig. The eyes are protected from the glare of the sun by an overhanging ridge of bone, giving a very forbidding expression. The canine teeth are prolonged to form formidable weapons, and are used not only in conflict between rival males, but in defence against prowling carnivores.

Like most primates, baboons are mixed feeders. In indulging their liking for non-vegetable substances, they meticulously search the desert sand, carefully sifting it for small reptiles, eggs and insects. A wasp or scorpion is always neatly deprived of its sting before being eaten. Food not immediately needed for consumption is stored in cheek pouches. These developments, common to many Old World monkeys, are probably the result of a communal life wherein food must often be gathered in haste, and may, at a second's notice, be snatched away or otherwise purloined by one's nearest neighbour.

As in some other monkeys, baboons present very noticeable bare patches of skin, particularly on the hinder regions. In the Gelada baboons these significant patches are seen not only upon the buttocks but on the breast, and are known as the "bleeding-heart" marks.

Baboons as a race offer a striking example of the strength which lies in unity. They are highly sociable animals, travelling in droves of from a few score to many hundreds strong, and despite organised "reprisals" on the part of cultivators whose crops they pillage, and possible casualties caused by lions and leopards, remain undiminished in numbers. Baboon troupes systematically "work" certain areas, and live under a complex social code of their own. A baboon community is composed of a number of family parties, each under the command of an overlord, who rules his several wives and numerous young male *attachés* with a rod of iron. But since these latter camp followers necessarily increase in age and strength, his sway never goes undisputed indefinitely. Sooner or later, one of them casts envious eyes upon the overlord's wives and exalted status, and in due course there is a fierce fight for supremacy. As likely as not this will cause the entire troupe to split into two rival factions, so that strife becomes general, and casualties—often fatal ones—may result. Similarly, a female found in the company of a rival male almost invariably causes a general mêlée, in which the delinquent sometimes pays for her infidelity with her life.

Apart from minor squabbles over food, etc., baboons as a

rule live in tolerable peace together. Their co-operation is at times remarkable, and even praiseworthy. Should a troupe be put to flight by well-armed humans, for example, and a weakling be left behind, a number of old males, seeing his predicament, will usually return, at risk to their own lives, and carry him into safety. Baboons, when thoroughly roused, can present a most formidable battle front, showing their immense fangs, bristling their hair and raising fiendish cries. Few dogs will face them thus, but in Africa special "baboon hounds" are trained to circle round the animals until the quarry is thoroughly bewildered, when it is attacked suddenly in the rear. Apart from periodic clashes with civilised man, baboons live at peace with most other animals, often sharing the same grazing-grounds with wild pigs, bush buck, etc.

The constant grooming of the hair, so obvious a ceremony with all monkeys, plays an important part in the daily routine of baboon society. It is not necessarily a mere search for vermin or even dried scurf, which is somewhat salt, and salt is highly appreciated by most mammals. Grooming, amongst baboons at least, has a largely psychic, or at least sensuous, significance; an overlord baboon will permit only certain privileged members of his suite to groom him, whilst similar action may be a mark of friendship between members of the same sex.

The baboon has earned a bad name through its destructive habits, but stories of its wantonly attacking humans or even domestic animals need corroboration. As a destructive agent the animal can scarcely be equalled. It may destroy locusts, but at the same time wreaks nearly as much havoc as do those insects upon crops.

Its curiosity frequently gets it into trouble—for it will even carry off the unguarded clothes of some luckless human bather. On one occasion a troupe of baboons entered a Boer farmer's cottage and spent a pleasant afternoon meticulously examining every article, opening drawers, cupboards, etc., and even turning up the carpets. All might have gone well, and the animals left with little damage done. As ill luck would have it, however, a door accidentally slammed, whereupon the troupe, believing itself trapped, yielded to panic, and in its search for an exit reduced the place to scarcely recognisable ruins.

Normally baboons forage for food by day and sleep at night in rocky fastnesses or dense thickets. Sentinels are not posted despite old tales to the contrary, neither do baboons abscond with children and rear them on "Tarzan" lines. The baboon's own progeny are born singly, the infant being for a time carried at the maternal breast and later promoted to a jockey seat on her back.

Of the dozen or so species of baboons enumerated, the best known is the Sacred baboon, or Tartarin, *Papio hamadryas*, of Egypt, Abyssinia, the Soudan and Arabia. It is well represented by a bachelor colony on the London Zoo's monkey hill. This species is at once recognised by the greyish colour of the fur and bright pink face. In males the hair forms a luxuriant cape over the shoulders, giving the wearer a very imposing appearance. In ancient Egypt this baboon held a position of great eminence. Prior to the Christian era, the ancient city of Hermopolis was literally given up to this beast, the baboon being dedicated to the God Thoth, to whom the Egyptians attributed the invention of writing. Baboons figure in innumerable wall-paintings monuments, etc., whilst thousands of their carefully embalmed mummies have been disinterred. Unlike many sacred animals, however, these baboons were not mere pampered idlers, relegated to a life of ease on the strength of their sacred associations. Wall-paints and ancient papyri prove that they were trained to perform numerous useful services. They acted as guards, watch-dogs, etc., were taught to paddle river craft and to gather the fruit harvest, being sent up into the laden branches of fruit trees, where they flung the crop into baskets held by slaves waiting below.

The Gelada baboon, *Theropithecus obscurus*, is confined to South Africa, and is distinguished by the breast marks already mentioned. Like all baboons it shows great cunning, and soon learns to distinguish between the well-armed white man and the native, who is not as a rule permitted to carry any weapons other than a spear, assegai, or knobkerrie stick.

The Olive baboon, *Papio anubis*, the Guinea baboon, *P. papio*, and the Yellow baboon, *P. synocephalus*, are small- or medium-sized animals, the first two inhabiting East and West Africa, the last being confined to the South.

The Chacma, *P. porcarius*, is the giant of the race, eclipsing a collie dog in size. It is a native of South Africa and, like the Hamadryad, is a striking example of the generally high intelligence found amongst these monkeys. One specimen which lived many years ago near Port Elizabeth has become an almost legendary figure, and the true story of its remarkable career is preserved in a special memorandum at the Port Elizabeth museum. In 1877, a railwayman on the Port Elizabeth main line lost both legs in an accident. To travel between the signal box where he worked and his house, he made a trolley which he punted along with a pole. One day he chanced to purchase in the local market a big "Jack", as male baboons are always termed in South Africa. The Jack not only proved a most affectionate pet, but an apt pupil. He learnt to help the dog

who normally assisted in the propulsion of its master's trolley, but, on the dog's death, utilised his formidable strength to perform this service single-handed. He would slave at a crude pump to draw water for his master's allotment, and even learnt to carry a key to the driver of a light engine who used it to adjust certain points further down the line. On hearing four blasts on the engine's whistle, Jack would hurry to the signal box, take down the key from its peg on the wall, and then hand it up to the engine-driver as he passed. Work over for the day, Jack's chief delight was to sit upon a bench outside the cottage, meditatively stroking his master's face.

The Mandrill, *Mandrillus sphinx*, is almost as large as the Chacma, being about a yard long, and standing well over four feet high when upon its hind legs. The general colour of the fur is a greenish brown, and the face in females and immature males is dark. That of the adult male is quite without its parallel amongst mammals. The enormous development of the upper canines forces the cheek bones into high ridges which are covered by fluted folds of skin, tinted a vivid azure blue. The nose is a flaming scarlet. The general body colour is auburn, shading to creamy white below. This, combined with the shell-pink ears, hands and feet, a creamy imperial beard, and hind-quarters quite as vividly coloured as the face, forms an ensemble striking to a degree. The mandrill is confined to West Africa where it consorts in small troupes, much dreaded by the natives. It has been reported to engage, and defeat, the leopard single-handed. Captive examples soon learn to catch rats, mice and sparrows, devouring them entire with tigerish relish. A famous mandrill, "Happy Jerry", was the "star" of a now demolished menagerie that graced the Strand, London, in the early part of last century. Jerry was much addicted to strong drink and tobacco, and was twice privileged to dine with King George IV.

The Drill, *Mandrillus leucophaeus*, enjoys a slightly wider range than the mandrill. It is closely similar in general appearance, but the face is uniformly black, the lower lip in adult males being marked with a bar of vivid scarlet. Like the mandrill, it is a fierce and truculent creature, but fortunately associates in much smaller companies than do the true baboons.

The typical Old World Monkeys are distinguished from those of America by having the tail entirely non-prehensile, well-formed extremities, and more or less bare patches on the buttocks. Most are highly gregarious, mixed feeders, and bear their young singly, twins being of the rarest occurrence. These monkeys are generally better known than those of the New World,

since they have been associated with man from earliest times, figuring widely in the religious beliefs, folk lore and heraldry of all ages and all Old World nations. Monkeys of the Old World are confined to South Europe, Africa, Asia and many East Indian Islands, their absence from Australasia being accounted for by the fact that this portion of the East became separated, by land subsidences, from the main continent of Asia before the race came into being. From Asia the monkey-hordes migrated west. Many species are hardier than is generally supposed, and have made their way well beyond the snow-line both in Asia and Africa. Several hundred species are known, and show upon the whole considerable uniformity of size and habits, though varying much in colour.

The Black "Ape" of Celebes, *Cynopithecus niger*, called in its own land a baboon, is probably a link between the baboons proper and the true monkeys. It is entirely confined to Celebes and fairly common in the northern areas of that island. It is jet black from head to foot, and the tail, like that of the Mandrill and Drill, is represented by a mere knob. It plays an honoured part in local folk-lore, the leading tribe of Celebes claiming direct descent from a "super race" of black apes, believed to have once owned the island. It is a powerful beast, and, unlike true baboons, largely arboreal. In the main it lives on good terms with the natives, only occasionally raiding crops. Its favourite change of diet is found on the sea shore, where at low tide it scours the rocks for sea worms and shell-fish of all descriptions.

The Macaques (*Macaca*) are represented by scores of nearly related species, abounding throughout India, northward to Kashmir and Tibet, southward to Ceylon, eastward to Bengal, Burma, Siam, the Malay Peninsula and innumerable island groups, but entirely absent from Africa. All are stocky, powerful animals with coats of a greenish brown. The tail may be of average length or entirely wanting.

The Common Macaque, *Macaca rhesus*, is the typical monkey of India. Until some twenty years ago it was a familiar street sight in this country, where it almost invariably accompanied itinerant "organ-grinders". It holds a semi-sacred position in India, infesting the famous monkey temple of Hanuman at Benares, and has been immortalised by Kipling both in prose and verse. This monkey has been a favourite subject for scientific investigators, and during the War great numbers were used by all the nations involved as subjects for the perfection of poison gas. The extreme hardiness of this monkey makes it a favourite for "acclimatisation", and large rockeries entirely peopled with it form a feature of nearly every Zoo. In this

connection an amusing incident once happened in Germany. A huge consignment of rhesus monkeys was being installed at Hagenbeck's famous animal park in Stellingen, which abuts upon the railway line, when some scores escaped, boarded a passing express train, and next appeared at the main line station of Berlin, much to the indignation of the station officials, besides causing much embarrassment to the passengers *en route*.

The Barbary Ape, *Macaca sylvana*, is unique amongst Old World monkeys in being the only species native to Europe. It abounds in the more arborescent portions of Barbary, and is a common pet all along the north coast of Africa, where it was originally introduced by the Moors. A long history attaches to this ape's sojourn on the Rock of Gibraltar, where it has been a species of mascot to the garrison since 1856. At the beginning of the last century there were 130 of these monkeys in residence, separated into several troupes, each under the command of an elderly male. These in turn were supposed to be more or less under the surveillance of a certain Sergeant Brown, though they never appear to have properly recognised military discipline. Crops, gardens, domestic animals, civilians and the military alike suffered from the monkeys' destructive and pilfering habits. Matters reached a crisis in 1921, when a huge old male became not only dangerous to humans but took to murdering females and young of his own species. He was transported to the London Zoo, and to-day all the rock monkeys are in private ownership, their unfettered liberty being no longer supportable to a complex and civilised community. The Barbary ape is called by the French *Magot*, a word descriptive of any goblinlike figure or even a grotesque face.

Next in order of "popularity" is the little Bonnet Macaque, *M. radiata*, an Indian species which owes its common name to the formation of the hair upon its head, suggestive of a Victorian "toque". The East Indian Pig-tailed Macaque, *M. nemestrina*, one of the giants of the genus, almost equals a baboon in stature. For centuries it has been semi-domesticated, being trained in its own country to gather coconuts. The monkey is tethered and then sent aloft, its owner, at the ground end of the leash, signifying which nuts it shall gather by jerking at the cord.

The Japanese "Ape," *M. fuscata*, is a big tail-less macaque with a dense mouse-grey fur and brick-red face. It is a mountain-dweller, frequenting the pine-clad heights, and is held semi-sacred. It figures in innumerable legends, and is represented abundantly throughout Japan in effigy. Many works of art show three of these apes sitting in a row. One covers his mouth with his hands, the second covers his ears, the third his eyes. They are thus supposed to embody the somewhat

negative virtues of being unable to speak, hear, or see evil of any description.

A related monkey, *Macaca cyclopis*, of Formosa has adopted an almost exclusively maritime mode of life. It lives chiefly in caves just above high-water mark, and though largely frugivorous, relies almost as much upon the sea for its food, devouring not only such creatures as the tide uncovers but even seaweed.

The Guenons (*Cercopithecus*) are an exclusively African group of large monkeys, more completely hirsute than the Macaques. They all have long tails, richly coloured coats and capacious cheek pouches. The best known is the Vervet or Green monkey, *C. pygerythrus*—a common arboreal species inhabiting South Africa. It is extremely nimble, and has constant need of activity in order to escape from the native farmers, and such natural enemies as wild cats, snakes and birds of prey. Many countries, it may be mentioned, possess eagles which live almost entirely upon monkeys, and these birds are in some areas protected for their services to the farmer. Monkeys are incorrigibly wasteful feeders, spoiling many times more fruit than they actually consume. The vervet's life is further rendered the reverse of dull by the constant warfare raging between rival clans, and when two such claim a common feeding-ground a battle royal ensues. The Kaffirs set a great value on vervet skins, which they convert into much coveted aprons. Vervets, besides destroying crops, unfortunately also eat the eggs of insectivorous birds, a habit which largely nullifies their own ravages upon locust hordes. These monkeys are, however, welcomed by grazing animals, since they rid them of insect pests, much as do the cattle egrets.

The Mona Monkey, *C. mona*, of West Africa has an iron-grey body, with vivid chestnut stripes running from the middle of the back to the root of the tail, and a glaring white chest and throat. Such striking combinations are characteristic of the group as a whole. The most famous of all is the Diana, *C. diana*, with black, brown, blue and chestnut upper parts, and a staring white chest.

These monkeys' French name of *Guenon* signifies a maker of faces, and is justified in varying degrees by all the species.

The long-legged and incredibly swift Patas monkey, *Erythrocaebus patas*, is nearly related to the guenons, but being largely a dweller amongst rocks and in open country has acquired calloused, "stubby" extremities similar to those of the baboons. It travels in troupes and is very fearless, often

assailing aggressors with a fusillade of sticks and other missiles. In common with the true guenons it often relieves excitement by a kind of dance, bouncing up and down on hands and feet alternately.

The Mangabeys (*Cercocebus*) are represented by a dozen African species, mostly of large size. They have long tails, and most forms display glaring white eyelids, which it has been suggested on no very good evidence are used for "semaphoring" messages one to the other in the gloom of their favoured forests. Mangabeys have no laryngeal sac, and are the most silent of monkeys, expressing themselves only by gentle "twitterings" or guttural grunts. They live in small companies and seldom leave the trees. The best known is the Sooty Mangabey, *C. fuliginosus*, a member of the uncrested as opposed to the crested group into which the tribe is scientifically divided.

The Guereza Monkeys (*Colobus*) are amongst the most ornate of all monkeys, many being of brilliant colours, and wearing extravagant "top-knots", beards, moustaches and similar hirsute adornments. The rich quality and vivid colour of the fur has been their undoing, and few monkeys have suffered more at the hands of commercial fur hunters. In 1894, over 168,400 of these monkeys were killed, their skins realising over £41,000. Where such butchery has been enacted, Nemesis has often overtaken the district thus robbed of its monkey populace. Plagues of locusts have ravaged the areas, undeterred by their natural foes, the monkeys, who eat them with great relish. To-day, as the result of mass monkey murder, the trade in monkey fur has died a natural death.

The name *Colobus* implies "mutilated", in allusion to the all but absent thumb, common to the genus. A strictly arboreal life causes the monkeys to use their hands largely as mere hooks, in which capacity a thumb becomes unnecessary and so has atrophied from disuse.

The Langurs (*Pithecus*) are typical Oriental monkeys hailing from Ceylon, Tibet, Malaya, India, Borneo, Sumatra, Java and a few adjacent island groups. Langurs are large, lithesome monkeys, with very long tails, greyish coloured fur and dark faces. Most affect hill country, some ascending to 4,000 feet, but are, nevertheless, delicate in captivity. The young are born with white faces, which may become coal black at maturity, when the animal also develops a peak of hair jutting over the eyes, suggesting a jockey's cap.

The best-known species is the Hanuman, *P. entellus*, familiar to all readers of Rudyard Kipling's works. It is fairly common in Central and Northern India, and, as an animal dedicated to the god Hanuman, is held in the highest reverence by all

devout worshippers. The monkeys seem to appreciate fully their privilege, for they not only infest shrines and temples but openly pillage shops, stalls, crops and private dwellings, confident that none dare molest them. So great is the damage sometimes done by them that natives, unable by religious decree to retaliate themselves, have appealed for Government intervention, with the result that numbers of the monkeys are rounded up and dispatched by trainloads to some distant area. It not infrequently happens, however, that the district so to be honoured gets to hear of the impending "privilege", and bribes the train driver to deposit his precious burden elsewhere.

Several non-sacred species are regrettably slaughtered for their fur. One, Langur, is in demand for yet another reason. Its gall-bladder often contains limey concretions of about the size of a hen's egg. These are known as Bezoar stones, and are sold chiefly to the Chinese who believe them to possess remarkable medicinal properties. A large stone may be valued at £6 sterling.

The Snub-nosed Monkeys (*Rhinopithecus*) are known by four species of giant langur distinguished by the curiously *retroussé* nose, which reaches its most grotesque development in the male. They are powerful animals, frequent high altitudes, and in ancient times were sometimes kept as fighting animals to make sport for savage potentates. They are clannish to a degree, and a story is told of how a Chinese village turned out to watch a vast concourse of them march through a mountain pass. Due no doubt to the onlookers' excitement, the monkeys took fright and dashed away—leaving behind numerous bottles of wine, which it turned out had been stolen from a neighbouring village.

Though justly respected for their boldness, these monkeys at least on one occasion forced suffering humanity to take reprisals. A mountain garrison had endured so much pillage from a troupe that at last the ringleader was captured, and his head shaved before being liberated. On returning to his fellows, he was greeted with such derision that he was thankful to go back, sadder and wiser, to his former foes, with whom he lived, sobered and reformed, for many years until his death.

The Proboscis Monkey, *Nasalis larvatus*, is confined to Borneo, and unique in the extraordinary development of the noses worn by adult males. These suggest caricatures of the Roman type, actually drooping over the mouth as far as the chin. In female and immature animals of both sexes the nose never advances beyond the *retroussé* stage of development. No satisfactory explanation for this facial adornment has yet been found, though

many strange legends attach to it. An early travellers' tale affirmed that when journeying through dense jungles a more than usually distinguished male covered his nose protectively with one hand. Possibly the nose is purely an insignia of masculine beauty, as judged in Proboscis monkey society. The Malays call the monkey Orang blanda, or "Dutchman", seeing in the creature's remarkable face an unflattering likeness to their masters, the Netherlandic colonisers. The general colour of the animal is a cinnamon brown, whilst the face gains additional grotesqueness by being of a very Nordic pink and white. Proboscis monkeys seldom wander far from jungle water courses, and are expert swimmers, readily taking to water, in which they can remain wholly submerged for fully half a minute. They are communal and peaceable with one another; two tribes of this species cheerfully sharing "grazing rights" though at once giving battle to and usually routing monkey troupes of any other species.

(The monkeys of Central and South America are distinguished from those of the Old World by several well-marked characters. They are almost exclusively arboreal; many have forfeited the thumb from disuse, and they have highly prehensile tails. In none is the thumb so opposable as in Old World species. Most have broad noses, with the nostrils directed forward. In most features they are more primitive than African or Asiatic types. Living as they do in countries teeming with insect-life, they show many features common to insectivorous mammals, from which all monkeys are believed to have sprung. The teeth are often of an insectivorous type, and the hands and feet bear claws rather than flattened nails. In some species it is quite usual for more than one infant to be born at a time.)

Many species have been tabulated, but much of the vast Amazon jungle is yet unexplored, and as a consequence one frequently sees in the Press reports of rumoured species, yet unidentified. One of the most persistent tales relates to a tail-less ape with vivid auburn hair.

Some justification for such reports is furnished by the rare Red Uakari Monkey, *Cacajao rubicundus*, of the Upper Amazon. This monkey is not much larger than a cat, has a bobbed or almost absent tail, thirty-six teeth instead of the normal thirty-two, bright "carrot" hair, and a brick-red or purplish face. It is a quiet, recluse-like animal, living in small family parties and, like most American monkeys, varying its fruit diet liberally with birds' eggs and insects. Its chief foes are snakes and harpy eagles. In captivity it becomes very tame, and the famous

traveller Bates recalls how a captive Uakari, though one night tempted to revert to the jungle, returned to its captors of its own accord a few days later, in spite of the fact that the ship was anchored in a jungle water-way to which it was unaccustomed.

Nearly related are certain Saki Monkeys (*Pithecia*), distinguished chiefly by enormous beards, and long, bushy, but non-prehensile, tails.

Sakis, like the Uakaris, are gentle and inoffensive, readily taking to human companionship. If kept as pets in their own country, they seldom show any inclination to return to the wild, though free to do so at any time they wish.

The Howlers (*Alouatta*), known by half a dozen species, are perhaps the most distinctive of all New World primates. Most are of large size, and the hyoid bones supporting the tongue are fused to form a large cup-like structure, in some species as large as the bowl of a wineglass. This serves as a resonator to the naturally powerful voice. The "sound box" is protected by deep expansions of the jaw bones, and a voluminous beard, reaching its greatest development in adult males. Many writers have testified to the wonderful vocal efforts of these monkeys, who usually sing in large companies at sunset and dawn, choosing the highest tree-tops wherein to indulge their tastes for community singing. A choir may make itself audible for several miles distant. The animals show a genuine aesthetic appreciation of their wonderfully rich and deep organ-like voices, their various cadences rising and falling in perfect unison, although old travellers' tales of elder monkeys solemnly "conducting" such choral efforts are not corroborated by more recent authorities. Howler monkeys are very tenacious of life, and the prehensile tail may retain its hold of a branch long after the monkey possessing it has been dead. New World monkeys generally are regarded as being delicate feeders, and only likely to survive in captivity if studied carefully as to their diet. A pet howler at the New York Zoo, however, contrived to survive—and even thrive—after in one day helping himself to hot rolls, sauerkraut, Frankfurt sausage and lemon meringue pie.

Nearly related to the howlers are the Capuchins (*Cebus*), their popular name referring to the peak of hair upon the head, a decoration recalling the peaked cowl of the Capuchin monks. About twenty species range from Mexico to Paraguay, and they are quite the most abundant and widely distributed of all New World Monkeys. The tail is very prehensile, and much used for lowering its wearer to within reach of honeycombs, birds' nests, etc. The diet is extremely mixed, and the monkeys' curiosity insatiable. They go about in companies of twenty or more,

often joining troupes of spider monkeys. The usual cry is a bird-like twitter, which may rise to a shrill scream under any stress of emotion. When angered, Capuchins arch the back, much as does a cat. In some parts where these monkeys destroy crops, natives have an ingenious mode of trapping them. They select large hollow seed cases produced by a particular tree, such pods having one narrow opening at the smaller end. Food is placed in these pods and a number of them being scattered about, the monkeys are left to meet their fate. This comes to pass as a result of the creatures' curiosity. A monkey finding one of these baited pods, makes his hand as small and thin as possible, and then forces it through the opening to reach the food. Once his hand is inside he has not sufficient reasoning power to again compress his extremity and so safely withdraw it. As a result he is rendered more or less helpless, until discovered and captured by the outraged agriculturist.

The Woolly Monkeys (*Lagothrix*) are perhaps the most attractive of all tailed primates. The round head and massive body are clothed in dense grey or brown woolly fur; the face is black, and the tail remarkably long and highly prehensile. Woolly monkeys are quiet and gentle, and although armed with formidable canine teeth appear to use these only for cracking hard-shelled fruits, such as Brazil nuts. The prehensile tail can be used as a hammock—its tip holding tightly to one branch, the monkey's toes to another, whilst the animal luxuriously leans his back against his caudal appendage. By crooking the end of the tail, resting it upon the ground, and rendering the rest of the tail rigid, the tail becomes an efficient shooting seat.

The Spider Monkeys (*Ateles*) found from Mexico to Paraguay are the most highly specialised of arboreal primates. The arms are of great length, the thumb has become *non est* from disuse, and the under surface of the tail's terminal portion is quite naked, giving a more effective grip to slippery creepers, etc. It is also used as a wrap at night, spider monkeys, like most primates, being diurnal. Like all South American monkeys, spider monkeys suffer much from attack by wild cats, large snakes and such birds as the king vulture and the harpy eagle.

The Squirrel Monkeys (*Saimiri*) found in South America from Costa Rica to Brazil and Bolivia are almost as common as the Capuchins, and are popular as pets. They are about the size of squirrels, subsist on a very mixed diet, and have long, non-prehensile tails. The brain case is proportionately larger than in man, though their mentality, curiously enough, is rather below the average monkey standard. In common with the Howler monkeys and marmosets, family cares devolve upon

the male squirrel monkey, who carries the single infant on his back, only handing it over to the mother at meal-times.

The Owl-faced Monkeys or Douroucoulis (*Aotes*) are found from Nicaragua to the Amazon and Eastern Peru, and are nocturnal in habits, spending the night in raiding birds' nests and capturing insects which are the dominant form of life in all South American jungles. The voice is a loud, cat-like howl, made the more startling as coming from such a small and timid-looking source.

The Marmosets (*Hapale*) have long been great favourites with all keepers of pets. They are, without exception, small animals, often brightly coloured and emblazoned with grotesque ornaments of hair upon the head or tail. The largest does not exceed a squirrel in size. The face and ears are naked, the extremities carry long claws, and the canine teeth may either be long or be quite reduced. The nursing proclivities of the male, as applied to monkeys, has been chiefly studied in the Common Marmoset, *Hapale jacchus*. There is usually only one infant at a birth, and this is handed over to the father immediately upon its arrival. Only when its nourishment demands mother's attention does that parent "take over", handing back the infant to her consort with all speed once her duties have been performed. Until the infant attains proportions little short of its parents, the devoted father carries it—first on one hip, then worn like a belt, and finally mounted on his back—like Sinbad with the Old Man of the Sea. The Pigmy Marmoset, *Hapale pygmaea*, measures barely seven inches in length, exclusive of the tail.

The Long-tusked Marmosets, or Tamarins (*Mystax*), are distinguished from the above group by having the canines longer than the incisors. Tamarins are so lightly built that they can sustain a fall of fifty feet without injury. In South America ladies sometimes carry these monkeys as pets in their abundant hair, from which strange retreat the animals may scuttle forth to snatch some passing insect, returning to their mistress's coiled tresses, wherein to devour it at leisure. The Emperor and Lion Marmosets are two highly ornate long-tusked species, the latter having a long silky coat of a flaming orange colour. In captivity marmosets once almost invariably died as the result of rickets. Nowadays, however, such vitamin providers as cod-liver and halibut oil, or, when obtainable, sun-ray lamps, have quite revolutionised the maintenance of these little primates.

The animals known as "Lemurs" (from the Latin, signifying a ghost or spirit) are classified as the lowest of the primates, since, although built largely on accepted primate lines, they

depart farthest from ourselves, and display many points suggestive of the insect-eating mammals. The hands and feet are highly tactile, the tail, when present, non-prehensile, and the face and head usually elongated. The eyes are usually large, testifying to a largely nocturnal mode of life. The teeth are very complex, and vary much in the different families. In many the incisors are numerous, very small, and closely set. To clean these of pips—resulting from a fruitarian diet, and also from hair which may become involved as a result of grooming—the tongue is peculiarly modified. On its under surface is another tongue-like organ having its tip developed into a sort of comb, which soon rids the teeth of any foreign bodies wedged between them.

The group is chiefly represented in Madagascar, a few only being found in Asia and Africa. Until well within historic times Madagascar was the home of a giant lemur called from its cry the *tré-tré-tré-tré*, which reached almost human proportions. It is known only by the skull, and is believed to have become extinct about 1680.

The typical lemurs (Family *Lemuridae*), known by eight species, come from Madagascar and the Comoro Islands. The best known is the Ring-tailed Lemur, *Lemur catta*, a popular Zoo animal, known by its grey fur, black face and extremities, and long ringed tail. It is a rock-dwelling animal in its native land, diurnal, and much given to sun-bathing, exposing its chest, with arms outstretched, to the sun's full force with the utmost enjoyment.

Nearly related are the almost equally well-known black, ruffed, brown and mongoose lemurs. In all the young are born singly and at first carried round the maternal waist, later being promoted to a "jockey seat". The largest of all lemurs is the Indri, *Indris brevicaudata*, or Babakoto, a near relative of the giant extinct lemur. It is nearly as large as a retriever, and when standing erect may have given rise to some of the old legends referring to "dog-headed men". Like the ruffed lemur, its coat bears a black and white "dazzle" pattern. It is rare, and even preserved specimens are not common, whilst captive examples are unknown. In common with many lemurs it is the subject of strange beliefs. In its native land the Indri is never molested, and the trees it frequents are believed to be of great medicinal value. If a spear is thrown at it, it is said to return the weapon with unerring aim. Another belief is that the single infant is at birth hurled from one parent to the other a dozen times or more, and should it survive this rigorous test is carefully nurtured and grows apace. If, however, it falls to the ground, it is left to die as being unworthy of survival. The Indri—also known as "dog of the forest"—goes in small troupes, and since

it has a laryngeal sac, these companies, like many lemurs, can raise a terrific chorus. One famous legend tells how a Madagascan tribe was almost cut to pieces by a rival clan when the pursuers found themselves confronted by a troupe of Indri. They fled in terror, and the survivors not only became champions of the giant lemur, but themselves rose to be the leading race of the island.

The Mouse Lemurs (*Microcebus*) scarcely exceed in size the rodents after which they are named. Just as our badger and dormouse sleep through winter, so these little animals "lie up" in hot weather, previously fortifying themselves against prolonged fast by eating to repletion. Large stores of fat accumulate thus beneath the skin, and serve as a reserve store of body fuel, as does the camel's hump. The smallest of the mouse lemurs is only four inches long from nose to rump.

The entirely arboreal Sifakas (Family *Indrisidae*) are by some regarded on slender evidence as not true lemurs, but connecting forms between the lemurs proper and the marmosets. They are gentle, inoffensive little animals, distinguished by exceptionally long tails, and dense woolly fur in which the ears are scarcely discernible.

The "Aye-Aye", *Daubentonia madagascariensis*, is so called from its cry—or, according to some authorities, from the exclamation of the Madagascan natives when first shown the animal by the French explorer Sonnerat in the 17th century. The Aye-Aye is about the size of a cat, with immense eyes and ears, and a dense coat of long coarse sepia-coloured hair. The incisor teeth suggest those of a rodent rather than a primate and are used for gnawing holes in timber. The most striking feature of the animal, perhaps, is the third finger of each hand. All the fingers are enormously attenuated, but the third is so thin as to suggest a piece of wire. The animal, though a seeming jumble of "oddments", is perfectly suited to its mode of life. It chiefly haunts bamboo jungles, searching for insects which tunnel the bamboo stems. The movements of these it detects with its quick hearing, and access being gained to the insect by means of the powerful teeth, the prize is drawn forth by means of the third finger. This peculiar digit is also used to convey water to the mouth. The Aye-Aye, which is nocturnal, chiefly finds water that has collected in the axils of bamboo leaves, and "spoons" it into its mouth, at the rate of about forty sips per minute.

In captivity Aye-Ayes gnaw timber and drink as described, but prefer a diet of eggs, milk and fruit, in the absence of the peculiar insect fare to which they are accustomed. Apart from the protection afforded the Aye-Aye by the French Government of Madagascar, it is held in considerable awe by all natives. If

caught in an ordinary lemur trap it is at once liberated, and chance specimens found dead are reverently buried. Even its huge, bird-like nest is never under any circumstances molested.

The "Bush Babies" (*Galago*) of Africa owe their name to their very human voice, which is quite out of proportion to these tiny animals, and suggests the efforts of a lusty and peevish infant. All are nocturnal, have large eyes and ears, the latter being in one species, the Moholi Galago, *G. moholi*, collapsible, and are folded up when at rest, as are those of our native long-eared bat. The fur is soft and dense, and the tail remarkably long, serving as a balancing pole in action, and a coverlet when asleep in the daytime. Galagos are omnivorous and highly pugnacious. They not infrequently fight to the death, when the victor may celebrate victory by cannibalism. An amusing story is told of the Grand Galago, *G. crassicaudatus*, common in South Africa. A party of these once used to irritate a planter past endurance with its nocturnal howlings, until, on one occasion, having reached "strain limit", he flung the remnants of his dinner ale over the choir. The "babies", having licked themselves dry, sank into Bacchanalian slumber. From that time on they howled until the mead of ale was forthcoming, the creatures evidently having acquired the flavour. The planter then hit on the plan of presenting them with a bowl of ale as soon as darkness fell, with the result that blessed peace ensued from the commencement, a ritual which was observed by all parties involved from thence onwards, to the general satisfaction.

Galagos are expert climbers, and have the strange habit of wetting their hands and feet before negotiating slippery branches or creepers.

The Lorises are Asiatic lemurs, nocturnal in habit, and represented by two species only. The Slow Loris, *Nycticebus coucang*, of South-East Asia is about the size of a guinea-pig, with a dense woolly coat, huge eyes and soft, heavily padded hands and feet which take a tenacious grip when climbing. Loris is derived from a Dutch word meaning a clown, and refers to the animal's grotesquely marked face. The single young is carried by the parent in a curious manner. If walking behind the parent, and feeling in need of a ride, it squeezes itself in between her hind legs, and so gaining her body clings to the breast, hands and feet being clasped over her back. As in most lemurs the nail of the first finger is long and claw-like, all the others being flattened in characteristic monkey fashion. An enormous number of legends attach to this harmless little creature. It is supposed to influence every conceivable human activity, from a happy marriage to murder, and to even control such natural phenomena as floods, earthquakes, or a harvest. Almost every

portion of its body is used in the witch-doctor's pharmacopoeia, the eyes in particular being in great demand for the concoction of love potions.

The Slender Loris, *Loris tardigradus*, found in South India and Ceylon, is not unlike the foregoing, but more lightly built and with a much shorter coat. It moves in the same tardy fashion, and being accustomed to shield its eyes with its hands in sunlight, is attributed by the natives with the power of "seeing ghosts".

The Pottos (*Perodicticus*) inhabit West Africa and are represented by several species. The tail is reduced to a stump; the first finger of the hand is rudimentary, and the second toe almost absent. Both hands and feet have enormous clasping pads. Though fairly common, these animals are difficult to obtain owing to native unwillingness to handle them. It is believed that, should a potto attach itself to a native, it must so be carried throughout its wearer's life, a contingency none are eager to risk. In the pottos the neck vertebrae are curiously elongated as regards their upper surfaces, these showing like pegs on a cribbage board through the animal's skin. They are surrounded by bare skin and connected with scent glands which are believed to serve in attracting the sexes to each other.

The last and lowest of the half-monkeys is the Spectral Tarsier, *Tarsius spectrum*, found in Malay and Celebes. The body is not much larger than that of a mouse and the limbs suggest a frog's. The digits bear adhesive pads, and these, combined with its prodigious leaping powers, enable it to progress much as does a tree-frog. The tail is very long, the eyes gigantic, and the entire *ensemble* is exceedingly grotesque. The name *Tarsius* applies to the elongated ankle bones. This primitive lemuroid is regarded as representing the root stock of a primitive race, similar creatures having enjoyed a very wide range in the earlier days of mammalian evolution.

The modern tarsier, which has never been kept successfully in captivity, is nocturnal, feeding upon insects, many of which it obtains by raiding the "pitchers" of the pitcher plant. When hunting, the tarsier holds an insect firmly in its mouth and shuts its huge eyes to protect them from the victim's wildly waving legs, which the hunter neatly removes with its fingers. Since the tarsius is most often seen in forest clearings where the waste branches, etc., have recently been burned, the natives persist in an absurd legend that the animal lives on charcoal, though its real mode of life must be well known to them. Its voice is a shrill, but very faint, squeak.

IV

INSECTIVORES

Order *Insectivora*

THE Insectivores are rat-like in form with elongated heads, probing snouts and sharply pointed teeth. They are nocturnal and feed mainly on insects. Though grouped near the primates, owing to certain anatomical features which they share with the monkeys, mentally they are poorly developed. Insectivores are of world-wide distribution, abounding in the tropical, sub-tropical and temperate zones.

The *Tree Shrews* (Family *Tupauidae*) are small arboreal animals of Asiatic origin, and feed on both insects and fruits. They have long pointed noses and bushy tails.

The members of this family are probably closer to the primates than the other representatives of the order.

The *Elephant Shrews* (Family *Macroscelididae*) are small African forms with long kangaroo-like hind limbs and grotesquely elongated noses. The female has the nipples placed on or near her shoulders and the young—not more than two at a birth—cling to her back with their long noses pointing over either of the maternal shoulders.

The *Hedgehogs* (Family *Erinaceidae*) of Europe and Asia are typified by our native species *Erinaceus europaeus*. The upper part of the body and sides of the head are covered with spines which measure an inch in length.

Our common species is a sworn foe of the adder, killing and eating considerable numbers, but is not immune to the snake's poison. The legend of its suckling cows still lingers in remote country districts.

The *True Shrews* (Family *Soricidae*) are represented in these islands by the Common Shrew (*Sorex araneus*) and the Fish-rating Water Shrew (*Neomys fodiens*). The former eats huge numbers of insects and wood lice, eating several times its own weight in the course of twenty-four hours. It is an inveterate fighter and cannibal, but is easily tamed and makes an amusing pet.

The *Moles and Desmans* (Family *Talpidae*) are represented in Britain by the Common Mole, *Talpa europaea*. It makes a complex series of burrows, centring round an inner grass-lined chamber, the excavations of which raise the well-known hillocks. Though disliked for this practice it is a valuable eradicator of surplus worms, and such garden pests as the leather-jacket and chafer grub. As a result of its subterranean habit, the eyes and

ears are rudimentary. Moles occur in Europe, Asia and North America.

The *Desmans* are shrew-like forms, with webbed feet and are purely aquatic, living on pond snails, etc.

The *Tenrecs* (Family *Centetidae*) come from Madagascar and the Comoro Islands. They hold the mammalian record for fecundity, twenty-one at a birth being not uncommon. The *Spiny Tenrec*, *Ericulus spinosus*, is covered with spines and resembles a hedgehog.

The *Golden Moles* (Family *Chrysochloridae*) are moles distinguished by their remarkable fur, which presents an iridescent or metallic sheen. They are exclusively African, and throw up long, continuous ridges in contrast to the complex fortresses and "hills" of the true moles.

Sometimes placed amongst the Insectivores but also placed in an order of their own (Order *Dermoptera*) are the Cobegos or Flying Lemurs. These animals are the size of small cats and are provided with large flaps of skin stretching on either side from wrist to ankle, by means of which they are able to volplane to the ground from the tops of trees. Cobegos are fruit feeders inhabiting the Malay Peninsula and the Philippine Islands.

BATS

Order *Chiroptera*

THE bats have, until within almost living memory, been regarded with superstitious dread, and are still viewed with repugnance by the less enlightened. Several hundred species have been described, only the Arctic and Antarctic regions being without representatives. The largest kinds are all of tropical origin.

The wing of a bat is an extension of the web between the fingers—the digits being greatly elongated to support it. The toes are invariably left free, and serve to suspend the animal, when at rest, or, in some cases, to convey food to the mouth. The hearing is extraordinarily acute, and the grotesque and complex fleshy facial ornaments so often present are likewise believed to serve as “aerials” by means of which vibrations of the atmosphere are picked up. These serve to give warning of obstacles in the line of flight. There are never more than two young at a birth, and the species range in size from that of a small mouse to creatures with a wing span of several feet.

Bats are of great economic value, devouring vast numbers of noxious insects that could be “controlled” by no other means. In Mexico, where bats specially abound, tall towers are erected for their shelter—the bats sleeping in them by day, and depositing their excreta, which commands a high market value as a fertiliser.

The Fruit Bats (Family *Pteropodidae*) of Asia and Africa and Madagascar are giants of the race, having a body bulk almost equal to that of a guinea-pig. All are frugivorous, often pillaging orchards. Some slight compensation is derived by fruit-growers, etc., since these bats are highly edible, the flesh resembling chicken.

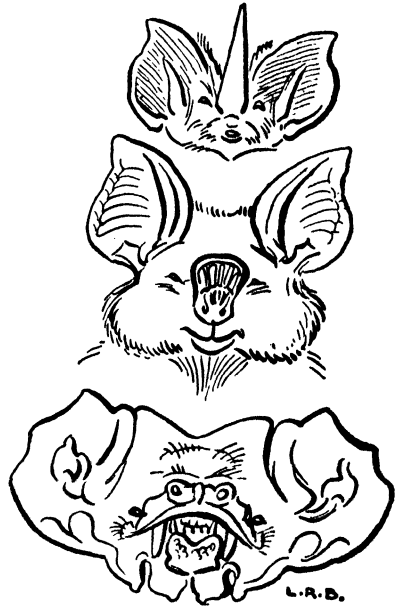
The Horseshoe Bats (Family *Rhinolophidae*) have extraordinary leaf-like appendages rising from the nasal region. Two species inhabit Britain.

The typical bats (Family *Vespertilionidae*) are world-wide in distribution and strictly insectivorous in diet. Four species—the Pipstrelle, *Pipistrellus pipistrellus*, the Noctule, *Nyctalus noctula*, the Serotine, *Eptesicus serotinesis*, and the Long-Eared Bat, *Plecotus auritus*—are common in our country. The last named folds up its enormous ears when retiring to rest. All are addicted to hiding by day in hollow trees, caves, ruins, etc., and in the

colder countries the animals largely hibernate, though sometimes tempted forth by a warm day in mid-winter.

Though so much alike at a hasty glance, the various families of bats vary as much as do any others in the various orders of the mammalia. The bats of the family *Emballonuridae* have the tail quite separate from the web or wing membranes, whereas in most other bats it is attached. In one species it is long and whip-like. Many of these bats have large glands, and pouches attached to the wings, whilst their food is as varied as their forms. Many are insectivorous, but some live exclusively on fish, or even on other bats. A few store fat in their tails—as a sort of emergency ration, to be drawn upon when other food is scarce.

Most remarkable of all bats is the blood-sucking Vampire, which has become so specialised that it subsists solely upon blood. The true Vampire, *Desmodus rufes*, of Brazil has for long been the subject of ghoulish legends, and has only lately been studied in detail. The animal is about as big as a mouse, and attacks any vertebrates available—horses, men and even fowls. It taps the victim's veins so gently as to arouse no suspicion, and having drawn blood rapidly laps it up, a wineglassful at a meal. Anti-coagulating properties of the bat's saliva cause the blood to ooze forth long after the bat is satisfied, and this, combined with the fact that it is a carrier of disease, causes it to be held in not unnatural aversion.



Heads of Bats

VI

CARNIVORES

Order *Carnivora*

THE Carnivores are known as Beasts of Prey or Flesh-Eating Animals. The group includes such familiar forms as the Lion, Cat, Dog, Bear, Hyaena, Otter, etc., and though displaying great diversity of shape and size, all are primarily characterised by the large canine or eye teeth. There are never less than four toes on each foot, all bearing claws. The so-called "collar bone" is either incomplete or absent. Carnivores are found in all countries. A few are dangerous to man, and all are highly predatory, thereby keeping a check upon the too prolific increase of herbivorous creatures of every kind.

The Cats (Family *Felidae*), as we know them to-day, are creatures of comparatively recent origin, and despite immense differences in size, coloration and length of hair show great uniformity of design. They are supposed to have been derived from certain primitive carnivores. The most specialised cats, known as Machaerodonts, were possibly contemporary with early man, but are now happily extinct. They were characterised by enormously exaggerated upper canine teeth, which in the sabre-toothed tiger depended a foot or more from the jaw when the mouth was closed. This remarkable specialisation implied possibly a peculiar diet, and led to the group's extinction when more generalised cats survived.

Wild cats, ranging from the lion downwards, number some fifty species and are generally distributed throughout tropic and temperate regions. Anatomically they are distinguished by the characteristic form of the teeth, and in the claws being retractable into sheaths, which is effected by the last joint of each digit bending backwards upon the one immediately behind it. Many are expert fishermen, the cats' traditional abhorrence of water being easily conquered by the overmastering passion which most have for a fish diet whenever available. Nocturnal habits have caused cats the world over to be associated with witches, demons and the occult generally—beliefs which die hard even in the face of widespread education and "enlightenment".

The Lion, *Felis leo*, famous in religion, folk lore and blazonry since early times, is, and always has been, the most imposing cat known. At one time it ranged over much of Europe, including England, but is now restricted to the more open

country of Africa and a small area of North-West India. In the latter area it is believed to have been largely ousted by the more cunning and courageous tiger, an animal which usually comes off victorious in any pitched battle with the "king of beasts".

Most animals tend to hint at their ancestry when very young. In our own species, the new-born infant shows in its hairy covering and prehensile toes a kinship with arboreal anthropoids which it soon loses with increasing years. There is every reason to believe that the lion was originally a forest animal, and wore a coat which blended, much as does the leopard's, with the chequer pattern caused by sunlight filtering through dense foliage. Some evidence of this appears in the coats of lion cubs, which are often almost as densely spotted as a leopard's. As the harassed animals on which the lion preyed sought sanctuary in open country, the lion would naturally follow them, and so in time become attuned to surroundings in which a "camouflage" suit of spots would no longer be necessary.

A large lion attains a length of 10 feet, stands some 3 feet 6 inches at the shoulder and weighs about 500 lb. It is adult when two or three years old, and a pair usually make their home in some convenient cave or dense thicket. Three to six cubs constitute a litter, the young animals being cared for almost entirely by the lioness, though the male frequently "forages" for the family. Lions are "clannish", going about in small family parties, whilst bachelor "droves" of a score or more are often met with. Circumstances permitting, lions will live almost exclusively upon Zebra, but their fondness for this meat often leads them to attack horses, so bringing them into collision with man. Man-eating, however, is usually only habitual with old lions, too feeble to attack fleetier or more resistive creatures. Much as the lion's courage has been called in question, it may be mentioned that during the building of the Uganda Railway a single lion killed no less than twenty-eight white men, many of whom were doubtless armed. Apart from legitimate "hunting", lions often like to play "cat and mouse" with their victims, and a game warden in the Soudan has recounted how a party of young lions "played" with a live horse throughout one whole night, driving the animal from one to the other until it died from exhaustion, when the "players" walked off quietly, apparently well content with their night's entertainment.

Despite the most relentless persecution lions are still a pest in many parts of Africa, and whites and natives alike respect them as foes to be reckoned with. In the Soudan natives commonly carry dried lion meat when on a long trek, believing the strength and courage of the lion may thus be assimilated.

Though no longer used for wholesale butchery—as in the

days of the Roman Colosseum—lions are still in enormous demand as show animals. Whilst many of the methods employed by so-called “tamers” are more than questionable, lions can to a certain degree be “domesticated” by humane methods. The owner of the famous private Zoo at Maidstone used frequently to ride one huge lion bred in his menagerie, and in one of the Hollywood Zoos a pair of lions habitually haul a forage cart. Unlike so many other wild animals, the lion is never likely to become scarce. It is hardy to a degree. The Indian lion—identical with the African species—once penetrated into the snow land, and will flourish and breed even in Northern Zoos. It breeds to an almost embarrassing extent, and the market price of £200 commonly obtained for a lion less than a century ago has now fallen to about a tenth of that sum. In the wild, the lion’s mane comes much in contact with thorn bushes, etc., and so seldom reaches the impressive proportions seen in menagerie examples. This, strangely enough, has led to lions being very frequently sold by Northern Zoos to African Menageries.

Like many wild cats, lions can be successfully “fostered” by dogs, and in the Sydney Zoo a venerable sheep dog exerted matronly authority over a lion cub she had been given to nurse until long after it had attained to full lion’s estate. She even bullied her giant charge, until the protests of visitors led to their separation. Whilst it is doubtful whether lions interbreed with tigers in the wild, such hybrids have on several occasions been produced in captivity. When the sire is a lion the result is termed a Liger, whilst the converse is a Tigon. A cross of either category is always much larger than either parent, shows a strange patterning of pale stripes upon the lion’s fawny ground colour, and like all mules, is probably sterile. In captivity lions live to be twenty-five—or even thirty—years of age, but in the wild succumb probably much earlier.

The Tiger, *Felis tigris*, attains to much the same size, weight and age as the lion. It ranges from India to Turkestan, Assam, the Malay Peninsula, Sumatra, China and Siberia, in which last locality it grows a long, shaggy coat, well designed to withstand the most rigorous climatic conditions.

Short-coated tigers from warm districts show enormous variation in the striping, no two being alike. Contrary to the lion a tiger’s skin shows no variation in markings throughout life. The tigress is distinguishable from the male by lacking the latter’s ruffle, or “side whiskers”, round the cheeks. Tigers are quite indifferent to water. Those in the semi-Arctic island of Sakhalin habitually fish in tidal pools, whilst in some areas of India which are periodically flooded, tigers may take to the

trees for weeks at a time—subsisting almost exclusively on fish and waterfowl.

The tiger well justifies its name being used as a byword for ferocity and blood lust. Only the elephant, rhinoceros and adult guar—or wild ox of India—appear to be safe from attack, whilst the human death-rate in India from tigers still totals some hundreds annually. Tigers breed in captivity much more rarely than the lion, being more solitary by nature and demanding greater seclusion than is offered by most menageries. They are incapable of roaring. The cry is a loud, harsh, plaintive howl, or cough—quite unique, though not easy to describe.

The Leopard, *Felis pardus*, is found both in India and Africa, in the former country being usually termed “panther”. Examples from either country are much alike, though innumerable local strains are recognised. Like the tiger, leopards are “fully dressed” from birth though, in cubs the spots are very close together, spreading further apart as age increases. Black Leopards inhabit the Far East. In black examples the spots show like the markings on “watered” silk. The leopard is an extremely ferocious animal and in all districts where it occurs is more dreaded than either the lion or the tiger. Addicted to attacking small animals and birds, it often invades human settlements in order gratify its passion for horse flesh. Being largely arboreal, it easily climbs into houses, where it unhesitatingly attacks human beings. A leopard in the Seonee district of India killed over two hundred persons in two years, a record seldom if ever equalled by a man-eating tiger.

Nearly allied to the leopard is the Jaguar—*Felis onca*—of South and Central America and Brazil, chiefly distinguished by its differently shaped spots.

The Ounce or Snow Leopard, *Felis uncia*, from the Highlands of Asia, Tibet, etc., northwards to the Atlas Mountains, appears much larger than it actually is owing to its dense, shaggy coat—a vital equipment in the frozen altitudes it frequents. The ground of the coat is whitish rather than golden, like the leopard's. Though occasionally prompted by dearth of smaller game to attack flocks and herds, the ounce is a much less ferocious animal than either leopard or jaguar, and the few shown in Zoos have usually become very amenable and docile under tactful treatment.

The Domestic Cat, *F. catus*, is probably derived from several species of Wildcat, such as the Egyptian Cat, *F. ocreata*, or the European Wildcat, *F. sylvestris*, once common in our own forest areas. To-day the domestic cat, represented by scores of “fancy” breeds, has been made the subject of a wealth of litera-

ture, and given rise to much legislation as regards its control, exhibition, etc., etc.

The Wildcat, *F. sylvestris*, still lingers in Scotland, and is common in many parts of Europe. It will cross freely with the domestic and many other smaller kinds of cat. Amongst other smaller cats may be mentioned the Fettered Cat, *F. ocreata*, common in Africa from Cape Colony to Egypt where it is semi-domesticated. The popular name refers to its markings on wrists and ankles. Other common African species are the Black-footed cat, *F. nigripes*, and the Jungle or Marsh Cat, *F. chaus*.

A large group of cats are known collectively as Lynxes. The name "Lynx" is derived from a Greek word meaning "to see", and the keen eyesight of these powerful nocturnal marauders is proverbial. The more important species are the Northern Lynx, *F. lynx*, of Scandinavia and Asia, the Spanish Lynx, *F. pardella*, of Spain and Portugal, the Canadian Lynx, *F. canadensis*, the Bay Lynx or Bob-cat, *F. rufa*, found from Nova Scotia to California, and South to Florida and Mexico. All are distinguished by a slight ruff at the sides of the face, and by the long "pencilled" ears. One species, the Caracal, *F. caracal*, common in both Asia and Africa, has been trained to "course" small game, such as hares, jerboas and antelope.

Wildcats confined to Asia are the *Manul* or Pallas' Cat, *F. manul*, the Indian Leopard Cat, *F. bengalensis*, the Rusty Spotted Cat, *F. rubinginosa*, the Marbled Cat, *F. marmoarata*, the Golden Cat, *F. temminckii*, the Fishing Cat, *F. viverrina* and the Clouded Leopard, *F. nebulosa*.

African species of note are the spotted Long-legged Serval, *F. servala*, and the Servaline Cat, *F. servalina*. The former is "coursed" like the caracal, being held in leash at neck and loins, and "slipped" at small quarry, which it runs down and holds until the huntsman comes up with it.

A large number of small wildcats come from Tropic and Sub-Tropic America, most being distinguished by rich colours and intricate skin patterns which blend with the riot of tropic verdure in which they live. Outstanding species are the relatively large and ferocious Ocelot, *F. pardalis*, the Margay, *F. tigrina*, the Jaguarondi, *F. jaguarondi*, the Eyra, *F. eyra*, the Argentine Wood-Cat, *F. gaffroyi*, the Salt Desert Cat, *F. salinarum*, Hensel's Cat, *F. pardinoides*, the Pampas Cat, *F. pajeros*, and the Puma or Mountain Lion, *F. concolor*.

The Puma is by far the largest of America's wildcats, being not far short of a lioness in structure, which animal it further resembles in the absence of a mane, and the general buff or fawn colouring, a livery which blends well with the open or rocky country of its choice. It ranges from Patagonia north to

the borders of the United States and British Columbia. Many local races of the beast are recognised—and sub-specifically named—by scientists. Though an inveterate marauder of flocks and chicken farms, the puma seldom attacks man, and becomes very docile in confinement.

Apart from the lion, tiger and leopard, most famous of all wildcats is the Hunting Leopard or Cheetah of Africa and India, which by reason of its many strange divergences from the accepted cat pattern has been placed in a separate genus, of which it is the only species, and is scientifically known as *Acinonyx jubatus*.

The cheetah, though in all essentials a leopard, has undergone many changes as a result of adopting a life in the open in preference to one spent in dense forest. The spots are not, as in the leopard, clustered to form rings or rosettes, but are small and set close together, each spot being separate and keeping its individuality. Though about the same size as a leopard, the cheetah is much more slender, being built almost on the lines of a greyhound, and well adapted to a cursorial life—chasing the fastest antelopes, etc., across open country. It is regarded as the fastest four-footed wild animal known. Continual running upon hard ground has had a marked effect upon the feet, which have more in common with those of a dog than a cat, and the claws, though sharp, are only partially retractile.

Its amazing running powers have made the cheetah a favourite “coursing” animal in India since early antiquity, and it is prized quite as much as the famous Afghan greyhounds. So great is the demand for cheetahs in India that numbers are exported from Africa, where, strangely enough, the animal’s prowess as a hunter has never been turned to account.

To-day, the cheetah—despite many more modern amusements introduced from the West—still holds an important place as a beast of ventry. Many palaces have extensive cheetah kennels—with enormous staffs—attached, and a coursing meet is attended by all the pomp and pageantry once accorded to falconry in our own land. The cheetahs, hooded, and cloaked in gorgeous draperies, are taken to the hunting-field on massive bullock waggons, each animal having its own attendants. When an antelope is sighted, the cheetah, leashed at neck and loins and held down in a sitting posture, is first relieved of its hood, and, the game being marked down, is dexterously “slipped”. Having reached and pulled down the quarry, it holds it until the huntsman, mounted on a fast horse, arrives. The game is then dispatched, and a vein being opened in its neck, the cheetah rewarded with a ladle full of fresh blood.

This ends the cheetah’s labours for the day, and it is taken

back to its equipage, to be returned to the kennels for food, rest and elaborate massage. At the Whipsnade Zoo, the cheetahs are kept in a large paddock, and their wonderful "speed track" capacities displayed at feeding-time, a joint being of course substituted for living game. The keeper merely whistles up the animals from about a hundred yards distance, which they clear in a matter of a few seconds.

The Fossa, *Cryptoprocta ferox* (Family *Cryptoproctidae*), is a strange cat-like animal which forms a connecting link between the cats proper and the members of the family *Viverridae*, which includes the civets, genets, mongooses and meerkats. It is a dun or fawn-coloured animal from Madagascar, having relatively short legs which give the body and tail—about five feet over all—a very elongated appearance. It has five toes on each foot, all being provided with completely retractile claws. Though walking on the soles of the feet like a civet, this strange creature more nearly suggests a curiously stunted puma. It is strictly nocturnal and lives chiefly amongst dense trees, where it preys on lemurs and birds. The fossa will on occasion attack goats and is much dreaded by the natives. The animal appears to be almost voiceless, the only sound it utters being a loud hiss.

The Family *Viverridae* is well represented in the warmer parts of the Old World. Its members differ from cats in a longer head and a somewhat different type of dentition.

The Civet Cats (*Viverra*) are handsomely striped or spotted terrestrial creatures from tropical Asia and Africa. Few exceed a spaniel in size, and the majority are noteworthy for a pouch beneath the tail, which generates a powerfully odorous secretion. To-day the scent is out of favour with Occidentals, though in the East civets are still farmed for the purpose of supplying it for native use.

The Genets (*Genetta*) and Palm-Civets (*Paradoxurus*) are similar to the civets but of slighter build and largely arboreal, subsisting chiefly on birds. The majority come from Africa, though one, the European Genet, *Genetta genetta*, is found in Spain, Portugal, France, the Balearic Isles and North and North-West Africa.

The Binturong, *Arctictis binturong*, is a striking arboreal form from South-Eastern Asia. It is jet black, with pencilled ears and a long prehensile tail enabling it to ascend high trees in pursuit of birds and squirrels. Though a powerful animal, with body bulk equal to that of a terrier, it is easily tamed, and one recently bred in the Zoo is amongst the most popular of the menagerie's "pets".

The Mongooses or Ichneumons (*Herpestes*) are terrestrial animals with non-retractile claws. As the generic name suggests they are adept serpent killers. Though little larger than a common ferret, they will fearlessly attack such powerful and deadly snakes as the cobra and puff adder. The mongoose relies for success in attack solely on its lightning rapidity. Its tactics consist in a rocking dance, which confuses the snake, causing it to strike at random, so that the mongoose can rush in and fix its teeth in a stranglehold on its neck. It invariably celebrates victory with a banquet of snake. Though prone at times to attack poultry, the service rendered by these nimble animals in killing both snakes and harmful rodents, such as rats and gerbils, makes them highly popular as house pets in India, Malaya and Africa. The thirty odd species are chiefly distinguished by differences in size and markings.

The allied Suricate or Meerkat, *Suricata suricatta*, of South Africa is a smaller, burrowing animal. It often forms small colonies, and is locally termed "prairie dog". Like the rest of the family it is prolific, producing eight at a birth.

The Family *Protelidae* is represented by a single species, the Aard Wolf, or Earth Wolf, *Proteles cristatus*, of South and East Africa. It is about the size of an Airedale terrier, and closely resembles the striped hyaena in general form and colouring. It is, however, distinguished by anatomical differences, chiefly as regards the teeth, and is considered as forming a link between the civets, etc., and the hyaenas. It lives solely on carrion and white ants.

The Hyaenas (Family *Hyaenidae*) are powerful animals of the Old World, once enjoying a wide range, remains being found in many parts of this country. They are about as large as an average wolf, with long necks and weak hind-quarters. The remarkable features of the group is the structure of the teeth, jaws and neck bones. Hyaenas are essentially carrion feeders, being able to crack and crunch to powder bones which defy even the lion's teeth. The enormous power implied lies in the massive jaws, and special muscles which are attached to them, and the enormous upright prominences on the neck vertebrae. A further muscular support is supplied by a comb-like crest on the skull.

Living as they do in countries where flesh quickly putrefies, and readily breeds disease, hyaenas do useful service in removing such offences. Their repellent appearance and stench, however, coupled with their inclination to disinter corpses, has resulted in their receiving less than the appreciation due to them. The cry is an unearthly howl, varied at times

by a deep, coughing roar or a noise which has been compared to the hysterical laugh of a human.

The Striped Hyaena, *H. hyaena*, is found both in Asia and Africa, and is distinguished by vertical black stripes on a grey or brownish fawn ground. The Brown Hyaena, *H. brunnea*, is confined to Africa, where it is called the Strand Wolf. It is a uniform dull brown, and like the other hyaenas has a mane of coarse black hair.

The Spotted Hyaena, *Crocuta crocuta*, ranges from the Cape of Good Hope to Senegambia and the Anglo-Egyptian Sudan. It is by far the largest of the three species, and well known in Europe as a show beast. It is a bolder animal than either the striped or brown species, often hunting in large packs and pulling down such large animals as the Koodoo and Eland. It is distinguished by its spotted coat and peculiar cry, which,



Skull of the Striped Hyaena

when the animal is agitated, suggests hysterical human laughter. Some twenty years ago, weird stories were widely circulated in our Press concerning a strange animal known as the Nandi Bear, frequenting Kenya Colony and peculiarly given to attacking women and children. The stories become so persistent that the British Museum authorities instituted a thorough enquiry. As a result, skins and skulls of the alleged bear were sent to England. These were always those of either leopards or hyaenas, the skull of one often being forwarded with the skin of the other—the two being alleged to belong to one and the same animal. Finally a tracing of the “bear’s” footprint arrived. This showed six toes—a state of things unknown amongst mammals recent or extinct. Close examination showed it to be two impressions of hyaena pads, one superimposed upon the other—and so the legend of the “nandi bear” was at last dispelled, since when no more has been heard of the animal.

Hyaenas are hardy in captivity, frequently breeding at the London Zoo. The first ever exhibited there was transferred to the Gardens in 1829 from the Royal Menagerie in the Tower of London.

The members of the dog tribe (Family *Canidae*) are perhaps the most generally familiar group of all the mammalia.

The origin of the domestic dog, *Canis familiaris*, is uncertain, but it is believed that the innumerable breeds recognised to-day may all be traced to a wolf-like ancestry, the various local races found in different countries being developed according to the dictates of the human inhabitants. About 100 different breeds of domestic dogs are recognised.

The Dingo, *C. familiaris dingo*, is the native name of a dog believed to have been originally brought to Australia by the Aborigines. It is a fawn-coloured creature the size of a foxhound, and though capable of semi-domestication is untrustworthy and highly destructive.

The Wolf, *Canis lupus*, once common in England is still a pest on the Continent, and is represented in Asia and America by closely similar animals. Wolves interbreed freely with large dogs of all kinds, and though savage and destructive are sometimes capable of being domesticated.

The "Prairie Wolf," *C. latrans*, is a smaller and more lightly built animal than the true wolf. It is common from Nebraska to Mexico, and is known in America as the Coyote.

The Common Jackal, *C. aureus*, is one of several similar species found in warmer countries, the common form being all too abundant throughout South-Eastern Europe, Egypt and practically the whole of Asia. It is about the size of a fox, subject to great variation in colour and, whilst of some service as a scavenger, is an inveterate thief and general pest in all districts it frequents. Old legends of its acting as a sort of *aide-de-camp* or camp follower of the tiger are based upon its habit of eating offal left by the larger carnivora. Several closely similar animals are common in Africa.

The Foxes (*Vulpes*) are well represented in our own country by *Vulpes vulpes*. Its cunning is proverbial, and this quality, together with the creature's build, characterise the many species found in all temperate, tropic and even Arctic countries, differences of coloration being their most distinguishing features.

One of the most interesting species is the Fennec Fox, *V. zerda*, of North Africa, which is conspicuous by the immense size of its ears, indicating a peculiarly acute sense of hearing, essential to an animal living in open country with little cover save such retreats as it excavates in the sand.

Some compensation for the damage done to game, poultry, etc., by foxes is now found in marketing the skins of certain species, and the scientific farming of American silver and black fox is now a thriving industry throughout both America and Europe.

The Arctic Fox, *Alopex lagopus*, differs in build from other foxes by its more stocky frame and rounded head. It abounds in

the Arctic regions of both the Old and New World. Like the Ptarmigan and Mountain Hare, its coat changes with the seasons, being russet or greyish in Spring and Summer, but turning pure white in Winter, the Summer coat being shed and the Winter garb—which matches the prevalent snow—usually forming beneath it.

Three genera, *Cerdocyon*, *Pseudalopex* and *Lycalopex*, comprise small fox-like animals from South America. They frequent coastal areas, and the habit which some have of foraging on the sea shore has earned them the name of “crab-eating” dogs.

The Antarctic Wolf, or Fox, *Dusicyon australis*, is the only dog recorded from the Falkland Islands. The last seen in this country was shown at the Zoo in 1870, and the species is now definitely extinct.

The Maned Wolf, *Chrysocyon brachyurus*, is a rare dog from Brazil and Paraguay, remarkable for its long slender legs and bushy mane on neck and shoulders. The Raccoon-like Dog, *Nyctevetes procyonoides*, is a fox-like animal from North-East Asia, which although unrelated to it suggests the racoon in build.

The Dhole, or Red Dog, *Cuon dukhunensis*, immortalised in Kipling's *Jungle Book*, is justly dreaded in those parts of India which it frequents. Unlike most wild dogs the Dhole will only touch carrion if starving, preferring to hunt in packs, and is recklessly indifferent to the size or strength of the quarry. It follows its prey with tireless persistence, and has been known even to run down and devour the tiger. Of a reddish-grey when adult, the young are a deep sooty colour.

The Cape Hunting Dog, *Lycan pictus*, is one of the most striking of the entire family. It stands higher than a wolf, is much more slenderly built, has large ears and a fawn or reddish coat handsomely marbled with black. It bears a superficial resemblance to the spotted hyaena. It is capable of astonishing speed, and hunts the largest and fleetest antelopes in packs. This dog ranges from the Cape to the Soudan, and, though fairly abundant, is seldom seen owing to its keeping to dense bush or long grass.

The South American Bush Dog, *Speothos venaticus*, is a strangely stunted, dark-skinned animal found from Brazil to Panama. It has a long body and exceedingly short legs, suggesting some of the more peculiar breeds of domestic dog so popular with professional breeders and exhibitors.

The Family *Mustelidae* is represented by a large group of

Carnivora, typified by the Common Stoat and Weasel, and including such other forms as the Otter, Glutton, Mink, Ermine, Sable, Marten, etc. The leading characteristic of the entire family is a more or less pointed head and exceedingly short limbs as compared with the very elongated body—a form largely resulting, perhaps, from the burrowing habit of the animals, or their penchant for invading the burrows of herbivorous rodents, etc., with murderous intent. All are highly predaceous, accepting almost any form of flesh, fowl or eggs, though a few are exclusively fish eaters.

The Otters (*Lutra*) are common throughout much of Europe, Asia, Africa and America. Our native form, *L. lutra*, has given its name to many parts of the country, such as Otterburn, Otter's Halt, etc., "halt" being the rustic name for its lair.

Whilst providing sport for various "hunts", otters are heartily disliked by fishermen, since they often kill fish far beyond their needs just for the sheer joy of killing. Extreme agility and grace mark the otter's every movement both on land or under water. Three to four cubs usually comprise a litter, the young being born in a deep burrow which usually has two exits, one always being below waterline. As an interesting survivor of our once much more numerous wild fauna, the otter's elimination is to be deprecated, and readers are commended to Henry Williamson's classic saga *Tarka, the Otter* as a sound, if colourful, tribute to a sagacious, courageous and resourceful animal.

The Sea Otter, *Latax lutris*, exceeds the common species by a foot or more, scaling about four feet from nose to tail tip. Like the other otters it has webbed feet, and is largely aquatic. Its range extends from Southern California to the coast of Asia. It is a shore-haunting animal, feeding largely on crabs and sea urchins. As with other otters its fur is highly resistant to water, and the pelt's richness and lustrous quality has led to the animal being almost exterminated. As much as £225 has been given for a single skin.

The Ferret Badgers (*Helictis*) are small Oriental carnivores not unlike the common badger in general build, but distinguished from true badgers by their more elongated form, climbing propensities and vivid colouring, combinations of white, brown, black and yellow being arranged in striking bars and streaks.

The Stoats, etc. (*Mustella*), are typified by the Common Stoat, *M. erminea*, which is found throughout Europe and Asia. Like the other members of the genus it is highly predatory, a good climber and quite indifferent to the rigours of winter. An adult measures nearly a foot in length. In summer its coat is brown, but like the Arctic Fox, it changes it to match the land-

scape, and in its winter phase provides the much-prized "ermine" of commerce.

The Weasel, *M. nivalis*, is little more than half the size of the stoat. It has a similar range and similar habits, but in the warmer parts of its habitat does not assume a white winter garb.

The Mink, *M. vison*, of North America is a dark-coated animal of about the stoat's stature. Being largely aquatic, its richly coloured pelt has the water-resisting qualities of beaver and other skins. Demand for its fur has led to the animal being farmed on the grand scale throughout North America and Europe. Several notable farms are established in this country, within a short distance of London.

The Irish Stoat, *M. hibernica*, is intermediate in size between the common stoat and the weasel. It is found only in Ireland and the Isle of Man.

The Polecats and Ferrets (*Putorius*) are known throughout Europe and North America, where several species, notably the common ferret, *P. furo*, are semi-domesticated, and employed to hunt rabbits and rats. The common ferret is usually an albino. It is regarded as being derived from the Polecat. Scent glands situated at the root of the tail secrete a highly offensive odour.

The Martens (*Martes*) are distinguished from the preceding animals principally by differences of dentition. Of the several species known, one, the Pine Marten, *M. martes*, is a rare inhabitant of deep forests in Scotland and North Wales. An allied form, the Beech Marten, *M. foina*, is abundant throughout Europe and temperate Asia. The American Marten, *M. americana*, supplies much of the "sable" so highly prized by fur fanciers, but the true sable, *M. zibellina*, is confined to North Asia, and is now being extensively farmed in Russia. Its export is forbidden by the Soviet Board of Trade. All the members of the genus will eat fish, as well as flesh or fowl when occasion permits, but the "Fisher Cat," *M. pennanti*, of Canada is almost as confirmed a fisherman as the otter, often killing numbers of salmon merely to devour the "shoulder" meat and other choicer parts. It is exceedingly rare and seldom seen in Zoological collections.

The Wolverine or "Glutton," *Gulo gulo*, is, as its popular name suggests, the most voracious of all this bloodthirsty group. Though scientifically allied to the weasels and martens, its general form suggests a bear cub with immense paws and a tufted, almost equine tail. It is common within the Arctic circle, both in Asia and America, where it is often known by the Indian name of Carcajou. Its greed and ferocity are proverbial,

and the damage it does to game is scarcely compensated for by the marketable quality of its fur, though this is considerable. Nothing of an animal nature comes amiss to it, and in hard weather it will break into fur stores, eating the dried pelts and even devouring leather boots, gloves, etc., left about by the trappers.

Though not bigger than an Airedale terrier, it is far more powerfully built and can kill game as large as the reindeer. It exhibits the trait—common amongst rodents and a few birds—of hoarding all kinds of objects of no edible, or other, value to it. Boots, revolvers, knives, hats, coins and cartridges often figure in the glutton's "museum", and at the Zoo it has satisfied this strange instinct by hiding in its sleeping quarters such oddments as silver paper and 'bus tickets.

The Tayra, *Tayra barbara*, of South and Central America is built somewhat on wolverine lines, but climbs trees and has a short close fur. Like the glutton, its voice is an unearthly howl.

The Badgers (*Meles*) are common in temperate Europe, Asia and America, one species being found in Japan. In most countries where the badger occurs, it figures largely in local folklore and legend, and in Japan is associated with a peculiar form of insanity. In our own land, the Common Badger, *Meles meles*, has for centuries been a famous figure of the countryside. Its old English name of "Brock" occurs in numerous place-names, and many names attest, it once abounded in what is now the London area. A few still enjoy protection in Richmond Park, but the chalk hills of Surrey appear to offer it the most ideal conditions. Its digging powers are astonishing, and not many years ago a badger "earth" driven sixteen feet down into solid chalk led to the collapse of a main road near Leatherhead. The "earth" is a circular chamber, lined with grass, at the end of a tortuous passage, several auxiliary passages or "bolt holes" being often constructed. "Drawing", *i.e.* digging-out, the badger is still a sport amongst our more brutal rustics, and the animal is also much persecuted by game preservers, though the damage it does to pheasants, etc., is probably inconsiderable. Badgers are nocturnal, omnivorous and inoffensive unless hard pressed, when they can prove more than a match for most dogs. The fact that foxes often share one of the badgers' "annexes" has long led to superstitious beliefs in an unholy partnership between the two animals. Two young constitute a litter, and an adult specimen may measure nearly a yard long and scale 40 pounds or more.

Like the bear, which it more nearly resembles than any others of the order, its flesh is excellent, and badger hams still figure on some rustic menus. The colouring of the badgers

reverses the principle seen in most mammalian liveries, for it is dark below and light above, a phenomenon not yet satisfactorily explained. In olden times the badger was frequently "baited" by dogs, heavy wagers being laid upon the issue of this cruel sport.

The so-called "Striped Weasels" (*Ictonyx*) of Africa and the Grisons (*Grison*) of South America are badger-like forms, connecting the true badgers with the Skunks (*Conepatus*). The skunks are essentially American animals, at once recognisable by their striking black and white coats, the vividly contrasted stripes of which serve as a warning to would-be molesters. Should the said warning be ignored, the skunk raises its huge bushy tail at right angles to the body, an act which causes certain glands to open, when the air for many yards around is filled with the appalling stench which has made the animal famous. Five or six species inhabit South America. *Mephitis mephitis* is found in Canada, whilst the little skunk, *Spilogale putorius*, is confined to the Eastern and Middle United States.

The African striped weasels (*Ictonyx*) are popularly known as Zorillas. They closely resemble the skunks in form and coloration, but lack the very distinctive scent glands. Zoologically they are classed as polecats, the best known being the Cape Polecat—*I. capensis*—which is often kept as a household pet for the sake of the tireless war it wages against vermin.

The Family *Procyonidae* includes a number of badger-like animals mainly distinguished by their peculiar tooth structure. All walk upon the soles of the feet, are largely arboreal and omnivorous in diet.

The Racoons (*Procyon*) of North and South America are best known by the Common Raccoon, *P. lotor*, immortalised in innumerable negro legends, songs, etc., and made famous in this country by the late Joel Chandler Harris when he gave the world his *Uncle Remus*. Racoons are distinguished by the curious badger-like stripes upon the face, and the alternate black and white rings upon the short bushy tail. Their cunning, audacity and resource are proverbial. One kept at Whipsnade escaped to Luton some seven miles distant and, invading a machine-belt factory, spent some hours travelling round and round upon the various belts that were being tested, before it finally consented to be captured. The Crab-eating Raccoon, *P. cancrivorus*, of South America is a shore-haunting form living on shell-fish.

The Coatis (*Nasua*) of South America resemble racoons but have very long tails and enormously produced snouts, which feature has earned them the American name of "snookum

bears". Like the true bears they are expert robbers of wild bees' hives.

The Pandas (Family *Ailuridae*) are known by two species only, both confined to the mountains of Asia, where they appear to take the place of the American racoons.

The best-known species, the Little Panda or Cat-Bear, *Ailurus fulgens*, is very like the common racoon in general build, but with a broader head. The thick coat and tail stripings are of a vivid chestnut brown. The little panda is fairly common in the Eastern Himalayan cedar forests, where it lives on a mixed diet, mainly bamboo shoots, and is an expert climber. Though powerful and well able to defend itself against a dog twice its size and weight, it can become tolerably tame, and specimens born in the London Zoo have proved very diverting pets. The voice is a harsh growl.

The Great Panda, *Aeluropus melanoleucus*, is amongst the world's "mystery" animals. In general form it suggests a half-grown brown bear, very remarkably coloured. The head and body are white, whilst the ears, a circlet of fur round each eye, and the legs are black. A black band encircling the shoulders completes a sufficiently bizarre colour scheme. It inhabits the more remote mountain areas of Tibet, and is so rare that a few skins and skeletons only are scattered amongst the world's museums. Two Great Panda cubs have recently been taken alive. Apart from the fact that it is known to be a mixed feeder, its life history is a profound mystery.

The Pandas at one time enjoyed a wider range than obtains to-day; fossil remains have been found even so far from Tibet as England.

The Kinkajou, *Potos flavus*, of South and Central America has long been a popular Zoo pet on account of its docility and quaint habits. It is a cat-sized fawn-coloured animal with a dense coat, rounded head and long prehensile tail. This organ is of great service to the animal in its nocturnal raids on birds' and bees' nests, high amongst tree branches. The animal can not only lower itself towards a nest by hanging from a branch above by its tail tip, but can effect a quick retreat, if occasion demands, by hurriedly climbing up its own caudal appendage. Its tongue is long and worm-like, well-suited for licking out honey—or insect grubs—from tree fissures.

Few of the larger wild carnivora have played a greater part in human destiny than The Bears (Family *Ursidae*). Religions and folk-lore of nearly all countries and all ages are full of references

to them. Legendary heroes are credited with being reared by the animal, and it figures largely in the heraldry of every land.

The bears are a well-defined group, comprising about a score of well-marked species, whilst sub-species and local varieties of recognised species are still more numerous. Anatomically, bears are heavily built animals with thick coats, enormously powerful limbs, and massive heads. The majority are expert climbers and swimmers, and, though called omnivorous, except in the case of the polar bear subsist mainly on a vegetable diet. Their intelligence is of a high order, and most show great ingenuity in obtaining fish, honey and other luxuries.

Though now restricted to America, Asia and a few remote areas of Europe, the race once had an almost world-wide range. The evidence of the rocks tends to show that the family had its beginnings in Asia, and crossed by a land bridge to America.

Most famous of all bears, perhaps, is the Polar Bear, *Thalarctos maritimus*. An adult specimen weighs 1,500 pounds, and stands 4 feet 6 inches at the shoulder, but towers nine to ten feet when reared upon its hind legs. It feeds almost exclusively upon fish and seals, showing extraordinary powers of swimming and exhibiting a ferocity and daring far beyond that of other species. In winter the female segregates herself, and brings forth two cubs, nursing them in a lair deep beneath the snow. The gleaming white or creamy coat is permanent the year round, though the bear does not live amongst eternal snow and ice. Circumstances permitting, it will make summer excursions inland to vary its flesh diet with a brief régime of berries and herbs. It was one of the first bears to be brought to this country, and an example lodged in the Tower during Henry III's reign was allowed to catch its own fish in the Thames whilst tethered to a long rope.

A good instance of Ursine cunning was once shown by a Zoo polar bear. A piece of food having fallen outside its cage, a benevolent visitor pushed it within reach of the animal, using an umbrella for the purpose. The latter the bear seized and demolished, to the delight of the onlookers. Evidently appreciating the applause, the bear from thence onwards laid a trap for unwary good Samaritans, deliberately placing food only just within its reach and seizing and dismembering their umbrellas with obvious relish.

The Brown Bear, *Ursus arctos*, once common in England, and used for "baiting" until only a century ago, is to-day represented in Europe, Asia and North America. Its size and weight may be little less than those of the polar bear. It is

subject to so much variation in colour that a number of subspecies have been tabulated in Europe alone. A variety known as the Syrian bear, *Ursus arctos syriacus*, is small and fawn-coloured and is still abundant in Western Asia. Like most bears it rarely breeds in this country, but, until thirty years ago, was commonly exhibited by itinerant showmen, who toured the country with the beast led upon a chain. As an example of the affection bears are capable of conceiving for their owners, the Zoo once "minded" a Syrian bear whose Basque master was serving a term in gaol for ill-treating the animal. When at last the pair were reunited, the bear's hysterical delight might well have been lavished upon a far more deserving recipient.

The Himalayan Black Bear, *U. tibetanus*, is a small close-furred species, with a jet black coat, having a large cream-coloured V marked upon the chest. Very nearly related are the little Japanese bear, *U. japonicus*, and the Sun Bear, *U. malayanus*, which are identically coloured, the latter, however, having an extremely short coat, tempered to the hot jungles it inhabits.

The forest areas of America were, as already suggested, early colonised by bears, and a number of species are peculiar to the northern areas, one only, the strangely marked spectacled bear, *U. ornatus*, being found in the South.

The best-known American species is the Black Bear, *U. americanus*, which ranges from Alaska to Florida and Mexico. This and several species habitually breed in American Zoos. It is unique in being the most docile and least treacherous of all bears, its liking for human society being at times embarrassing. In the Yellowstone Park reserve black bears commonly hold up motor-cars, refusing to give way until toll has been paid in the form of eatables. The London Zoo's famous "Winnie the Pooh" belonged to this species, and would permit children to handle her—even when she was feeding—with as much abandon and boisterous confidence as might be extended to a house dog.

The Grizzly Bear, *U. horribilis*, that has provided so many "thrillers" for readers of all ages, ranks next to the polar bear in size, weight and savagery. Its habitat is Western North America from Alaska to Mexico, and it is still tolerably common, though much persecuted—as much for the sake of its massive pelt as for its depredations. It is amongst the few bears that attack at night, and is possibly the most carnivorous of all, apart from the Arctic Bear. It has been known to live for as long as thirty years in captivity. The name "grizzly" is affirmed by some to refer to the animal's colouring, and by others to its sanguinary disposition. Few animals are more completely armed. Its "hug" is fatal to any creature encountering it, whilst

the fore-claws—which are in great demand as ornaments—may measure well over four inches long.

Though it conforms to all the main ursine characters, structural peculiarities have caused the grotesque Sloth Bear, *Melursus ursinus*, to be placed in a separate genus. Its long shaggy coat is a dull black, whilst the muzzle is a ghostly white.

The snout indeed is one of the bear's most striking characteristics, for it has all the mobility of a pig's snout, whilst the lips are even more extensile than a chimpanzee's. The bear literally converts them into a funnel which it plunges into the heart of a bee or wasp nest, and "siphons" up the grubs and honey, with a complete indifference to the outraged owners' stings. Love of good living causes large numbers of these bears to be caught in the Karachi district in a strange manner. The bears have a habit of climbing palm-trees to drink the contents of the cups hung there to collect "toddy"—a juice which issues from incisions made in the bark. The juice, fermented by the torrid heat, takes quick effect upon the bear's not too powerful brain, and, sliding down the trunk, he composes himself to slumber indifferent as to whether he is captured or otherwise.

VII

SEA LIONS, SEALS AND WALRUS

Order *Pinnipedia*

THE Pinnipeds, or fin-footed mammals, are highly specialised carnivores, of world-wide distribution, which have taken to a salt-water life and, as a natural corollary, a fish diet. All the members may be at once recognised by the digits of all four extremities being prolonged to form "flippers", by means of which the creatures propel themselves at high speed. All have suffered much from persecution, the flesh being edible, whilst the fur of many species and the ivory tusks of the walrus have always been in great demand. Most members of the group are highly intelligent and extremely sociable. All recognise one particular season for the propagation of the species, and at such times in most cases the males congregate on favoured beaches, and engage in fierce warfare for their respective brides. The voice in most species is a hoarse bark.

The marine Sea Lions (Family *Otariidae*), so well known as show animals, have a wide distribution. They are characterised by their short external ears and relatively long hind limbs, which, being doubled under the body when on land, enable the beast to proceed at an awkward gallop, and to clamber over high rocks with remarkable facility. As with the rest of the order, only one young is produced at a birth. The Californian Sea Lion, *Zalophus californianus*, is the best known of the entire order, and by far the commonest in menageries, circuses, etc. Its remarkable balancing feats, though developed by training, are inherent, and are employed to toss fish—caught broadside on—so that they can be conveniently swallowed head first. If fish is not available, it will make shift with other flesh, as the Zoo once discovered when a sea lion developed an unfortunate liking for the live penguins which shared its enclosure. During the War, an attempt was made to employ the sea lions' wonderful intelligence and susceptibility to under water vibrations in tracking enemy submarines. Strangely enough the animal's amazing swimming and diving powers are not wholly inherent, since the young go through a hard schooling under parental tutelage until they gain full efficiency.

The Patagonian Sea Lion, *Otaria byronii*, and the Cape Sea Lion, *Arctocephalus pusillus*, are also popular show species, and distinguished from the Californian species by minor anatomical differences. The New Zealand Fur-Seal, *Arctocephalus forsteri*, is the only sea lion providing a marketable fur, and its whole-

sale destruction in times past is now controlled by rigid legislation.

Sea lions are prodigious feeders, an adult easily eating forty pounds of fish a day, thereby placing a wholesome check on "over-production" of surface and mid-depth fishes. They further "round up" shoals, bringing them within reach of sea birds which seldom range far from land for their food. A guano company once mistakenly assumed that the killing off of the sea lions on a certain guano island would lead to an increased food supply for the birds, and as a result an increased guano output. The reverse was the case, for the removal of the sea lions led the birds to wander far away in search of food.

The Walrus, *Odobenus rosmarus* (Family *Odobenidae*), is one of the largest members of the order, reaching a length of ten feet and a weight of a ton or more. It is unique in the extreme development of the upper canines, which are prolonged to form tusks of two feet or more in length. The ears are represented merely by small orifices. It lives almost exclusively within the Arctic Circle, and, though sparsely haired, is protected from cold by its thick hide and enormous layers of fat. The tusks are used to assist the animal in clambering upon ice floes, and to dig shell-fish from mud at a great depth. In extremity also they can act as effective weapons. Normally, however, the walrus is a gentle and pacific animal, young examples readily becoming tame. It still ranks amongst the more expensive show-beasts, commanding £200, against £40 for a sea lion or £5 for a seal.

The Seals (Family *Phocidae*) embrace five genera, all characterised by the hind limbs being permanently directed backwards. This, though rendering the animal relatively helpless on land, aids materially in swimming, for the hind feet being placed sole to sole are used much as a man uses an oar at the stern of a boat. As in the walrus, the ear is marked externally by only a small slit.

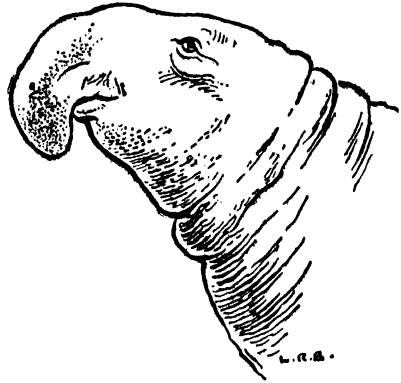
The Grey Seal, *Halichoerus grypus*, is found in the North Atlantic and haunts the rocky shores of Scandanavia and North Britain. It reaches a length of ten feet, and its skin is in considerable demand. Like most seals and sea lions it has a marked appreciation of music (often referred to in classic legends) and this is often made use of by hunters to lure it within gun-shot, a concertina or mouth-organ being often enough to lead it to its doom.

The Common Seal, *Phoca vitulina*, is our commonest native species, and at a recent attempt by the Board of Fisheries to take a census of British seals it was estimated that Cornwall alone had a "standing army" of between five to seven hundred

the year round. At one time it was urged by the more ignorant fishermen that its toll of fish competed dangerously with their livelihood, and a bounty was paid for the seal's destruction. Its persecution is now happily discouraged, since observation has shown that much of its catch comprises squid, cuttlefish or fish of no marketable value.

Of the thirty or more species of seal recognised, outstanding examples are the handsomely spotted Leopard Seal, *Ogmorhinus leptonyx*, the Antarctic White Seal, *Lobodon carcinophaga*, and the Bladder Seal, *Cistophora cristata*. All are remarkable for their handsome coats, and the last named—from Arctic seas—is unique in that adult males wear a huge distensible

hood upon the summit of the head, and overhanging the muzzle. The giant of the race is the Southern Elephant-Seal, *Mirounga patagonica*. The Elephant-Seal may reach a length of over twenty feet and a weight of many tons. An eighteen-foot long example in the Berlin Zoo consumes eighty to two hundred pounds of fish per day, according to season, being considerably less voracious in summer than in winter.



Head of Male Elephant
(Northern) Seal

VIII

WHALES, PORPOISES AND DOLPHINS

Order *Cetacea*

THE Cetaceans are represented to-day by the true whales, the porpoises and the dolphins. All are recognisable by the entire absence of hind limbs, though the remnants of these appendages are present, and lie deep within the body wall. In some extinct whales hind limbs are much more apparent, and there can be little doubt that whales are derived from terrestrial ancestors which took to a life afloat, as much in search of food as to avoid enemies on land. As regards the latter, it was scarcely a change for the better. Modern weapons of destruction have of late years made the whale's preservation a matter for ever-increasing anxiety, all nations taking an annual toll of whales numbering many thousands. The situation is further aggravated by the difficulty of discovering the creature's habits, span of life, rate of growth, etc., though all commercially interested in whaling are now engaged in this belated task. One fact recently ascertained is that whales, despite their often vast size, may not—contrary to the general rule amongst mammals—live to a great age, since they are sexually mature at the surprisingly early age of two and a half years.

Whales, whilst varying in size from the Sulphur Bottomed Whale, 100 feet or more long, to the Porpoise of 4 or 5 feet and a weight of 60 pounds, show many other features in common, beside the reduction of the hind legs. The head, though often enormous, is relatively light. The brain is large and richly convoluted, but the senses of smell and hearing are very slight. The nostrils are placed at the top of the head to form the well-known "blow-hole" which can be closed by a powerful valve. Teeth may be huge and numerous, or altogether absent. The tail, flattened into two horizontal paddles or "flukes" of fat, provides most of the motive power, propelling the animal with an "up and down" motion as opposed to the "from side to side" movement seen in all fishes.

The Whalebone Whales (Sub-order *Mystacoceti*) comprise the Right Whales (*Balaena*) and the Grey Whales (*Rhachianectes*). Both are characterised by the roof of the mouth being developed into long strands of horny substance which hang down for a distance of several feet to form a curtain-like sieve (whalebone), which strains off the sea water, when a mass of this, together with the small animal life it contains, is suddenly engulfed. Northern whalebone whales live chiefly upon minute molluscs and crusta-

ceans. The grey whale is remarkable amongst whales in having all its neck vertebrae separate. In most whales they are more or less fused together.

The Sulphur Bottom or Blue Rorqual, *Balaenoptera sibbaldi*, which attains a length of 100 feet, is the largest mammal now living. An adult African elephant, 11 feet at the shoulder, could stand comfortably inside it.

Most whales are gregarious, travelling in herds or schools—the term “school” being applied to the miniature species, i.e. dolphins and porpoises. Many show great speed and activity. Notable in this regard is the Humpback Whale, *Megoptera boöps*, which, despite its length of 50 feet and immense weight, indulges in a grotesque courtship, leaping high out of water like a tarpon or salmon.

The Toothed Whales (Sub-order *Odontoceti*), unlike the whale-bone whales, are aggressive animals. The largest species is the Cachalot or Sperm Whale, *Physeter catodon*, of Southern Seas, valued for its oil and ambergris—a waxy secretion found in the digestive tract. The latter is composed partly of the horny beaks of giant squid on which the whale feeds, and is highly prized in perfumery. Aptly named “floating gold”, it is valued at £5 per oz.

The Beaked Whales (*Mesoplodon*), etc., are remarkable for their long heads, and for the teeth of the males being reduced to a few large tusks in the lower jaw.

Nearly related are the numerous species of porpoises and dolphins found in both the coldest and warmest seas. Many of these are estuarine or given to frequenting fresh water. It may be mentioned that the proverbially small “swallow” of the whale does not apply to any of the beaked forms, since the cachalot, for example, has been reported to have inadvertently swallowed a man. Dolphins are distinguished from porpoises by their more graceful form and the distinctly “beaked” character of the head. These lively beasts inspired the conventional dolphin of classic design. Our Common Porpoise, *Phocaena phocaena*, lives chiefly upon herring and mackerel. The “White” Whale, or Beluga, *Delphinapterus leucas*, supplies the so-called “porpoise hide” of commerce. Nearly related is the Narwhal, or Sea Unicorn, *Monodon monoceros*, which is unique in that one incisor tooth is prolonged into a spirally twisted tusk, projecting from the upper jaw. Usually the right incisor is thus prolonged, but sometimes the left and occasionally both. In males these attain four or five feet, and project horizontally like bowsprits.

The Grampus or Killer, *Orcinus orca* grows to 30 feet long, and has a hide handsomely mottled in black and white. It has

enormous teeth, and is possibly the most savage and predacious mammal in existence. It is cosmopolitan, hunts in packs and refuses nothing in the way of flesh. The remains of four porpoises and ten seals have been found in a single specimen. When other food fails, it will capture penguins by rising beneath the floe and "bumping" them off the ice. Frequently a pack of killers will worry to death and tear to pieces a whale 50 or 60 feet long, and in the South, forty per cent of other whales captured show marks of the killer's attentions. Like all whales, it may come to grief by running aground—usually as the result of chasing fish, etc., into shallow water. Some years ago a killer was caught in the Thames at Chiswick, whilst in May, 1934, a big school of the allied False Killer, *Pseudorca crassidens*, went ashore near Swansea. As an example of the whale's "globe-trotting" propensities, and the consequent difficulty of following its movements, it may be mentioned that this whale has been met with off Denmark, India and Tasmania, whilst it was first made known to science by the discovery of a skull in the Lincoln fens. Twenty or thirty species of whale have been taken alive in British waters.

IX

RODENTS OR GNAWING ANIMALS

Order *Rodentia*

THE Rodents are perhaps the best known of all mammals, and they number several thousand species. They infest every part of the globe, from the tropic jungles and deserts to the polar regions. Many species are farmed for food or fur, whilst others cost all communities enormous sums annually in the damage they do to property of every kind. All members of the order are at once recognised by the two chisel-like teeth, incisors, placed in the front of each jaw. These teeth grow continuously, and are only kept at the requisite length by constant use. Almost all substances, save the hardest minerals, can be negotiated by their razor-like edges. Injury to these teeth may cause them to grow beyond bounds, so that they curve upwards and outwards over the front of the animal's head, precluding it from feeding, and eventually causing death. As with most mammals, the larger species of rodents tend to produce smaller families than do the more diminutive kinds. Some of the latter may have eight or more young at a birth, and can reproduce their kind when but a few months old. The order is divided into numerous sub-orders, families and genera.

The Capybara or Carpincho, *Hydrochoerus hydrochoerus*, is the giant of the order, equalling a pig in size, though prehistoric forms rivalled the rhinoceros. It inhabits South America, frequenting river banks and swamps, where the natives largely hunt it for food. The feet are splayed the better to negotiate swampy soil—a feature seen in the common guinea-pig, which is a domestic production from an allied form, the Wild Cavy.

The Cavies (*Cavia*) are, like the giant capybara, characteristic of South America, invading not only swamps but open plains. Typical of the latter localities are the Agouti (*Dasyprocta*) and the Paca (*Dinomys*). The Viscacha (*Viscacia*) rivals all the preceding in its burrowing powers, throwing up huge earthworks above its subterranean "tube" system. To cleanse its fur of the dense reddish soil which it excavates, one toe of each foot is provided with a stiff brush, with which the creature meticulously grooms itself after work. Like many other rodents, it has a passion not only for storing food but all kinds of chance debris of no ostensible use to it. The natives of South America regularly search Viscacheries (as the "warrens" are called) for pistols, knives and other lost property, such search seldom being

in vain. Zoo specimens will collect cigarette pictures, 'bus tickets, silver paper, etc.

The Chinchillas (*Chinchilla* and *Lagidium*) are inhabitants of the barren, rocky and often mountainous regions of Central and South America, where they live in large colonies. They have large bushy tails which, like those of squirrels, serve as balancing poles. The great demand for their thick, pearly-grey fur has led to the farming of these rodents, which in the days of promiscuous hunting with ferrets were all but exterminated.

The Patagonian Cavy (*Dolichotis magellanica*) is so completely a plain dweller that it has developed on the lines of an antelope, and at a glance might almost be taken for a gazelle.

The Pikas or Mouse Hares (*Lagomys*), like the allied true hares and rabbits, have a second smaller pair of cutting teeth behind the large pair in the upper jaw. They have short ears and limbs and no tails. They are hidiers amongst the mountain rockeries of Eastern Europe, Asia and America, showing wonderful agility in their precipitous and almost inaccessible haunts.

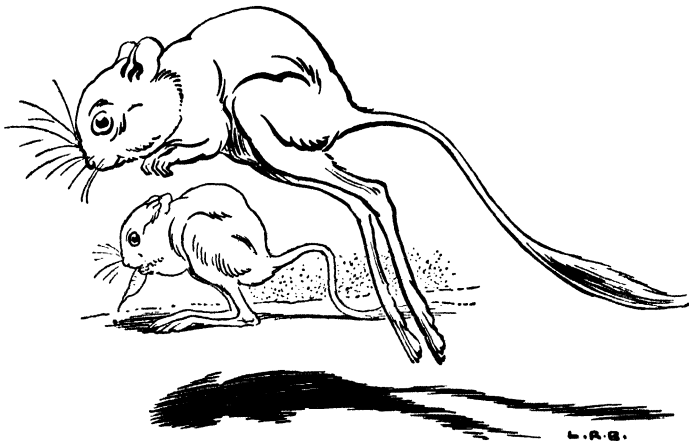
The Hares and Rabbits (Family *Leporidae*) are in striking contrast to the pikas with their long ears and limbs, both features adapted to a life in the open, where quick hearing and movement are essential to safety. Like most plain animals the hares make no permanent home, the young being merely nursed for a short while in a declivity or roughly made grass nest. They are self-helpful much earlier than the burrow-reared rabbits. They are born with the eyes open, and soon fend for themselves.

Rabbits are at birth blind and naked, but hold their own against numerous foes, such as hawks, foxes, etc., by their burrowing habits. They have relatively larger families than those of the hares. In Australia and other places where introduced, they have so multiplied—in the absence of natural foes—as to become a plague. Despite the fact that Australia exports vast numbers for food, and converts the fur into felt, gelatine, etc., millions of surplus rabbits are annually killed and burnt in order to save crops from their depredations.

The common rabbit has by selection and intensive breeding been subdivided into such "fancy" strains as the Flemish Giant, Chinchilla, Beveren, Havana, Argente, Lilac, Marten Sable, Fox, Rex, Dutch, etc. The rabbit can, indeed, be made, by the breeder and fur-worker's art, to counterfeit almost any fur required. In the case of the famous "Angora" the long fur is merely combed out, the same rabbit living to supply the trade for several years. Before facing the judges at an exhibition a well-trained Angora will sit quietly whilst the exhibitor "fluffs" its snowy fur by means of a pair of bellows!

The Mountain Hare, *Lepus timidus*, of North Europe and Asia changes its brown summer coat to snowy white in winter.

The Porcupines (Family *Hystriidae*) are of course distinguished by the peculiar hair which, on the upper portions, is developed into sharp spines. These are so loosely planted in the skin as to remain in any solid substance (such as the calf of a man's leg) with which they may come in contact. Porcupines are warmth-loving animals of both New and Old Worlds, those from tropic America being completely arboreal and having highly prehensile tails. The big ground-dwelling forms of India and Africa are burrowing animals, given to charging backwards when attacked, and having certain hollow quills in the



Egyptian Jerboas

tail which can be shaken to emit a loud rattling sound. The quills are in great demand for fishing floats and various ornaments, whilst the flesh is highly esteemed. The stumpy-tailed Canadian species forms a connecting link between Old and New World forms. All are strictly nocturnal.

The Hutias (*Capromys*) are giant rats confined to the West Indies, measuring 22 inches from nose to the root of the tail. Closely allied are the aquatic South American Coypu Rats (*Myocastor*), also prized as food, but more particularly for their skins (nutria), which resemble those of the otter, and have led to the rats being farmed on a large scale in many countries. The chief farming centre in England is the well-watered country of East Anglia.

The Jerboas (Family *Jaculidae*) have been aptly described as "Mice on stilts". Most are of very small size, and have the hind legs and tail enormously developed. A jerboa can all but

out-distance a greyhound, and at rest uses hind legs and tail as a tripod, much as does the kangaroo. In Egypt civilisation has proved a friend to the jerboa, for it burrows beneath the wire netting roads laid down for motor transport, and in such situations is safe both from hawks and the digging proclivities of the jackal. The giant of the race is the Cape Jumping Hare (*Pedetes*), ranging from Capetown to Angola and Mozambique. It is about the size of a cat, apart from its prodigiously developed hind limbs. True jerboas inhabit Africa and Asia, whilst the Kangaroo Rats (*Dipodomys*), which resemble them but differ in various anatomical features, are confined to parts of North America.

The Pocket Gopher, *Thomomys bottae*, is a small rodent inhabiting California. It is an indefatigable tunneller, storing large quantities of food in its burrows. Much of the food is carried to these retreats in remarkable cheek pouches, which stretch from the animal's face down the neck as far as the shoulder. Large pieces of roots, besides grain, are thus carried.

The Mole Rats (Family *Spalacidae*) are Old World rats that live so much like the mole as to have taken on many characteristics of that creature. They subsist entirely by burrowing for roots, and have the eyes covered with skin. They also have rudimentary ears and reduced tails, as seen in their insectivorous namesake. Remarkable members of this family are the Sand Rats (*Heterocephalus*), which burrow in the hottest desert sand and are almost completely naked.

The true Rats, Mice and Voles (Family *Muridae*) are world-wide in distribution and have, with few exceptions, earned general dislike by their destructive habits.

An exact census of our Common Rat, *Rattus norvegicus*, population is impossible, but experts record that these destructive and disease-carrying vermin in this country alone must number over seventy million and entail an annual damage and wastage of approximately twenty million pounds. Rats breed throughout the greater part of the year. The period of gestation is twenty-one days and impregnation may be renewed within twenty-four hours of the birth of a litter. Mr. Mark Hovel has stated that the number of rats produced in a single year by a pair and its descendants amounts to over one thousand, and if, on the happily fallacious basis that there is no mortality amongst rats, and the calculation is continued for one year longer, the figure increases to twenty million. Mr. Hovel, who has also calculated the amount of wheat and flour that a rat will eat, says that a single pair will devour more than eighty quartern loaves in a year.

The common brown rat is supposed by some to have origi-

nated from Asia, reaching Europe as a camp follower of man at some time in the 14th century, and England in 1728 or 1729. The war between human beings and these rodents has been a ding-dong campaign ever since. Deadly poisons, traps, gas, firearms and innumerable other methods and weapons have been marshalled against the rat, and yet the animal contrives to live and flourish at the expense of its foes.

Though it is common to credit animals with more intelligence than is their due, the rat's sagacity is, without doubt, considerable. As an example I offer the following story vouched for by two witnesses actually carrying out official investigations at a huge rubbish dump. There a hoary old grandfather rat was known to have two connecting burrows, one of which was usually used by the animal. One of these exits was therefore guarded by a trap, with the result that he used only the untampered exit. When finally both escapes were trapped, the rat sprang the remaining instrument of death by turning his back upon it and casting a heavy mound of earth over the trap with his hind limbs.

In the course of recent investigations it has been ascertained that not only has the common brown rat very greatly increased in numbers of recent years, but that since the War the old English Black Rat or Plague-Rat, *Rattus rattus*, has become more abundant in London. I have myself found both species living in harmony on the same premises.

The House Mouse, *Mus musculus*, also hails from the East, and is to a certain extent kept in check by the omnivorous rat, rats and mice seldom infesting the same areas. In Europe the breeding of fancy mice is a large industry, such mice being put to many uses apart from their attractions as mere pets or exhibits. Vast numbers are used for all kinds of experimental purposes; many are eaten in Chinese restaurants, and mice are part of the personnel both in mines and the submarine service, the animals being highly sensitive to atmospheric changes, and so often giving timely warning of dangerous conditions to the humans involved. The Japanese waltzing mouse is a fancy strain perpetrating what originated as a cerebral disease. The impulse to "waltz" may seize the mouse at any moment—sleeping, feeding, etc.—the creature rotating nose to tail with extreme rapidity.

The Voles (*Microtus*) are at once distinguished from rats and mice by their rounded heads, small ears and short tails. Like rats and mice they may under favourable conditions multiply so fast as to constitute plagues, and there is no doubt that such legends as the Pied Piper and the Rhenish "mouse tower" are well founded upon fact. Owls, hawks, etc., are largely to be

encouraged as anti-rodent allies of the agriculturist. The Lemming, *Lemmus lemmus*, common in Norway, Sweden and Finland, suffers from its own tendency to excessive multiplication. It periodically increases when it treks in vast numbers to the coast, where millions are drowned. A curious sidelight is cast on these vast migrations by the Arctic Snowy Owl. When this bird visits our Northern shores in some numbers it is a sign that the lemmings are suffering from the periodic decrease and the owls thus deprived of their main food supply trek south on a "hunger flight".

The Hamsters (*Cricetus*) are sturdy, tail-less rodents inhabiting Europe and Asia, which, like the lemmings, often multiply so excessively as to constitute a plague.

The Crested Rat, *Trilophomys imhausi*, of North-East Africa, which is entirely arboreal, has a central crest of long hair and a bushy tail.

The Gerbils (*Gerbillus*) are desert mice of Asia and Africa, with rather long hind legs and often long tufted tails. In a few species the tail is short and club-shaped, being used as a storage for fat, much as is the camel's hump, the animal drawing upon this reserve in times of famine. The Gerbil is, like the rat, a carrier of plague, and in Africa scientists watch, with some anxiety, the excreta of the mongoose, a stoat-like animal that hunts by day. Should it be found from the excreta that the mongooses are eating Gerbils, it is known the latter are leaving their holes by day—a sure sign that they are plague stricken. War is then made on all gerbil burrows in the area to prevent the epidemic spreading further.

The Dormice (Family *Muscardinidae*) are known to all by our own native species, *Muscardinus avellanarius*, fairly common in wooded districts of the South. It is more nearly related to the squirrels than true mice, being entirely arboreal, and building a nest of leaves, etc., in some dense hedge or hollow tree. Like many rodents it stores great quantities of food for winter use, although in severe weather it may spend much of its time in a torpid condition. A dormouse thus sleeping can be heard "snoring" from a distance of several feet.

The Beavers (Family *Castoridae*) are represented by two species only, a European, *Castor fiber*, and a Canadian, *Castor canadensis*. The Beaver was common in our own country until some centuries ago, many place-names, such as Beaverbrook, Beverley, etc., testifying to its former presence. The demand for its fur has all but exterminated the European form, though in America and Canada conservancy methods are doing much to reinstate the animal.

Beavers breed once a year only, bearing three to five at a

litter, and the young may live with their parents for years, most colonies being composed of interrelated family parties. The animals live almost wholly on the timber and bark of various trees, cutting large numbers of maple, willow, etc., and storing up the bark for winter use. Immense "lodges" or houses of cut sticks are raised for shelter, such lodges having communication by burrows with the shores, exits and entrances being both above and below water line. Wonderful selective powers are shown in choosing the sites for lodges, store-rooms, etc., the animals deliberately diverting streams, by means of dams, and so converting country to the peculiar conformation which best suits their purposes. At Horsham in Sussex, on the property of Lady Loder, is a small colony of captive beavers—the only "free" colony in this country—occupying a sheet of water half a mile long by 100 yards across. One end is completely dammed, with heavy tree trunks and branches cut by the beavers—the dam having been originally built in 1897 and kept in repair by successive generations ever since. The beaver's characteristically flattened ovate tail is used chiefly as a rudder, and at times may serve as a raft on which the baby beavers "surf ride". It can also be used as a signal gun, striking the water surface with a resounding crack—a manœuvre at once warning other beavers in the vicinity that danger threatens.

The Marmots (Family *Sciuridae*) are compact, heavily built rodents frequenting open or mountain country throughout America, Europe and Asia. The most notorious is the Prairie Marmot, *Cynomys ludovicianus*, of America, whose burrows are shared by the burrowing owl and rattlesnake. This "combine" is not, as once represented, a Utopian commonwealth, but the reverse. Both reptile and bird take toll of the marmot's young, the luckless householder often being compelled to evacuate and set up another home elsewhere.

The Squirrels (Family *Sciuridae*), represented by numerous genera and species, are found all over the world with the exception of Australia and Madagascar. They are typified by our native Red Squirrel, *Sciurus vulgaris*, now in some parts less in evidence than the introduced Grey Squirrel, *S. carolinensis*, of Canada. Squirrels with few exceptions are arboreal, with long bushy tails which serve both as balancing poles and coverlets when the animals sleep. All build somewhat bird-like nests, often, however, appropriating the ready-made nest of jay or magpie.

The Chipmunks of North America (*Tamias*) have large cheek pouches wherewith to carry food to their store chambers. They establish themselves in the bark of trees or among the roots of a tree, where they collect vast quantities of food for the winter.

It is recorded that in a nest tenanted by only four chipmunks was found a quart of nuts, a gill of corn, a peck of acorns, a quantity of Indian corn and two quarts of buckwheat.

The Flying Squirrels (*Petaurista*) of Asia and Africa are characterised by the skinny membrane extending from the fore to hind limb on either side, which enables the creature to "plane" from one tree to another, covering considerable distances. In the African species, the membrane stretches from the ankle to a cartilaginous rod attached to the elbow, whilst in Asiatic kinds it is fixed to an "outrigger" extending from the wrist.

ELEPHANTS

Order *Proboscidea*

ELEPHANTS to-day are known by two species only, confined to tropical Asia and Africa. These, however, are only the survivors of a long series of elephantine forms, which had their beginning more than a hundred million years ago.

The story of "how the elephant got his trunk", as told by Rudyard Kipling in the *Just-So Stories*, is known to all, and the true version of this achievement, though more gradual, is equally dramatic, and known with remarkable completeness, thanks to the abundance of fossil remains.

The first-known Proboscidian existed in certain parts of Egypt, and in size and appearance suggested a tapir. The next step in elephantine evolution is traced to a somewhat similar animal of the same region. It was, however, larger, had two tusks in either jaw, and a noticeably elongated nose. From the Eocene period onwards, elephantine forms grew both in bulk and numbers, spreading to all parts of the world, as the rising or subsidence of land masses permitted. Until relatively recent times two tusks in each jaw were the rule. But there were many variants on this theme, since some had the lower jaw elongated to form a vast shovel, six feet long. One form had tusks in the lower jaw only, curved downwards like a walrus's. There is little doubt that the gradual restriction of a hot climate and lavish vegetation to the equatorial belt led to the decline of the race. The Mammoth met the cold by growing a dense coat of wool, and to-day Mammoths "in the flesh" are found frozen in the remote areas of Alaska and Siberia.

Whilst the precise relationship of Proboscidians to other forms is still debatable, it is significant that the remains of the primitive Sirenians—sea cows and dugongs—show a remarkable similarity to that of the extinct *Moeritherium* or "dawn elephant", and it may be that in the Eocene a common ancestor led to two divergent forms, one the *Sirenia*, which became purely aquatic, the other the Proboscidian, which developed the largest terrestrial mammals now extant.

Modern elephants are characterised by their long trunks, big ears, and unique teeth. Of these there are two only in either jaw, which grow from the rear forward, their flat but finely sculptured crowns being constantly worn away in triturating vegetable food. An average elephant reaches some ten feet at the shoulder, and weighs three to four tons. The period of gestation

is twenty months, the animal reaching puberty when from thirteen to seventeen years old, and only a single young one is produced at a birth. Contrary to popular tradition, the average age limit falls at no more than fifty years.

Though the Indian elephant is most popular as a semi-domestic beast, the African species was the first introduced to Europe, its homeland being more accessible. It was formerly more often seen than the Indian species in England, and there is little doubt that Hannibal's army of several hundred elephants which crossed the Alps were of the African breed.

The African Elephant, *Elephas africanus*, is recognised by its convex forehead, immense ears—each often a yard across—and the two movable “fingers” at the trunk tip. Jumbo, the world's most famous elephant, who lived at the London Zoo between 1865-1882, was of this species. He practically doubled his height in this period, being just over eleven feet at death.

Eleven local sub-species of *E. africanus* are recognised, the most remarkable being the so-called dwarf race of the Belgian Congo, which does not exceed five feet at the shoulder. The upper incisors, *i.e.* “tusks”, of the largest African elephants may each measure five feet or more and weigh over seventy pounds. A long and tragic history, involving wholesale warfare, slavery and reckless butchery of elephants, is enshrined in the history of Ivory, which once commanded extravagant prices. To-day it is so little in demand that the elephants have lived to taste revenge. They have increased in some districts on a vast scale, and do such extensive damage to cultivation that special “punitive” expeditions are organised under Government supervision. Since Hannibal's time little organised attempt has been made to utilise the African elephant's immense strength, though of recent years an elephant haulage company has been formed with some success in the Belgian Congo. The Mahouts, or drivers, in this organisation bestride their charges' backs, and not the animal's neck, as obtains in India.

The highest point in the African elephant is the shoulder, and this corresponds roughly to the width across the expanded ears, or six times the forefoot's diameter.

The Indian Elephant, *E. indicus*, differs from the African chiefly in its smaller ears, flat forehead, and the presence of a single “finger” to the trunk. As in the African race, this organ is the animal's chief tool and weapon. The young sucks through the mouth.

The Indian elephant has a wide range, extending to Ceylon, Burma, Siam and Malaya, and its “social” status is in striking contrast to that of the African. For unknown centuries it has played a vital part in Oriental religion, and every activity of

life. Rajas have used elephants to provide spectacular fights, to carry their troops into battle and to act as executioners to criminals or political "undesirables". To-day the Indian elephant is in as great demand as ever for drawing the plough, hauling timber, machinery or guns, uprooting trees and a thousand other requirements. It is far too valuable to be slaughtered for ivory, and a Government department regulates its capture. This is generally effected by means of a stockade or Keddah, a herd being gradually driven into such an enclosure and there secured. The "drive" may take many weeks to effect, but once a herd is caught, its individuals, under the skilled management of native keepers and tame elephants, are sufficiently "domesticated" for work within a few months. The "Keddah" drive has been fully and dramatically described in Kipling's *Toomai of the Elephants*", and the films "*Chang*" and "*Elephant Boy*".

Ganeesh, the elephant-headed god of longevity, wisdom and good fortune, eloquently testifies to the awe and affection in which the elephant is almost universally held throughout the Orient. A veritable library has been devoted to the animal's place in religion and labour. So part and parcel of the Indian people's lives is the elephant that native mahouts are often hired in this country, by reason of their specialised knowledge and tact in dealing with the animals. With few exceptions, cow elephants only are used in England for performing or other purposes, the periodic "brain storms" to which the male elephant is liable rendering the use of "bulls" somewhat hazardous.

Considerable mystery still surrounds many features of the elephant's ways of life. The legend that elephants repair to special burial-places when feeling they are about to die, although generally regarded as improbable, is not entirely discounted by those who have studied these animals.

XI

HYRAXES

Order *Hyracoidea*

THE true position of these small mammals, now confined to Africa, was for long imperfectly appreciated, owing to confusion caused by the various names applied. "Hyrax", for example, is the Greek for Shrew Mouse, whilst the name of "Coney", used by the earlier translators of the Bible, led to a general belief that the animal was a species of rabbit. The Dutch name of "Dassie" signifies a badger. Actually the hyrax is closely related to the elephant and rhinoceros, its teeth, feet, and many other structural features showing its affinity to those creatures, despite its small size and covering of close brown fur.

Numerous species and sub-species are recognised, but the race of hyraxes may be broadly divided into rock-dwelling and arboreal forms. The common "Rock Rabbit" or Cape Hyrax, *Procavia capensis*, is tolerably abundant in open, rocky country throughout South Africa, and a closely similar species inhabits Syria. The animal is about the size of a large rabbit, and lives exclusively upon vegetable food, feeding by day and hiding in rock fissures at night. Very active sweat glands on the soles of its feet render those limbs remarkably adhesive, so that the animal may still remain clinging tenaciously to rock even after it has been shot. It is entirely defenceless, but if an attempt is made to drag it from its retreat, may resist capture by distending its body with air, so making itself too large to be dragged forth. The animal has innumerable enemies—wildcats, dogs, owls, eagles, pythons, etc.—whilst its flesh and fur are in great demand amongst natives. It produces two or three young at a birth.

Tree Hyraxes (*Dendrohyrax*) are strictly arboreal, hiding by night in hollow trunks, etc. They are confined to coastal areas, and apart from their climbing propensities are identical in habits with the terrestrial species.

HORSES, RHINOCEROSES AND TAPIRS

Order *Perissodactyla*

THE *Perissodactyla* are to-day represented by such animals as the horse, ass, zebra, tapir and rhinoceros. Though often very dissimilar in general form, all agree in carrying their weight chiefly upon the middle, and largest, digit of each foot. In the case of the horse, etc., this has been reduced to one only.

All these animals are herbivorous, the molar teeth being used for crushing soft vegetation, canine teeth when attaining to any size being employed only by the males as weapons of aggression against other males of their own species. Most of the *Perissodactyla* are of large size, and to-day reach their maximum development in the warmer countries where vegetation abounds. Thanks to the abundance of fossil remains, the development of the group since its inception, during Miocene times some 20,000,000 years ago, is very well known.

The familiar Horse, *Equus caballus* (Family *Equidae*), is known to have been first represented by an animal not much larger than a dog, and having four toes on each foot—a construction well suited to life amid swamps. Through an almost unbroken series of fossil remains the gradual loss of toes can be traced, as the animal gradually took to a life in open country, where speed would prove vital to safety. The useless “cannon” bones of the horse’s fore-limb once supported hoofs, and are a legacy from the beast’s prehistoric swamp-dwelling forebears.

The domestic horse, to which a veritable library has been devoted, is believed to have originated in Asia, and was probably derived from a form similar to that still found in Mongolia—Przewalski’s horse or the Mongolian Tarpan, *Equus przewalskii*, a short stocky animal with a dense shaggy coat.

Horse and ass are differentiated by many minor anatomical features.

The Kiang, or Tibetan Wild Ass, *Equus kiang*, is almost as tall as an average horse, and one of the fleetest of hoofed animals. This, like the Onager, *E. indicus*, and the wild ass of Persia and Syria, lives in open country. All members of the family are easily interbred, and innumerable hybrids have been thus produced, such mules showing characters of both parents, the sire’s markings predominating. The most reliable hybrid for harness purposes is the well-known “mule”, derived from a domestic mare and a stallion of a domestic ass,

Equus asinus. The latter is found wild in Africa from Nubia to Somaliland.

The Zebras are represented by four species, distinguished by differences of striping, which characteristic patterning earned the animals the classic name of "hippo-tigris".

Grevy's Zebra, *E. grevyi*—unknown until 1882—is the largest of the four, being as tall as a horse, *i.e.* about 4 feet (16 hands) at the shoulder. It is found in Abyssinia and British East Africa.

Burchell's Zebra, *E. burchellii*, is short and stocky, and ranges from Abyssinia to East Africa and the Orange River in the South.

The hardy Mountain Zebra, *E. zebra*, comes from South-West Africa and together with Burchell's is the species most often bred in captivity.

The Quagga, *E. quagga*, was virtually a Burchell's zebra, but with the stripes fading out at the waist and absent from the hind-quarters. Demands for its skin have caused it to become extinct, the last ever seen alive dying at the London Zoo in 1864.

Zebras usually live in herds of from twenty to two hundred strong, all kinds of antelope, besides ostrich and giraffe, often intermingling with them, and finding collective protection from their common foe—the lion. Zebras are highly temperamental and not easily tamed. A Zoo specimen would cling to a roof beam with its teeth.

The voice is something between an assinine bray and a hoarse roar. In the breeding season, Zebra stallions fight savagely with forefeet and canine tusks. It may be mentioned that the old expression "donkey's years" scarcely finds justification in fact, since the bulk of the equidae seldom survive more than forty years.

Economically, the horse family still plays an important part in human activities. Although all but banished from a few of the largest cities in favour of motor transport, the horse and ass still hold their own in every country of their adoption, and in many parts of the world are still a main form of travel. A curious characteristic of all the horse family is the "callosity" or "chestnut"—a horny protuberance on the inner side of the fore limb above the carpus or knee, and in the hind limb below the hock. It yields a viscid fluid, which if liberated by operation will quickly attract other equine animals in the vicinity, and produces narcotic effects in dogs. In medieval times the fluid was used in pharmacy, and is apparently the decadent remnant of a once functional scent gland.

The Rhinoceroses (Family *Rhinocerotidae*) are to-day known by some half-dozen species, confined to Africa and Asia. The

typical "rhino" is a massively built beast, with three toes on each foot, powerful grinding teeth suitable for crushing lush vegetation, and a hide about $1\frac{1}{2}$ inches thick, usually thrown into pleats or folds. "Rhinoceros" is derived from the Greek meaning "nose-horned", and refers to the one or more horns—actually composed of highly compressed hair—borne upon the forehead and nasal region. "Rhinos" often weigh several tons, and since they are active and immensely powerful, are dangerous.

The living rhinoceroses are but a small remnant of a once numerous and world-wide race. The earliest forms were little larger than tapirs, and built on "horsey" lines, being lithe, high-legged and evidently fleet runners. As the race spread throughout Europe and Asia, and to a lesser extent America, there arose a bewildering number of changes, rung upon the accepted rhinoceros form. From Kansas have come remains of a rhinoceros built on the lines of a Dachshund, with a long body and grotesquely stunted legs. Another fossil form from Siberia was a giant with one big horn set between its eyes. This and *Ceratotherium*—a huge two-horned form—invaded the Far North, where they probably lived on moss, like reindeer, and wore heavy coats of reddish-brown wool. From Asia, there was recently discovered the hornless *Baluchitherium*, one of the largest land animals the world has ever seen. It stood fourteen feet at the shoulder, and could probably browse on herbage more than twenty feet above ground.

With the advent of man and his weapons, the rhinoceroses underwent a steady decline. Until world transport was an accomplished fact, however, the various species remained unknown to civilisation. Before the 17th century, the Indian species was believed to be the only rhinoceros in existence.

The Great Indian Rhinoceros, *Rhinoceros unicornis*, is now confined to a restricted area of North-East India, where it is rigidly conserved. It is distinguished from all other species by the concise, armour-like folds of the skin. An adult male stands between 5 and 6 feet, weighs 2 tons, and carries a single horn upon the nose. There is only one young at a birth, and the life span is placed at about thirty-five years.

For countless centuries this animal was in demand by the ancients, who accredited miraculous properties to the horn. In days when Eastern potentates had reason to dread being poisoned, a cup of rhino horn was believed to detect at once any toxic fluid placed in it. The horn, ground to powder, was regarded as a general elixir, which belief still persists throughout the East. In China, rhino horn of any kind commands £14 per pound weight. This quaint superstition is recalled by the crest

of the Apothecaries' Society—"a rhinoceros statant". The Rhinoceroses appear to be virtually without enemies, no animals—apart from man—daring to molest them, though lions or tigers may occasionally attack calves.

The Asiatic two-horned rhinoceros, *R. sumatrensis*, of South-East Asia, Assam, Burma, Siam, the Malay Peninsula, Sumatra and Borneo, is a smaller and less ruggedly coated animal. It is less pugnacious than the one-horned species, and when in the early days of the Zoo it was desired to shift two of these rhinos to new quarters on the other side of the gardens, they were conducted thence by means of collar and lead—the leads being ropes with a dozen or more keepers clinging to them.

The Javan Rhinoceros, *R. sondaicus*, ranges from the Sandarbans of Bengal to Java, and is only distinguished by the shoulder skin folds continuing across the neck, and by the simpler pattern of its teeth. All the Asiatic rhinos have pointed prehensile upper lips and dagger-like upper canines.

The African Rhinoceroses have almost smooth skins, with a few vertical creases over the ribs, square upper lips and two large horns placed close together. They live in more open country than the Asiatic species.

The Black Rhinoceros, *R. bicornis*, ranges from the Cape of Good Hope to Somaliland and the Anglo-Egyptian Soudan. It eats only leaves and twigs.

The White Rhinoceros, *Ceratotherium simum*, is almost extinct, existing only in Central Equatorial Africa, near Lado. It is the giant of the race, of a pale slate colour, and is nearly related to the huge woolly rhinoceros once common in Siberia. The horns slope outward, so that the one furthest from the creature's eyes projects like a bowsprit. It is a yard in length—three times as long as that of the Indian species. The animal lives exclusively on grass, and mingles peaceably with herds of antelope, etc., but is notoriously dangerous when attacked. When enraged it charges blindly at its opponent, indifferent to size or capacity for resistance, attacking with equal aplomb a defenceless man or a three-ton motor lorry. Like most herbivorous animals, the rhino, despite its thick hide, is much infested by ticks, and in consequence cheerfully tolerates the attentions of the insect-eating starling which perches on its back and relieves it of the pests. Cave-drawings show these birds so engaged upon their gigantic "host" some 50,000 years ago.

Though amongst the world's untameable animals, rhinos prove docile for the first year or two of their lives. One at the Zoo for long consorted with a baby elephant and a pair of goats, whilst until recently a rhino in the Calcutta Zoo even permitted children to ride upon its back. The demand for rhino flesh, hide

and horn has gone far to usher the entire race into extinction, and the remnant survives only as the result of national conservation.

The Tapirs (Family *Tapiridae*) are to-day represented by four species only, a remnant of a race once scattered over most of the world. One species has found a final refuge in Malaya, and three nearly related forms find sanctuary in South America.

Tapirs are somewhat clumsily built herbivorous animals with three toes on each foot—characteristic of swamp-dwellers—thick skins sparsely haired, and a pendulous nose serving the purposes of a trunk. The young—one at a birth—are strikingly marked with white spots and bars on a brown ground, which livery slowly disappears with advancing age.

The Malay Tapir, *Tapirus indicus*, affects the densest jungles of the Malay Peninsula, spreading North into Tenasserim. It also occurs in Sumatra. The body is white, whilst the head, neck, shoulders, all four legs and short tail are black. Like all tapirs it is quite defenceless, clumsy in retreat, and its only cry is a plaintive bleat.

The Brazilian Tapir, *T. terrestris*, together with the other American tapirs, is coloured a uniform brown. It is rather smaller than the Malay species, with a less pronounced "trunk", and keeps to the more mountainous regions of South Brazil and North Argentina, Peru, the Guianas and Venezuela.

Dowis's Tapir, *T. dowii*, and Baird's, *T. bairdii*, are two very similar forms from Central America, and are the giants of the race. Baird's tapir stands over three feet at the shoulder—considerably less than some extinct forms common in Europe during Tertiary times. Baird's is the rarest of the four known species, and two specimens only have been kept in captivity.

XIII

CATTLE, SHEEP, GOATS, ANTELOPES, GIRAFFES, DEER, CAMELS, SWINE, HIPPOPOTAMUSES

Order *Artiodactyla*

THE Artiodactyla, or "even-toed ungulates", are known to all by such familiar animals as the Ox, Giraffe, Deer, Sheep, Camel, Pig, and Hippopotamus. Though having little kinship at first glance, and varying greatly in size, form and habits, all these, and many interrelated animals, have one primary feature in common. The digits on all four limbs are more or less symmetrically arranged, *i.e.* paired. In some cases all four toes touch the ground, in others each outside toe is free of the ground, and has so ceased to perform any useful function, but the symmetry still persists. Numerous strange forms of even-toed ungulates now no longer exist, but a vast number of species are still scattered over all parts of the world, from the equator to the poles, and many are of the first importance to man.

The Ox family (Family *Bovidae*) is divided into forty-four genera, headed by the type genus "Bos", meaning an ox.

The origin of the domestic ox is largely lost in antiquity, and the innumerable breeds recognised to-day can be traced to more than one source of ancestry. They vary from the hornless varieties to such types as the Long horn, Soudanese and Hungarian breeds, in which the horns may span more than two yards. Our own oxen have by careful selection and intensive breeding changed greatly within little more than a century. At one time mountainous creatures carrying a great weight of fat were the ideal, and old prints of early cattle shows depict creatures standing six feet at the shoulder. To-day we desire meat rather than fat, and modern breeds of pedigree stock seldom exceed four feet in height and show great compactness of build.

English cattle are generally regarded as being descended from the White Chartley and Chillingham Cattle, still kept in a few parks, and these in turn are traced to the now extinct Aurochs, a huge black animal. Chartley and Chillingham cattle not infrequently breed black calves.

Cattle, like all creatures intimately associated with man, have naturally played a large part in folklore, heraldry and religious beliefs. The ox, for example, is associated with

St. Luke, and in many lands domestic cattle are still held in the greatest veneration. Throughout Brahmin India, for example, the sacred Zebu, *Bos indicus*, is a privileged animal, being permitted to pillage bazaar stalls and crops, or monopolise public thoroughfares, secure from all molestation, none daring to oppose it—at least openly.

The Gaur, *Bibos gaurus*, and Gayal, *Bibos frontalis*, are wild oxen of India and Assam, noted for the strength and courage which render them dangerous antagonists. In Assam the powerful Gayal is largely domesticated.

The Banteng, *Bibos banting*, of Java is the dwarf of the family, seldom exceeding a Great Dane in size. It has short horns and is, for an ox, very docile, being often domesticated.

The Yak, *Poephagus grunniens*, or Grunting Ox—so-called from its deep guttural voice—is a native of Tibet and neighbouring countries. For centuries the yak has been domesticated, and its wonderful indifference to severe cold, sure-footedness in precipitous countries, and ability to thrive on the coarsest food have made it invaluable to man. But for the yak, indeed, life would be impossible to the nomadic tribes and small-holders of Eastern Asia. It supplies every conceivable want. The long hair which often sweeps the ground is put to innumerable uses, from clothing to fly whisks, whilst the yak further furnishes meat, milk, all manner of products which can be derived from bones, horns and hoofs, and is quite unsurpassed as a beast of burden. It will doubtless long outlive the horse as one of man's vital necessities.

The Bisons (*Bison*), once widely distributed, have long been confined to North Europe and North America. The European Bison, *B. bonasus*, or Wisent, once rigidly protected in Russia under the Czars, was virtually exterminated during the European War. The Soviet Government, co-operating with the world's Zoos and park owners, however, is now slowly reinstating it. It is a forest-dwelling animal, and, like its cousin, the American bison, is at once recognised by the massive head and forequarters clothed in shaggy hair and the short tail.

The American Bison, *B. americanus*, is chiefly distinguished by the larger horns. Its range extended originally from Pennsylvania to, and across, the Rocky Mountains, and from Mexico to far into Canada. Until within half a century ago the whole history of this statuesque animal has been one tragic story of wanton persecution and needless slaughter. Its wholesale destruction by white men created much of the sanguinary friction between settlers and natives, the latter naturally being aghast at seeing the slow elimination of an animal which provided them with most of life's necessities—food, clothing

and shelter, "wigwams" being largely built of bison hide. Both whites and redskins, however, played their part in reducing the bison herds from millions strong to mere hundreds. A favourite sport was to stampede a big herd between rock or wooden pallisades, leading to a precipice over which the animals poured—by thousands—to destruction.

The creation of the American Bison Society, and hundreds of affiliated branches, ranks amongst the triumphs of conservation. To-day bison are almost as numerous as before, and the semi-domesticated herds provide a handsome annual revenue in meat, hides and numerous other commodities. The American bison is a plain-dwelling animal, and lives exclusively on grass.

The Indian Water Buffalo, *Bubalus bubalis*, abounds in India and the East generally, where it has long been domesticated, and has also been successfully introduced into Hungary, Australia and other distant lands. It is a huge slate-coloured animal, as large as a short-horn bull, and the numerous breeds show great diversity of horn. These, like the horns of all *Artiodactyla*—apart from deer—are hollow cones placed over bony prominences, richly supplied with blood-vessels. The horns persist throughout life. Water buffaloes are invaluable beasts of burden and thrive best in damp, humid areas. Though so large and powerful they are easily handled, and their herding in the East is conducted almost solely by young children, trained to the work almost as soon as they can walk. In Java, the buffalo is largely used for stamping out weeds on ground needed for cultivation. Also being driven up and down the fields in straight lines it performs the function of a primitive plough.

The Anoa, *Anoa depressicornis*, is a small buffalo, half the size of an ox, and confined to the island of Celebes. The animal is spry and active, with a short close coat and small backward-curved horns. These latter serve to help the animal force a passage through the dense jungles of "rattan" cane which it inhabits, lifting up the otherwise impenetrable barriers, much as might be effected by a giant hay fork. Like other members of the ox family it seldom produces more than one calf at a birth, and the average life span is about twenty years.

The Sheep (*Ovis*) is an animal nearly related to the goat, ibex and antelope, all these seemingly very different forms being linked together by "intermediary" forms, combining the characters of sheep and goat, goat and antelope, sheep and ox, etc. All have the two central toes of each foot touching the ground, the other two being represented by so-called "claw hoofs" that have ceased to share in the animal's support. Horns are usually present, and the eye has a horizontally placed pupil. The

stomach is complex, being divided into several compartments, the animal being able to regurgitate food from one compartment and masticate at leisure food eaten in haste—the characteristic “cud chewing”.

The Domestic Sheep, *Ovis aries*, is a creature of unknown origin, appearing to have been widely used almost since the dawn of man, and has now been introduced into every part of the world where conditions permit. Essentially creatures of the temperate regions, sheep can still withstand great cold, developing, to meet such condition, the dense coat of wool which has so commended them to human use. Flesh and milk are amongst the sheep's other well-known products, whilst in many countries it is still used as a transport animal. Every land has produced numerous breeds to meet the special requirements of the inhabitants, and in our own islands practically every county has its distinctive type.

The plasticity of the sheep, in the breeder's hands, has led to many strange developments. In the East, the general love of adipose foodstuffs has brought about the fat-rumped and fat-tailed breeds, the latter having a caudal appendage of such gargantuan proportions that it is often supported on a small carriage harnessed to the animal. Horns may be equally overdeveloped, or entirely absent. In South Africa and several other parts of the world four-horned sheep are common, and from India comes the so-called unicorn sheep in which the horns are united. The famous Merino, originally from Spain, has a coat of such vast proportions as to have earned its wearers the name of “elephant sheep”. In the Soudan, New Guinea and other hot countries, local sheep have dispensed with wool in favour of a short goat-like coat of hair.

Wild sheep, with immense spirally twisted horns, are found in nearly all mountainous countries. Such forms have finely pointed hoofs and coats of hair instead of wool. Well-known species are the Mouflon, *Ovis musimon*, of Sardinia and Corsica, the Canadian Big Horn, *O. canadensis*, and Marco Polo's sheep, *O. poli*. These and many allied species have long been favourite victims of “trophy” hunters. The Marco Polo sheep of the Pamir Pass is possibly the finest of the race, having a horn measurement of six feet along the curve. All are exceedingly wary animals, and affect country which makes them difficult of approach. The Tibetan Argoli Sheep, *O. ammon*, ascends to a height of well over 13,000 feet above sea-level.

Mountain sheep usually travel in small parties, as opposed to the vast flocks of domestication. While domestic sheep have lost much of their intelligence and independence, centuries of cultivation have not wholly eradicated primitive instincts. The

more independent breeds of the Scottish Highlands, for example, present a well-organised battle-front when faced by a presumed enemy—such as a strange dog. The older rams at once step to the front, the younger males rank themselves just behind them, whilst the ewes and lambs bring up the rear. Thus arranged they stamp in unison, taking their lead from the older males—a manœuvre which often has a very subduing effect upon the foe.

The Barbary Wild Sheep, *Ammotragus lervia*, of North Africa is by far the best known of all wild breeds. In the London Zoo alone well over 150 have been bred in the course of sixty years.

The Goats (*Capra*) are so nearly allied to the sheep as to be not easily distinguished, especially as regards wild forms. Leading features are the simply curved or vertically twisted horns, hairy muzzle and coat, reduced or absent facial gland below the eye, and the presence of scent glands between the forehoofs. The latter glands emit very distinctive odours in the different species and doubtless serve to “blaze a trail” in desolate country, to bring the sexes together or help the various members of a herd to “keep in touch”.

Most domesticated goats are regarded as traceable in origin to the Mediterranean wild goat, and like the sheep have lent themselves to much manipulation at man’s hands. Some famous “Dairy” breeds give a yield of milk proportionately larger than that of a pedigree cow. In the Nubian breed, the little lappets of skin often ornamenting the neck have been exaggerated into enormous tassels. The goats of Mount Carmel have pendant ears which almost reach to the knees. From Persia and Turkestan come the famous “shawl” goats, the long silky hair of which forms immense curtains sweeping the ground. Though so responsive to human agencies, the goat quickly reverts to the wild, if permitted, such wild goats existing in many distant areas, as in Scotland, the islands of Skye, St. Helena, Juan Fernandez and the Azores. An entirely hornless breed comes from China.

The goat’s intelligence has lent itself to far greater development than that of the sheep. As a circus animal it is very popular. One such can, at a sign from its trainer, leap into the air and alight, neatly poised, upon the precarious support of a bottle. Throughout North Africa, Italy and Switzerland the goat-herd does not drive his animals, however numerous, but leads them—playing on a pipe. Goats figure frequently upon ancient Egyptian wall paintings and monuments.

Wild goats are even more adaptable and imbued with a “pioneer spirit” than domestic varieties. No mountains appear to be inaccessible to them, or vegetation too scarce and poor to afford them nourishment. As with most hoofed animals leading

exposed nomadic lives, the young are noted for their precocity. Kids are usually born singly, twins being rare, and the infant can walk when only a day old. Though naturally a little unsteady upon its feet for the first few days of its existence, it soon acquires experience and self-confidence as a mountaineer by taking its first lessons in climbing by laboriously clambering over the recumbent forms of its parents, even balancing itself upon their arched horns.

Typical wild goats, as distinguished from the tame or half-wild common goat, *Capra hircus*, are commonly known as Ibex, and are distinguished by the huge, wrinkled and backward-curved horns—which may measure fully a yard—and the voluminous beard, which in some males continues to the knees, forming twin skirts. The hair is determined by climate. In some species the beard is reduced to a minimum, but grows longer during the mating or “rutting” season. The males fight savagely at such times, butting with their horns whilst reared upon their hind legs, whereas rams invariably charge, head to head, upon all fours.

True Ibex are represented by the Common Alpine Ibex, *C. ibex*, the Asiatic Ibex, *C. sibirica*, the Nubian Ibex, *C. nubiana*, and the Abyssinian Ibex, *C. evalie*. Demands for meat and hide and horns—either for trophies or conversion into trumpets, drinking-vessels, powder-flasks, etc.—have done much to reduce the numbers of these animals. All are becoming increasingly wary, despite protection.

The Markhor, *C. falconeri*, extends over the mountains North and South of Kashmir. A very large number of local varieties have been described. The horns develop a very open spiral like a corkscrew, though almost straight horns are known. The coat changes from a short brown pelt in summer to a grey shaggy covering in winter. It surpasses all other goats in its climbing abilities, and will even ascend trees, the horizontal, spreading branches affording steps by which it mounts to considerable heights.

The Tahr, *Hemitragus jemlahicus*, of the Himalayas has small, smooth, simply curved horns, sloping backwards, of almost equal size in both sexes. A thick mane round neck and shoulders takes the place of a beard. It is large for a goat, standing a yard at the shoulder, but even the bulkiest males show wonderful agility, negotiating crags and passes beyond the powers of all pursuers.

The Chamois, *Rupicapra rupicapra*, has long been famous as the ideal type of mountain goat, and is a coveted—and strictly preserved—game animal of the Alps, Pyrenees, Carpathians and Caucasus. It is distinguished by its neat, short-haired limbs and

body, small "crochet hook" shaped horns and black face markings. The beard is a much sought after hunter's trophy. Shortly after the War, the chamois herds of Switzerland were almost decimated by a disease, but careful segregation of untainted animals has now seen its steady reinstatement. Its leaping powers are remarkable, though exaggerated in many old prints and engravings.

The Rocky Mountain Goat, *Oreamnos americanus*, of North America is unique amongst goat-like animals in its ponderous build, glistening shaggy coat of pure white, and small jet-black horns, behind each of which is a large globular gland.

Though apparently clumsy, it can ascend to the highest and most precipitous altitudes, where it lives on moss and lichens scraped out of rock fissures, or from beneath the snow. It is regarded as one of the links between goats and antelopes and is exceedingly rare in menageries, even those of North America. One only has been seen alive at the London Zoo (in 1900) when, although ample shelter was provided, it elected to live upon the roof of its hut, however unpropitious the weather.

The Serow, or Goat Antelope, *Capricornis sumatrensis*, as the popular name suggests, is another "living link". It is a large, clumsy-looking goat-like creature, with short triangular horns, slightly curved, and comes from rocky country in Sumatra. Allied species are recognised from Cochin China, Tibet and the Malay Peninsula.

Still rarer than the Serow is the Takin, *Budorcas taxicolor*, only twice imported alive to this country—in 1909 and 1923. The first specimen lived for nearly ten years. It is a heavy, almost ox-like creature, of a dull brown colour, with a broad flattened nose and large horns which sweep outwards and downwards with the points directed towards the animal's tail. The few examples known have been found only in the more inaccessible portions of Tibet. The creature's scent is offensive and penetrating.

The Musk Ox, *Ovibos moschata*, is yet another link between the goats proper and the antelopes. It is about the size of a Kerry cow, with horns not unlike the Takins, but with fur forming at their bases and a massive boss covering the forehead. The musk ox comes from Arctic America, including Greenland, where it lives in rigorous surroundings, well protected by its coat of long densely matted hair. It is a sullen and dangerous animal, and presents a bold front to all foes, herds frequently warding off the attacks of wolves and polar bears.

In the Pleistocene epoch musk oxen wandered over Central and Northern Europe, including Great Britain. Though long known to hunters, living specimens did not reach England until

about 40 years ago, since when they have been regularly exhibited in the London Zoo.

The whole of the remaining members of the family *Bovidae* are, with one exception, grouped under the convenient title of "antelopes". Whilst at one time enjoying a considerably wider range, antelopes are to-day confined to Asia and Africa, finding in the latter continent their widest distribution and maximum development in size, variety of form and number of species.

An antelope may be broadly defined as a hoofed ruminant mammal, with two toes on each foot, and a pair of horns springing from the frontal bones. The horns are hollow, chitinous shells fitting tightly over bony cores, which feature chiefly distinguishes them from deer, which they otherwise closely resemble. A second pair of hoofs—dew, or false hoofs—are usually present on each foot, but are always non-functional.

The antelopes whilst varying enormously in size, colour and general form, range throughout all Africa, appearing in their greatest numbers upon the vast grazing areas of the south. Though often well armed against such foes as lions and leopards, they are with few exceptions peace-loving animals, offering violence only during the mating season when the males often engage in savage duels. The more prolific species congregate in vast herds. Frequently herds of several species combine to make one extensive troupe, which in turn may be joined by zebras, giraffes and ostriches, these diverse animals finding safety from common foes in such mass formation. Antelopes usually produce but one at a birth, the calf being able to walk when a few hours old, and quickly adapting itself to the nomadic life of its elders. Feeding is conducted almost exclusively by day, and at dusk the animals repair to known water-holes or river courses before retiring to rest. Like most hoofed animals antelopes are much plagued by various insect parasites infesting their skins, and for this reason cheerfully tolerate the small cattle egrets and various other birds which perch upon their backs and rid them of the pests. Wholesale slaughter of antelopes by man has greatly reduced their numbers, some species having become extinct within recent times. Conservation, however, has still preserved a considerable number, and on various reserves, such as the famous Kruger Park at Pretoria, the animals are almost as numerous as in the days of the early pioneers.

The first group, comprising Sables, Roan and Oryx antelopes, consists of large animals approximating an average cow in size, though of much lighter build. The Sable Antelope, *Hippotragus niger*, of South and tropical Africa, has backward curved horns, slightly crinkled and of great strength. The general colour is a

deep chestnut. As in many other species the face bears grotesque black and white markings, whilst the rump bears a light coloured horseshoe or crescentic device which is believed to serve as a guiding, or "follow my leader", mark, aiding its wearer to keep other members of the herd in sight, much as the rabbits white "bob" helps the members of a warren to "keep touch" when danger prompts them to bolt for cover.

The Addax, *Addax nasomaculatus*, has straight, spirally twisted horns, whilst the members of the genus *Oryx* have yard-long horns faintly spiralled or entirely smooth. Viewed from the side the animal appears to have but a single horn jutting from its forehead, and it has been suggested that this illusion gave rise amongst early hunters to belief in the fabled unicorn.

The Hartebeestes, Gnus, and Wildebeestes are large antelopes with grotesquely elongated faces and nostrils placed in a downward direction, believed to serve as a protection against their becoming filled with sand. The best known of the hartebeestes is the Cape species, *Bubalis caama*.

The Gnus, or Wildebeestes (*Connochaetes*) justify their Dutch title by their savage temperament and the grotesque gambols in which they indulge when confronted with any unusual object. They are large equine-looking animals, with crested manes, flowing tails and long faces, having a broad truncated nose profusely bristled. The horns curve outwards and downwards like those of the musk ox.

The Blesbok, *Damaliscus albifrons*, is a small member of the group, and now exists only in the reserves of Cape Province and in zoological collections. Its flesh is highly prized, and in the past great quantities were used to make "biltong", the dried meat "emergency ration" which natives and whites alike invariably carried when on a prolonged trek.

The Waterbucks are large or medium-sized animals, and the males only bear horns. As their name suggests they are largely marsh-dwelling creatures, seldom being found more than a mile or two from a water supply.

The Elands are the largest of all antelopes, with straight or slightly spiralled horns, and the coat often marked with vertical or horizontal stripes of a light colour.

The true Eland, *Taurotragus oryx*, is the largest of all antelopes, a bull standing as high as a shire stallion, and weighing over half a ton. It is remarkably hardy, over a hundred having been born at the London Zoo. Half a century ago great hopes were entertained of so completely acclimatising the animal as to add it to the national food supply. Several eland banquets were held in London with a view to popularising the meat, but, owing to the difficulty of introducing fresh blood into the herds of this

country, the movement has made little progress, and British beef still remains unchallenged.

The Koodoo, *Strepsiceros strepsiceros*, is a beautiful species, slightly smaller than the eland and with corkscrew-like horns of great size, forming so desirable a "trophy" as to have largely reduced its numbers at the hands of "sportsmen" afflicted with "trigger itch".

The Four Horned Antelope, *Tetracerus quadricornis*, of peninsular India is unique in that the male bears two pairs of horns, one behind the other, the anterior pair being quite minute. Another remarkable Asiatic species is the "Saiga", *Saiga tatarica*, of Western Asia and the steppes of Russia, at once distinguished by the enormous truncated nose of the male. It is rarely seen in captivity, though one reached London from the Moscow Zoo in 1864. Fossil remains of this animal have been found in England. The tubular nose can be shortened by wrinkling, and is specially designed to prevent sand particles reaching the nasal chamber.

The Gazelles, found in Africa, Arabia and India, are small antelopes, seldom exceeding a goat in stature and most delicately formed, with very slender limbs and horns curved in the manner of an earwig's "pincers". Gazelles are wonderfully fleet of foot, and in India are "coursed" with hunting leopards, caracals and greyhounds. Some of the desert species are practically independent of water, though quickly acquiring a taste for it in captivity. The beautiful Grant's Gazelle, *Gazella granti*, was once so prolific in Africa that lions were occasionally surrounded by vast migrating herds, and forced to walk pacifically for miles in the moving mass of antelopes.

The Nylghaie, *Boselaphus tragocamelus*, is the largest of Indian antelopes, almost equalling the eland in stature. The male bears short straight horns, and is a courageous and aggressive animal, even facing the tiger. Its flesh is eaten by Mohammedans, but not by Hindoos, since "Nylghai" signifies a "blue cow", though of course the animal has no affinity with a cow of any description.

The Duikers, etc., are the smallest of all antelopes, some species being little larger than hares. "Duiker" signifies a "diver", and refers to the animal's habit of leaping high out of long grass, and plunging into it from aloft, head first, a herd so engaged suggesting a school of porpoises rollicking at the sea surface. Many of the true Duikers, *Cephalophus*, affect deep woods and thickets, but the famous Klipspringer, *Oreotragus oreotragus*, of Eastern Africa has taken to a life amongst precipitous hills, and has acquired all the agility of a chamois.

A striking form is the West African Harnessed Antelope,

Tragelaphus scriptus, the reddish-brown coat of which bears a complex pattern of white stripes and spots suggesting a suit of harness or a grotesque inscription. Very similarly patterned and even more brilliantly coloured is the African Bongo, *Böocercus euryceros*, which lives in forests.

The Prong-horned Antelope or Prong Buck (Family *Antilocapridae*) of the Western United States and Mexico forms a link between the antelopes proper and the deer. It is about the size of a goat, and once swarmed upon the plains of North America. Its leading feature is the extraordinary character of the horns. These are periodically cast, the pronged horns fitting over conical bosses of bone like those of a cow. The casting of the horns was first discovered by chance at the London Zoo in 1865. The keeper in charge was horrified to see one of the rare exhibit's horns lying on the floor of its stall, and hastily summoned the curator, who arrived in time to see the remaining horn join its fellow on the ground. Curiously enough this remarkable animal was given little attention, save as a meat supply, in the country of its origin, and two specimens which later arrived at the Zoo were discovered by their donor being used to draw a goat chaise in New York City.

The Prong Buck is remarkably fleet of foot, but the devouring curiosity, which it shares with many deer and antelope, render it an easy victim; it will often approach to within a few feet of the gun levelled at it.

The Giraffe, *Giraffa camelopardalis* (Family *Giraffidae*), is one of two survivors from a past epoch when the race was much more widely distributed. Skeletons of huge giraffe-like quadrupeds have been found in the island of Samos, whilst an allied monster with remarkable horns is known from the Siwalik hills, in India. To-day the family is confined to Africa, the typical giraffes ranging in semi-open country from the Anglo-Egyptian Soudan down to the Cape, though entirely absent from the West-Central portion of the Continent.

"Giraffe" is a corruption of the animal's Arabic name, whilst the specific name, signifying a camel-leopard, was given it by the ancients, to whom it was well known. The distinctive feature of the animal is the remarkable elongation of the neck, the evident result of persistent browsing upon high foliage. The limbs are similarly elongated, so that in drinking the animal is obliged to bend or straddle the fore limbs in order to reach the water. Its principal food is the foliage of the mimosa-tree. The characteristic spot pattern of the coat serves as an ideal camouflage amongst the chequered shadows cast by sunlight filtering

through foliage, the spots varying considerably according to locality. Several sub-species have been founded upon this variance. The male usually carries a pair of short skin-covered horns, and a large bony boss often surmounts the forehead. The tongue is long and prehensile, tearing foliage down as might the trunk of an elephant. The giraffe is unique amongst mammals in being entirely without vocal organs, and under no circumstances has it been known to express itself other than by a hissing expulsion of the breath.

An adult giraffe may stand eighteen feet high, and weigh about a ton. There is a single young at birth, and it reaches puberty in five years, and senility some twenty years later. Giraffes are strictly diurnal, consorting in small troops. The usual gait is a leisurely slouch, but it can break into a loping trot or clumsy gallop under pressure. Its sole means of defence appears to be striking out with the fore feet, but males are said to "duel" by delivering swinging blows with their horned heads.

Prior to the advent of man the giraffe's sole enemy was the lion, but the high quality of its flesh soon commended it to savages and civilised men alike. It has in consequence suffered considerably. Its protection is now well established, but in certain areas herds are regarded with mixed feelings owing to the damage they do to crops.

The history of the giraffe in this country is a curious one. Until exactly a century ago it was known only in the living state by a young specimen in the possession of King George IV, which was kept first at Windsor and later at the royal residence in Chiswick. In 1836, however, a M. Thibonet obtained four specimens for the London Zoo, and these were actually "walked" from Blackwall docks to Regent's Park, a three-hour trek. The animals soon became acclimatised, and in the course of less than half a century over a score were bred, most of which prospered. In captivity the giraffe is as a rule docility personified, only one Zoo specimen being known to have attacked its keeper. It is recorded to have aimed a blow at him, with its head, the blunt horns making an appreciable dent in the wooden panelling of its stall.

The only other living representative of the giraffe family is the famous Okapi, *Okapia johnstoni*, discovered by Sir Harry Johnston whilst on Government service in the Belgian Congo. Prior to 1898 the creature's very existence was unsuspected, but in that year Johnston sent to the London Zoological Society some mysterious strips of skin taken from native shields and bandoliers. These showed a strange blending of Zebra stripes on a white ground, joined to skin of a rich brown colour. They

were attributed to some kind of horse, and for two years their finder traversed the Congo, confidently expecting to light upon an equine animal new to science. His search was partly inspired by the strips of skin and partly by a reading of Stanley's *Darkest Africa*, in which mention is made of a mysterious beast described by the natives as a species of donkey.

In 1909, however, a young Belgian officer shot a specimen of the actual animal, and Sir Harry Johnston was later able to send skins and skulls to England, since when the beast's identity, if not its habits, have become familiar to all.

The okapi closely follows the giraffe in general build, but is adapted to a life in the dense and all but sunless Ituri forest—its only known habitat. The legs are striped like those of a zebra, but the neck and body are a rich chestnut brown. It remained a mystery as regards its habits until 1919, when a living example reached the Antwerp Zoo. Since that year several specimens have graced that establishment, whilst two have been on exhibition in the London Zoo.

The okapi, like the giraffe, is silent, but unlike its relative is almost entirely frugivorous, and in captivity thrives best upon bananas. In the wild it is said to be difficult of approach and more courageous than the giraffe. The relatively short neck does not permit swinging the head like a hammer, but the sharp hoofs can be used with damaging effect.

The Deer (Family *Cervidae*) are ruminants at once distinguished from all other mammals by the horns or "antlers" which are usually present in males, and when absent, are compensated for by the dagger-like upper canines. Antlers are bony outgrowths from the skull, usually branched, and during the period of growth richly supplied with blood-vessels. Until mature they are covered with a hairy pile known as the "velvet". When the antlers are fully developed this is rubbed off. In most species the horns are shed at the beginning of spring, the new horns sprouting from their sites shortly afterwards, and maturing in about six months. They are used almost exclusively in fighting with other males. A new branch, or "tine", is added from time to time until the animal reaches the prime of life, when a point is dropped annually. Old deer, therefore, may have but few tines, as in young specimens, but the more shrunken appearance of the antlers denotes their wearer's seniority.

Deer are largely polygamous, leading a harem of six or more does in the mating season, but usually living solitary lives during the rest of the year. All are herbivorous. They are found throughout the world with the exception of Australia, Madagas-

car and Africa, south of the Tropic of Cancer. There is one young at a birth, and the life span is about twenty-five years. The family is of relatively recent foundation, and reached its peak in the giant Irish Elk, which had an eight-foot span of antlers. The latter animal became exterminated shortly prior to historic times. Most deer are forest dwellers, a few frequenting open plains, swamps, or mountain ranges.

The Reindeer or Caribou, *Rangifer tarandus*, has, as its name suggests, been trained to harness from remote times, and whilst found wild in North Europe, Asia and America has been introduced into many other lands where climate permits its propagation. Immortalised as forming the beneficent team of Santa Claus; the reindeer is a docile animal, and exceedingly spartan in its diet, producing, if no better fare is available, excellent fur, flesh and milk on a diet of moss. The American variety, known as the caribou or woodland reindeer, is almost identical with its congeners of Asia and Europe. In Canada it congregates in vast herds, and during the seasonal migrations an unbroken stream of these animals has been known to pass through certain districts, day and night, for a week or more at a time. When first brought to the London Zoo, the Zoological Society went to great pains to procure Iceland moss for the animals, believing that to be vital to their welfare. Long before the moss was forthcoming, however, the animals acquired a taste for clover and English hay, refusing the moss when eventually it arrived.

The Elk or Moose of Canada, *Alces alces*, is the largest living deer. The male has a tassel or "bell" of hair depending from the throat, the nose is flattened and trunk-like, whilst the palmated antlers span about four feet. An adult stands as high as a shire stallion. It was largely hunted for food prior to its conservation, Indians luring it within bow-shot by imitating its loud "belling" note, using a birch-bark trumpet, or "moose-call", for the purpose. The female is quite fearless in defence of her single calf, and has been known to kill bears and wild cats by striking out with her sharp fore-hoofs. In winter the bull makes, with his six or more ~~does~~, a clearing in the deep snow, known as a "mooseyard". It is less speedy than most deer when pursued.

The Muntjac, or Barking Deer, *Muntiacus muntjak*, of India and the Far East has a curiously ribbed face, short pronged horns, and down-curved upper tusks, used for defence and also for digging roots. Like most deer it is largely silent save in the rutting season, when it develops a voice like the bark of a dog.

The Fallow Deer, *Dama dama*, was originally a native of the Mediterranean region and of Asia Minor, but is now acclimatised in parks the world over. Whilst most young deer are ornamented with a juvenile pattern of spots, the fallow deer

retains such colouring throughout life. The antlers are palmated though less so than those of the moose. Owing to their springy nature they sometimes interlock when two bucks fight, the animals being thus held until they fall from starvation or the attack of some predacious mammal.

Many of the smaller species find no true voice even at mating time, but express their emotions by grinding the molar teeth together, producing a loud squeaking sound. Neither is the shedding of the antlers entirely universal. The Axis Deer, *Cervus axis*, of India for example casts its horns at irregular intervals, sometimes carrying them for several years, whilst Père David's Deer, *Elaphurus davidianus*, of North China actually grows two sets of antlers annually.

The Wapiti, or "Elk" of America, *Cervus canadensis*, is second to the moose in size, but has antlers like those of our own red deer. It is highly aggressive during the mating season, when it has been known to hold up pedestrians and motor vehicles. Deer have figured largely in the heraldry, etc., of all nations, and the Japanese Deer, *Sika nippon*, is held in semi-sacred esteem, the annual marking of young bucks being attended with considerable ceremony. Like all deer, this species is much infested by insect parasites, which it discourages by indulging in mud baths—a process known as "soiling".

The Red Deer, *Cervus elaphus*, though usually associated in Britain with the Scottish Highlands, is common throughout Europe, Western Asia, North Africa and Persia. Its courting voice suggests the roar of a lion. For centuries a beast of venery, a veritable language has grown up around its chase, the bucks being known as pointers, warrantable stags, hart royals, etc., according to the number of branches on the antlers. The Roe Deer, *Capriolus capriolus*, is a smaller British species.

The Chinese Water Deer, *Hydropotes inermis*, is a small, hornless animal with tusk-like canines. It frequents swamps and does much damage to rice fields, feeding largely at night. It is the most prolific of deer. At the Whipnade Zoo it has increased during five years so as to become almost a pest, digging up choice roots, bulbs, etc., and destroying crops.

A number of small deer from India, China and Malaya are known as Chevrotians. All are hornless and tusked. To this group belongs the Mouse Deer, *Tragulus javanicus*, of South-East Asia, which is the dwarf amongst deer, scarcely exceeding a hare in size.

The Camels and their allies (Family *Camelidae*) are even-toed ruminants. Two divergent races have evolved upon different lines. Both are distinguished by the cushion-like soles of the two

large toes upon each foot, long necks and legs, compact bodies and tusk-like lower canine teeth.

The well-known Camels (*Camelus*) have adapted themselves to even more arid country than the Llamas (*Lamas*) of South America. They have also attained greater proportions, an adult standing about seven and a half feet, and weighing nearly a ton. Special provisions against shortages of food and water in semi-desert country are the humps, which retain stores of fat, and the honeycomb-like nature of the stomach, which can absorb a supply of water sufficient to tide the animals over some days.

The Dromedary or one-humped camel of Arabia, *Camelus dromedarius*, is, like its Asiatic relative, essentially a creature of vast arid tablelands, and has been introduced into almost every sterile land where cheap transport is required. Like the other members of its race, the dromedary is of a morose disposition, and years of domestication have failed to elicit from it the slightest response or reciprocal attachment for those who tend it. Its powers of endurance and stoical fortitude can scarcely be exaggerated. In the East, for example, camels often patiently survive nearly a quarter-century of habitual brutality, overloading and the coarsest fare. In Arabia its principal ration is a meal ground from date kernels, whilst in Australia it has been found to be the only mammal which can derive nourishment from the spiney prickly-pear cactus.

Throughout Egypt and Arabia dromedaries are divided into many grades, those of the highest order being magnificent animals, which by careful selection and good treatment have acquired amazing speed and even powers of leaping. They form an essential branch of our military service. In mating-time the males fight savagely, and "camel fights" have for centuries been a popular Eastern sport.

The Bactrian, or two-humped camel, *C. bactrianus*, of Central Asia, is a much larger beast, having two humps and growing a dense coat of wool, which is shed on the approach of warm weather. No extremes of cold seem to affect it. It is widely used in Australia and in the semi-desert areas of America.

The Llamas (*Lama*) are animals about two-thirds the size of a camel, with less prehensile lips, no humps and protruding incisor teeth. Centuries of domestication have evolved endless colour varieties, the camels on the other hand showing few deviations from their usual sandy-brown tint. Like camels, llamas are valued in arid districts, where they are employed as beasts of burden, besides supplying wool, flesh and milk.

The Huanaco, *Lama huanacus*, and the Vicuna, *L. vicugna*, are

the wild representatives of the race. Both are much smaller than the domesticated breeds, and inhabit the mountains, steppes and open plains of South America (Peru, Chile, Patagonia, etc.). The Vicuna is the hardier animal, forming large herds in the most inhospitable areas of the Andes of Peru, Ecuador and Bolivia. These animals are as a rule shy, but domestication appears to develop latent aggressiveness. They attack with the front teeth, or by striking out with both knees simultaneously. The acrid saliva can be ejected to a considerable distance, and with accurate aim.

The Domesticated Llama, *Lama glama*, is domesticated in the Andes and elsewhere. As a beast of burden it may often be seen forming extensive "caravans", whilst animals "off duty" wander about the towns and villages in small companies, quite unattended. It is almost as unresponsive to human overtures as the camel, and like that animal expresses its emotions in a harsh scream, bubbling howls, or guttural grunts.

The semi-domesticated Alpaca, *L. pacos*, has long been famed for its valuable wool, and this, just prior to shearing-time, may form immense curtains, sweeping the ground on either side of the animal.

The Pigs (Family *Suidae*) are to-day confined to the warmer regions of Europe and Asia, though in a domesticated state they are known in almost every region of the world. In many countries escaped animals have established semi-wild herds. The leading characteristic of the race is the elongated head, the nose being protracted to form almost a short trunk. The hoofs are long and sharp, the skin covered with short close hair, the ears usually pencilled, and the tail abbreviated. The teeth are very complex, adapted to an omnivorous diet, whilst both upper and lower canines point upwards and may be developed into formidable tusks. Pigs of most kinds normally live in small herds known as "sounders", and there are generally three to four young in a litter, though domestication has made the farmyard pig one of the most prolific mammals, producing sixteen or more at a birth.

The domestic pig has probably been derived from the wild boar, and is to-day known by numerous breeds, of which the Tamworth most nearly approximates to the ancestral form.

The Wild Boar, *Sus scrofa*, is the European and Asiatic representative of a large group of closely similar animals, and is characterised by the very long head and crest of stiff bristles running from neck to withers. It has been extinct in England since medieval times, but an identical animal abounds in Northern France. It is a savage and courageous animal, offering

fight to all and sundry, with complete indifference to the size or armature of its foe. The almost identical Indian Wild Boar, *S. cristatus*, has been known even to face and defeat the tiger.

One of the most distinctive wild pigs is the Red River Hog or "painted pig", *Potamochoerus porcus*, so called from its vivid red-gold coat, long black ears and grotesquely marked face. It comes from West Africa, and is remarkably docile in captivity, being, like most pigs, highly intelligent.

The Wart Hog, *Phacochoerus aethiopicus*, is found from Abyssinia to the Cape, frequenting river-beds, in the banks of which it digs large tunnels. It is distinguished by its enormous head, embellished with large tusks and numerous bony protuberances.

The Babirusa, *Babirusa babyrussa*, owes its popular name to the Malay words "babi" and "rusa" signifying "pig-deer". The animal stands very high upon the legs and has an almost bare skin. The male is the possessor of enormously developed tusks which curve backwards over the head. These weapons form a sort of fencing mask, and aid the beast to make a passage through the dense rattan forests of Celebes, to which island the animal is confined.

The Giant Forest Hog, *Hylocherus meinertzhageni*, is the largest of the group, a male measuring six feet in length. It is found only in dense forests, and until 1936, when two living examples reached London, was known only by a few skins and skeletons. It was first discovered in 1904 in Kenya.

The Peccaries (Family *Tayassuidae*) of the New World are distinguished from the pigs proper by there being only three instead of four hoofs to the hind feet. Further, the stomach shows some of the complex features common to ruminants.

The White-lipped Peccary, *Tayassu pecari*, and the Collared Peccary, *Pecari tajacu*, are, like several other associated forms, found in South America from Brazil and Paraguay onwards. They are chiefly nocturnal, and travel in larger companies than most other members of the group. They are wild and aggressive, seldom consenting to be tamed. The various species readily interbreed in Zoological collections.

The Hippopotami (Family *Hippopotamidae*) are the most primitive and least specialised of the even-toed hoofed animals. Their former distribution is evidence that the world's climate was once far more uniform than to-day, for remains of these essentially tropical animals have been dredged from the river Thames. The race is now wholly confined to tropic Africa, notably the Nile valley and certain of the Great Lakes. Anatomically "hippos" are heavily built animals, with an almost naked skin, four toes upon each foot, and elongated heads with

the eyes, ears and nostrils so placed that these features can be kept above water when the rest of the animal is wholly submerged.

The Common Hippopotamus, *Hippopotamus amphibius*, has been well known since early times. It figures amongst the gods of ancient Egypt, and was "featured" in the Roman circuses. It is the larger of the two surviving species, an adult male standing about 4 feet 6 inches with a length of 10 feet, and a weight of 2½ tons. The canine and incisor teeth grow continuously throughout life, and are exaggerated to form formidable tusks, used for digging up and cutting the lush vegetation which constitutes the animal's sole food. A single young is produced, and the life span is probably forty odd years, many having lived over thirty years in confinement. Such hair as the animal possesses is confined to a few bristles on the tail, face and between the toes. The skin exudes a curious pink "sweat" which vividly colours parts of the face and body, eventually drying to a fine powder which can be rubbed off.

In spite of continuous persecution for its flesh, and the enormously thick hide and layer of "blubber", this species is still fairly common in the tropic river systems of Africa. It lives chiefly in a submerged condition, but comes ashore by night, when it not infrequently pillages crops. By nature it is a harmless and pacific animal, though showing great ferocity when molested. Many instances are recorded of its attacking and demolishing native canoes, with crews of twenty or more men, whilst unfortunate natives have even been bitten in half by the animal's sharp edged tusks, which may reach a length of a foot. Its voice ranges from a calf-like bellow to a terrifying roar. In the adult state it knows no enemies—apart from man.

The single calf is about the size of a bacon hog at birth. Although it can swim almost at once, it is frequently carried in infancy upon the maternal back. Although so long known to civilisation, the first example to reach Europe since Roman times did not appear until 1850, when one was presented to the London Zoo by H.H. Abbas Pasha, then Viceroy of Egypt. The animal's advent caused a sensation never since repeated. It had its own special attendant, and a small herd of cows and goats which supplied it with seven gallons of milk per day.

The Pigmy Hippopotamus, *Choeropsis liberiensis*, is less than a quarter the size of its better-known relative. It was practically unknown until the latter part of last century, and the first living specimen did not reach England until 1913. It breeds freely in captivity, and the Zoo now possesses quite a small herd of these creatures. The animals have thriven on the wide pastures provided at Whipnade, living in the open until the first autumn

frosts. Exposure has had the curious effect of lengthening such scanty hair as they display.

The Pigmy Hippopotamus is found only in the torrid heat of Liberia and Sierra Leone, where it leads a much less amphibious life than does the common species. It is in all respects less specialised, having a smaller head and tusks, and relatively long legs with widely separated toes. Although thoroughly at home in the water, it spends much of its time ashore, browsing in dense areas, often a considerable distance from water. It possesses but a single pair of lower incisor teeth.

XIV

MANATEES AND DUGONGS

Order *Sirenia*

THE *Sirenia* are large aquatic mammals, so completely adapted to life afloat that the body has become whale-like in form. The hind limbs are vestigial, whilst the tail is converted into a broad, flattened blade which propels the body forward by moving in a vertical plane. The skin is almost bare, its few scanty hairs often acquiring algoid growths. The fore limbs are reduced and flipper-like: they are used in guiding the beast over submerged rocks or, in the female, for clasping the single young to the breast. The eyes are small and the external ears reduced to pinholes. The lips are modified to form a powerful grasping organ, being divided into two lobes, which act like a huge thumb and forefinger, and so tuck sea weeds and other vegetable food into the mouth. The *Sirenia* show many anatomical features linking them with the elephants. Extinct forms possessed functional hind limbs.

To-day the group is represented by the Manatees (Family *Trichechidae*) and the Dugongs (Family *Halicoridae*). The former extend from Florida to South America, and make their appearance in the coastal waters of Africa, ascending the rivers of both continents. Manatees often rise waist high out of the water, and this trait caused them to be named "Sirens" by the ancients, who attributed to them a quasi-human origin. They gave rise to endless legends of mermaids, etc. Unlike their classic prototypes, manatees and dugongs are almost voiceless.

The Dugongs inhabit the Red Sea, and are chiefly distinguished from manatees by their bifurcated tail, larger size and the presence of two tusks in the upper jaw. Steller's Sea Cow, *Rhytina gigas*, measured twenty feet, or twice the length of the other members of the order. It was discovered in 1741, when it was abundant in the Bering Sea. Like its allies it was quite defenceless and highly edible, with the result that it was wholly exterminated within twenty years of its discovery.

Two manatees now living in the London Zoo show a low intelligence. They are prodigious feeders, each consuming fifty lettuces per day.

AFRICAN ANT-BEARS

Order *Tubulidentata*

THE Ant-bears (Family *Orycteropidae*) are known to-day by two closely related species, one found in South Africa, the other ranging northwards to Abyssinia. Fossil remains have been found in Greece. Unlike the true ant-eaters, the Aard Varks, as they are called by the Afrikanders, possess degenerate teeth without enamel crowns.

They are clumsily built animals, about as large as hogs, with all but naked skins, large sensitive ears, powerful tails, and big, curved claws with which they tear down the earthen strongholds of the white ant or termite. The tongue is long, whiplike and lubricated by enormous salivary glands. The animals are strictly nocturnal, and can dig tunnels in hard earth with amazing rapidity.

The ant-bear renders great service to man in its destruction of termites, but is unhappily subject to much persecution. Natives hunt it for its flesh and hide, whilst the single young is often open to attack by the python, which searches the parents' subterranean retreat in its search for this delicacy. At the Zoo, Aard Varks soon become tame and show a much higher intelligence than most animals of the nearly allied orders.

XVI

PANGOLINS

Order *Pholidota*

THIS order includes a dozen or more animals found only in Asia and Africa and comprised in the single family *Manidae*. All are distinguished by elongate bodies, covered above with large overlapping erectile and often spiny scales, composed of aggregations of hair. The tongue is whiplike, often three times as long as the animal's head and adapted for licking up insect prey, notably ants. Some species dig burrows with their powerful claws; others are arboreal, using the long tail as a prop or support on a vertical tree trunk. Asiatic species have a few true hairs scattered amongst the scales, relatively short tongues, and the ear represented externally by a fold of skin. African species are quite hairless, have mere pinhole ears, and enormous tongues, the roots of which are attached to the sternum. All pangolins are toothless.

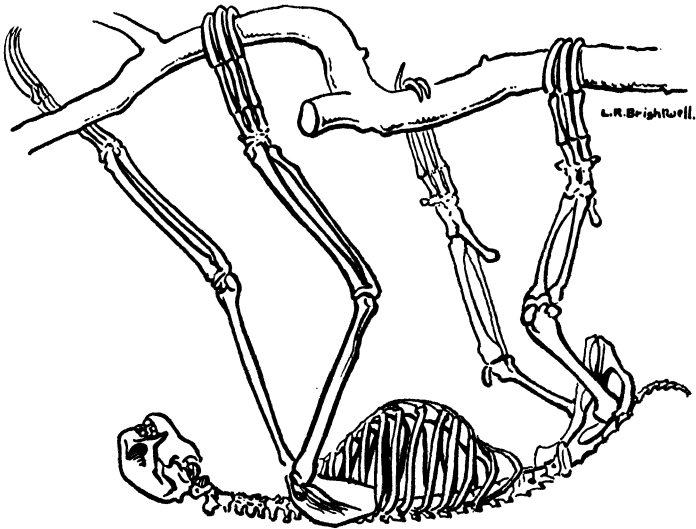
These remarkable mammals will attack even the dreaded hordes of the driver ant, being protected by their scales. They also make free use of certain "stink" glands situated near the tail, which eject an acrid fluid with great force. There is a single young at birth, which in its infancy frequently rides on the parental tail. The flesh is eaten, and the scales are in demand east of Suez as a "rejuvenator". The largest species, *Manis temminckii*, comes from Asia. It reaches a length of nearly two yards, and a weight of sixty pounds.

XVII

SLOTHS, ANT-EATERS AND ARMADILLOS

Order *Xenarthra*

THIS order comprises the sloths, ant-eaters and armadillos. Though diverse in shape, they agree in being without front teeth, whilst the molars grow throughout life, and are rootless. The order is confined to South America, and appears never to



Skeleton of Three-toed Sloth

have migrated further than the Southern States of Central America. Few species now reach a large size, though ground sloths and armadillos larger than oxen flourished until almost the dawn of civilisation.

The Sloths (Families *Choloepodidae* and *Bradypodidae*) are small animals, about as large as cats, found only in the densest jungles of Guiana and Brazil. The crippled-looking limbs are immensely elongated and tipped with large hooked claws, by means of which the animals climb tree branches in an inverted position: They never voluntarily come to earth—where they are all but helpless—but are powerful swimmers, and habitually avail themselves of the endless waterways of the Amazon basin. They live almost exclusively upon leaves. The long greenish-brown hair blends with the moss-covered tree-tops; it further acquires a growth of minute vegetation, which adds to the

wearer's effective camouflage. Sloths, like most of the order, produce but one at a birth. They are broadly divided into two-toed and three-toed species, of which the most notable are the Common Two-toed Sloth, *Choloepus didactylus*, and the Three-toed Sloth, *Bradypus tridactylus*. Scent glands are often present between the shoulder-blades.

The Ant-Eaters (Family *Myrmecophagidae*), though in striking contrast to sloths, agree in their reduced dentition. Like the ant-bears and pangolins they are exclusively insectivorous, attacking, however, only the relatively unarmed termites or white ants. All are confined to South America. They produce a single young at birth, which is carried for a time on the back of the female. The long-snouted Great Ant-Eater, *Myrmecophaga tridactyla*, of the swampy forests of Brazil reaches the size of a Malayan sun-bear, and is strikingly figured with black and white. The immense, almost overwhelming, hairy tail serves as a shelter from sun or tropic rain.

The Tamandua, or Lesser Ant-Eater, *Tamandua tetradactyla*, is not larger than a cat, has short yellowish-red hair, and is strictly arboreal—its long prehensile tail forming an effective climbing organ. The Little Two-toed Ant-Eater, *Cyclopes didactyla*, is similar in build to the above but is not larger than a rat. It has a relatively short head, and two toes only on its forefeet.

The Armadillos (Family *Dasypodidae*) are small animals in which the body is protected above by overlapping bony scales or plates. The dorsal armour is usually divided into a head-shield, a shoulder-shield and a rear-shield, the two last named being separated by movable transverse bands, enabling the creatures to roll into a ball on alarm. Prehistoric species, one roaming the Pampas, had the carapace in one piece, like that of a tortoise. Some ancestral forms exceeded the largest "giant" tortoises, and had the tail terminating in an enormous club set with strong spines.

Living armadillos have pointed heads and jointed armour, varying much in the score or so of species recognised. All have small ears, reduced teeth and whiplike tongues for licking up insect prey, though worms, molluscs, etc., are also taken. Their bodies are separated into twelve movable bands. The entire group is confined to Central and South America. The species frequent open country and dig deep burrows with their powerful claws. The Giant Armadillo, *Priodontes gigas*, of Surinam reaches a yard in length, but the other species are much smaller.

XVIII

POUCHED ANIMALS

Order *Marsupialia*

THE Marsupials are mammals provided with a pouch. This receptacle for the young marks a more primitive manner of bringing offspring into the world than that in vogue with the placental mammals, and has possibly militated against the general advancement of the order, now almost wholly confined to Australia. Fossil remains show that allied creatures once flourished elsewhere, but to-day the only non-Australasian marsupial is one in South America. In the not very remote past the Marsupials, like the sloths, armadillos, etc., were represented by giant ancestors, both herbivorous and carnivorous, some rivalling a rhinoceros in bulk. The order appears to have become segregated in the Australasian region at a comparatively recent date, where, immune from the fiercer competition of the Asiatic mainland, it developed to the utmost its own peculiar features. Some marsupials have mimicked the large herbivores of Asia and the New World, others have developed on carnivorous lines. Some are purely arboreal, others are burrowers, and others again are almost wholly aquatic. Lack of competitive stimuli may be responsible for the relatively feeble brain of all members of the order.

The Kangaroos (Family *Macropodidae*), known by several score species, are the best known of all marsupials. They are characteristic of the group. They range in size from animals standing five feet and over to forms no larger than rats, but all show a remarkable similarity of build.

Being exclusively herbivorous, they rely for safety upon speed, to which end the hind limbs are immensely exaggerated. The tail is developed to form a counterpoise when progressing in a semi-erect posture, and also to form a support when seated. If "cornered" a kangaroo can rest on the tail alone, and strike out with both hind feet simultaneously. The fore limbs, though small, are efficient grasping organs. As in all marsupials they bear five digits on the front feet, whilst the hind extremities have four only, two being reduced in size and confined in a single sheath of skin. The front teeth of the kangaroos are remarkable in that there are from two to six in the upper jaw but two only in the lower. These have knife-like edges, and, being movable, serve as a pair of shears for clipping the grass on which the animals chiefly feed.

The production of the young was for long a mystery and has been only recently elucidated. The single offspring of a kangaroo is born in the open, when even in the largest species it is under an inch and a half long and is blind and naked. It is left to make its way on knees and elbows up the maternal abdomen, fighting its way along a tract of hair licked smooth by the mother until it finds the pouch. This it enters and attaches itself to one of the two nipples therein. The end of the nipple swells into a bulb within the infant's mouth, holding it firmly in position. A baby kangaroo can generally face the open when some six months old, often, however, repairing to the "pram pocket" when danger threatens.

The inroads of agriculture, etc., have done much to restrict the movements of kangaroos wherever they occur. Vast numbers have been killed for food, fur, etc., and few farmers tolerate them owing to the havoc they wreak upon crops and fencing. It may be mentioned the name 'kangaroo' is believed to have originated when Captain Cook's followers, demanding of the natives what they called the strange animal, were answered by "kangaroo?" *i.e.* "what do you mean?" or "I don't understand you."

All the smaller species of kangaroo are designated "wallaby", and to be "on the wallaby" is polite Australian term for "unemployed", *i.e.* wandering at large. A baby kangaroo of any species is termed a "joey", and a giant kangaroo as an "old man boomer".

The largest member of the genus *Macropus* is the Giant Kangaroo, *Macropus giganteus*, formerly found in all forest-covered Australia save the centre and north. This is the "boxing" kangaroo still popular with showmen. Its "boxing" movements are, of course, quite unintelligent, its normal defence being a forward kick. A large animal thus defending itself can disembowel a man.

Adapting themselves as they have to all types of country, the kangaroos provide a remarkable instance of meeting extreme conditions. Tree Kangaroos (*Dendrolagus*) are represented in New Guinea and Queensland, where they frequent mountain country covered with tall pine and other trees. The animals are less extravagantly modified than most kangaroos as regards the disparity between fore and hind limbs. They can climb with remarkable celerity, ascending the highest trees, and show a goat-like indifference to dizzy heights and precipitous crags. They are usually docile in confinement, and at the Zoo have formed amusing partnerships with various apes and monkeys.

The Rat Kangaroos (*Bettongiam*), which have a wide distribution in Australia, show great agility and are remarkable for

their long prehensile tails. They are the size of rabbits and live in nests made of grass. These nests they carry about from one place to another by means of their tails.

The Phalangers (Family *Phalangeridae*) or Australian opossums are cat-sized animals with squirrel-like heads and sturdy limbs, all the feet having five toes, whilst the tail is long and generally prehensile. They are nocturnal, arboreal animals feeding on fruit, eggs and honey, which last is sipped by means of the long tongue.

The Flying Opossums (*Petaurus*) have a wing-like expansion of skin stretching from wrist to ankle on either side of the body, which enables them to execute long, flying leaps. Like many of the smaller marsupials they produce several young at a birth, which are at first carried in the pouch, but later on the parental back. They come from Queensland.

The Koala, or "native bear", *Phascolarctos cinereus*, is the sole representative of the family *Phascolarctidae*. It once abounded in the extensive eucalyptus forests of Eastern Australia. This attractive animal is about the size of a cat, of stout chubby build, with powerful claws, and a dense coat of wool. The latter feature virtually caused its extermination at the hands of fur dealers until the few surviving animals were, some years ago, made the nucleus of the now famous "Teddy-bear Park" near Sydney. This institution, founded by two Englishmen, is it is hoped going to reinstate the animal.

The Koala feeds exclusively upon eucalyptus or "gum-tree" leaves, being able to subsist only on the leaves of two or three species out of over two hundred kinds known to botanists. It climbs the highest trees, methodically clearing one branch of shoots before proceeding to another. It is unique in having the longest vermiform appendix of any known animal. It bears a single young, which is carried upon the maternal back until almost of adult size. Owing to its peculiar diet it is difficult to keep the creature outside its own country.

About 200 specimens are now living at the Koala Park. In 1927 the fur trade slaughtered 584,738 adult and over 200,000 infant animals within a month!

The Wombats (Family *Phascolomiidae*) or pouched bears are small marsupials which have developed upon entirely different lines from the kangaroos, the arboreal phalangers and the koala. They are essentially ground-dwellers, heavily built, and walking, bear-like, on the soles of the feet. The largest of the four species about equals an Airedale terrier in size. All are confined to Tasmania and Australia, South of the Tropics. In Australasia

they hold the position which in other lands is held by the burrowing rodents. There is a single young at a birth, produced in a deep subterranean burrow which the parents excavate. Wombats are nocturnal, subsisting on roots, etc., and are quite inoffensive. The voice is a low growl. At the Zoo, these animals often make docile cage mates for other creatures which need company.

The animals of the family *Peramelidae* are commonly known as Bandicoots, and together with all the remaining marsupials are distinguished by having more than one pair of teeth in the lower jaw. The Bandicoots are small animals with pointed noses, large ears and fairly elongate hind limbs. The true Bandicoots (*Paragalina*) are found in Tasmania, Australia, Papua and neighbouring islands. They are the most numerous of all Australasian carnivorous mammals, feeding chiefly upon earthworms. The best known is the common rabbit-eared Bandicoot, *P. lagotis*.

All the members of the family *Dasyuridae* are strictly carnivorous, and often mimic the better-known carnivores of the Old World mainland. The second and third toes are not united, and the pouch, when present, opens downwards and forwards.

The black-haired, short-legged Tasmanian Devil, *Sarcophilus harrisii*, is exclusive to Tasmania, where civilisation is fast banishing it to the less accessible mountain regions. Though only about the size of a cat, this animal is far more powerful and destructive. The head is proportionately large and the massive jaws are used with devastating effect upon fowls and sheep. There are several young at a birth. The voice is an unearthly yell.

The Tasmanian wolf, *Thylacinus cynocephalus*, is the largest marsupial carnivore. It is about the size of a collie dog, and inhabits similar country to the Tasmanian Devil. It is even more destructive than the "Devil". Its coat is brown with a number of broad, dark stripes on the rear part of the body, and its voice is a husky growl or coughing bark. It formerly inhabited the mainland of Australia.

The so-called "Native Cats", *Dasyurus*, are small rather weasel-shaped marsupials of savage disposition and arboreal habits. The Viverrine Cat, *Dasyurus viverrinus*, and the Tiger Cat, *D. marcourus*, live partially on insects, though taking heavy toll of birds and their eggs. Both are distributed throughout much of Australia and Tasmania. They are conspicuous by their brightly coloured coats, having patterns of white spots.

The Pouched Mice (*Phascogale*), known by a dozen species, are chiefly arboreal and insectivorous. The largest species equals a rat in bulk.

The typical Opossums (Family *Didelphiidae*) are confined to America. The pouch, when present, is usually represented only by two folds of skin. The numerous young are carried on the parental back, where they maintain their equilibrium by wrapping their prehensile tails round that of the female.

The Common Opossum, *Didelphis marsupialis*, is typical of the group. It is about the size of a cat, with pointed head and long, bare tail. The creature's agility is remarkable and its cunning scarcely less so. It has indeed given rise to a common Americanism, "playing 'possum'", *i.e.* keeping quiet under trying circumstances, from strategic reasons. An opossum, apparently mortally hit and left for dead, will rise up and make for safety once it feels the road is clear, and this, though it has sustained injuries which would prove fatal to most animals. Opossums are virtually omnivorous, but prefer a flesh diet, and do great damage amongst poultry runs. A score or more species are known. Some of the smallest kinds are little larger than mice, and frequently come to this country from Jamaica as stowaways amongst bunches of bananas.

The remarkable Yapock, *Chironectes minimus*, or water opossum of Brazil has a completely developed pouch and webbed hind feet. It is entirely aquatic, subsisting upon fish.

The Marsupial Mole, *Notoryctes typhlops*, is generally mole-like in build, and is amongst the few creatures inhabiting the Central Australian desert. It is of a pale golden colour, and the eyes and ears are almost buried in the dense fur. The creature digs long horizontal burrows in the burning sand, where it feeds almost exclusively upon ants. It is seldom seen at the surface.

XIX

EGG-LAYING MAMMALS

Order *Monotremata*

THE Monotremes derive their systematic title from the Greek word meaning a "single aperture", in reference to the genital and excretory organs having a common outlet. Such a feature in a mammal implies a very primitive organisation, and the general structure of the living monotremes has gone far to justify the now generally accepted thesis that both mammals and birds originally owed their being to a reptilian ancestry. These animals are distinguished by laying eggs.

There is no evidence, fossil or otherwise, that the monotremes have existed outside the Australasian region, where to-day they are confined and owe their continuance to their unobtrusive habits and capacity to hide in deep burrows secure from foes. The group is divided into two families, the *Ornythorhynchidae*, and the *Tachyglossidae*.

The sole representative of the former is the Duck Mole, Duckbill, or Platypus, *Ornythorhynchus paradoxus*, now found only in Australia, though once occurring also in Tasmania. In its present habitat it is now rigorously protected, specimens only being allowed to leave the country to grace *bona fide* zoological institutions. The only Duck Mole seen in captivity outside Australia was one sent to the New York Zoo some years ago, where it survived a few weeks only.

The animal presents the outer characters of an otter, though with a shorter body, a flattened tail, a duck-like muzzle, and webbed feet. Young animals show rudimentary teeth, but these are discarded in adolescence. In the male, each hind foot bears a large curved spine, which is hollow and connected with a poison gland. Whilst the glandular fluid is highly irritant, its use is believed to have also some sexual significance. The animal's natatory powers are considerable, and experiments have shown that although there are no external ears, it is highly sensitive to vibrations. Upon the slightest disturbance of the water, it will at once deflect its course. The dense fur is quite impervious to water, which fact, combined with its rich texture, formerly led to the creature's wholesale destruction at the hands of fur dealers. Duck moles frequent the obscurer rivers, rivulets and forest streams, feeding exclusively on molluscs and various small shrimp-like crustaceans. For the capture of such prey the duck-like mandibles are perfectly adapted, a thick leathery "guard" surrounding the base of

the bill, and protecting the animal's eyes when delving in deep mud.

The retreat of this animal consists of a long and complex series of subterranean galleries leading to a central chamber in which a rude nest is constructed. There are exits and entrances above and below water-line, these being closed with plugs of mud when the creature retires for any length of time. In the spring the female produces two whitish eggs which are brooded, like a bird's, in the nest, the marsupial-like pouch of the parent being too small for their reception. Within the pouch, however, are situated the mammary glands, which exude milk through innumerable minute openings in the spongy abdominal wall. The young are thus suckled for some time, until large enough to take solid food, which is brought to them by the parents, who carry snails, shrimps, etc., packed in their capacious cheek pouches. Duck moles are chiefly nocturnal, sleeping by day, rolled into a ball, with the tail wrapped round their bodies.

The members of the family *Tachyglossidae* are represented by the Echidnas or Spiny Ant-eaters, and they are divided into two closely related genera—*Tachyglossus* and *Zaglossus*. The group is distributed throughout Australasia, the first genus being found in South-Eastern New Guinea, Australia and Tasmania, the second in Papua.

The best-known species, *Tachyglossus aculeata*, is typical of the entire family. It is a clumsily built animal, weighing about 20 pounds, with stoutly clawed limbs, a beak-like muzzle, and a thick skin covered with strong spines intermingled with coarse hair. The eyes are very small, and the large ears have no external structure, but are each covered with a flap of skin, like those of an owl. The tongue is long and whip-like, adapted for licking up insects which adhere to its covering of viscid saliva. The hind feet are twisted backwards, so that the animal shuffles along on the palms of its "hands" and its insteps. Echidnas are exclusively nocturnal, digging with their strong claws deep burrows in which they hide by day. No ground appears to defy their excavating powers, the common species being especially abundant in arid mountain areas where the earth is baked by a sub-tropic sun. In feeding the insects are licked up with great speed, and escape is made impossible by sharp spines on the tongue and palate, a feature also seen in various birds.

The female produces a single egg, about the size of a pigeon's, and this is carried about in the pouch which is much more distensible than that of the duck mole. Echidnas generally are more intelligent animals than the latter, having large and well convoluted brains. Though non-aggressive, these animals are

well able to defend themselves. If attacked, an echidna rolls itself into a ball, the consequent tightening of the skin causing the spines to stand erect, and presenting a formidable defence.

In menageries, the echidna makes an unsatisfactory exhibit owing to its nocturnal habits, though disclosing many interesting features of its general economy. "Daydream," a New Guinea specimen that lived at the Zoo over thirty years, enjoyed climbing up the wire front of a tall monkey cage. Arriving at the ceiling some twenty feet above ground, Daydream would "let go" and fall to the stone flags below, curling into a ball in transit, and arriving without apparently suffering any inconvenience, since it at once embarked upon another laborious ascent. Amusingly enough, Daydream was scheduled and regarded as a male until, after twenty years of residence, "he" surprised the Zoo authorities by presenting them with an egg.

XX
BIRDS^v

A BIRD may be briefly summarised as a warm-blooded vertebrate, covered with feathers, having the fore limbs modified into wings, the jaws covered with horny sheaths forming a beak, and producing its young from eggs. Living birds are known by about thirteen thousand species, divided into over a hundred and fifty families.

The faculty of flight, which characterises the majority of birds, is due not only to the indispensable wings but to other modifications. The bones are hollow, and can be filled with air from the lungs. It is this lightness of construction which is partly responsible for the presence of only very scanty fossil remains. As a result, our knowledge of the race's evolution is less complete than that of the mammals'. It is established, however, that birds are undoubtedly derived from reptilian stock, the egg-laying habit, combined with numerous structural features shared by birds and the geologically much older reptiles, justifying this view.

The first recognisable birds appeared in the Jurassic epoch about 150 million years ago, and are known by two skeletons only, found in Bavaria. One of these, known as *Archaeopteryx*, was contemporary with the huge dinosaurs, "flying dragons" and other monsters of the "age of reptiles". It was about the size of a domestic fowl and was not unlike it in general shape. The chief distinctions were the presence of teeth in the beak, three clawed "fingers" on the "knuckle" of each wing, and a long lizard-like tail. The wings bore characteristic feathers, whilst the tail carried a single row of feathers on either side, and was more lizard-like than the characteristic fan-shaped tail of living birds. Between this crude foreshadowing of the avian form and modern birds is a limited series of fossil forms, which show a gradual development of the accepted avian structure. Many of the early and largest birds attained to huge size only by sacrificing the capacity to fly. The power of flight is commanded by certain mechanical limitations, beyond which no creature has been able to develop, otherwise flying animals would literally possess the earth. A weight of forty to sixty pounds—as seen in the condor—apparently marks the carrying power limit by wings alone.

Apart from their egg-laying habits, birds show reptilian affinities in the general structure, and particularly that of the eye and heart. The eye, like that of a lizard, is supported by a series of bony plates arranged and moved precisely like the

“diaphragm” of a camera, and commands a telescopic vision not enjoyed by any other creatures. Hearing is acute, though there is no external ear, the auditory opening being hidden by feathers.

Feathers, apparently so unique, are in reality a natural development of scales, split into innumerable fine strips which interlock, giving great strength and air resistance combined with the minimum weight. They also serve to retain body heat even more than does fur, and this again is a factor enabling birds to endure the extreme cold met with when swimming and flying at high altitudes. An important feature in the care and preservation of the feathers is the presence of oil glands situated at the root of the tail. These can be “tapped” by pressure from the bird’s beak and the oil so released transferred to the plumage. Cold is further withstood by the high body temperature, which may attain to 112° F., as in the swallow, and averages from 8° to 12° above that of mammals.

Mentally birds stand midway between mammals and reptiles. Like the former, their intelligence can be improved by contact with man, and even in the wild often show an “aesthetic” sense unknown in mammals. As regards courtship, most birds find obvious expression in song, bright colours and even architecture of a kind. The colouring of a bird’s feathers is due to pigment as regards yellow, brown, black or red. Green—save in touracos—and blue are formed chiefly by refraction of the light from divers structural layers in the feathers, as are also the wonderful metallic hues so often observable.

Lightness is the keynote of avian structure, and much of it is due not only to the large, spongy lungs, but various air sacs that in some species may be exaggerated to form large external ornaments, or, as in the case of the skylark, to augment the voice.

Birds have colonised almost every part of the earth, even contriving to exist within appreciable distances of the poles or in the centre of waterless deserts. The majority are migratory, relatively short flights, involving no overseas travel, entitling a bird to be considered as “resident”. Long seasonal flights are, however, the rule, and innumerable regular air routes were favoured by many species millions of years before the advent of adventurous man. Migrations are at all times “hunger flights”, and immense distances are thus imposed upon many species twice yearly.

The economic value of birds has from early times been of the utmost importance to man. Not only do they provide food, covering and adornment in endless variety, but yield innumerable by-products, notably guano. In maintaining the balance

of nature, and assisting agriculture by destroying noxious insects and distributing seeds, they are similarly all important to world welfare. It is this latter consideration which, during the last few decades, has given rise to the various bird-protection societies, etc., in which work Britain and America have been prime movers.

Birds are classified, like the mammals, in an ascending or descending scale, with the most highly specialised, or truly avian, at one extremity, and the more primitive forms at the other. Living birds are embraced in the single sub-class *Neorinthes*, which is divided into two sections, the *Ratitae* and the *Carinatae*.

OSTRICHES, EMUS, CASSOWARIES, ETC.

Section *Ratitae*

IN this Section is included the largest living birds, most of which are flightless. Living examples are now confined to Africa, the Papuan Islands, Australia, New Zealand and South America, but at one time they were much more widely distributed.

The best known of the group are the Ostriches, now typical of Africa and Arabia. The "common" or South African Ostrich, *Struthio camelus*, is the largest living bird, an adult male standing eight feet high and weighing two hundred pounds. The toes are reduced to two, and the wings, though useless for flight, aid the bird in running and are also used as fans in hot weather. The male bird is polygamous, and his several wives deposit between them about thirty eggs in a shallow pit in the sand. Here they are incubated by the male over a period of seven weeks. A single egg is equal to a dozen hens' eggs. "Nursing fathers" are the rule amongst all the *Ratitae*, the males' duties being chiefly requisitioned at night, since the sun's heat by day is sufficient to keep the eggs warm. Ostriches are still in some demand for their tail and wing plumes, and are farmed both in Africa and Australia. The intelligence of the birds is exceedingly low, but the old story of the ostrich putting its head in the sand when danger threatens may be discredited. The ostrich usually seeks safety in running at high speed, but may attack in the breeding season. On ostrich farms it is usual to keep a dangerous bird at a distance by means of a long pole with a bunch of thorns at the top. This is held beneath the bird's "chin", where the skin is thin and sensitive. During the "plume boom" ostriches were plucked every six or nine months. Since the "slump" large numbers have been killed for food. A single leg will weigh twenty to forty pounds. In the breeding season the cock ostrich roars so loudly that its voice has been mistaken for that of a lion.

The Rheas (Family *Rheidae*) are ostrich-like birds, distinguished by having three toes on each foot. Until early historic times they were represented in New Zealand and Madagascar by flightless birds of gigantic stature. These extinct birds stood fully ten feet high and laid eggs of two to three gallons capacity. The living rheas are confined to South America, where they are farmed for their flesh and feathers, the latter being used for making mops, dusters, etc. Nidification is con-

ducted on lines similar to that of the ostrich. Prior to mating, the male birds indulge in grotesque courting displays and fight vigorously with rival suitors, the belligerents intertwining their long necks, and also kicking and biting.

The Emus (Family *Dromiceidae*) are the Australian representatives of the ostrich tribe, and, like the rhea, have three toes on each foot. As with most members of the section, *Ratitae*, the young are vividly marked with dark stripes on a light ground. Emus are of little commercial value, and are fast being decimated owing to the damage they do to crops and fencing. Both sexes have a capacious pouch-like distension of the windpipe enabling them to emit a loud booming note. Like the rheas they are very hardy, and have been extensively bred in zoos and private parks. The eggs are dark green in colour.

The Cassowaries (Family *Casuariidae*), represented throughout Australasia by about a dozen species, are large birds with coarse, black, hair-like feathers, the wing feathers being reduced to a few stout spines, and vividly coloured wattles of blue, red and yellow. The inner toe of each foot bears a huge nail which can prove a dangerous weapon, especially as the birds are by nature pugnacious and aggressive. Cassowaries inhabit dense bush, and occasionally water-courses, where they indulge in a unique form of fishing. They have been known to enter the water and, after some time, walk ashore, where they shake out their feathers and devour small fish, crustacea, etc., that have become entangled in them. The group is at once distinguished by the high bony crest surmounting the head.

The Kiwis (Family *Apterygidae*) are the smallest of the *Ratitae*, being not much larger than domestic fowls. There are three toes on each foot, with a small hind toe or "hallux". There is no visible tail, and the wings are so small that they are concealed by the feathers. The beak is long, thin and curved, with the nostrils at the tip, and is used to probe the earth for worms, which form the chief food. The four or five species known are confined to New Zealand, where the birds are found chiefly in dense bush on the mountain slopes. Here the male constructs a burrow with a rough, grass-lined cavity at the extremity, wherein the hen lays one or two white eggs, equal to a quarter of the bird's size. These are incubated by the male. Being much esteemed as food, and having no other means of defence save running for cover, the kiwis are fast approaching extinction.

The Tinamous (Family *Tinamidae*), though classed with the

ostrich-like birds, have keeled instead of flattened breast-bones. They are small and partridge-like in general form, and though well able to fly are essentially ground birds, running at high speed. The best known of the sixty odd species is the Rufus Tinamou, *Rhynchotus rufescens*, which is hardy and has been successfully acclimatised in England. All the tinamous are confined to Mexico and Central and South America. From four to sixteen eggs are laid in a rough declivity scratched in the ground. The eggs are remarkable for their porcelain-like polish and varied colours, which, according to the species laying them, may be red, chocolate, purple, dark blue, blue green, or even primrose.

CARINATE BIRDS

Section *Carinatae*

THIS Section includes all other existing birds. They are distinguished—with few exceptions—by having a well-formed and keeled breast-bone, and being capable of flight.

The Order *Galliformes* includes all the “game” birds, typified by such well-known forms as the domestic fowl, turkey, partridge, etc. They have short arched bills, long tails and broad wings. They are active on the ground and fly heavily.

The Mound Builders, or Brush Turkeys (Family *Megapodiidae*), are large turkey-like birds from the Moluccas and South and West Australia. They build, either singly or in large companies, mounds of leaves which are scraped together by the males, and in which the hens lay their eggs. One bird can accumulate a heap many yards in circumference, and weighing over five tons. The male superintends the incubation, using his bare neck as a thermometer and adding or removing debris as required. The young are fully feathered when hatched. They struggle through the debris to freedom, and at once care for themselves.

The Currassows and Guans (Family *Cracidae*), though similar to the Mound Builders in general form, build nests in trees or bushes and incubate the eggs in normal fashion. The nestlings emerge covered with down. They are all found in Central and South America. Some forms have wattles on the throat or sides of the head.

The Pheasants, Partridges and Quails, etc. (Family *Phasianidae*), are world-wide in habitat. They are ground builders and very prolific, some North American partridges laying up to thirty-seven eggs. To this family belong the Guinea Fowls and Turkeys, the last well known by the domestic turkey introduced to us from America in the 16th century. For many centuries prior to its arrival in Europe the turkey was semi-domesticated in America. Prince Montezuma, ruler of the ancient Aztec civilisation in Mexico, fed the many animals in his private zoo entirely upon turkeys, so common were these birds.

The innumerable strains of domestic poultry are derived from the Indian jungle fowl, *Gallus gallus*, which is still used for cockfighting, much as was the Indian gamecock in this country.

Grouse, etc. (Family *Tetraonidae*), have a wide range, ascending to great altitudes in mountain districts and even living in deserts, where they subsist entirely without water. They are peculiar in having the nostrils covered with feathers, while, in some forms the legs, too, are completely feathered. Some, like the Black-game of this country, gather together for remarkable parades in the mating season, the males indulging in grotesque posturings and dances.

The Doves and Pigeons (Family *Columbidae*) are known by about 450 species. Innumerable domestic strains have been derived from the wild Rock Dove, *Columba livia*. Pigeons range in size from that of a thrush to a domestic fowl, some breeds being arboreal, others purely terrestrial. To the latter order belonged the flightless Dodo, once common in Mauritius and finally exterminated in the 17th century. The Tooth-billed Pigeon, *Didunculus strigirostris*, of Samoa is remarkable in that, like the Dodo, it was terrestrial; it became almost extinct in 1870. Now, however, as a result of adopting an arboreal life it is once more on the increase. Pigeons, although associating in flocks, are supposed to be monogamous. Their eggs are laid in nests formed of sticks, or on the ground.

The Rails, Moorhens and Coots (Family *Rallidae*) are birds adapted to life in dense undergrowths, some forms being semi-aquatic. They occur almost all over the world. Our native Corncrake, *Crex crex*, is a typical example, whilst a characteristic aquatic form is the common Water Rail, *Rallus aquaticus*.

The Grebes (Family *Podicipidae*) are not unlike Rails, but all are purely aquatic and have the toes remarkably flattened to serve as paddles. Five species occur in Britain, the largest being the Great Crested Grebe, *Podiceps cristatus*.

The Divers, or Loons (Family *Colymbidae*), are handsome Northern aquatic fish-eating birds of somewhat duck-like form, but with pointed compressed beaks. The body and neck are long, and the short and flattened feet are placed far back. Several species visit our shores, notably the great Northern Diver, *Colymbus immer*, which can stay under water in pursuit of fish for some minutes at a time.

The Penguins (Family *Spheniscidae*) are confined to the Southern hemisphere, reaching the equator only on the Galapagos Islands off the West Coast of South America, their northernmost limit.

Penguins, of which there are twenty species, are the most

heavily built of all birds in proportion to their size, the Emperor, *Aptenodytes forsteri*, standing three feet, and weighing over fifty pounds. They live solely on fish, and display wonderful powers of swimming and diving. Breeding principally on barren rocks or icy shores, little attempt is made at a nest. The smaller kinds incubate the one or two eggs in the usual way, both sexes participating alternately. The Emperor and also the King Penguin, *A. patagonica*, incubate their one egg whilst standing erect, the egg being held in a fold of skin between the abdomen and instep. When one partner desires a rest, it calls its mate, and the egg is transferred from one to the other by a dexterous movement of the ankles. Penguins often congregate in vast numbers, and appear to drill in almost military fashion when assembling for seasonal migrations. The voice of most is a harsh bray or shrill whistle. They are peaceable birds, seldom quarrelling, and willingly adopt any fledglings which may have become orphaned. Courtship resolves itself into grotesque bowings and similar gestures.

The Petrels (Family *Procellariidae*) and Albatrosses (Family *Diomedidae*) are purely oceanic, and come ashore only at nesting-time, when the eggs are laid in a shallow declivity. They have stout hooked bills. A well-known petrel is the common "Mother Carey's Chicken" or Stormy Petrel, *Procellaria pelagica*. The giant of the race is the famous Wandering Albatross, *Diomedea exulans*, which is almost as large as a turkey and has a wing span of eleven feet. Albatrosses and petrels live mainly on crustaceans and cuttlefish, or floating carrion of a fatty nature. The young are fed by their parents on regurgitated food and by squirting oil from the mouth down the infant's throat. Some petrels, such as the Shearwaters (*Puffinus*) nest in rudely constructed burrows.

The marine Auks, Razorbills and Puffins (Family *Alcidae*) suggest penguins in general form, the appearance, however, being superficial. They are confined to the Northern Hemisphere, living and nesting on precipitous cliffs. All are expert swimmers and divers, and like the penguins use their wings to literally "fly" through the water. The Great Auk, once common round Iceland, became exterminated in 1844, and to-day hundreds of pounds are paid by collectors for stuffed skins or eggs. The Common Puffin, or Sea Parrot, *Fratercula arctica*, is found all round our coasts. It nests in disused rabbit-holes, and in spring the male bird wears a vivid red and orange covering to its large triangular beak, which is later shed.

In the Gulls and Terns (Family *Laridae*) the plumage in the adult is usually grey above, white below. The young are mottled

with brown. Our native Common Tern, *Sterna hirundo*, has long straight wings. Like all terns it has a swift and graceful flight. The nest is a mere hollow amongst sand or stones, and the eggs, like those of all sea birds, perfectly blend with their surroundings. The terns seldom settle on the water, but gulls frequently do so.

The Waders (Family *Charadriidae*) include also the short-billed, long-legged plovers, snipes and sandpipers, phalaropes and woodcocks. All are heath or marsh-loving birds, with mottled plumage that blends with their surroundings. As with most birds that make little or no nests, the young can look after themselves almost as soon as hatched. To this family also belong such British species as the Godwit, Curlew, Oyster Catcher, Turnstone, Dotterel, Avocet and Stilt.

The Coursers (Family *Cursoriidae*) are plover-like birds inhabiting Europe, India and Africa. The Black-backed "Plover", *Pluvianus aegyptius*, is also known as the Crocodile bird. It fearlessly enters the open mouths of crocodiles as they lie basking and rids the reptiles' gums of leeches, etc.

The Pratincoles (Family *Glareolidae*) are allied birds, one of which, *G. pratincola*, sometimes lands on our shores during migratory flights. They are insectivorous and have a swallow-like flight.

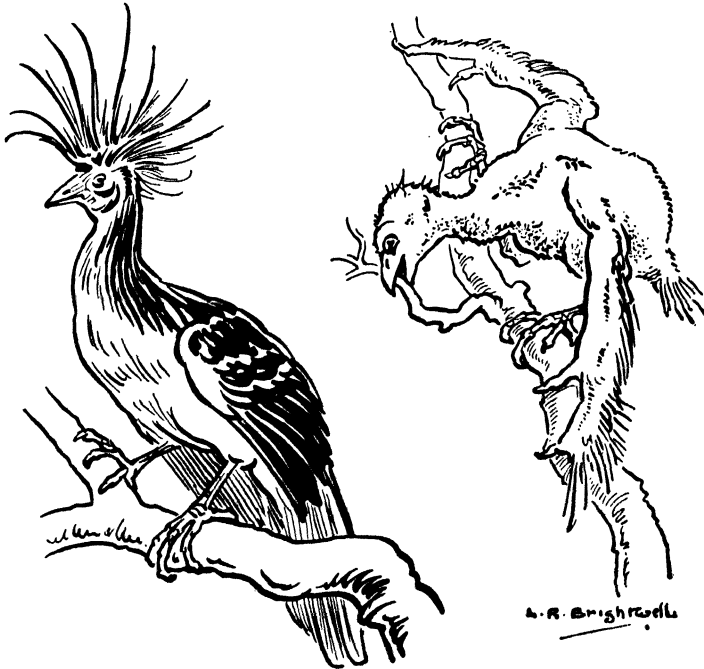
The Jacanas (Family *Jacanidae*) are aquatic, though looking like plovers. They have extraordinarily long toes with long claws. By means of these they run over the leaves of the large aquatic plants covering the lakes in most tropic lands of both hemispheres. Their nests, consisting of water-weeds, are built on floating plants.

The Stone-Plovers, Stone-Curlew, or Thick Knees (Family *Burhinidae*), are long-legged, large-headed plover-like birds living on open wastes. One, the so-called "Norfolk Plover", *Burhinus oedicephalus*, is a summer visitor to some English counties.

The Bustards (Family *Otididae*) are big turkey-like birds typical of the Old World. The Great Bustard (*Otis tarda*) was once common in Norfolk, and was a regular food supply of all classes, but became extinct less than a century ago. The cock bird has feathery moustaches, and in courting performs grotesque antics, the tail being folded upon the back and the wings crossed above it.

The Hoatzin, *Opisthocomus hoazin*, the only member of the family *Opisthocomidae*, lives in the dense forests of the Amazon.

The adult looks not unlike a guinea-fowl, with a grotesque crest. The bird lives chiefly upon leaves and eats vast quantities, the breast-bone being curiously modified to accommodate the enormous crop. The bird develops a very unpleasant odour after death and is known as "Stinking Hannah". It is clumsy on the wing, but extremely active in many ways as a nestling. In all other birds the "fingers" of the wing, as stated in the introduction, are functionless save as supports to the feathers. In the



Hoatzins: Adult, and Young climbing by means of clawed wings

young hoatzin, however, they bear well-developed claws, and form effective grasping organs, so that the bird, using feet, wings and beak together, can scramble about the tree branches almost as actively as a monkey. *Archaeopteryx*—the "dawn bird" already described—must have behaved in the same way. Young Hoatzins if pursued unhesitatingly plunge from aloft into the water, if such be available, where they swim strongly, striking out with all four limbs.

The long-necked and long-legged Crane-like birds are of world-wide distribution and represented by several families.

The Limpkins (Family *Aramidae*) are known by two American

species, noted for their piercing cries, which have earned them such names as Clucking Hen and Crazy Widow. Ten or twelve eggs are laid in reed-beds.

The Kagus (Family *Rhinocetidae*), are known by one species only, *Rhinocetos jubatus*, a native of New Caledonia. The Kagu is not much larger than a fowl, but conspicuous by a large erectile crest. Like most cranes, etc., it indulges in grotesque bowing and dancing during the mating season.

The Cariamas (Family *Cariamidae*) and Trumpeters (Family *Psophiidae*) are all South American birds, suggesting long-legged turkeys or pheasants, and given to uttering loud, trumpet-like calls. The Brazilian Cariama, *Cariama cristata*, is protected owing to its habit of killing snakes, which it strikes down with its feet, as does the South African Secretary Bird.

The true Cranes (Family *Balearicidae*) are tall graceful birds, inhabiting as a rule open plains, some, like the Sarus Cranes (*Megalornis antigone*), standing nearly six feet high. They are found in all countries save South America. One species, *Grus grus*, was at one time a regular migrant to England. They are of great service to agriculture owing to the number of noxious insects they destroy. Two or three eggs only are laid. Many, like the "Native Companion", *Megalornis rubicunda*, are famous for their dancing powers. The Crowned Cranes (*Balearica*) carry crests consisting of strong wiry feathers on the head.

The Herons (Family *Ardeidae*) resemble the Cranes, but are chiefly wading birds and consequently fish-eaters, some also consuming small mammals and reptiles. A remarkable example is the Boat Bill, *Cochlearius cochlearius*, of Central America, with its broad boat-like bill.

The long-necked, long-billed Bitterns (*Botaurus*) are famed for the deep booming sounds they utter.

Nearly allied to these birds are the large, four-foot high, fish-eating Whale-headed Storks or Shoe-bills (Family *Balaenicipitidae*) of the Soudan, which have long and very broad beaks shaped like a shoe and terminating in a hook.

Endless legends surround the European Stork, *Ciconia ciconia* (Family *Ciconiidae*). It is in fact of great benefit to man by reason of its insect diet, and in Holland literally saved the country from inundation prior to the building of concrete dykes. This is explained by the fact that in the olden days of mud and

reed dykes, certain insects much relished by the storks were a source of danger owing to their tunnelling propensities. The Common Stork winters in Africa and Egypt, repairing to Europe in spring for nesting purposes. Often a cart-wheel is fixed upon a pole to serve as a nesting site near some farmstead, where the birds' proximity is believed to bring good fortune to all in the neighbourhood.

The instinct of orientation is very highly developed in these birds. Some years ago a large number of storks bred in East Prussia were marked and sent to West Prussia, where they were released, with the object of ascertaining whether they would, when confronted with migration, favour the route to Africa *via* South-East Europe and Egypt taken from time immemorial by their forebears, or the shorter route *via* France, Spain and North Africa which has always been used by West German storks. Without exception all proved their conservatism by choosing the longer route.

The Indian Adjutant, *Leptoptilos dubius*, the largest member of the family, is a scavenger and is welcomed in the neighbourhood of towns.

Storks clatter their mandibles together with a loud noise when angered or alarmed.

The Ibises and Spoonbills (Families *Plegadidae* and *Plataleidae*) have long bills, which in the former are curved. Ibises are chiefly of Eastern origin, and one was formerly worshipped in Egypt, and frequently mummified at death.

The Spoonbills are characterised by the unique beak, suggesting a table-tennis bat with a very long handle. Spoonbills are shy, marsh-dwelling birds. One species, *Platalea leucorodia*, once regularly lived in England, but is now only an occasional visitor.

The Ducks, Geese and Swans (Family *Anatidae*) are among the best-known of all birds, and many are of great economic value. All are characterised by a long neck, usually wide bill, and strongly webbed feet. The sides of the bill are often alternately toothed and notched, a device whereby the birds strain off the mud in which they delve for plant-roots, insects, molluscs, etc. The males are usually more vividly coloured than the females, but many have the curious habit of changing, after breeding-time, into a dress very like the females, a condition known as "eclipse". Two hundred or more species are known, and a score or so are resident or regular migrants in Britain. Most are marsh-dwellers, but many are purely marine. Notable species are the Wild Duck or Mallard, *Anas boschas*, from which our domestic

breeds are probably derived; the Eider Duck, *Somateria mollissima*, a marine species, giving the valuable eider down; and the remarkable "Steamer" Duck, *Tachyeres cinereus*, which often loses the power of flight.

Geese are usually heavier birds than ducks, and less purely aquatic, but the two groups largely merge one into the other. Our domestic goose is possibly descended from the "Grey Lag", *Anser ferus*, the only wild goose breeding, and that not abundantly, in Britain.

The Swans all have much longer necks than either ducks or geese. Three species breed in Britain, the Mute Swan, *Cygnus olor*, the Whooper, *Cygnus cygnus*, which has a trumpeting call, and Bewick's Swan, *Cygnus bewickii*, a smaller species. Swans are still, theoretically, "royal" birds, and those on the Thames are marked annually by the King's Swan Master, an official of the Ancient Vintners' Company.

Flamingos (Family *Phoenicopteridae*), despite their exaggerated necks and legs, are virtually highly specialised ducks. The "strainer" character of the bent bill (straight in fledglings) is very marked, and is entirely filled by the large fleshy tongue. Flamingos assemble in large flocks and abound in the tropics of both hemispheres. The nesting is unique, consisting of a huge circular earthen mound some two feet high, with a depression in the centre. Here one or two eggs are incubated, the fledglings being fed on pre-digested food, which they obtain direct from the parents' gullet.

The Screamers (Family *Palamedeidae*), known by three species only from South America, are remarkable birds, possibly allied to the ducks but having fowl-like beaks and ribs more like those of mammals than birds. They carry powerful spurs on the wings, and in America are domesticated, and used to guard poultry and ducks from birds of prey.

The Darters and Cormorants (Family *Phalacrocoracidae*) are web-footed aquatic birds with long beaks, and in the darters the neck has a "spring-trigger" arrangement of bones and muscles, allowing it to be darted forth at fish below water with lightning rapidity. Darters are tropical. Cormorants, known by their hooked bills, are of world-wide distribution.

The Gannets (*Sula*) are Northern Sea-birds, with sharp-pointed, straight beaks. They fly at great heights, scanning the sea surface for fish, and dive with the speed and force of aerial bombs. Our Gannet, *S. bassana*, is the only bird whose population is fairly accurately known. There are about 50,000 pairs.

The Pelicans (Family *Pelecanidae*) are web-footed aquatic birds with large bulky bodies and enormous bills, the skin attached to the lower mandible being extended to form a pouch in which many pounds weight of fish can be literally "netted", and kept till an opportunity to swallow it at leisure occurs. They are powerful fliers but nest on the ground, and, like so many aquatic birds, feed the young on pre-digested fish. They are found in all parts of the world, and assemble in great flocks. Whilst usually fishing independently, they may combine to form a single line across a lake, when they drive the fish before them into the shallows where the victims are easily captured.

The Frigate or Man-O'-War Birds (Family *Fregatidae*) are not unlike pelicans, but have no pouch, and in their remarkable powers of flight rival the hawk and the albatross. They are tropical forms and live mostly on fish.

The Tropic Birds, or "Boatswains" (Family *Phaethontidae*), are similar to the foregoing groups, but have short, straight bills. They range the intertropical oceans, searching for fish hundreds of miles from land. The single egg is laid on a cliff or in a dead tree, without any pretence at a nest.

The Turkey Vultures (Family *Cathartidae*) are confined to America, and are exemplified by the Condor, *Sarcorhamphus gryphus*, the largest known flying bird. It has a wing span of ten feet. The group feeds both on living animals and carrion.

The Secretary Bird, *Sagittarius Serpentarius* (Family *Sagittariidae*), is found over the greater part of Africa, where it is largely protected for the useful service it performs in killing snakes and vermin. This bird has aptly been termed a "Vulture on Stilts", the long legs serving to keep it well clear of deadly snakes, and also enabling it to deal its quarry a kick of terrific force. The name "Secretary" refers to the crest, suggesting when closed a number of pens.

The true Vultures, Hawks, and Ospreys (Order *Accipitriformes*) show considerable uniformity of structure and habits. All are carnivorous, with hooked beaks and claws suited to hold and tear their food. Most are powerful fliers, and the nest is a crude structure of twigs raised on some lofty crag.

The Vultures (*Aegyptiidae*) are the least predacious of the group, being largely carrion feeders, and in this are of service to man since most inhabit tropic lands where corpses quickly

rot and spread pestilence. The neck and legs are bare—thus avoiding unnecessary “fouling” in the course of the bird’s decidedly “messy” banquets.

The Egyptian Vulture, *Neophron percnopterus*, once worshipped in ancient Egypt, occasionally wanders northwards to our islands.

The Eagles and Hawks (Family *Falconidae*) range in size from that of a pigeon to a large turkey. All are birds of impressive bearing, with piercing eyes, the gaze of which is directed downwards by an overhanging structure of the bony orbit. All are highly predacious, the largest eagles even carrying off lambs and foxes. The group is of world-wide range, some northern species living largely on fish, whilst many tropic forms feed almost exclusively on monkeys. Falconry, though little practised in England now, is still popular in many parts of the world, and in Turkestan, Persia and India even eagles are trained to fly after and capture other birds, besides mammals.

The powerfully-built Golden Eagle, *Aquila chrysaetus*, inhabits the mountainous regions of Europe from Lapland to the Mediterranean, its range extending into Asia and North America. In the British Isles it is now confined to the Highlands of Scotland. It attains a length of nearly three feet. The nest, built on rocky ledges, is made of sticks, and being repaired annually attains an enormous size.

The Kites and Honey Buzzards are less purely predacious than most of the group. The Common Kite, *Milvus milvus*, still abundant in the East, was once a common feature of London. In Henry VIII’s reign vast flocks swarmed in the City, where they were regarded as one of the “sights” and were further valued as scavengers at a time when the main thoroughfares were virtually open sewers.

The Ospreys (Family *Pandionidae*) are large fish hawks, with spiked soles to their feet, enabling them the better to grip their slippery prey. They are almost world-wide in habitat, and were once common in Scotland. Like certain Eagles, the Ospreys often build on the same site year after year. One pair in the Hebrides raised a tower of sticks twenty feet high.

The Owls (Order *Strigiformes*) are represented in all parts of the world. They are much like hawks and eagles, but have the skull more rounded, and the outer toe—as in the Ospreys and some other birds—is reversible, so that two toes can point forwards and two backwards. The eye is remarkably modified to see clearly in indifferent light, the sclerotic rings being so

large as to form a circular box, half an inch or more high. Owls are largely nocturnal and lay their two to ten white and almost globular eggs in eaves, hollow trees, barns, etc. Hunting at night, their food largely consists of mice and rats, the bones of which are ejected from the mouth in the form of pellets. Some tropic owls feed exclusively on fish and are partially diurnal.

The Commonest Owl in the British Isles is the Tawny Owl, *Strix aluco*. Its long-drawn-out hoot is familiar. In England the Owl's vermin-killing habits were at one time more appreciated than they are to-day, and many old barns still display an "owl window" by which the Barn Owl, *Tyto alba*, may enter and nest. In this and all other species the ears are enormously developed. A remarkable owl is the Burrowing Owl, *Speotyto cunicularia*, of America, which forms colonies in the burrows of the Prairie Marmot. Rattlesnakes also favour these burrows, and old natural histories represent the three contrasted creatures as living in communal harmony, though it is now realised that "civil war" more nearly describes the case. The giant amongst owls is the Winking Owl of Australia, *Hieracoglaux connivens*, which is almost as large as an average eagle.

The Parrots, Macaws, Cockatoos, Lories, Parakeets, etc., Order *Psittaciformes* (Family *Psittacidae*), are familiar arboreal birds, allied to the owls and similar in structure, but of diurnal habits and chiefly frugivorous. The majority build in hollow trees, but some affect cliff faces, where they nest in burrows or rock fissures. Many are of vivid colouring, whilst a few, such as the common grey African parrot, are famed for their talking powers. Parrot speech, whilst reliant on the bird's imitative powers, is, of course, not directly associated with the deliberate conveyance of ideas, hence the amusing inconsequence of most parrots' utterances. When they appear to be applicable, it is usually a matter of coincidence, though the results may be none the less dramatic. Zoo parrots, for example, when kept near the canal bank at a time when all barges were propelled by horse power, often brought teams to a standstill by shouting "whoa there"—a phrase the birds had acquired by listening to the vociferous bargees. Some of the smaller species of parrots are known as parakeets. The cockatoos from Australasia are distinguished by an erectile crest. Most remarkable of the entire group is the Kea, *Nestor meridionalis*, of New Zealand. Prior to the arrival of white settlers the bird was almost exclusively frugivorous. With the establishment of sheep farms—and slaughter-houses—however, it soon acquired, in certain districts only, a taste for offal, and later took to attacking live sheep for the sake of the kidney fat. Its depreda-

tions in this direction have unfortunately led to its suppression by order of the Government.

The Order *Coraciiformes* includes a large number of widely contrasted birds, mostly of small size.

The Oil birds (Family *Steatornithidae*) are represented by a single species, *Steatornis caripensis*, the "Guacharo" of South America. It lives in deep caves, where the three or four white eggs are hatched. The young, when a few weeks old, become enormously fat, a character which brings them into great demand amongst the natives. They are killed and the fat melted down into a colourless substance known as "guacharo butter", which is used both for cooking and illumination.

The Frog Mouths (Family *Podargidae*) are owl-like birds of Indian and Australian regions. They make flat nests in tree forks, where the two white eggs are incubated by both parents. The adult frog mouth has the largest mouth proportionately of any bird, and quickly engulfs large frogs and rats.

They are further notable for the soundness with which they sleep. They can be lifted from a branch without being awakened, and should one of a flock be shot whilst sleeping, the others are not even roused by their mate's violent demise.

The Kingfishers (Family *Alcedinidae*) are most plentiful in the Malay Archipelago, though representatives are found in most countries. The beak is long and straight, and the plumage usually brilliant. One of the smallest species is the Common Kingfisher, *Alcedo ispida*, of the British Isles, which nests in burrows dug in the banks of streams. The largest of the family is the "Laughing Jackass", *Dacelo gigas*, of Australia, where it is known as the Kookaburra. It is about the size of a fowl, lives far from water, and devours reptiles, rats, etc. Its loud, cacophonous cry well justifies its popular name.

The Rollers (Family *Coraciidae*) are birds of gay plumage, abundant in the warmer forests of the Old World. The eggs are laid in holes in trees or banks, and the popular name refers to the birds' strange habit, in the breeding season, of rolling in their flight and even turning aerial somersaults.

The Bee-eaters (Family *Meropidae*) are brilliant and graceful birds from the Old World tropics, breeding, in large colonies, in sandy river beds. They live exclusively on insects, and often do great damage to apiaries.

The Hoopoes (Family *Upupidae*) are all highly ornate Old World Birds. The Common Hoopoe, *Upupa epops*, distinguished by its handsome erectile crest, is a regular visitor to England and its cry suggests the group's popular title. The nest is placed in a hollow tree or rock fissure, and the nestlings are unique in that the crest is well-developed whilst yet in the "fledgling" stage.

The Hornbills (Family *Bucerotidae*) range from Africa and the Indo-Malayan regions to the Solomon Islands. They are mostly large arboreal birds, with partially united toes and gigantic bills often ornamented with a bony crest. This structure, however, is cellular and very light for its size. When nesting, the hen seeks a hollow tree, and creeping in at a convenient hole, is "walled up" with mud by her consort. A small orifice, large enough to admit her beak tip only, is left. Through this her consort feeds her throughout the entire term of incubation. One species only, the Ground Hornbill, *Bucorvus cafer*, is purely terrestrial. It is about the size of a turkey and inhabits Abyssinia. Whereas most of the group are frugivorous, this bird devours snakes, lizards and small rodents. Several may combine to kill a large snake, advancing on the reptile with their wings outspread to act as shields.

The large mouthed Night Jars and Goatsuckers (Family *Caprimulgidae*) are nearly allied to the Frog Mouths. They make no nest, are chiefly nocturnal, and live on insects. The plumage imitates in a remarkable manner moss-covered tree stumps or dried bracken, thus serving as an effective disguise. The flight is very swift and erratic, and the cry is a strange "churring" sound, suggesting an old time watchman's rattle, plied with great vigour for long periods without pause. This family has a world-wide distribution, but is not represented in New Zealand.

The Swifts (Family *Micropodidae*) are not unlike Swallows in general form, but differ widely in structure. They are incredibly powerful upon the wing, but the feet are so small and feeble as to be useful only for clinging to vertical surfaces. Rising from a level area is effected only after a severe struggle. Several species make nests out of a sticky secretion from the salivary glands. These nests are edible and are much prized by the Chinese. The nests of other species vary much in materials, mud, feathers and even interwoven plant seeds being used. Swifts capture their insect prey on the wing. They have a wide distribution, being found in all parts of the world.

The Humming birds (Family *Trochilidae*) are at once the smallest and most brilliant of birds. They abound in the tropics of the New World, their sole habitat, where some five hundred species are recognised. Of the smaller species, five go to the ounce, and the eggs of many are no larger than peas. The wonderful iridescent feathering is often set off with extravagant quills, frills, crests, or globular masses of down. The "humming" of these birds is caused by their remarkably rapid wing-beat, the wing being almost invisible when the bird "hovers" in mid air. This hovering suggests that of the hawk moth and enables the bird to obtain its nourishment—minute insects and nectar. The tongue probes tubular flowers at lightning speed and to effect this its tip is frayed or feathered, whilst the bony roots pass up over the back of the head and are anchored at a point between the eyes. It thus works like a spring trigger or a piston rod.

The Colies (Family *Coliidae*) are small fruit-eating birds of Africa, remarkable for their creeping gait, which has given them the alternative name of Mouse Birds. All four toes point forwards. At night the birds sleep in densely packed ranks upon branches, hanging head downwards in extraordinary poses.

The Trogons (Family *Trogonidae*) come from the forests of Africa, India, Malaya and America, and are unsurpassed for brilliant colouring. A famous example is the Quetzal, *Pharomacrus mocinno*, from Central America, where it is the national emblem of the Republic of Guatemala, figuring on the postage-stamps of that country. Trogons are heavily built birds with short necks and short feathered legs.

The Cuckoos (Family *Cuculidae*) are world-wide, and typified by the common species *Cuculus canorus*, which leaves Africa for our shores in the spring. Whilst most cuckoos follow the habit of laying or placing their eggs in the nests of other birds, leaving them to be incubated and the young reared by them, this does not apply to all. The American "Rainbirds," for example, are not parasitic. The majority, however, billet their eggs upon other birds, and in many such cases the "changeling" eggs bear a remarkable similarity to those of the foster parents. One group of New World cuckoos make huge communal nests in which numerous females deposit their eggs and then "sit" in mass formation. Like our common cuckoo, most members of this large family have very persistent cries. One of these, a large African "Hawk Cuckoo", has gained the ominous title of "Brain-fever Bird". The eggs of our common cuckoo are usually laid in the nests of the Hedge Sparrow, Reed Warbler, Meadow

Pipit, Robin, Willow-wren and Pied Wagtail. There is a hereditary tendency for the birds to lay in the nests chosen by their forefathers.

The Touracos or Plantain-eaters (Family *Musophagidae*) of Africa are unique in that most of the species have crimson flight feathers which yield a pigment called Touracine. It contains copper and is so soluble as to be washed out by heavy rain, though later renewed. The green feathers of these birds are also unique in that the green is due to pigment, and not, as in all other birds, to prismatic reflections from yellow, black and blue feathers. Touracos are moderately large arboreal fruit-eating birds with very small heads.

The Order *Piciformes* consists of birds having two toes directed forwards and two backwards.

The Toucans (Family *Rhamphastidae*) are brightly coloured perching birds of Central and Southern America. They have enormous brightly coloured beaks, which like those of the hornbills are cellular and therefore very light. The tongue is very long, with feathered edges. The sixty odd species are all fruit-eaters, and tip their food down their throats by a backward jerk.

The Barbets (Family *Capitonidae*) are common to the tropics of Asia, Africa and America and are famous for their metallic voices, the best known species being known as the "Copper-Smith" (*Xantholaema*) of the Far East, whilst others bear such names as Tinker Bird and Iron Smith. They are heavily built birds with large bills which carry bristles.

The small Honey Guides (Family *Indicatoridae*) of Africa and the Orient well deserve their name, especially as regards the African species. These birds are said to deliberately lead human beings or arboreal mammals to trees containing bees' nests, when the birds "stand by" whilst the comb is rifled, afterwards picking up such bee grubs as fall to the ground.

The Woodpeckers (Family *Picidae*) are presented by three species in our own country and many others throughout the world, apart from Madagascar and Australasia. The birds live almost solely on insects dug from the bark of trees with their sharp-pointed, wedge-shaped bills, the birds sitting back on their tails. When so engaged they cling to the tree trunk with their feet. The tongue plays an important part in extracting the insects, and is constructed on lines similar to the tongues of

humming birds, already described. Nesting is usually effected in hollow trees. Certain ground-feeding species have curved bills. The Wry-neck or Cuckoo's Mate, *Jynx torquilla*, a well-known summer visitor to the British Isles, has a curious habit of twisting and jerking its neck in all directions.

The Puff Birds (Family *Bucconidae*) of Central and South America are moderate-sized insect-eating birds, but instead of digging for them, usually capture the more active species on the wing. Their short bills have hooked tips.

The Lyre birds, Order *Menuriformes* (Family *Menuridae*), are Australian forms, suggesting game-birds in general build. The males are conspicuous by the remarkable "lyre"-shaped tail, and the enormously developed feet with which they scratch up insect food. They are accomplished mimics, imitating with great fidelity the songs of other birds, cries of mammals, and even such sounds as running water, the wind in trees, etc.

The great order of Perching birds, *Passeriformes*, is usually divided into songless and singing species, and is distributed all over the world. A distinguishing feature of the group is the hind toe which can be opposed to the other three like a thumb. Most are arboreal and mixed feeders. It includes over forty families and thousands of species. Only the more outstanding forms can be mentioned here.

The Swallows (Family *Hirundinidae*), of which our common species, *Hirundo rustica*, is a typical example, build a nest made of mud and lined with feathers on the beams and rafters of houses and barns. In summer they range north over Europe and Asia, and well into the Arctic Circle, wintering in Africa and Malaya. To this family belong the House Martin, *Chelidon urbica*, and the Sand Martin, *Riparia riparia*, which nests in tunnels excavated in sand-banks.

The Flycatchers (Family *Muscicapidae*) and the Cuckoo Shrikes (Family *Campophagidae*) are both Old World families of small birds feeding chiefly upon insects. The Bulbuls (*Pycnonotidae*) of the Orient are thrush-like forms remarkable for their liquid song, as also is the Old World family of Babblers (Family *Timaliidae*). The Wrens (Family *Troglodytidae*) are mostly minute birds of the Old World and America. Our Common Wren, *Troglodytes troglodytes*, is a small bird with a very loud song. The Dippers (Family *Cinclidae*), also represented in England, are aquatic Wrens, living on fish ova, etc., and swimming below the surface of mountain streams by means of both feet and wings.

The Mocking birds (Family *Mimidae*) are restricted to America and related to the Thrushes (Family *Turdidae*), which are of world-wide distribution. Both families include notable songsters, and the latter embraces, besides true thrushes, such familiar species as the Redstart, Stonechat, Fieldfare, Ring Ouzel, Redwing, Blackbird, Nightingale, Robin and Wheatear. Closely allied to the Thrushes are the Hedge Sparrows and Accentors (Family *Prunellidae*), the Warblers (Family *Sylviidae*), the Greenlets (Family *Virconidae*), the Waxwings (Family *Bombycillidae*), the Wagtails and Pipers (Family *Motacillidae*), and other small groups. The Shrikes (Family *Laniidae*) are given to "putting by for a rainy day," impaling insects, frogs, mice, etc., on thorns near their nests, and using this garnered provender as needed. The Musical Piping Crows (*Gymnorhina*) of Australia belong to this family.

The Titmice (Family *Paridae*) are all small birds of the Old and New World, much addicted to haunting human habitations, and unhesitatingly using the first snug nesting sites available, such as hollow trees or even bottles, tins, old hats, boots and letter-boxes! Allied families are the Wren-tits, Crested Wrens, Nuthatches, Tree Creepers and White Eyes.

The Flower Peckers (Family *Dicaeidae*) and the Sun Birds (Family *Nectariniidae*) are dazzlingly brilliant Old World groups, mostly from tropic countries. Related are the Honeysuckers, American Warblers, Tanagers, Larks, Buntings and Finches. The last includes many well-known British species, such as the Sparrow, Goldfinch, Chaffinch and Crossbill.

The Weaver birds (Family *Ploceidae*) of the Orient are famed for lacing leaves together and so forming very safe and effective cradles for their young. They are represented in the New World by the allied Hang Nests (Family *Icteridae*), which make wonderful pendant nests of grass and fibre attached to tree branches.

The Orioles (Family *Oriolidae*) and the Drongos (Family *Dicruridae*), both of the Old World, contain some of the most noted feathered songsters.

The Tree Starlings (*Eulabetidae*) are not unlike the True Starlings, but are strictly arboreal in habits. They are further distinguished by having bristles at the base of the bill, and in laying mottled eggs.

The best known are the talking Mynas, or Grackles (*Eulabes*), of the Orient, famous for their powers of mimicry.

The true Starlings (Family *Sturnidae*) are not unlike the Crows, which they resemble in their habit of walking, rather than hopping, as do most perching birds. Our common starling, *Sturnus vulgaris*, is a British resident, the "starling army" being reinforced in winter by hordes of migrants from the Continent. During post-War years it has supplanted the sparrow as the typical London bird. Many thousands now forage daily in suburbia, but return to such favourite roosts as St. Paul's, the British Museum, etc., every night. The starling is principally insectivorous, though it does damage to orchards.

The Bower Birds (Family *Ptilonorhynchidae*) are for the most part inconspicuous, crow-like birds peculiar to New Guinea and Australia. They have become world-famous for their "bower-building" habits. The bower varies much amongst the numerous species. It may suggest a scout's "bivouac" in size and shape, or form a rude tower propped against a tree. The materials vary from twigs and mud to grass or similar herbage, and the bower is often decorated with skulls, bones, shells, feathers and flowers—the decorations being renewed as often as they fade or show other signs of wear and tear. Sometimes a neatly kept lawn forms part of the decorative scheme. Both sexes join in the construction of the bower, and although it seems to serve primarily as an assembly place in the courting season, the birds appear to take an aesthetic delight in its maintenance more or less the year round. At the Zoo, coloured bus-tickets, silver paper, etc., have thus been utilised by captive Bower Birds. Many prefer blue objects to those of other colours. The bowers are not to be confused with the nests which are built in neighbouring trees and bushes.

The nearly related Paradise Birds (Family *Paradisidae*) are above all other members of the avian world renowned for the finery of the males—the hens being quite unadorned and easily passing for dingy starlings or thrushes. The male's plumage is often so extravagant as to baffle verbal description. Enormous waterfall-like plumes may spring from beneath the wings, wiry ornaments may decorate the tail. Immense, collapsible feather shields, and capes, are often in evidence. In the courting season the males assemble to form a kind of mannequin parade before the hens. Courting antics are as extravagant as the courting dress. Some birds of Paradise turn completely upside down, trembling from head to foot, and remain thus for several minutes at a time.

To-day these wonderful birds are happily sedulously protected from plume hunters by Government regulations. In 1766,

when stuffed skins first came to Europe, they all arrived minus their legs. The famous Linnaeus—probably in jest—actually named one of the largest species *Paradisea apoda*, or “the Paradise Bird without legs”. These birds betray their close kinship with crows in their harsh voices.

The true Crows (Family *Corvidae*), though world-wide in distribution, are most evident in the Northern Hemisphere. All have strong sharp beaks, omnivorous appetites and a high intelligence which often prompts them to acts of wanton mischief and destruction. The Raven, Carrion Crow, Jay, Magpie, Jackdaw and Rook are famous examples of our resident crows. Less known are the Chough and the migrant Nutcracker, the former often a resident along the cliffs of Dorset and the West Country generally. Some of our native crows have been immortalised in song and legend. Thus the Jackdaw is inseparable from the Ingoldsby Legends, whilst the Raven is equally associated with Charles Dickens and Edgar Allan Poe. For the last half-century Ravens have been a feature of the Tower of London, and are entered on the garrison strength.

XXIII

REPTILES

Class *Reptilia*

MODERN reptiles are cold-blooded, vertebrate animals not provided with hair or feathers. They always breathe by means of lungs and do not undergo in their early stages a transformation from gill-breathing to lung-breathing creatures as do the amphibians. The skull is articulated with the first vertebra by means of a single ringed knob or condyle, a feature which the reptiles share with the birds, thus differing from the mammals and amphibians in which it is attached by two knobs.

In defining reptiles as cold-blooded animals, we do not mean to infer that their temperature is always very low, but that their blood rises and falls according to the temperature of their surroundings and is not more or less constant as in the mammals and birds.

In the remote past reptiles were the preponderating type of vertebrate animal. They may even be said, at one time, to have ruled the world. Existing reptiles number little short of five thousand and are most abundant in tropical and semi-tropical countries. They may be divided into the following Orders:—

1. The *Rhynchocephalia*: The Tuatara.
2. The *Chelonia*: Turtles, Terrapins and Tortoises.
3. The *Crocodylia*: Crocodiles, Alligators and Gharials.
4. The *Lacertilia*: Lizards.
5. The *Ophidia*: Snakes.

XXIV

THE TUATARA

Order *Rhynchocephalia*

THE Order *Rhynchocephalia*, once rich in members as indicated by many fossil forms, is to-day represented by a single living member, the Tuatara (*Sphenodon punctatus*), a lizard-shaped animal once common on the mainland of New Zealand, but now found only on certain small islands in the Bay of Plenty, where it is afforded Government protection. Although lizard-like in form, it is perhaps more nearly related to the tortoises and crocodiles. It differs from lizards in various features, one of the most important being that the temporal region of the skull is bridged over by two arches instead of one and that it possesses certain abdominal bones which are absent in lizards and which foreshadow the plastron of tortoises. The Tuatara is possessed of a third, but vestigial eye—the pineal eye—an organ situated on the top of the head, which is no longer functional. This organ is likewise faintly indicated in certain lizards. The body of the animal is stoutly built and its back is ornamented with a series of lobes which extend from the massive head to the end of the short, thick tail.

The Tuatara is a burrowing reptile and lives in deep holes excavated in the earth, which it usually shares with various species of sea birds. The excavations measure about two feet in length and a foot in width. The animal is omnivorous, feeding on rodents, frogs, worms, etc. It is oviparous, and lays from six to ten eggs.

TURTLES, TERRAPINS AND TORTOISES

Order *Chelonia*

TURTLES, which may be freshwater or marine, are entirely aquatic. Terrapins are mainly aquatic and live only in fresh water. Tortoises are exclusively terrestrial. The body of these animals is protected above by a bony carapace covered, as a rule, with horny shields. The bones forming the shell are mainly expansions of the vertebrae and ribs. The clavicles and abdominal bones form the under-surface, or plastron. The under and upper surfaces are usually connected by a bridge. The neck and tail are the only movable parts of the spinal column.

In certain terrapins and tortoises, the plastron is connected to the carapace by one or two elastic ligaments. Thus, in the Mud Terrapins of North and Central America the anterior and posterior portions are connected with the central part by hinges, whilst in the Box Tortoise (*Cistudo*) the plastron is divided by a single hinge into two movable lobes. These animals can, as a result, withdraw their heads, necks and limbs into their shells, closing them hermetically.

In the terrapins of the South American genus *Sternothaerus*, the front lobe of the plastron is movable, whilst in the tortoises of the African genus *Kinixys*, the hinder portion of the carapace is hinged. The toothless jaws are covered with horny sheaths. The neck, which varies much in length, may be completely or only partly withdrawn into the shell.

The sense of hearing in these animals is not very acute, and some forms which have no tympanum or ear drum are entirely deaf. The members of the Order which are oviparous lay round and, with the exception of the marine turtles, hard-shelled eggs which are buried in the ground. The eggs of the marine turtles are soft-shelled and are buried on sandy beaches.

Tortoises feed mainly on leaves and fruit, whilst terrapins and turtles may enjoy both animal and vegetable diets—mainly the former. The number of living Chelonians to-day amounts to 225 species.

The Marine Turtles are divided into two families—the *Dermochelidae*, represented by the Leathery Turtle (*Dermochelys coriacea*), and the *Chelonidae*, represented by the Green Turtle (*Chelone mydas*), the Hawksbill (*Chelone imbricata*) and various species of Loggerhead (*Caretta*). These are all adapted to marine life, their limbs being transformed into powerful, paddle-shaped

flippers. The females come ashore at rare intervals and only for the purpose of laying their eggs.

The Leathery Turtle differs from the other marine turtles in its ribs being free and not united to form a carapace. Its body is covered by many small bony plates fitting closely into each other. These are embedded in the skin and covered with a very thick leathery skin. Its paddle-shaped flippers have no claws. This, the largest member of the Order, attaining a length of nine feet and a weight of 1,500 lb., wanders far out to sea and has a world-wide distribution. It occasionally visits the coast of Great Britain.

In the members of the family *Chelonidae*, the flippers are provided with one or two claws, and the shell is covered with horny shields.

The Green Turtle, which occurs in all tropic seas, is famous for the soup that is obtained from its flesh. The eggs, which are deposited on sandy shores, are laid in holes two or three feet deep and covered with sand. The nest is hidden by the sand being well flattened down, the operation being performed by the creature with its flippers. The young on hatching a few weeks later make a bee-line for the sea.

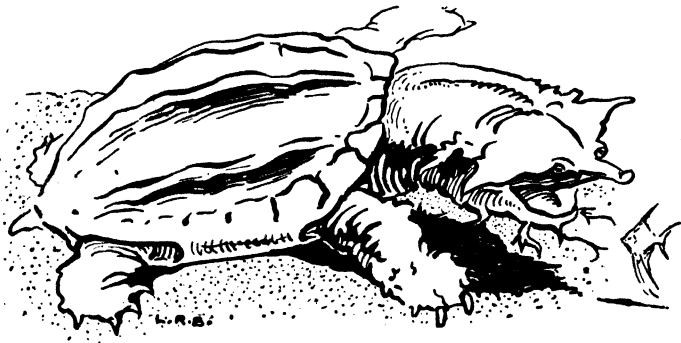
In the Hawksbill Turtle, the shell, which provides the "tortoiseshell" of commerce, is marbled yellow and brown. The quantity of tortoiseshell obtained from an average specimen $2\frac{1}{2}$ feet in length is about 6 lb.

The Loggerhead Turtles are remarkable for their enormous heads. They are of no value from the commercial point of view.

The North American and Mexican Freshwater Turtles belonging to the family *Chelydridae* are known as Snapping Turtles. *Macrochelys temminckii* of the Southern United States attains a length of three feet and a weight of 100 lb. It has a head as large as a terrier's and its popular name of snapper is derived from its habit of striking at the object of its anger, which it does with such rapidity that the eye is barely able to follow the movement. As its jaws have cutting edges and are endowed with great muscular power, a bite inflicted by one of these creatures is a very serious matter, since the amputation of an entire hand or foot is an accomplishment of no difficulty to the reptile. Snapping Turtles spend the greater part of their existence with their heads hidden in the mud of the rivers they frequent. There they lie motionless awaiting the approach of the unsuspecting prey.

The members of the family *Pelomedusidae* are fresh-water turtles in which the neck is completely retractile within the shell. A remarkable member is the large Matamata Turtle, *Chelys*

imbriata, an inhabitant of the rivers of Brazil and the Guianas. Its appearance is grotesque and it has strange feeding habits. The extremely flattened head of this reptile is triangular in shape, and its nose is produced into a long tube. The shell, which invariably carries a mass of aquatic weeds, is very rugose and is divided into a number of protuberances each of which simulates a boulder covered with algae. The chin affords, however, the most remarkable of its many strange features, being provided with a pair of long fleshy appendages which in the water resemble worms, and these ever-waving "whiskers" are said to serve the purpose of attracting the fish upon which the reptile feeds, the prey being engulfed before realising its fatal mistake. The jaws, being weak and covered with soft skin, are



Matamata Turtle

not used for actually seizing the fish, which are sucked into the huge cavernous mouth by the inrush of water.

The Long-necked Terrapin, *Chelodina longicollis*, of Australia has a neck which exceeds its foot-long shell in length.

The soft-shelled river turtles of the family *Trionychidae* are represented in both the Old and the New World. The soft carapace is covered with skin and the snout is tube-shaped.

The Ganges Trionyx, *Trionyx gangeticus*, is the largest species, attaining a length of 2½ feet. *T. triunguis*, which is found in the Nile and most of the rivers of Tropical Africa, is only slightly smaller. New World soft-shelled turtles are represented in the South-Eastern States by four very much smaller species.

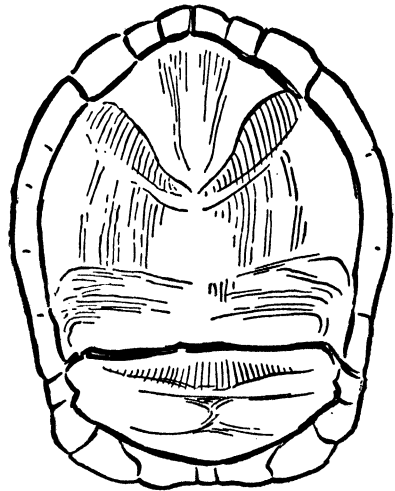
The Family *Testudinidae* includes about 130 species, some aquatic, others terrestrial.

The medium-sized terrapins of the genera *Chrysemys* and *Malacoclemmys* are found in North and Central America. In most species the shell is beautifully marked. In *Chrysemys ornata*, the head and neck are striped with orange, and some shields on the shell are ornamented with orange ocellar spots. In

Chrysemys scripta the head is striped with yellow and pink bands. The eggs of these terrapins are laid some little distance from the water in a nest made of sand or clay. Some of these terrapins are edible, especially *Malacoclemmys palustris*, which is regarded as a delicacy in the United States.

The European Pond-tortoise, *Emys orbicularis*, occurs in the ponds and rivers of Central and Southern Europe, North Africa and South-western Asia. The shell is dark brown or black with numerous spots, blotches or lines. The head is black speckled with yellow. This terrapin is very aquatic, but spends some time on land basking in the sun.

It hibernates in the mud from the end of October to the beginning of April. Another European terrapin is *Clemmys leprosa* of Spain and North Africa. In this dark olive terrapin, which derives its specific name from the disease to which it is subject and which gives the shell a leprous appearance, the plastron is united to the carapace by bone and not by ligament as in the terrapins of the genus *Emys*.



Plastron of Carolina Box Tortoise

In the small American Mud Terrapins, the anterior and posterior lobes of the plastron are movable and connected with the central bridge by hinges. The Musk Terrapin, *Clemmys odoratum*, is so-called from the musky odour that it exudes when alarmed.

In the true Box Tortoise of North America and Mexico (*Cistudo*), the plastron is divided by a central cartilaginous hinge. The lobes close so tightly against the margin of the carapace that the animal may be completely encased. Box Tortoises are land forms, inhabiting dry woods. The shell is rounded, and the digits are almost entirely free of web. In the genera *Kinixys* and *Testudo* the feet are club-shaped and quite webless. In the former genus the front and back portions of the shell are much serrated, whilst the plastron projects beyond the front of the carapace. Further, the hinder part of the carapace is hinged, and consequently movable.

Testudo is represented by over fifty species. The common Greek Tortoise, *Testudo graeca*, is frequently kept as a pet in this

country. The name Greek Tortoise would suggest that it is only found in Greece, but this is not the case, the reptile being distributed over the greater part of Southern Europe, North Africa and Western Asia. Its shell is yellowish and marked with black spots or blotches. A specimen is recorded to have lived for ninety-six years in a garden in Cornwall.

The Giant Tortoises of the genus *Testudo* in the past inhabited many islands in various parts of the world, but to-day are indigenous only in the Aldabra group, Madagascar, Mauritius and the Galapagos Islands off the coast of Ecuador. Less than a hundred years ago they were still very abundant on these islands, which were uninhabited by man until the middle of the 17th century. It is in fact recorded that in 1690 on some of these the tortoises could be observed in flocks of three to four thousand. Man, however, found that they were edible, and for many years the reptiles were used for provisioning ships. It is not surprising, therefore, to learn that these witless reptiles are on the verge of extinction. The shell of the South Albemarle Tortoise, *Testudo vicina*, and the Elephantine Tortoise, *Testudo elephantina*, grow to a length of over five feet. Giant tortoises undoubtedly attain to a very great age, and the late Lord Rothschild, an authority on these creatures, pronounced some of the largest specimens to be over three hundred years old. A giant Aldabra Tortoise which is alive on St. Helena to-day was befriended by no less distinguished a co-exile than the great Napoleon, and was at the time of the latter's sojourn on the island no smaller than at the present day. The history of another that died a few years ago in Columbo dates back 220 years.

The Gopher Tortoise, *T. polyphemus*, of Florida takes its name from that active burrowing rodent, the American Gopher. It makes long tunnels descending at an angle of 35 degrees for about 10 feet or more, the excavation being effected by the animal's enormously long claws and the shovel-like forward portion of the undershell.

The extremity of the burrows enjoys a remarkably even temperature, not falling below 70 degrees in winter or rising above 80 degrees in summer. The tortoise's retreat often commends itself to such "gate-crashers" as racoons, opossums, owls, rattle-snakes and other creatures who gladly avail themselves of this ready-made and comfortable home.

CROCODILES AND ALLIGATORS

Order *Crocodylia*

CROCODILES, alligators and their relations are ponderous, elongate reptiles covered above with an armour of bony plates. The powerful tail is used to propel the animals through the water and when swimming the comparatively short limbs are flattened against the sides of the body. The tail also serves as a weapon of attack. The eyes and nostrils are situated on the top of the bony head, which is often completely submerged except for the extreme upper surface on which these organs are situated. The fore limbs are provided with five toes and the hind limbs with four. These are webbed. The nostrils are valvular, with the result that they can be kept closed when the reptile is submerged. Apart from an upper and lower eyelid, these reptiles are provided with more or less transparent nictitating membranes, and, as a result, vision is not impaired when the eyes are closed as they are when the animals are under water. The tongue is attached to the floor of the mouth except for the tip. The posterior edge of the tip of the tongue meets a flap from the lower side of the palate and this shuts off the mouth from the opening of the trachea and gullet. A crocodile or alligator can thus open its mouth when submerged without water entering the trachea. The teeth, placed in a single row, vary in size. They are planted in sockets and renewed periodically. The snout may be rounded, as in alligators, or pointed as in most crocodiles. In the fish-eating gharials it is extremely long and slender—almost rod-like.

The Order is represented throughout the tropical and semi-tropical parts of the world by the following genera:—*Alligator* of the Southern United States and China, *Caiman* of Central and South America, *Osteolaemus* of West Africa, *Crocodylus* of Africa, Asia, Australia and Central America, *Gavialis* of India and *Tomistoma* of the Malay Peninsula, Borneo and Sumatra.

The difference between the alligator and crocodile is a technical one, but a distinct feature of the alligator is that the fourth tooth of the lower jaw, the largest, fits into a pit in the upper. In the true crocodiles this tooth fits into a notch in the upper jaw and not a pit. Size has always been much exaggerated in all species of crocodiles. Thirty-foot examples of the fish-eating Gharial, *Gavialis gangeticus*, and the Marine Crocodile of the Far East, *Crocodylus porosus*, are recorded, while at the other end of the scale is the 6 foot long Chinese alligator, the only known

alligator inhabiting the Old World. In Africa, east of Suez, the human death-rate levied by crocodiles has necessitated their wholesale destruction, and professional hunters are often paid according to the notoriety of examples slaughtered, the 'grim evidence of bangles, rings, etc., found in their interiors often bearing testimony to the creatures' man-eating proclivities. At a meeting of the Zoological Society held some years ago, Mr. C. F. M. Swynnerton, the then Game Warden of Tanganyika Territory, exhibited the contents of the stomach of a large crocodile. The exhibition revealed the fact that this animal had been a man-eater. Apart from antelope hooves and turtles shells, the reptile, when opened, was found to contain a large number of metal bangles such as are worn as bracelets and anklets by the native women. The animal also contained beads and a long strand of metal cord. The metal cord solved the mystery of the disappearance of a native boy who was known to frequent the river-bank to collect wood, the cord being similar to the type he used for tying his bundles together. Two small pieces of carved ivory were also found in this crocodile, but no explanation was offered as to how they came to be in the reptile's possession. Had the full facts been known, they would, no doubt, have brought to light another human tragedy.

Dangerous qualities, no less than beauty or utility, may lead to the worship of an animal, and it is not surprising, therefore, that the crocodile should figure in the world's gallery of sacred animals. The huge Muggers, *Crocodylus palustris*, in the great muzzer pit at Karachi are regarded with the greatest veneration, and tourists may acquire popularity by contributing to the "muzzer fund", such donations being spent by the priests upon poultry and other offerings to their sacred charges. On the head of each crocodile is painted the sacred caste mark as worn upon the foreheads of all the devout.

There is ample evidence that, in the age of reptiles, the earth's climate was much more equable than it is to-day, and that at one time crocodiles enjoyed almost world-wide distribution. These reptiles were abundant even in Europe.

Although the foe of most animals, the Nile Crocodile, *Crocodylus niloticus*, tolerates a certain bird—the Spur-wing of Egypt. Ticks and other parasites cause the reptile much discomfort by infesting its gums, and these pests the bird removes and devours, entering the crocodile's open mouth for this purpose.

Alligators and crocodiles have well-developed voices, and often make the reptile house at the Zoo resound with their roars. Most crocodiles express themselves in barks or roars, while the long-nosed gharial voices its feelings in a devastating cough.

XXVII

LIZARDS

Order *Lacertila*

LIZARDS are as a rule provided with four well-developed limbs with five clawed digits, but some are practically limbless and serpentine in form. The latter, like all lizards, differ from snakes in the two halves of the lower jaw being united and not connected together by an elastic ligament. As a result, the mouth is not nearly so extensible as in snakes. From crocodiles, lizards may be differentiated by the possession of a movable tongue and in the cleft of the vent being horizontal and not longitudinal. Most lizards are covered with scales which may be coarse and keeled or smooth and polished. Some degenerate burrowing forms have lost their scales and the body is encircled with hardened polished skin which assists them in locomotion. In burrowing species, the limbs may be very short or, as in the members of the family *Amphisbaenidae*, not visible externally and represented internally by vestigial structures.

The tongue differs considerably in lizards. In some it is long, forked and snake-like, whilst in others it is broad and flat. In a few, which live exclusively upon insectivorous fare, it has a sticky end. In the true Chameleons this organ is extremely long and club-shaped at the tip. In the teeth, which likewise vary considerably in structure, we have an important characteristic bearing on the classification of these reptiles. In some lizards the teeth belong to the so-called *acrodont* type, being inserted on the edge of the jaw in opposition to the dentition known as *pleurodont*, in which they are attached to the inner side. In the single genus *Heloderma* the teeth are fang-like and provided with a groove which communicates with poison glands. Lizards usually possess eyelids and ear openings. The tail, which may be long or short, smooth or bristling with spines, is often very fragile and easily broken off. The brittle tail is of use to the animal when seized by an enemy, since it often remains in the mouth of its would-be captor. The tail, when broken, grows again, sometimes in a double, or even triple, form. The break does not take place, as is popularly supposed, between two vertebrae, but in the middle of a vertebral joint at a weak spot. The feet may bear adhesive pads adapted for ascending smooth surfaces or they may, as in the arboreal chameleon, form grasping organs. The skin of these reptiles is shed at intervals, usually in flakes, but occasionally entire. Most lizards are insectivorous, but some of the larger kinds, such as monitors, feed on mammals,

birds and their eggs. A few are vegetarians. The majority of lizards lay oval soft-shelled eggs, but some produce their young alive.

In the Geckos (Family *Geckonidae*), which are represented in Southern Europe and all tropical and semi-tropical parts of the world, the digits are usually dilated to form adhesive pads, and by means of these they can attach themselves to and walk over smooth surfaces. In a few geckos these pads are absent, the digits being sub-cylindrical and provided with claws which are retractile within a sheath. The eye is large, has no lids, and is protected by a transparent disc. Some geckos inhabit woods, a few live in desert districts, whilst others take up their abodes in houses. The great majority are nocturnal. The popular name gecko is derived from the reptile's call, which is produced by clicking the tongue against the roof of the mouth.

One of the largest geckos is *Gecko verticillatus* of India and the Far East, which attains a length of a foot. It is light blue in colour spotted with red or orange.

The so-called Flying Gecko, *Ptychozoon homalocephalum*, of the Malay Peninsula is the possessor of an expansion of skin on each side of the body which is supposed to be of use to the reptile in planeing from the top of a tree to the ground, or from one tree branch to another.

The members of the family *Pygopodidae* are inhabitants of Australia and New Guinea. They are snake-like in appearance and attain a length of nearly two feet, of which the very brittle tail occupies about two-thirds the total length. The fore limbs are absent, but the hind limbs are represented by large scaly flaps underneath which digits are hidden.

The lizards of the large Old World family *Agamidae* may be differentiated from the lizards of the equally large New World family *Iguanadae* by their acrodont dentition. These lizards, which inhabit Africa, Asia, Australia, Polynesia and South-East Europe, vary much in shape according to the mode of life they adopt. They are sometimes ornamented with crests and gular appendages.

Very remarkable are the beautiful "Flying" Lizards (*Draco*) which are abundant in various parts of the Malay Peninsula and Archipelago. In these the long ribs are connected on each side of the body by folds of skin—the "wings"—which are expanded when the lizard planes from one tree branch to another or from the topmost tree branches to the ground. The "wings" are so highly decorative that the creatures when gliding are more

suggestive of butterflies than of reptiles. According to Major Stanley Flower, who has observed these lizards in their native haunts, they glide through the air with their wings quite steady for a distance of over twenty yards, alighting on all-fours and closing their "wings" as they settle. These lizards, which are of small size, are the possessors of a gular appendage which, in the case of the males, may attain a length of three times that of the head.

The members of the Asiatic genus *Calotes* are moderate-sized lizards with long tails and compressed bodies. One of these, *C. versicolor*, is popularly known as the Blood-Sucking Lizard from the fact that when excited or alarmed the throat becomes much dilated and of a brilliant scarlet. This lizard is most entertaining during courtship, when the males give way to their emotions and perform a curious dance in front of their "intendeds", who appear quite unmoved by the undignified antics of their swains.

The lizards of the genus *Agama*, represented by over fifty species—African, Asiatic and South European—are inhabitants of somewhat barren districts. Many are remarkable for the sudden changes of colour which they undergo. The common West African species, *Agama colonorum*, is found in bands consisting of an overlord and a retinue of six or seven wives. The females look to one master only and always wait for their lord to take his fill before satisfying their own appetites.

The Australian genus *Chlamydosaurus* is represented by the Flying Lizard, *Chlamydosaurus kingii*, which, although only a yard in length, resembles a veritable dragon by reason of the large frill surrounding its neck. When the animal is excited, this frill is extended like an Elizabethan ruff. At the same time the lizard opens wide its jaws disclosing a saffron-yellow mouth. This exhibition of frightfulness on the part of the reptile is a mere piece of bluff and is intended to scare its enemies away. In the event of the performance not having the intended effect, the lizard folds its frill along the sides of the body and makes off at full speed, running along the ground on its hind limbs only and with its tail lifted clear of the ground.

The genus *Amphibolurus*, represented by sixteen species, is also restricted to Australia. The Bearded Lizard, *Amphibolurus barbatus*, attains a length of two feet. Its popular name is derived from the fact that the sides of the head and throat are covered with bristly spines which, when the mouth is opened, stand erect, presenting a likeness to a beard.

The Mastigures, genus *Uromastix*, inhabit the deserts of North Africa and South-West Asia, where they construct burrows in the sand in which they sleep at night. They have very flattened

bodies, small round heads and a tail covered with spines. These lizards seldom bite, but defend themselves by lashing at their aggressor with their tails.

Very curious is the Australian York Devil, *Moloch horridus*, a small brown lizard, barely six inches in length, inhabiting barren deserts. It is covered from head to tail with enormous spines and prickles. The largest spines are half an inch in length and are situated above the eyes. The "devil" feeds exclusively upon ants.

The family *Iguanidae* is represented by a large number of lizards varying much in size and form. Its members, with the exception of a few inhabiting Madagascar and the Fiji Islands, are restricted to the New World.

Anolis is a genus of very small and lively arboreal lizards inhabiting North, Central and South America. It comprises well over a hundred species. The body is slender, the head is long and the throat is provided with a large appendage, or dewlap, which may be distended when the animal is excited. Some of the digits are expanded to form adhesive discs, with the result that these reptiles are able to ascend smooth surfaces. Members of the genus misnamed "Chameleon" in America are remarkable for their quick colour changes, the colours varying from black to brown, from brown to yellow and from yellow to bright green. The males seldom meet one another without giving battle.

The genus *Basiliscus* is represented by four species restricted to Mexico, Central America and northern South America. These lizards are very aquatic, and the males carry high crests on the head, back and tail. The crests on the back and tail are supported by bony rays. Basilisks frequent trees overhanging the water, into which they dive on being alarmed.

The true Iguanas of the genus *Iguana* inhabit Central and South America. They are large animals reaching a length of over five feet. The compressed body is green in colour with black transverse stripes, and is provided with a dorsal crest composed of soft leathery spines. A striking feature of the iguanas is their much developed dewlaps. In Central America they are occasionally eaten, and their flesh is said closely to resemble chicken. In the Horned Iguana, *Metopoceros cornutus*, of Haiti a large horn-like scale surmounts the snout.

The Marine Iguana, *Amblyrhynchus cristatus*, is the only lizard that habitually enters the sea. It is found on the rocky coasts of the Galapagos Islands, where it feeds on seaweed. It is a powerful swimmer and is said to avoid sharks by swimming along the sea bottom.

The Horn Lizards of the genus *Phrynosoma*, are small, much flattened, toad-shaped creatures common in arid regions of North America. The head usually bears a number of large spikes arranged in crests. The colour of these lizards, known in America by the name of "horned toads", is greyish or light brown, with markings which blend with the lichen covering the rocks of their environment. Specimens from the black lava belt near the Grand Canyon, Colorado, are black and yellow, the gloss of the dried black lava being perfectly reproduced. When attacked, the horned lizard may disconcert its foe by squirting a fine jet of blood from the corner of each eye to a distance of several feet—a defensive measure unparalleled in the animal world.

The family *Zonuridae* is represented by a number of lizards inhabiting Tropical and Central Africa and Madagascar. They are characterised by being covered all over by large bony spines. In some species, especially in the Giant Zonure, *Zonurus giganteus*, of South Africa, which attains a length of twenty inches, the body, tail and back of the head are armed with long and very pointed spines.

The family *Anguidae* comprises forms with well-developed limbs, with only the rudiments of limbs and with no external limbs at all. Vestiges of the pectoral and hip girdles are, however, always present. The body is covered with bony plates underlying horny scales. Sometimes it is completely surrounded with armour, but the ventral and dorsal portion may be divided by a fold extending on each side of the body. A familiar representative of the family is the snake-shaped, limbless Slow-worm, *Anguis fragilis*, of Europe, Asia and Algeria, which is very common in the British Isles. The slow-worm, which attains a length of eighteen inches, is a perfectly harmless animal, but is often mistaken for a snake and killed. Its sole means of defence rests on its very brittle tail, which, when seized hold of, may remain in the hand of its enemy. The young, ten to twenty in a litter, are very beautiful, differing from their grey or brown parents in being silvery white.

The European glass-snake, *Ophisaurus apus*, of South-East Europe, which attains a length of three feet, belongs to the division of the family with a lateral fold along the sides of the body. It has minute rudiments of hind limbs.

The family *Helodermatidae* comprises two species of Gila Monster, *Heloderma suspectum*, of North America and *Heloderma horridum* of Mexico. These are the world's only poisonous

lizards. The teeth are grooved and fang-like, and those in the lower jaw communicate on each side with a poison gland. The North American Gila Monster is a stockily built reptile with a tuberculated skin strangely marked with a jazz pattern of salmon pink and black. It bites and hangs on with a bulldog grip. Although its venom is of considerable potency, fatalities from its bite are infrequent. It progresses at a crawling pace, but is nevertheless at times surprisingly agile. It can at a leap completely reverse its position so that the head points where the tail was but a second before. Although its poison fangs are no doubt intended to capture prey as well as to repel attack, Zoo specimens appear to prefer a diet of eggs. Dwellers in desert areas, at the London Zoo these lizards curiously enough spend most of the time luxuriating in a warm bath.

The Monitors (Family *Varanidae*) are the largest of living lizards. They inhabit Africa, Southern Asia and Australasia. One specimen, the so-called Komodo Dragon, *Varanus komodensis*, attains a length of twelve feet and a weight of a hundred pounds. Monitors have long bodies and tails covered with small scales. The latter organ, which is used as a weapon, is rounded in desert and arboreal forms, but is compressed in the species that frequent water. The limbs are strong and well developed. Striking features are their long necks and long and deeply forked tongues. These lizards prey upon mammals as well as birds and their eggs.

The members of the Old World family *Lacertidae* are small typical lizards with well-developed limbs and long bodies and tails. The two British lizards, the Common Lizard, *Lacerta vivipara*, and the Sand Lizard, *Lacerta agilis*, are members of this family as are also the Wall Lizard, *Lacerta muralis*, of which numerous geographical varieties are known from Europe, North-West Africa and South-West Asia, and the Green Lizard, *Lacerta viridis*, of the Channel Islands and Central and Southern Europe. The Common Lizard, which attains a length of five or six inches, is common on heaths or in meadows throughout the greater parts of England and Scotland. It is the only reptile found in Ireland. The young are brought forth alive in litters of from six to ten. It is light brown or golden brown in colour, with usually a dark line down the middle of the back and another tinged with yellow on the sides. The Sand Lizard has, in Britain, a curiously local distribution. It is found on the heaths of Dorsetshire and Hampshire and on the dunes in the neighbourhood of Southport in Lancashire. It is somewhat larger and sturdier than the common lizard and, in spite of its

specific name, not nearly so active. The female is brown with eye-spots on the back and sides, whilst the male is emerald green.

The largest member of the family is the beautiful Eyed Lizard of Southern France, North-West Italy, Spain and North-West Africa. It attains a length of eighteen inches. In the typical form of this lizard the body is bright green while the sides are ornamented with dark blue eye-spots.

Skinks (Family *Scincidae*) are found in nearly every part of the world except the North. The body is usually much depressed. In some forms, the limbs may be fully developed with five toes, whilst in others these organs may be reduced in number or be quite rudimentary. Most skinks are found in arid districts.

The genus *Chalcides* shows every stage in the reduction of the limbs. In some species, such as the Eyed Skink, *Chalcides ocellatus*, of Southern Europe and North Africa, the limbs are fully developed. In other species the digits may number four or three only, whilst in Guenther's Skink, *Chalcides guentheri*, each limb is reduced to form a single, and almost invisible, rudiment. The Blue-tongued Skink, *Tiliqua scincoides*, which derives its popular name from the colour of its tongue, is the largest member of the family, attaining a length of nearly two feet. The body is smooth and shiny.

The Stumped-tailed Skink, *Trachysaurus rugosus*, is a very different type of reptile, being covered with numerous rough scales, the body suggesting the large and somewhat elongated cone of a fir-tree. This lizard is sometimes called the Two-headed Lizard from the shape of its tail, which resembles the massive head. The Stump-tailed Skink is viviparous, producing a single young which is nearly half the size of its parent at birth.

Very remarkable are the members of the Family *Amphisbaenidae*. The majority of these appear limbless and resemble worms, and like worms are able to move backwards and forwards by means of vertical undulations and not by lateral movements as do other limbless reptiles. They are usually found in ants' nests, where they feed on the insects and their eggs.

The Chameleons (Family *Chamaeleontidae*) are so different from other lizards that by some authorities they are placed in a separate sub-order—the *Rhiploglossa*. There are over sixty different species of chameleon from Africa, Arabia, Madagascar, India and Ceylon, and Europe. The common species, *Chamaeleon chamaeleon*, occurs in the South of Spain. Chameleons have helmeted heads and protruding eyes that can be turned in

opposite directions, enabling them to see all round without moving their position. The feet are split in two equal portions, of which one is turned outwards and the other inwards. The tongue, which has a club-shaped sticky end, may be thrown out, when the animal is catching an insect, to a length exceeding that of the animal itself. Chameleons change colour under the stimulus of passion and in adaptation to altered surroundings. The colour changes, however, are produced much more slowly than is commonly supposed. In some forms, such as *Chamaeleon jacksoni* of East Africa, the male's head is ornamented with stiff horns—one over each eye and one on the snout—and recalls an extinct dinosaur which flourished some thirty million years ago.

The South African Dwarf Chameleon, *Chamaeleon pumilus*, is remarkable for its small size—four to five inches—and the fact that it brings forth its young alive.

XXVIII

SNAKES

Order *Ophidia*

THE chief difference between snakes and lizards lies in the fact that in the former the branches of the lower jaw are not fused in front forming a solid union, but are connected by an elastic ligament, giving the animals the power to engulf entire prey of enormous size. The eyes may be provided with rounded, vertical or even horizontal pupils. Snakes are without ear openings and are consequently almost entirely deaf. They are, therefore, unable to appreciate music. In spite of all that has been written on the subject, many still cherish the illusion that snakes can be charmed by music of a certain kind. Much colour has been given to this fallacy by the efforts of itinerant snake charmers, yet there is no scientific basis for accrediting any appreciation of music to serpents of any kind, and when a snake dances apparently in sympathy with the charmer's doleful tune, it is merely following the rhythmic movements of his body in a ceaseless search for a favourable opportunity to strike.

The rudiments of hind limbs are present in the members of the Boa family and a few others. In snakes, the ribs and muscles are the chief agents of progression. The entire body and tail are covered with scales which may be smooth or keeled. On the under surface the scales are replaced by broad transverse shields which are disposed singly on the abdomen, but usually in pairs on the tail. The tongue is deeply forked and acts as a feeler; it is retractile into a sheath. The teeth are usually long and pointed. They are shed at intervals and replaced by reserve ones. In harmless snakes the teeth are solid, but in the poisonous forms at least a pair are either grooved or canaliculated and connected by a duct with an almond-shaped poison gland situated on each side in the back of the head. In a certain viper of the genus *Causus* this gland is produced along the sides of the body for one-third its length. The poison is discharged along the duct through the compression of certain muscles. Some snakes, notably the so-called Spitting Cobras, can eject their venom by shooting the poison to a distance of several feet. The poisonous snakes are divided into three groups. 1. The Opisthoglyphs, in which the fangs are situated at the back of the upper jaw. 2. The Proteroglyphs, in which the fangs are situated in the front of the upper jaw. 3. The Vipers, in which the fangs are borne on a very short maxillary bone which is vertically movable and can thus be raised and lowered. The

poison fangs, like the other teeth, are shed at intervals, when they are replaced by others.

Although the majority of snakes are quite harmless, barely one-third being poisonous, the destruction of human life by snake bite is still very large, and this in spite of the fact that anti-snake-bite sera are available throughout snake-infested districts. In most fatal cases of snake bite, death results from the coagulation of the blood. It follows, therefore, that the first axiom in treating snake bite is not to do anything which might still further overtax the heart. The old-time remedy of dosing a patient with large quantities of whisky and walking him up and down probably helped into eternity many unfortunates who might otherwise have survived. Some thirty years ago research workers in various countries realised that anti-venom sera could be made from the venom itself. At first it was believed that any snake venom might provide a universal remedy for the bites of all snakes, but this was soon proved otherwise. As a result research laboratories and snake parks sprang up in all countries where venomous reptiles occurred and the matter was made the subject of systematic "team work" and investigation. To-day, snake-bite cures are grouped and the laboratories provide anti-toxins arranged under such classifications as rattlesnakes, other American vipers, Asiatic vipers, cobras, etc. As a result of these discoveries many thousands of lives must have been saved.

Snakes change their "skin", the outer layer or epidermis being cast at more or less regular intervals. The skin is usually cast entire and is turned inside out in the process. Snakes feed on mammals, birds and their eggs, lizards, frogs and fish. A number are cannibals and a few are insectivorous. Snakes are able to abstain from food for considerable periods, it having been recorded that a specimen in the Jardin des Plantes in Paris fasted for a period of four years and a day. Some snakes feed without attempting to kill their prey, whilst others strike at their food before seizing it, the poisonous forms waiting for the poison to kill or paralyse their prey. The great constricting snakes, having seized their victims, coil themselves round them and crush them to death.

Some snakes lay eggs which have a thick parchment-like shell; others are viviparous. In many snakes the snouts of the newly born reptiles terminate in a very small "tooth" which serves to cut the shell of the eggs in the process of hatching.

Snakes inhabiting the temperate parts of the world hibernate during the winter months.

The families *Typhlopidae* and *Glauconiidae* are represented by

small worm-like burrowing snakes that spend the greater part of their lives underground, appearing on the surface only after heavy rain. They have teeth in one of the jaws only and minute eyes, more or less hidden under the skin. The body is covered with polished scales and the short tail usually terminates in a small spine.

The members of the family *Typhlopidae* are to be distinguished from those of the family *Glauconiidae* by the fact that the teeth of the former are restricted to the upper jaw whilst in the latter only the lower jaw is toothed. These snakes are related to the giant members of the family *Boidae* which are likewise provided with the rudiments of a hip girdle.

The giant constricting snakes (Family *Boidae*) are represented in nearly all tropical countries. The largest of these reptiles may measure over thirty feet in length and are able to overpower goats, pigs and small antelopes. The family is divided into two sub-families—the *Pythoninae* and the *Boinae*. In the former there is present a bone situated above the eye (the supraorbital) which is absent in the latter. Boas may as a rule also be distinguished from pythons by the shields on the anterior part of the head being small and irregular in shape instead of being large and regular. Members of the python family lay eggs which are incubated by the mother. Boas bring forth their young alive.

True Pythons—Genus *Python*—occur in tropical Africa, Asia, the East Indian Archipelago and Australia. The largest member of the genus is the Reticulated Python, *Python reticulatus*, of Indo-China and the Malay Peninsula and Archipelago. It attains a length of a little over thirty feet. It is darkish brown in colour with bluish black iridescent markings which are sometimes edged with white: a thin black line runs along the middle of the head from the end of the snout to the neck. Snakes, and especially pythons, often display surprising caprice in dietary. A reticulated python that once lived in the Paris Zoo hunger struck and seemed likely to die when, to the delight of the authorities, it at last accepted a goose, which accident had necessitated being killed. It was naturally assumed that the snake had recovered its appetite and would in future accept the fowls, ducks, pigeons, rabbits, etc., offered. This, however, did not turn out to be the case, the python resolutely fasting until another accident again put a goose on the casualty list. It was eventually found that this particular snake, which lived for many years, would eat goose and nothing but goose.

The Indian Python, *Python molurus*, is dark or light brown in colour with irregular dark blotches. The dark brown specimens

are restricted to Northern India, the lighter ones to Southern India and Ceylon. It is a heavier animal than the reticulated python, but seldom exceeds twenty-five feet in length. The somewhat slender Australian Diamond Python and Carpet Python, *Python spilotes*, attain a maximum length of nine feet. These snakes do not differ in general structure, but in the Diamond python of New South Wales the general colour is bluish black with a yellow spot in the centre of each scale. In the Carpet python of Victoria, Southern and Western Australia, as well as New South Wales, the greenish brown ground colour bears irregular-shaped yellow markings.

The genus *Calabaria* is represented by a purplish-brown burrowing snake—*Calabaria reinhardtii*—of West Africa. The rounded head is not distinct from the neck and resembles in shape the short, thick non-prehensile tail.

The members of the sub-family *Boinae* are inhabitants of Central and South America, the West Indies, South-West Asia, North Africa and New Guinea. The very aquatic Anaconda, *Eunectes murinus*, of the Guianas, Brazil and Peru shares with the reticulated python the distinction of being the largest living snake, likewise attaining a length of thirty feet. It is greenish yellow above with large black spots. It feeds principally upon birds, these being constricted and devoured under water. A much smaller species of Anaconda, *E. notaeus*, inhabits the Argentine and Paraguay.

The true Boas—genus *Boa*—are inhabitants of Tropical America and Madagascar. The Common Boa, *Boa constrictor*, of Tropical America and the West Indies, although often referred to as the giant among snakes, does not attain a length of more than twelve feet, specimens of over nine feet being, in fact, rare. Unlike the pythons and anacondas, boas do not often frequent the water, spending the greater part of their lives high up in the branches of trees.

The genus *Eryx* takes the place among the *Boinae* of the genus *Calabaria* of the *Pythoninae*. It is represented by two species—the Indian Eryx and the Javelin Eryx of Central and South-West Asia and North Africa. The thick and rounded heads of these reptiles, which resemble the tails in shape, are not distinct from the neck and as a result these snakes are often known as two-headed snakes, natives believing that each end feeds in turn, and that one end sleeps while the other remains on guard.

The large family *Colubridae* is divided into over two hundred and fifty genera. The species show every possible form of struc-

ture. Ground snakes, burrowing snakes, aquatic snakes and arboreal snakes are all represented.

The family is divided into three sections :

1. The *Aglypha*—harmless snakes with solid, ungrooved teeth.
2. The *Opistholypha*—snakes which are as a rule more or less harmless to man, although the posterior maxillary teeth are grooved and connected with poison glands.
3. The *Proteroglypha*, which are all very poisonous and in which the anterior maxillary teeth are grooved or canaliculated and likewise connected with poison glands.

The snakes of the section *Aglypha* are divided into three sub-families :

1. The *Acrochordinae*—broad-headed, aquatic snakes with a body covered with wartlike tubercles resembling the shagreen of sharks, and with the nostrils situated on the top of the head.
2. The *Colubrinae*—typical snakes.
3. The *Rhachiodontinae*—egg-eating snakes with rudimentary teeth.

As its popular name implies, the thick grey body of the Elephant-trunk Snake, *Acrochordus javanicus*, bears a superficial resemblance to an elephant's proboscis. It feeds entirely upon fish, and in Siam its skin is used for making drumheads. The Grass Snake, *Natrix natrix*, is a well-known member of the sub-family *Colubrinae*. In England this reptile may be distinguished from other British species of serpents by the yellow or orange patch which it bears on the neck. The grass snake is rare in the northern counties and is not found in Scotland. It is somewhat aquatic in its habits, frequenting the neighbourhood of water and feeding upon frogs and fish. It usually hisses loudly when caught, but has seldom been known to bite. Its eggs, up to forty in number, stick to one another forming a bunch, and are deposited in mounds of dead leaves or in manure heaps. In England the grass snake seldom reaches a length of three feet, but in Southern Europe it may attain five feet in length. Garter Snakes, *Natrix sirtalis*, occur all over North and Central America. They are ornamented with vivid stripes and markings. These snakes have been divided up into a large number of species which, owing to the existence of intermediate forms, should be, however, regarded as merely geographical varieties. The garter snake is viviparous, bringing forth broods of up to seventy young.

The brown or black South African Mole Snake, *Pseudaspis cana*, which attains a length of six feet, is even more prolific, producing broods of over eighty living young.

The large genus *Zamenis*, which is composed of both terrestrial and arboreal snakes, is represented in Europe, Asia, North

Africa and North and Central America. In America the snakes of this genus are known as whip snakes and racers. The head is elongate and the eye is large.

The Indian rat snake, *Zamenis mucosus*, which superficially resembles a cobra, is the largest species, attaining a length of nine feet.

The savage Dark Green Snake, *Z. gemonensis*, is common in Central and Eastern Europe. This slender snake attains a length of six feet and feeds on small mammals, birds, lizards, frogs and sometimes upon other snakes.

The genus *Coluber* embraces a large number of typical snakes with heads distinct from their necks with moderate-sized eyes and with elongate bodies and tails. A familiar species is the Four-lined Snake, *Coluber quatorlineatus*, from Central Europe, which attains a length of eight feet.

The Aesculapian Snake, *Coluber longissimus*, is widely distributed throughout Europe and is found as far north as Denmark. In colour it is yellowish or olive with whitish spots. A legend that it is the snake that was worshipped by the ancient Romans has arisen as a result of its being found in localities which were once Roman thermal stations.

The Striped Snake, *Coluber taeniurus*, is found nearly all over South-Eastern Asia. The normal colour of this serpent is greyish brown with a dark stripe on each side of the body, but in certain parts of the Malay Peninsula, where it is found living in complete darkness in limestone caves a mile or more from the light of day, the reptile is pale yellow in colour. These cave-haunting snakes are said to feed entirely upon bats, but a number exhibited some years ago in the London Zoo accepted rats and mice.

The North American Bull Snake, *Coluber melanoleucus*, is so called from the fact that when excited it produces loud bellowing sounds. In this snake the glottis terminates in a movable flap which vibrates rapidly as air is expelled from the lungs.

The genus *Coronella*, which differs from *Coluber* in its dentition, is represented in this country by the slender Smooth Snake, *C. austriaca*. The Smooth Snake, which seldom attains a length of more than two feet, is common over the greater part of Europe, but in this country has a peculiarly local distribution occurring in Surrey, Hampshire and Dorsetshire and in the same sandy localities favoured by the Sand Lizard upon which it preys. The snake bears a very superficial resemblance to the common Viper, from which it may be immediately distinguished by its more slender shape and the absence of the dark zigzag vertebral band. Further the pupils of its eyes are round and not vertical slits as in the Viper.

Its relative, the black and white or black and yellow King Snake, *C. getula*, of North America reaches a length of six feet. It wages war on other snakes, including such deadly forms as Moccasins, Copperheads and Rattlesnakes. Whilst it is immune to the poison of New World snakes, playing the part of a benevolent cannibal, experiments have curiously enough shown that it invariably succumbs to cobras and other poisonous snakes inhabiting the Old World.

The short-bodied Hog-nosed Snake, *Heterodon platyrhinos*, also of North America, is so called on account of the reptile's up-turned snout. The Hog-nosed Snake seldom bites, but when disturbed stages a mock tragedy. When threatened, the snake inflates its neck to form a hood, but if this exhibition of frightfulness fails in its object, it falls into apparent convulsions and finally rolls over and remains motionless as if dead. The snake will remain perfectly still for a considerable time and will only crawl away when convinced that all danger is over.

The Egg-eating Snake, *Dasyveltis scabra*, of South and West Africa is the sole representative of the sub-family *Rhachiodontinae*. It feeds exclusively upon eggs, its teeth, which are minute and reduced in number, being specially adapted for the purpose. A snake's immense plasticity of skull is seen at its maximum in the Egg-eating Snake. Between meals the head measures little more than three-quarters of an inch across yet it can surround a hen's egg—a much more remarkable feat than the swallowing of a pig or deer on the part of the python. The unyielding egg is taken entire and remains whole until it reaches the entrance of the gullet. The distorted head then falls into its normal formation and certain enamel tooth-like projections on the under surface of the vertebrae come into play. They crush the egg shell, powerful muscles force the yolk into the snake's interior and the shell, cracked into a hundred pieces but held together by its membranous lining, is presently expelled in the form of a pellet. The Egg-eating Snake is able to estimate the contents of an egg before the shell is broken since captive specimens will turn away when confronted with an egg that is not "new laid".

The *Ophistoglypha* or Back-fanged Snakes are, as a rule, perfectly harmless, their poison being only sufficiently active to paralyse their prey. The five-foot long Boomslang, *Dispholidus typus*, of Tropical and South Africa is an exception, being as dangerous as the Puff Adder or Cobra.

The section is divided into three sub-families †

1. The *Homalopsinae*—entirely aquatic snakes with valvular nostrils situated on the top of the head.

2. The *Dipsadomorphinae*—with lateral nostrils.
3. The *Elachistodontinae*—with rudimentary teeth.

A few members of the *Homalopsinae* are marine, feeding on fish and crustaceans. All are viviparous.

The *Dipsadomorphinae*, the typical back-fanged snakes, are represented by eighty genera. The majority are arboreal in their habits and feed on birds and lizards.

Kirtland's Tree Snake, *Thelotornis kirklandii*, of tropical Africa is greenish brown or pinkish brown in colour. Its very thin and elongate body harmonises with the branches of bushes in which it lives. When the reptile is excited it distends its neck, which becomes globular in shape.

The reddish-brown Annulated Snake, *Leprodira annulata*, of the West Indies and Tropical America has a large head distinct from the neck and a large eye with a vertical pupil. Specimens of this snake are frequently received at the London Zoo from Covent Garden Market, the snakes arriving in this country concealed in bunches of bananas.

The so-called Flying Snake, *Chrysopaelea ornata*, of India and Ceylon is remarkable for its habits of taking flying leaps from one tree branch to another or from the top of trees to the ground. The snake does not, of course, actually fly, but has the habit of parachuting when its ventral surface becomes concave. Major Stanley Flower has given an account of captive specimens which leaped from the windows at the top of his house downwards and outwards to the branch of a tree—a distance of several yards. The Flying Snake is green or black in colour and is a constrictor feeding on rodents, birds and lizards.

The green Whipsnake or Eye-poking Snake, *Dryophis mycterizans*, of India is an extremely attenuated serpent which coils its thin prehensile tail tightly round tree branches. Using its tail as a leverage, it flicks itself like a living whiplash at the birds and lizards that come within reach, striking in this manner from a distance of several feet. Its native name of eye-poking snake refers to its alleged custom of striking at the eyes of any human intruder.

The very poisonous Front-fanged Snakes (*Proteroglypha*) inhabit Asia, Africa, Australia and America. The anterior teeth of the upper jaw are grooved and connected with large poison glands. The front-fanged snakes are divided into two sub-families—the *Hydrophinae*—Sea Snakes—and the *Elapinae*—Land Snakes.

The Sea Snakes, all of which are poisonous, inhabit the tropic parts of the Indian and Pacific Oceans, spending, with a

few exceptions, the whole of their life in the sea. Although they are usually found floating on the waves, they can dive to great depths owing to the dilatibility of their lungs which are capable of storing large reserves of air. The most striking feature of a sea snake is its paddle-shaped tail, which is as a rule prehensile enabling the serpent to obtain a firm hold by twisting this organ round corals or seaweeds. The nostrils, which are valvular, are placed on the top of the head and are open when inhaling air on the surface and closed when under water. The prey of these reptiles consists almost entirely of fish, which are killed by the action of the poison before being swallowed. The largest sea snakes do not attain a length of more than nine feet.

The terrestrial Coral Snakes (*Elaps*) are usually beautifully ornamented with scarlet, yellow and black bands and exhibit what has been called "warning colours". In spite of their comparatively small size, they are most dangerous and are regarded in America as being as poisonous as the largest Rattlesnakes. After striking at its victim, the Coral Snake does not immediately withdraw, like the majority of other snakes, but hangs on like a bulldog, with the result that the maximum amount of venom enters the wound. Coral snakes are distributed over the Southern United States and Central and South America. The head is small and rounded and not distinct from the neck and the body is elongate and cylindrical. The poisonous properties of the Kraits (*Bungarus*) of South-east Asia is very highly developed. Fortunately the disposition of these snakes is a passive one and they seldom bite unless trodden upon.

The common Krait, *B. candidus*, reaches a maximum length of four feet. It is dark brown or bluish black above, striped or spotted with white. The Banded Krait, *B. fasciatus*, which is marked with bright yellow and black rings, has the same distribution as the common Krait. Kraits feed not only on small mammals, but on other snakes.

In the Cobras, genus *Naja*, the neck is dilatable, the resulting hood being supported by the anterior ribs. The head is distinct from the neck and the eye is large. About a dozen species of Cobra are known to-day, seven of which come from Africa, the others from India and the Far East. All are very poisonous and characterised in a varying degree by the hood which is spread under the influence of anger or other excitement. Whilst all cobras justly claim the respect due to all deadly animals, the Indian Cobra, *N. tripudiens*, has always been the most famous. Though it takes an annual toll of many hundreds of human lives, it is worshipped by millions as it is regarded as the snake that once sheltered Buddha from the sun by spreading its hood above him as he slept. The typical Indian Cobra has a spectacle-

shaped marking on the upper surface of the neck. Other varieties of the species may be ornamented with rings or other markings. In a variety from South-eastern Asia, the hood is uniformly dark brown or black. Although the fangs of the cobras are not very large their lethal potentialities are great and this combined with their spectacular attitude has impressed itself upon human imagination in an unusual degree. Cobras, moreover, by their fondness for haunting cellars, temples, bungalows, etc., come into contact with humans more than most snakes—a habit not prompted by any sinister intent, but merely the outcome of their love of retirement and their fondness for vermin.

The most intelligent of an intelligent race is the yellowish-brown King Cobra or Hamadryad, *N. bungarus*, of Indo-China and Malaya—a serpent also claiming the distinction of being not only the fiercest but the giant among venomous snakes. A specimen received at the Zoo Reptile House a few years ago measured eighteen feet four inches in length. The King Cobra uses its venom largely to slay serpents, poisonous or otherwise, a habit which renders it something of a human benefactor, living as it does in a country literally swarming with noxious snakes of every kind. Though essentially a snake-eater, its great intelligence usually permits it to avoid vipers whose fangs make deep lacerated wounds. Some years ago, the London Zoo's first King Cobra was placed by an ignorant keeper in a small cage with six common cobras. Morning light found "the King" only in possession, the others having disappeared into his interior. The snake's dinner cost the Zoological Society £18 since the other snakes were on deposit from a dealer and valued at £3 each. A bite from a King Cobra produces death in man in under two hours and according to a recent account published in an Indian journal, an elephant bitten on the trunk by this snake died within three hours.

The Asp or Egyptian Cobra, *N. haje*, figures largely on Egyptian monuments. The Egyptian Cobra together with the Indian species is the favoured item in the stock-in-trade of snake charmers.

The Rhinghals Cobra of South Africa, *Sepedon haemachates*, shares with certain West African cobras—*N. melanoleuca* and *N. nigricollis*—the alarming faculty of being able to inflict its poison upon a victim without making contact. So powerful is the compression of the glands and ducts which force the venom out at the tip of the fangs that it can be ejected in two thin streams to a distance of several yards. Motor goggles are invariably used by the Zoo staff when introducing food into the cages of the spitting snakes. The venom may often be seen to splash against the glass front of the cage. Should it enter an open wound

serious consequences may result, whilst a charge entering the victim's eyes may cause weeks of or even permanent blindness.

The members of the genus *Dendraspis*, known as Mambas, inhabit Tropical and South Africa. The Common Mamba, *D. angusticeps*, of Tropical and South Africa grows to a length of nine feet. It has the reputation of being very poisonous and aggressive, instantly pursuing an intruder venturing anywhere near it. There are two varieties of this Mamba—the Green Mamba and the Black Mamba. The former makes its home amongst the branches of trees and often chooses to lie entwined in the branches of those overhanging paths cut through the forest. As a result natives are frequently bitten on the head or shoulder whilst passing under a branch. The Black Mamba seldom ventures far from the ground and is most commonly found in the neighbourhood of farm buildings, where it feeds upon rats and mice.

The majority of snakes found in Australia are members of this sub-family of front-fanged snakes. A deadly representative is the so-called Death "Adder", *Acanthophis antarcticus*, which has a viperine appearance, having a stout body with a head very distinct from the neck. The snake which also occurs in Malacca and New Guinea, is reddish brown in colour with black cross bars.

✓ In the Vipers—Family *Viperidae*—the poison fangs are fixed to a much shortened maxillary bone which is movable vertically and, as a result of this mechanism, the very large fangs may be raised or lowered. The family is divided into two sub-families, the *Viperinae*—the true Vipers of the Old World and the *Crotalinae*—the Pit Vipers of South-eastern Asia and America, which are distinguished by the presence of a very deep pit situated on each side of the snout between the nostril and the eye. As the name Viper suggests, the majority are viviparous, only a few laying eggs.

The Common Viper, *Vipera berus*, is the only poisonous snake inhabiting the British Isles. This snake, which is very abundant on heaths and downs, awakes from hibernation towards the beginning of March. It differs considerably in colour and may be pale silver grey, slate grey, light brown, reddish or dark brown with a black zigzag line down the centre of the back. The pale specimens are almost invariably males whilst the dark brown or reddish brown ones are females. The snake bears its initial, a V-shaped marking on the back of the head.

The young, up to twenty in number, are born in the late summer in a very active condition and on approach of human

beings they sometimes disappear with lightning rapidity, thus giving rise to the statement that when in danger the mother viper swallows her young. The story is to be explained by the fact that the spectator is the victim of an optical illusion. On the mother being opened up she is found to contain active young which are not the snakes that have already been born, but unborn young about to be expelled. The largest British Adder on exhibition at the Natural History Museum at South Kensington measures twenty-nine inches.

Russell's Viper or Tic polonga, *V. russelii*, is found in India, Ceylon, Burma, Siam and Sumatra. The coloration of this justly dreaded snake is of a very pale grey or brown with a series of black, light-edged rings which encircle brick-red spots. With the exception of the Hamadryad, this Viper is more venomous than any of the other snakes, its bite killing dogs in under an hour and man in under twenty-four hours.

In the Tropical and South African snakes of the genus *Causus*, the head is not very distinct from the neck and is covered with large symmetrical shields. The snakes are remarkable in that the poison gland is very elongate and is produced along the anterior third of the body on each side. The South African Night Adder, *C. rhombeatus*, grows to a length of three feet. Unlike most vipers, it does not produce living young, being an egg-laying species.

The snakes of the genus *Bitis* are very impressive, being massively built serpents some five feet in length and with enormous heads. The Gaboon Viper, *B. gabonica*, and the Nose-horned Viper, *B. nasicornis*, are extremely evil-looking. The general pattern of the skin of the former consists of a chain of rich brown hour-glass shaped blotches on a lighter brown background with blotches of brown and purple intermingled with the main theme, the whole presenting a design only comparable to some complex achievement of the weaver's art. The Rhinoceros Viper, which is usually resplendent in purple, red and yellow, owes its name to an erection upon the snout which may attain a length of fully an inch.

The Puff Adder, *B. arietans*, which is found over a large part of Tropical and South Africa, is so called from the fact that when disturbed it hisses violently with each inhalation and expulsion of breath, the hissing sounds being audible at a distance of several yards. The Puff Adder is dark grey or brown in colour ornamented with black chevrons separated by white or pale yellow crescents. It is a much-dreaded snake in South Africa, but its poison is not very violent and its bite as a result is not as a rule fatal. It grows to a length of four feet.

The small vipers of the genus *Cerastes* inhabit the desert regions of North Africa, Arabia and Palestine. They are yellowish

or light brown in colour and harmonise perfectly with the sand in which they live. The North African Horned Viper or Asp, *C. cornutus*, which is alleged to be the serpent figuring in the suicide of Cleopatra, is usually found hidden in the sand with only the horns on its head visible. When excited the Asp rubs the coils of its body against one another causing by the friction of its scales a loud rustling sound similar to and nearly as loud as those produced by an infuriated rattlesnake.

The Pit Vipers (sub-family *Crotalinae*) are represented by four genera—*Agkistrodon*, *Lachesis*, *Sistrurus* and *Crotalus*. In the latter two genera the tail ends in a rattle. The fangs in all are very highly developed. In the rather short and stout snakes of the genus *Agkistrodon*, the upper surface of the head is covered with large shields. Two well-known species are the Water Moccasin, *A. piscivorus*, and the Copperhead, *A. contortrix*, both of North America. In the Moccasin the general colour is brown above with dark vertical bars on the sides of the body. A white, pale yellow or dark brown stripe passes from the eye to the angle of the mouth. The very beautiful Copperhead is yellowish or pale reddish above with brown or brick-red cross bars. Both, and especially the Moccasin, are very aquatic, being found in the neighbourhood of rivers and ponds. The Moccasin is omnivorous, feeding on fish, frogs, mammals and even other snakes. A specimen that was kept some years ago at the Clifton Zoological Gardens was fed entirely on raw meat, which it devoured from a plate.

In the somewhat more slender snakes of the genus *Lachesis* of South-eastern Asia and Central and South America, the upper surface of the head is covered with scales or very small shields. An interesting member of this genus is the Temple Viper or Sacred Viper, *Lachesis purpurimaculatus*, of South-eastern Asia, which attains a length of three feet. It is worshipped by the natives and encouraged to take up residence on their property. In the snake temple at Penang the reptiles cover the altar and altar steps and are looked after by the priests. The temple Viper is usually bright grass green or bluish green in colour, but old specimens may become blackish.

The Fer-de-lance or Jararaca, *L. lanceolatus*, of Brazil and certain islands in the West Indies attains a length of over six feet. It is justly dreaded in the island of Martinique, where it is very abundant in the coffee and sugar plantations and where it annually accounts for many deaths. It is usually brown or grey in colour with dark spots or cross bars and with dark triangles on the sides enclosing pale centres. The snake is in the habit of vibrating the end of its tail when excited or alarmed and this when rustling among dead leaves produces sounds similar to

those of the rattlesnake. In certain parts of Brazil a premium was many years ago placed upon the head of this reptile. Payments had, however, to be abolished for as soon as the scheme was adopted, the natives took to breeding the snakes in captivity. When it is considered that it brings forth over fifty young at a birth, it is not surprising that the rewards had to be discontinued.

The Bushmaster, *L. mutus*, of Central and Tropical America is pinkish in colour with large black markings. The snake, which inhabits forest districts, is oviparous. According to Mr. R. R. Mole who made this discovery, the eggs are larger than those of a duck and are incubated by the female who coils round them until they are hatched.

The very poisonous Rattlesnakes, of which about twenty species are recognised, are represented by the genera *Crotalus* and *Sistrurus*. In the former genus the upper surface of the head is covered with scales or small shields whilst in the latter it is covered with nine symmetrical shields. The rattle of these snakes consists of a number of segments of dried horny skin fitting into one another and the rattle sounds are produced merely by shaking the apparatus as the reptile does when disturbed. It is often believed that the age of these snakes can be told by the size of the rattle, each segment representing a year. This is an error as an additional segment is added after each shed of the skin. The shedding takes place three or four times a year, whilst a number of segments are continually being lost owing to wear and tear. At birth the snake has merely a small button to represent the rattle. Rattlesnakes inhabit America and Southern Canada, British Columbia and Brazil and Argentina. The members of the genus *Crotalus* are mostly of large size. They attain a length of over eight feet and inhabit dry rocky districts, where they feed on small rodents.

The "rattlers" of the genus *Sistrurus* are small, seldom attaining a length of over two feet. They frequent the swampy districts of the South-Eastern United States, where they feed almost entirely on frogs.

AMPHIBIANS

Class *Amphibia*

THE early days of most amphibians are spent in water, and only a few are entirely independent of water in the adult stage. Zoologically, the group stands mid-way between the reptiles and fishes. Many amphibians are distinctly reptilian in general shape, and all—like fishes—are gilled, at least in the larval stage. They differ from reptiles in the skull, articulating by means of two condyles instead of one, and save in a single group, the limbless *Apoda*, have scaleless skins. The class is of immense antiquity, and had its heyday in the carboniferous epoch, many millions of years ago. Some then reached almost the dimensions of crocodiles, which they resembled in appearance. Living amphibians are mostly of small size, a few only exceeding a foot in length. Although cold blooded, they enjoy a rather more northern range than the reptiles, but reach their maximum both in size and numbers within the sub-tropic belt.

The Class is divided into three main groups or orders :

1. The Anura, or Tailless Amphibians: Frogs and Toads.
2. The Urodela, or Tailed Amphibians: Newts and Salamanders.
3. The Apoda, or Limbless Amphibians: Caecilians.

The Anura are short-bodied creatures, the members of the remaining groups having cylindrical forms. In the majority the neck is scarcely discernible. The head in Amphibians is generally broad and flattened, and the eyes are large in the tailless but often small in the tailed species. They are protected by upper and lower lids, and a transparent, nictitating membrane, which moves vertically and is of special use to the land forms when submerged. The pupil varies much in both its dilated and contracted form, being generally round and horizontal in the tailed species, and either round, triangular, horizontal or vertical in the tailless species. The ear is rudimentary in all save some of the tailless amphibians, where it is represented by a circular "drum" just behind the eye. The corners of the mouth generally extend to behind the eyes, and the jaws may be toothless or provided with small but often very sharp teeth. The nostrils have internal openings at the back of the palate. The tongue is absent in a few aquatic frogs and toads; in most forms it is either rooted more or less completely to the floor of the mouth, or extensible to a considerable degree, the club-

shaped tip being sometimes adhesive for the better capture of insect prey.

In the Anura the hind limbs are much longer than the fore limbs, but in the Urodela they are of approximately equal length. There are in most forms four fingers and five toes, the latter being frequently united by a web.

The tail in the Urodela is cylindrical in land forms, but in aquatic kinds is flattened to form an effective paddle. In the European genus of newts, *Euproctus*, it is prehensile. Sense organs exist on the sides of the head and body in many newts, all tadpoles, and the aquatic frog *Xenopus*. The skin, like that of reptiles, is periodically changed, being turned inside out in the process.

TAILLESS AMPHIBIANS

Order *Anura*

FROGS and Toads are creatures of compact, more or less globular body form, with short fore limbs. The order to which they belong comprises about 1,200 species, and is divided into:

(a) The tongued *Phaneroglossa*, and (b) the tongueless *Aglossa*.

The *Phaneroglossa* are further divided into:

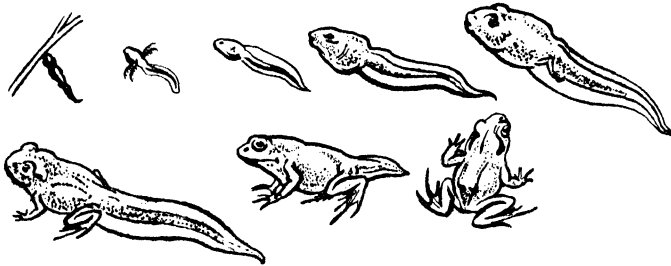
(1) The *Arcifera*, having the two halves of the shoulder girdle free and overlapping, and (2) the *Firmisternia*, in which they are fixed by a firm bridge of cartilage.

Like all amphibians, the skin of frogs and toads is highly absorbent, and plays an important part in respiration, for which reason the majority live in or near water. The few desert species are subterranean, venturing out only at night. The skin is further highly charged with glands, often forming blister-like patches or elliptical masses behind the eyes. These glands secrete toxic fluids, varying considerably in virulence. In medieval times they were much used in so-called "Medicine", and are even to-day largely responsible for the group being held in dread by ignorant persons. In this connection it may be mentioned that the glandular secretions are only dangerous when introduced into a wound. The fluid secreted by a Colombian Frog, *Dendrobates*, is, however, sufficiently virulent to be used by the Indians for poisoning arrows. It is obtained by holding the frogs in a pan over a fire, and a single specimen will yield enough poison for about fifty arrows.

Frogs and toads lay their eggs usually in gelatinous masses, the number of eggs varying greatly in the various species. The approximate number of eggs laid by the Common Toad is 6,000, by the Common Frog 3,000, by the European Tree Frog 900, by the Edible Frog 10,000, and by the Green Toad 11,000. In the great majority of amphibians the eggs are deposited in water, the period of "incubation" varying with the temperature. The young usually emerge in the well-known form of tadpoles, breathing by external, tree-like gills and at first anchoring themselves to weeds by a sucker on the under-side of the head. In many cases where only a few eggs are laid these receive special protection. They may be protected by means of nests—in the water, on trees, bushes or rocks overhanging water, or on trees or plants away from the water. They may also

be nursed and guarded by the parents. They may be carried about by the parent, encircled round the legs of the male, on the back of the female, or they may be attached to the female's undersurface. The eggs may also be carried in the mouth or gular pouch of either parent. Normally the sex proportions in an egg mass are 50-50, but an insufficiency of water may result in a surplus of females. Iodine added to the water has an opposite effect. In the tadpole form the food consists largely of algae, but is soon changed for animal food, and all adult amphibians are strictly carnivorous.

The true Frogs (Family *Ranidae*) are world-wide in distribution, exclusive of the Southernmost regions of South America,



Metamorphosis of the Common Frog, from leaving the egg to final absorption of gills and tail, and development of limbs

most of Australia, and New Zealand. Teeth are present in the upper jaw only.

The genus *Rana* includes the Common Frog, *R. temporaria*, abundant throughout North and Central Europe, North Asia, East Siberia and North Japan. The skin is smooth and varies from olive to reddish brown with darker markings. The male has more pronouncedly webbed toes than the female. The breeding season in England occurs towards the middle of March. The well-known egg masses formed of perfectly round eggs are laid indiscriminately in the first water available, often coming to an untimely end where an early drought causes the water to dry up. In the breeding season the male develops swollen pads on the inner fingers for the purposes of clasping the female, and a pair of internal vocal sacs, which give, however, only a very feeble carrying power to the voice. The eggs hatch in two or three weeks, and by May or June the tadpoles have developed two pairs of limbs, absorbed gills and tail, and become frogs. In the Far North tadpoles may delay the full change until August, and even be obliged to hibernate.

The more aquatic Edible Frog, *R. esculenta*, is found throughout Europe, West Asia and North-West Africa. It has been

introduced into England. It is distinguishable from the common frog by the sharp snout and dark green or olive colour, marked with black. The green tint is produced by a mixture of black and yellow pigment, pure blue or green being unknown in amphibians. It is an essentially aquatic species, and has long been farmed on the Continent, where the hind limbs, which resemble chicken in flavour, are regarded as a great delicacy. The male croaks loudly during May and June and is the possessor of a pair of very large, inflatable sacs on each side of the head. The eggs, up to 10,000 in number, are similar in shape to those of the common frog, but unlike those of the latter do not float.

A large number of bulky frogs are commonly spoken of as bull frogs, but the true Bull Frog immortalised in Uncle Remus is *R. calesbiana* of Eastern North America, where it is farmed for food. An adult measures about eight inches long, and has a voice in proportion. Unlike the common and edible frogs which are almost exclusively insectivorous, this species will devour any kind of living animal food, from worms to small birds and water voles.

The Giant Frog, *R. goliath*, of the Cameroons is the largest of the Anura, measuring nearly twelve inches long. It is immensely powerful, and the first specimen which it was attempted to bring to Europe forced the lid of a ten-gallon spirit drum containing it and escaped.

R. Opisthodon of the Solomon Isles lays its globular eggs in rock crevices above running water, and here they hatch, the young passing through the usual metamorphosis within the egg shell and emerging as perfect miniature frogs.

The members of the allied genus *Arthroleptis* are small and very slender frogs with long limbs.

A. Seychellensis, from the Seychelle Islands, is unique in that one of the parents carries the twelve or more tadpoles about on its back, where it is believed the greater part of their metamorphosis is undergone.

Rhacophorus is an arboreal genus numbering some fifty species from the East Indies, China, Japan, and Madagascar. Both hands and feet are sometimes completely webbed, and as in the true tree frogs the tips of fingers and toes bear flattened adhesive pads. In one of these frogs, the hands and feet are so extensively webbed that they enable the frog to take flying leaps from the top of high trees to the ground.

R. schlegelii of Japan is remarkable in that the male and female make a subterranean "nest" on the edge of a flooded rice field where the earth is damp. Having installed the eggs in a frothy secretion, beaten into a lather with the feet, they leave a passage

way leading to the nearest water, which the tadpoles gain soon after hatching.

In *R. malabaricus* of India the eggs are laid in nests formed of foam and attached to the leaves of trees and bushes overhanging water into which the tadpoles fall at an advanced stage of their development.

In *R. reticulatus* of Ceylon, the eggs are carried for some time attached to the mother's undersurface.

In the members of the Family *Dendrobatidae*, represented by a number of small forms from West Africa, Madagascar and South America, the jaws are toothless.

The genus *Dendrobates* is arboreal and confined to tropic America. *D. trivittatus* is a native of Brazil and Peru, where it spawns in shallow pools. These quickly dry up by evaporation and the male spends his time shifting the tadpoles from one pool to another, transporting the family on his back. *D. tinctorius* is the species providing poison for arrows, and its venom is also stated to be used for dyeing green parrots yellow, the colour of the feathers changing on being rubbed with the living frog.

The Family *Engystomatidae* includes a large number of small frogs having narrow mouths adapted for picking up ants, upon which most of the members feed. They may be terrestrial, aquatic, or subterranean. All agree in having toothless jaws.

The genus *Rhinoderma* is represented by the famous "Darwin's Frog", a minute species in which the male swallows the eggs, secreting them in an enormous throat pouch which covers the whole of the undersurface. The entire metamorphosis takes place within this vocal sac.

Phryniscus nigricans of South America, a member of this family, is remarkable in that when alarmed it rolls over on its back displaying its brilliant scarlet and orange undersurface. During the breeding season both sexes give vent to their emotions by uttering a musical call which almost exactly resembles that of our native Greenfinch.

The Family *Cystignathidae* is represented in America and Australia by aquatic, burrowing, terrestrial and arboreal species. Its members belong to the division *Arcifera*, in which the two halves of the shoulder girdle overlap. All the frogs previously described belong to the division *Firmisternia*, in which they are fixed.

An outstanding genus is that of *Ceratophrys* from South America. Some representatives have a bony shield beneath the skin.

The big, brightly-coloured, so-called Barking Toad, *C.*

ornata, is probably the fiercest of all the tailless amphibians. It has a movable prominence above each eye, and commonly lies half-buried in earth. When enraged it swells up like the frog in the fable, and utters loud squawls like those of a peevish infant. Its food consists of other frogs, mice and birds. In *C. cornuta* the eyelids are produced into large horn-like appendages.

Leptodactylus ocellatus of tropic America, which resembles a typical frog, has remarkable breeding habits. It lays its eggs in a miniature swimming bath, made by enclosing a small piece of water on the edge of a pond by means of a mud wall.

Other members of this same group deposit their eggs in foamy masses beneath leaves, leaving the larvae to be washed into the adjacent stream or pond by tropical showers.

Hylodes is an arboreal genus and its representatives have the fingers and toes dilated at their tips. *H. martinicensis*, from the West Indies, was for years "naturalised" in some of the hot-houses at Kew Gardens. The young undergo their entire metamorphosis within the egg.

Chiroleptes of Australia is a burrowing genus. One species, *C. platycephalus*, is remarkable in retaining large quantities of water in the body cavity, helping it to withstand long droughts. This fact is appreciated by the natives, who collect it when drink is otherwise scarce, one frog supplying a wineglassful of water. The eggs laid in puddles hatch very rapidly but suffer a heavy mortality as the result of the puddles evaporating.

The Family *Bufo*nidae, the true Toads, includes types with arboreal, burrowing, terrestrial and aquatic habits. About a hundred and twenty species are known and they are widely distributed, being excluded only from Madagascar and certain Pacific islands. They are all toothless, large headed and warty.

The Common Toad, *B. vulgaris*, of Europe and North-West Africa and most of temperate Asia, is familiar to all in this country, where until a century or less ago it was an object of superstitious dread. It is nocturnal, and a valuable ally of the gardener, destroying slugs, worms, and other noxious insects. It deposits its eggs in long, gelatinous strings, the ovules being disposed two abreast. The eggs are laid somewhat later than those of the Common Frog, usually in early April, and a rigid conservancy is shown in selecting the water destined to receive them. Toads will trek many miles, year after year, to the same "ancestral" pond, travelling usually by night, and overcoming all obstacles in their path. In spite of many old tales relating to the toad's power of living indefinitely "walled up", experiments show its power of survival in this direction does not exceed a year. It should be remembered that even when

apparently completely incarcerated, small insects generally find their way into the retreat and so provide a meal. Save at mating time the toad is very terrestrial in habits. It is far the most intelligent of amphibians, soon learning to recognise a human owner and to feed from his hand. In Jersey and certain parts of Southern Europe the common toad attains a length of nearly six inches. The males are always much smaller than the females.

The Natterjack Toad, *B. calamita*, is a smaller species, with a blunt nose. It inclines to a greenish or olive tint with dark markings and a warty skin. A yellow vertebral line extends along the middle of the back. It affects sandhills near the sea. In our islands it is commoner in England than in Scotland and Ireland. Being short-limbed it does not hop but scrambles along in a manner more suggestive of a mouse than an amphibian. The breeding season is prolonged and extends from the end of April until the middle of August.

The Giant Toad, *B. marinus*, of South and Central America and the West Indies may measure fully six inches in length. The head bears prominent bony ridges. Despite its large size the young are only a quarter of an inch long when fully emerged from the tadpole state.

Nectophryne is a genus of toads from Africa and Southern Asia remarkable in having suctorial finger tips, as in tree frogs, and in bringing forth fully-formed young.

The Family *Hylidae* includes about two hundred species of frogs most of which are arboreal, and have dilated and suctorial tips to all the digits. Only the upper jaw is toothed.

The Common Tree Frog, *Hyla arborea*, is a small species, usually vivid green in colour. The male has a highly distensible vocal sac which, when in use, swells like a large bladder below the chin. The breeding season is usually in May, when the eggs, about 900 in number, are laid in clusters on submerged water weeds. This frog has a very wide distribution, being found in Europe, Asia, Madeira, and the Canary Islands.

The members of the genus *Hyla* are distinguished for their resonant voice, one species, *H. Faber* of Brazil, having earned for itself the title of "coppersmith". It builds circular nurseries, with mud walls, on the edges of ponds for the deposition of its eggs.

White's Tree Frog, *H. coerulea*, of Australia attains a length of four inches. During the breeding season the male is provided with enormous dagger-like spines situated on the inner side of each fore-finger.

H. goeldii of Brazil and *H. evansii* of British Guiana have

remarkable breeding habits. The eggs, about two dozen in number, adhere to the female's back, where they remain until the young frogs hatch out.

Phyllomedusa is a small genus confined to Tropical America. *Ph. inheringii* lays its eggs in leaf cradles overhanging water-courses, into which the larvae fall at an advanced stage of their development. In *Notatrema* the female carries the eggs in a pouch beneath the skin of her back. The young have enormous bell-shaped gills.

The Family *Discoglossidae* includes the handsome Painted Frog, *Discoglossus pictus*, of South Europe and North Africa. It lays its extremely small eggs singly on the bottom of a pond, the larvae attaining to frog status in one to two months.

The genus *Bombinator* includes the well-known Fire-bellied Toad, *B. igneus*, and Yellow-bellied Toad, *B. pachypus*, of Europe, conspicuous by their luridly-coloured undersides, which they display when disturbed by throwing themselves into grotesque postures, thus warning off possible foes. Freshly caught specimens of these toads sham death. Having gone through various antics they suddenly bend their spines, turn up their heads and hinder part of their bodies and remain motionless until the supposed danger has passed. The Fire-bellied Toad breeds only in clear water, but the Yellow-bellied Toad will deposit its eggs in dirty pools or even puddles.

The genus *Alytes* includes the remarkable European Midwife Toad, *A. obstetricans*, the male of which undertakes the incubation of the eggs. As soon as the eggs, laid in rosary-like strings, emerge he twists them round his hind legs, and then repairs to some underground retreat, coming out at night only to bathe the eggs in the nearest pool, or failing that, in dew. When instinct apprises him that the eggs are about to hatch he makes for some convenient pool in which to launch the tadpoles.

The Sub-order *Aglossa* is represented by a single family, the *Pipidae*, which includes certain tongueless frogs of aquatic habit.

In the Clawed Frog of South Africa, *Xenopus laevis*, the three inner toes are clawed and the hind feet bear enormous webs, suggesting umbrellas. Though known occasionally to travel overland, it is normally completely aquatic. About a hundred eggs are laid singly, attached to aquatic plants, and the tadpoles possess long tentacles dependent from the head which serve as balancers. A smaller species, *X. calcaratus*, comes from West

Africa. In common with the rest of the family these toads have very small eyes.

The Surinam Toad, *Pipa americana*, has a depressed, triangular head with short tentacles in front of the eye, and star-like terminations to its fingers. This grotesque creature's breeding habits were unknown until observed at the London Zoo in 1896. The eggs as laid are pressed by the male into the skin on the back of the female, which, during the breeding season, becomes spongy. Each egg sinks in and becomes covered by a drum-head of skin, like the cellophane cover of a jam pot. Thus incarcerated, the tadpole stages are passed through, the brood finally emerging as perfectly formed toads.

TAILED AMPHIBIANS

Order *Urodela*

THE Tailed Amphibians are less adapted for a varied existence than the Anura, and as a result are less numerous. Most are provided with two pairs of limbs, a few with the anterior pair only. All have cylindrical bodies varying from lizard-like to eel-like forms. The group is divided into four families.

The large family *Salamandridae* includes the true Salamanders and Newts. They are gill-less in the adult form, have well-developed eyes, teeth in both jaws, two pairs of limbs, and a long tail.

The Spotted Salamander, *S. maculosa*, is common throughout Central and Southern Europe, and ascends to an altitude of 3,000 feet. It is handsomely marked with black and yellow, scarcely two specimens bearing identical patterns. It is largely subterranean by day, emerging at night, often in large numbers, to devour earth worms. The female releases ten to forty gilled larvae in a convenient pond or small stream, merely taking a hip-bath for the purpose. The larvae are ready for terrestrial life in about six months, and reach maturity in four years.

The entirely Black Salamander, *S. atra*, lives in the Alps at altitudes above 2,500 feet. It produces two young only, which are born in the fully-formed, air-breathing condition.

The Newts (*Molge*) are aquatic during the breeding season and have compressed tails. They are represented in our islands by the Common Newt, *M. vulgaris*, the Crested Newt, *M. cristata*, and the Palmated Newt, *M. palmata*. The males put on picturesque dresses in the spring, consisting in some cases of high festooned dorsal crests, and thus attired they engage in grotesque nuptial "displays".

The Alpine Newt, *M. alpestris*, common throughout most of Europe, reaches a length of about four inches and is generally a uniform dark green, brown or blackish colour above, orange or red below.

The very aquatic Pleurodele Newt, *M. waltii*, is unique in this numerous clan by reason of its ribs, which are peculiarly long and so pointed as sometimes to pierce the skin. It comes from Spain and Morocco.

Amblystoma, known by twenty species, is made familiar by *A. tigrinum* of North America and Central Mexico, which has a great vogue amongst aquarists in its larval form. Known as the Axolotl, this curious creature, reaching some six inches or

more in length, may spend its whole life in the aquatic, gilled stage, laying fertile eggs whilst in this "immature" condition. Reduction of its water supply—as by drought—may, however, cause it to lose its gills and fins on the back and tail, develop eyelids and seek terrestrial life as a Salamander. Administrations of thyroid gland similarly hasten its change into the *Amblystoma* or terrestrial form. Axolotls abound in the vicinity of the city of Mexico, where they are a popular article of diet.

A remarkable representative of the Japanese genus *Hynobius* is *H. Keyserlingii*. The eggs are laid in a gelatinous bag suspended from the bough of a tree overhanging water, with the lower end submerged. The larvae, when hatched, break through the bag and swim away.

Spelerpes is a European and Central and South American genus, represented by about twenty species. An outstanding feature of these Salamander-like animals is the manner in which they shoot out their tongues to a considerable distance when catching the insects upon which they live. *S. fuscus* inhabits limestone caverns in France, Italy and Sardinia. The young of the European species are produced alive, but most other members of the genus deposit eggs.

The family *Amphiumidae* contains three aquatic genera represented in the United States and Eastern Asia. There are no gills in the adult although gill openings are occasionally present. There are teeth in both jaws, and the fore and hind limbs are generally well developed.

Megalobatrachus is represented by two species. *Megalobatrachus maximus* of China and Japan is the largest living Amphibian. Adults reach over five feet in length and are near relatives of the great extinct Salamander known by fossil remains from Miocene deposits in Oeningen, Baden. This animal, which was about four feet long, was described by its discoverer in 1726 as a fossil man—*Homo diluvii testis*—"Man a witness of the deluge".

The living Giant Salamander is a sluggish dark-brown creature with a flattened head, minute eyes, a deep fold of skin running from thigh to armpit, short limbs with blunt digits, and a long, paddle-shaped tail. The tuberculated skin gives out when handled an irritant secretion which solidifies on contact with the air. The creature is solitary, and lurks beneath boulders in clear mountain streams, where it lives on fish, worms, and crustaceans. It is esteemed as food, and is readily taken with hook and line. It deposits its eggs in late summer, the ova forming rosary-like strings. These are guarded by the male, who aerates them by periodically getting beneath them and lifting the mass with his body. The emergent larvae show external

gills and rudimentary limbs. This Salamander has bred in the Amsterdam aquarium and is known to live for at least fifty-two years; its potential life-span is probably much longer.

M. sligoi is not unlike the above, but with an even more flattened head. It is known only by a single specimen which appeared fifteen years ago in the Hong Kong Botanic Gardens, where it made a dramatic entry *via* a burst water main during a cloud burst. The animal, which measures over three feet in length, was presented by the Marquis of Sligo to the London Zoo, where it still lives.

Cryptobranchus alleghaniensis, a species represented in the Eastern United States, is inferior in size to either of the foregoing. It is remarkable in having the neck pierced by two small holes. The Hellbender, or Water Dog, as this creature is called, lives in rock crevices, as does the Japanese Salamander, which it also resembles in that the male takes charge of the eggs. The mother's cannibalism renders this necessary, and even the male is not above an occasional "snack", though never devouring all his progeny. About four hundred eggs are laid. This species, like the Japanese Salamander, has a habit of rocking its body to and fro.

The genus *Amphuima* is represented by a single species, *A. means*, an eel-shaped animal with rudimentary limbs provided with only two or three fingers and toes. It inhabits the swamps of the South-eastern United States.

The family *Proteidae* is represented by two genera; *Necturus*, from North America, and *Proteus* from Austria. Gills are retained throughout life, the family being wholly aquatic.

The Mud Puppy, *Necturus maculatus*, of the Eastern United States, has large bright-red gills and minute but functional eyes. It attains a length of about twenty-four inches, and its colour is dark brown with black spots. Like the Giant Salamander it is nocturnal and very tenacious of life.

The Proteus or Olm, *Proteus anguinus*, lives in subterranean mountain caves to the east of the Adriatic, keeping to the chilly streams of those regions, wrapped in perpetual darkness. Like certain other creatures living under similar conditions, it is quite blind, and has a flesh-coloured skin, which, however, develops pigmentation on exposure to light. The body is elongated and slender, and the tail short and finned. The animal is generally oviparus, its fifty or so eggs yielding after about ten weeks larvae measuring some two inches long. If kept at a relatively high temperature, however, *Proteus* brings forth its young alive.

The eel-shaped members of the family *Sirenidae* are distinguished by a total absence of teeth, horny coverings to the jaws taking their place. They carry large external gills and the body has anterior limbs only. The two representatives of this family, namely *Siren lacertina* and *Pseudobranchius striatus*, come from the South-eastern United States.

XXXII

LIMBLESS AMPHIBIANS

Order *Apoda*

THESE are worm-like, burrowing amphibians inhabiting tropical Africa and America, South-East Asia and the Seychelles Islands. The body bears numerous ring-like grooves, the minute eyes are usually covered with skin, there is no auditory apparatus visible, and a retractile, cone-shaped sensory organ rises between the eyes and the snout. The members of this order burrow in damp earth. Some lay eggs—in strings—on the banks of water-courses, others bring forth living young. In some cases the female wraps herself round the eggs, which are gathered into a compact mass and are thus protected until the emergent larvae have absorbed their gills. Their place is then taken by a small opening—the spiraculum—on either side of the head.

The single family *Caeciliidae* is represented by twenty-two genera. Their anatomical differences consist mainly in the presence or absence of scales embedded beneath the skin, presence or absence of eyes, shape of the sensory organ, and the structure of the skull. None of the species reach more than about eighteen inches in length.

XXXIII

FISHES

Class *Pisces*

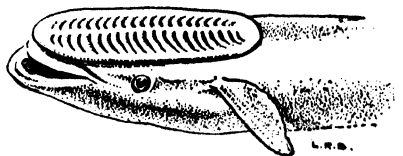
FISHES, of which about twenty thousand living species are recognised, represent the vertebrate form in its simplest terms. Modern fishes may be regarded as the latest and most specialised members of a race that had its beginnings in periods assessed at some four hundred and fifty million years ago. The first fishes were scarcely recognisable as such by modern standards. They conformed, however, to the simplest definition of a fish, *i.e.* a cold-blooded vertebrate, living in water, and breathing by means of gills. Other piscine attributes they scarcely possessed. The earliest fish known were encased from head to tail in bony armour, were without fins, and had only suctorial mouths, like those of living lampreys and hag fishes. Jaws, a development in vertebrates of the gill arches, came considerably later. The possession of a jointed backbone, however, gave them a great advantage over all other forms of life, and it is significant that apart from the giant cuttlefishes, all the world's largest creatures are vertebrates.

Owing to their relatively flimsy skeletons, the fishes have left less satisfactory evidence of their being in the rock strata than have either reptiles or mammals. Their remains, however, are sufficiently numerous to give a tolerable series of clues as to their onward progress towards the forms familiar to-day. The fishes of the later Devonian strata were, like the first fishes, still encased in inflexible armour, with the tail attached as a very distinct organ, but they showed the first foreshadowings of paired fins. Some bear clear evidence of articulated lower jaws.

The development of a lower jaw marked an immense step forward, and it is from this point onwards that the Palaeontologist can trace step by step the gradual advent of such relatively primitive fish as sharks and rays, and later the scale-clad forerunners of the fishes with well-ossified skeletons, which creatures form the great bulk of living species.

The most distinctive feature of fishes, as such lies undoubtedly in the fins. Fins are of two well-defined types—median fins and paired fins, the latter foreshadowing the articulated limbs of the amphibians, which in their turn gave rise to the birds' wings, and the highly specialised arms and legs of the higher mammalia. Median fins may be situated on either the back or belly of a fish, and are generally present in both situations. They

may present abrupt, sail-like structures, or run the entire body length, merging into the tail fin. Their function is chiefly to preserve the creatures' equilibrium, as does the centre board of a yacht, but sometimes they are highly mobile and provide the motive power, as in the familiar sea horse and pipe fish. Paired fins are placed near either extremity, and not only provide motive power of a natatorial kind, but can also serve as hands whereby to walk and even climb. The bulk of the propulsion, however, is provided by the tail, which in some species may also serve to lever the fish forward over ground above or below water. In the thresher shark it is used as a whip to round up shoals of smaller fishes, and in many species bears spines and bony scutes converting it into a powerful weapon. The paired fins near the hinder extremity serve, amongst sharks and rays, as clasping organs during the act of mating. Yet other modifications of fins are seen in the various sucking fishes, such as the Lump Fish, Remora, Cornish Sucker, etc., where dorsal, anal or ventral fins may have been converted into organs of adhesion, holding the fish securely to some stable object, such as a rock or ship's keel. Again, fins can be adapted as lures to attract other fishes within reach, and often they bear lights or vivid colour patterns that are supposed to help their owners to find favour with one of the opposite sex in the breeding season. Practically all fishes progress by lateral movements of fins and body, such movements sometimes being seen as wave-like undulations passing throughout the entire length of a continuous ventral or dorsal fin. Such progression is seen also in aquatic worms and reptiles whereas in most aquatic mammals, such as seals and whales, the movement is in a vertical plane—*i.e.* it takes an "up and down" form. Nearly all fishes adopt a horizontal pose, but there are exceptions, such as the Sea Horses (*Hippocampus*) and Needle fish (*Aeoliscus*) that habitually maintain a vertical position. A Cat Fish (*Synodontis*) has the extraordinary habit of actually swimming for much of its time upside down.



Head of Remora

Respiration by means of gills is a trait shared by fish with many other creatures. Fish are cold blooded, one only, the tunny, having a body temperature above that of the surrounding water. Whilst appearing to breathe water, fishes are really extracting the oxygen only from it, just as terrestrial creatures extract oxygen from the air. This is accomplished by the gills,

tree-like structures richly charged with blood-vessels. The amount of oxygen required varies much with the species of fish. The late Dr. Albert Günther has, for example, calculated that a tench a little over a foot long needs only 1/50,000th the amount of oxygen necessary to maintain life in a man. It is of interest to note that our piscine ancestry, and that of all the higher vertebrates, is made apparent by the presence of gill-like structures manifest at certain stages of the embryo's development, whether it be that of a chick or a man. The water passes in at the fish's mouth, and, being deprived of its oxygen, flows out through the gill flaps. This applies to the bony fishes and sharks, rays, etc., but in the primitive lamprey the water enters by a single nostril on the top of the head. Sharks and rays are usually characterised by the presence of two small openings known as spiracles which are in reality degenerate gill clefts.

On the back of each gill arch are present complex comb-like structures, the gill rakers. These serve as strainers to the water passing through, and in many fishes, such as the huge Basking Shark, perform the function of retaining small food particles. An important structure is the air bladder, which may, as in the lung fishes, be modified to serve as a kind of lung or accessory breathing organ, enabling its possessor to survive draughts, or breathe in peculiarly foul and muddy water, wherein most fishes would succumb.

In speaking of fish and fishes, it may be mentioned that fish is properly the plural for a number of fish all of the same species, whereas fishes implies an assortment of divers individuals representing various species of genera.

Respiration varies very greatly in different kinds of fishes. The Common Angler, for example, breathes slowly and rhythmically. The Trunk Fish, on the other hand, breathes in a panting "palpitating" manner suggestive of a frog. The gill chamber may further often retain a quantity of water, which again gives great advantage to the fish, enabling it to live for hours out of its natural element.

Whereas most fishes are of characteristic "fish form", *i.e.* stream-lined, the rule is far from universal. The normal cigar or torpedo shape is associated always with fast-moving forms. Many bottom-dwelling fishes, however, are far from stream-lined. Their square or lumpish shapes involve strong eddies in their wakes, and such fishes can never make any appreciable speed. Similarly a vertical stance in the water—as in the pipe fishes—is inconsistent with any rapidity of movement. A tunny or sword fish, on the other hand, can literally make rings round any vessel short of a motor "speed boat".

Scales are always associated with fishes, but they are no

monopoly of the class. Mammals, like the pangolin, are scaled, as are also many reptiles. In fishes, scales are a hall-mark of the bony skeletoned species, and may vary from almost microscopic size to the scales of the tarpon that are as big as average saucers. All coverings of a fish's skin are products of lime salts, and vary much in form as well as size. In sharks and rays they are reduced to minute ossicles, or as in the Thornback Ray, sharp spines anchored to the skin by a bony boss or stud. Large ossicles are very apparent in some bony fishes like the turbot, and in various cat-fish they form a defensive armour, whilst in the Trunk and Pipe Fish they unite to form an unyielding cuirass. Still more striking are such dermal structures as the serrated spine of the Sting Ray, and the huge saw-like rostrum of its relative, the Saw Fish. Scales indeed may show an extraordinary range of modification, ringing the changes on every conceivable form, from large smooth plates to erectile spines, or extravagant outgrowths from almost any part of the body. In the bony fishes scales are of peculiar interest as affording very reliable records of the possessor's age. Annual growth is marked upon them in well-defined rings, so that of these fishes more than almost any other creature, apart from the shelled mollusca, age can be ascertained with the minimum of guesswork.

The mouth, as already noted, is an outgrowth of the gills, but in the course of evolution it has undergone a remarkable transformation. In most bony fishes it is largely telescopic, and can be shot forth at great speed. The Pipe Fish, File Fishes and others, have it much reduced, but in the Halibut or John Dory it is extraordinarily distensible, and literally sweeps all before it like a living trawl net. In some sharks the mouth is quite large enough to permit the passage of a man, and even an average cod can comfortably engulf a stone of several pounds' weight. Often the jaws are toothless, or minutely toothed, but quite the reverse is equally common. The Wolf Fish has teeth capable of cracking up the hardest cockle shells, and the small Caribe of Brazilian rivers can literally make mincemeat of the largest mammal. Even these powers are eclipsed by some of the File Fishes, that, with their parrot-like beaks, break off and chew up lumps of stony coral. Teeth are often movable, or ranged in several rows, as amongst sharks and rays. They may often also extend into the gullet, or cover the palate, as is very evident in the Common Wrasse. A fish's "capacity" is determined by the size of its mouth, and some abyssal fish such as the Black Swallower (*Chiasmadoen*) can accommodate fish several times their own size. Such a mouthful has its drawbacks, and the swallower's victim, naturally resenting its incarceration, sometimes struggles so violently that both are carried to the surface, where some pass-

ing sea-bird appropriates banquet and banqueter together. Mouths may be of almost any shape, from great circular orifices to crocodile-like jaws, or mere tubes with a minimum opening, or blade-like expansions suggesting a whale-headed stork's bill. The mouth is as a rule directed forwards, but this is far from universal. In the Dragonet it can be bent downwards like a tube, and in the Sturgeon, another bottom feeding form, it is actually on the undersurface of the head, and virtually "vacuum cleans" the sea-bed of worms, small clams and crustaceans.

The water world is notoriously a place of unending strife and hazardous adventure. Few fishes can afford to live in placid inactivity, and the sense organs, whereby to seek food or escape providing a meal for others, show a wide range of development and often great perplexity. The individual capacity to appreciate pain, or appraise the surrounding environment, rests primarily—as in other creatures—with the brain. This, the "head office", may show a relatively high development, and is possibly seen at its best in the common carp, a notoriously "crafty" fish, as Izaak Walton bears eloquent testimony. The spinal column and auxiliary nervous system which take messages to the brain are in turn connected with all kinds of accessory organs which "pick up" messages in a variety of ways. All kinds of filaments and feelers play their part in thus keeping the fish informed of its surroundings. The "barbules" of carp and sturgeon are obvious examples, but these are only small items in the fish's armoury. Fishes often have the sense of smell well developed. Thus many fishes are irresistibly attracted by the scent of blood.

The eye is similarly well developed in many fish, but "hearing" in the full sense of the term is lacking in most forms. Fishes can certainly appreciate vibrations under water, but there is no evidence of any structure comparable to a mammalian, or even a reptilian ear. The so-called ear bones or otoliths, present in most bony fishes, serve largely to maintain the creature's sense of balance. Like the scales, these limy concretions bear well-marked rings of growth.

The eyes, like all other features, show extraordinary diversity, not merely in size but position. In the Hammer-head Shark and certain abyssal forms they are mounted upon long stalks; in the Mud Skipper and Flat Fishes they are poised on the summit of the head. Their degree of perfection corresponds to the wearer's mode of life, and should this be spent in turgid water or complete darkness the organs of vision are often reduced to vanishing point. Similarly they may reach a huge size, the better to absorb whatever light may be available. Where the eyes are reduced, compensation is found in the enhanced sen-

sibility of scent, or tactile organs. Sense organs are also represented in the median line, usually quite apparent along either side of the average bony fish. Tactile organs reach their maximum development in the often immense "whiskers" of some cat-fish, or the complex beards of certain deep-sea anglers.

Sensibility is often intimately connected with the coloration of fishes, which in most tends automatically to adapt itself in harmony with its surroundings. In no fishes is this more apparent than in the familiar Flounder, Plaice and Turbot. The crowded pigment cells "shut off", or on, according to the ground on which the fish rests at the moment, and some flat fish can even accommodate themselves to geometrical arrangements in black and white, blending so perfectly with such backgrounds as to defy detection. Coloration, however, is not wholly a matter of "camouflage". As in other creatures it may have a "warning" value, or serve to attract the opposite sex.

Other functions intimately connected with the nervous system are the production of light, electrical discharges and venom. Light owes its presence chiefly to special glandular cells in the skin, which vary from widely dispersed vessels giving a general luminescence to large organs fitted with lens and reflector that serve as veritable searchlights, illuminating all around for a considerable distance. Organs such as these are very characteristic of the deep-sea fishes, which scientific dredging apparatus have brought to light in large numbers during the last few decades. These special light organs are termed photophores, and are in use by many widely different types of fish, which, however, enjoy a very general distribution throughout the ocean deeps the world over. Certain small sharks have the whole of their undersurfaces thus illumined; some deep-sea fish have lights arranged in rows along their sides, and such an arrangement gives the wearer the appearance of a miniature liner with vividly lit up portholes. A deep-sea Indian Ocean form has a huge light organ below each eye, and these are cut out and used as lures by native fishermen, the lights retaining their brilliance long after being removed and threaded on a fish-hook. Most striking of all photophores are those carried by some abyssal angler fish, the lights being in the form of large bulbs mounted upon modified fin rays.

Electrical organs are similarly distributed amongst several quite differently organised fishes. The best known, because an occasional visitor to our shores, is the Torpedo Ray, one of a class widely scattered over the warmer seas. In such a ray there are two large electric organs occupying most of the body cavity, in the form of numerous hexagonal cells or cylinders, filled with a clear jelly, and standing upright between the

ventral and dorsal surfaces. The electric current passes from the upper or positive surface to the lower or negative, and can, in large fish, deliver a severe shock. The ray uses its power to stun fish such as the mullet, hurling itself at its victim, and devouring it whilst it is yet numbed, if not killed, by the discharge. This ray was well-known to the ancients, who used it as a primitive form of vibro-massage for the relief of rheumatoid affections, the patient standing bare-footed on the fish as long as his own powers of endurance, or the physician's orders, dictated.

In the Electric Eel two batteries are ranged one on each side of the tail, which constitutes four-fifths of the creature's entire length. Since the fish often measures fully seven feet its electrical powers may be imagined to be formidable. In the New York Aquarium a specimen has even been "harnessed" to start an airplane, and also to light the million candle-power beacon on the top of the Woolworth Building. The traveller Humboldt, encountering these fish in their native Brazilian waters, has described how horses and mules being driven into the stream, the fish exhaust their batteries, and make it possible for human travellers to cross in safety. In all electric fishes time is required for recuperation between discharges.

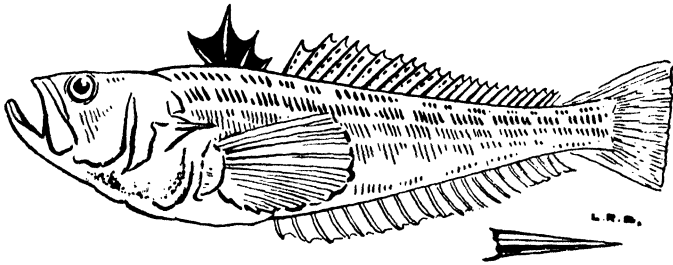
The electrical powers of the fresh-water Catfish (*Malopterurus*) of Africa are well developed. In this fish the whole of the body wall generates electricity, and the fish is known to the Arabs as the Raad, or Thunder Fish. It does not use its electricity in the manner of the Eel, or Ray, to kill living prey, but shocks other fish into regurgitating food, which it promptly appropriates, much as the Squa Gull torments other sea-birds into disgorging food. Despite its very appreciable electric powers, the Raad is largely eaten, the process of cooking nullifying all electrical properties.

Venom is one of the less met with perquisites of fishes, the principal poisonous species being the Stone-cats (*Noturus*), the "Poison-toads" (*Thalassophryne*), Scorpion fishes (*Synanceiidae*), the Sting Rays (*Trygon*), and the Weevers (*Trachinus*) of our own seas. In all these fishes the poison is conveyed from special glands into wounds inflicted by a sharp and often serrated spine. The Weever Fish, whose name is derived from the old Anglo-Saxon word Wyvern, meaning a viper or dragon, has poisonous dorsal spines, and also a large poison spine on each gill cover. The fish, living as it does half buried in sand, may easily sting incautious waders, and the notice "Ware Weevers" may sometimes be seen displayed on piers, etc. The fish is good eating, and in France legislation compels removal of the spines before it is exposed for sale.

The Sting Ray carries one or more large spines in its tail, and

wounds from these have been known on several occasions to terminate fatally.

In view of the fact that fish are, by human standards, virtually deaf; it may seem strange that many can produce sounds. Sound and feeling, however, are intimately connected, both depending on the agitation of air, or water waves, and the consequent creation of vibration, which may be received without the aid of any true auditory apparatus. One can readily appreciate how light-producing organs may serve a useful purpose, either in attracting prey or illuminating the owner's environs. Sound production is less easily understandable, although in some instances it may have a sexual significance. Often, however, it appears to be quite accidental, and to serve no special purpose. Expulsion of air from the swim bladder, as when a fish is "landed," may often result in accidental



Lesser Weever Fish, and Poison Spine (enlarged)

noises, such as the alleged "bark" of the Conger. Where sound is deliberate it is usually the result of stridulation, and examples of this "fish music" are offered by the common Horse Mackerel or Scad (*Trachurus*), certain Trigger Fishes (*Balistes*), or the common Sun Fish (*Mola*). Our little fresh-water Bullhead, or Miller's Thumb (*Cottus*), produces a stridulating sound by means of the gill covers, but in the file fishes sound is the result of tensely grinding together the exceedingly hard teeth. The true "Drum" Fishes (Family *Sciaenidae*) make deep booming sounds by vibrating special muscles connected with the air bladder.

In consideration of the vital importance of many fishes from an economic viewpoint, the greatest interest surrounds their manner of reproduction and relative fecundity. Most procreate their species at stated seasons, and these often involve vast migratory movements. Fish migrations cannot, of course, be coupled with anything approaching to "sentiment" on the part of the animals. Mating time usually brings about certain physiological changes in the fish, which require particular chemical conditions of the water, food, etc., whilst prevalent

currents, winds, etc., all play their part in producing the mass movements of fish which have long aroused man's wonderment, and been turned to his advantage.

As amongst other animals, the size of a fish's "family" is largely determined by the particular fish's mode of life. Where parental solicitude manifests itself, small families are the rule, but in others, such as most of our food fishes, families of vast magnitude may be broadcast on the principle of the survival of the fittest, millions being launched upon the waters that a few only may survive innumerable foes, and live to perpetuate the race. In this regard the Common Ling (*Molva*) holds the world's record for fecundity, a fish five feet long producing not far short of thirty million eggs, or more than half a million for each pound of its weight. The cod yields over six million, and the flounder one million eggs, such prodigality being equalled amongst other animals only by a few molluscs and certain insects.

These broadcast eggs are either floating or deposited on the sea floor. The more carefully brought up eggs are deposited in nests of many kinds. Trout and salmon place their ova in shallow troughs excavated in gravel, but the Bow-fin of America and our native Stickleback lay their eggs, a few hundred only, in nests built of grasses or weed debris. Other fishes, like the Blennies and Lump Fishes, attach masses of ova to the underside of rocks, or tuck them snugly within shells, the guarding of the eggs and protection of the emergent fry usually evolving on the male parent. Some tropic fresh-water fishes, like the Siamese Fighting Fish and Paradise Fish, blow rafts of bubbles in which the eggs are placed, whilst others again, like the Gaff Topsail Cat Fish, incubate the eggs within the parental mouth, or as in the Pipe Fish and Sea Horse in an abdominal pouch borne by the male.

The smallest families, often confined to a dozen or so, are generally the products of more primitive types, like sharks, rays and the deep-sea chimaeras. Such fish may deposit large leathery egg cases, each containing a single embryo, the case being anchored in silt, or amongst weeds, by means of hooks and filaments. These egg cases are often of large size and bizarre form. Egg production, however, is not by any means universal. Widely separated fishes, such as various sharks and rays, blennies or the fresh-water tropical "Live Bearers", produce their young alive, and these fishes yield the smallest families of all.

Although lowest of the vertebrates, the production of young amongst fishes is not without a certain "glamour", as provided by the ceremony of courtship. Many male fishes, like that of our common stickleback, put on the most vivid colours at

pairing time, or as in the salmon develop special features—such as a deeply hooked under-jaw, the better to engage in conflict with rival males. Very frequently courtship and pairing completely exhaust a fish's energies, as exemplified by the Common Eel and the Lamprey. These fish having once ensured the continuance of the race, succumb from their labours.

In many of the higher vertebrates the young are at least recognisable as the progeny of their parents, but save amongst sharks and rays this applies to few fishes. Most fishes hatched from eggs have a yolk sack attached, from which they absorb nutriment, but few bear any discernible family likeness until arrived at a relatively advanced stage of development. The fish egg itself is as a rule buoyant, being provided with an oil globule that aids it to float, and the emergent fry is usually pelagic, *i.e.* living in the upper layers of the sea water, and frequently actually at the surface. The newly-hatched fry's lightness and small size usually demands special provision for its stabilisation in the water. Often the fry carries bizarre spines, or immense fins that serve to preserve its equilibrium, and in all surface-living larvae there is at first an almost complete lack of colour, pigmentation developing as the adult form is approached. Minute plant life forms the basic nutriment of most baby fish, but adult fishes are with few exceptions predatory, feeding on almost any other creatures they can engulf. The study of fish larvae is of relatively recent development, and a very large proportion of the fishes known are still unidentified in their earliest stages.

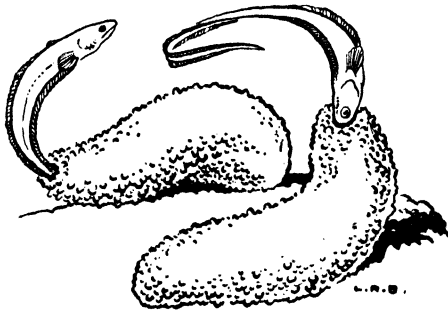
Fishes, whilst pre-eminently aquatic creatures, display immense variety in their ways of life. The bottom-haunting species are often solitary, but some, such as the smaller sharks, may associate in packs, and flat fish, whilst not truly shoal-forming, are sufficiently gregarious often to form large companies. Most of the species affecting the upper water layers tend to be sociable, and form large shoals that, though not recognising a leader, as seen in many social animals, live and move together in concord, and with great uniformity of impulse. This does not apply to some of the large sharks, which are mostly solitary, and thanks to their great size and strength, literally roam the seven seas, leading more or less cosmopolitan existences. Some surface fish, such as the Remora, are also largely solitary, but being of small size, and feeble capacity, tend to be semi-parasitic. Remora relies greatly upon large fish for its sustenance, attaching itself to them by its dorsal sucking disc, and is carried about without effort on its own part, subsisting chiefly on scraps of food dropped by its more independent host.

Some fish again lead semi-communal lives, as "hangers on"

to widely diverse creatures. A small Mediterranean fish, *Fierasfer*, lives concealed in the body of large *Holothurian*, or Sea Cucumber, entering and leaving it at will. The gorgeous coral fishes, *Amphiprion*, hide in the body cavities of large sea anemones, whilst our common Horse Mackerel similarly shelters amongst the stinging cells of large jellyfish.

A number of species have to a certain extent conquered the dry land, the Mud Skipper, *Periophthalmus*, being an example.

Few subjects have been more obscured by poetic fancy—as opposed to scientific fact—than have the migrations of various animals. As regards fishes accurate data is still lacking as to the precise movements of many quite common species, though in this direction up-to-date research, with all the wonderful appliances now at its command, is making remarkable progress.



A Fish (*Fierasfer*) living in partnership with a Sea Cucumber

The latest work in this direction has been undertaken by the French Government, who recently sent a fisheries research mission into the Atlantic under the directorship of Monsieur Jean le Danois. The expedition points out that Great

Britain once joined the European continent and that the Rhine had then its outflow near the Firth of Forth, and that this fact casts an interesting light on the movements of two fish, namely the haddock and the tunny, which have long been known to make periodic journeys from the Atlantic into Continental waters. These fish, one would imagine, would in order to enter the North Sea from the Atlantic take the short cut offered by the English Channel. They still, however, travel laboriously round the north of Great Britain just as their ancestors must have done countless centuries before the Channel came into being.

The salmon is another fish that illustrates to a remarkable degree the conservative manner in which certain fishes direct their courses. As is well known, this fish, although spending some years in the sea, invariably returns to the river of its origin when the time comes to propagate the species. The late Frank Buckland has given a remarkable instance of this blind homing instinct in a letter published many years ago. He wrote: "A friend of mine who owns a well-known island on the west coast

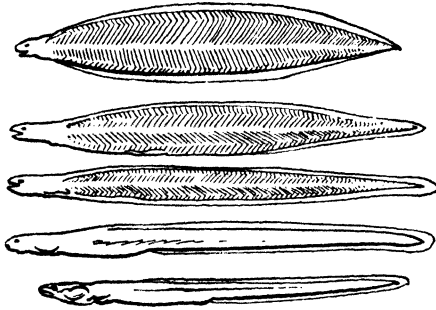
of Scotland, netted a certain pool in his fishing, and out of a number of fish caught he carefully marked some twenty or thirty. He then put these fish on board his yacht and sailed right round his island, then up a creek to the mouth of a river. The salmon were transferred up the river, which although close to the river in which they were caught was in no way connected with it, having a different watershed. It is as though the salmon had been carried from one heel of an enormous horseshoe round to the other heel, and then taken right up into the middle of the horseshoe and let loose. During the season that these fish were transferred some of the marked fish were caught in their own pool with a net and one with a rod. On examining the map I find that these fish must have come back again to their own river, a circuit of forty miles at least from the lake where they were turned out, and they must have passed six or seven tributaries which they did not ascend, although there was nothing to prevent them."

Perhaps the most remarkable of all fish migrations, because it is the longest, is that of the eel, which makes its way from its nursery in the West Indian waters to the opposite side of the Atlantic. The eel, in fact, reverses the salmon's programme, breeding in the sea and resorting to fresh-waters for food and growth. For centuries the complete life history of the eel and its origin had been a mystery, and the subject for much speculation, and it is only as the result of careful research in recent years that the mystery has been solved. Pliny and Aristotle believed that eels originated from mud at the bottom of the sea and that they had no sex; whilst other curious beliefs were that the fish originated from horse hairs dropped from the animals' tails when wading in the water, from maydew, from the gills of other fishes and from aquatic beetles.

It was not until the year 1904 that Dr. Johannes Schmidt conclusively traced the eels' breeding grounds to a region of the West Atlantic south-east of Bermuda, where the water is 3,000 fathoms or more deep. On hatching the infant eel in no wise resembles the form of its parents, being flat, leaf-shaped and transparent. When a few months old these tiny creatures leave their birthplace and ascending towards the surface where they meet the eastern currents, are swept along towards European shores. For three years they travel slowly upwards, moving a few miles a day in a journey eventually covering about 3,000 miles. It is not until the third year, when they are about three inches in length, that they begin to alter in appearance and become round-bodied fish, when they are known as glass eels or elvers. Their journey by sea completed, the invading hosts of elvers make their way inland, ascending rivers, and streams unde-

tered by any obstacle, however formidable. They scale lock gates, wriggle up the boulders beside waterfalls, and sometimes even travel overland when the ground is damp. Eventually they find their way to those ponds, ditches and lakes which must constitute a haven of peace after their prolonged travels. Here they settle for from five to eight years, when the mysterious call of the sea summons them back to their birthplace. They then once more set out on their stupendous journey through fresh-water and salt to the depths of the Atlantic from whence they came. Their return, however, is the completion of their life cycle, for after spawning death ensues and another multitude of larval eels sets out on its tremendous journey.

The breeding-grounds of the nearly related American eel are situated in proximity to those of the Old World species, the larval stages of both forms having been taken in the same haul of the net. But whereas the latter takes three years to cross the Atlantic, the former's journey to its native ponds and rivers is completed in just over a year. How these minute larvæ can decide upon



Development of the Common Eel

which direction to take, whether an easterly or westerly one, is an unfathomable mystery. In the case of the eel, the migratory routes are probably not determined by custom but by physiological changes in the fish themselves which demand certain chemical conditions of the water. In other fishes, the sudden or gradual changes of food supply and the irresistible force exercised by the great ocean currents, play their parts in determining the way of a fish in the great waters. Only a few giants of the race can be more or less independent of such factors and shape their courses as their inclinations dictate.

Major Stanley Flower has already made valuable contributions to Science by summarising the age limits of various groups of animals. His latest work deals with Fish, and is a matter of considerable interest to pisciculturists, anglers and the general public.

The various ages given in Major Flower's report were obtained by readings of the annual rings on the scales and otoliths or ear-bones, from statistics dealing with the travel of marked fish, and especially from observation of captive speci-

mens in enclosed water, aquaria, etc. As pointed out by the author, the system of marking—carried out in many ways—may not always be effective. Too conspicuous a distinction, such as a metal disc, may betray the fish to predacious foes and thus defeat its own object.

In view of the vast number of species of fish known, the list must obviously be incomplete. Major Flower's most reliable records are of captive fish from temperate waters. These tend to show that fishes, unlike mammals and birds, do not reach a "peak" as regards their years of growth, but grow more or less continuously throughout life, and further, the age limit does not necessarily bear, as in most mammals, any notable relation to the size of the individual. Size may be largely a matter of environment, so that a pike of 20 lb. is not necessarily older than one of half that weight.

It will be a matter of surprise to most people that careful records show that the carp, often credited with centuries of life, seldom attains an age of more than fifty years.

One the oldest of our so-called native fishes would seem to be the eel. At the time of writing, there lives—privately owned—an eel known to be 42 years old. It was caught when little larger than a worm and has spent most of its life in a medium-sized aquarium. It is now about 13 inches long, feeds sparingly, and never fails to prophesy the approach of a storm by vigorously disturbing the shingle in the bottom of its tank.

The oldest European fresh-water fish is the huge cat-fish known as the Wels, two of which monsters measuring nearly six feet in length still inhabit the great lake in Woburn where they were placed 61 years ago. The Sterlet, or fresh-water sturgeon of the Danube, likewise lives to a great age, specimens received in this country 50 years ago and now in the London Zoo Aquarium being still active and in perfect health.

Major Flower modestly prefers to follow the example of a 15th-century pisciculturist, who used to write of himself as being "loath to wryte more than I know and have provyd". Even so, the figures amassed are highly illuminating. Fish that attain an age of between 15 and 30 years include such varied species as halibut, sea perch, plaice, bowfin, thunder loach, sting ray, herring, trout, lung fish, bream and haddock. It will come as a surprise to learn that such large fish as cod, salmon and pike cannot be reliably shown to live for more than 20 years, however great their size.

The economic importance of fishes would seem to be so obvious as scarcely to merit comment, but its full appreciation is a matter of quite recent date. The Marine Biological Stations or Fishery Research Depots, now numbering about two hun-

dred, and scattered over the world, are all under half a century old. In olden times fishing was purely a matter of chance, man regarding the harvest of the seas as quite inexhaustible. Wholesale methods of fish, and fish ova destruction as effected by the modern trawler, the pollution of waters, both fresh and salt, together with many other considerations now make, however, the safeguarding of the world's fisheries a matter of paramount importance. A detailed knowledge of fishes and their habits is, moreover, acquired with greater difficulty than is an understanding of terrestrial life, the wind and the waves still placing many yet insurmountable limitations to man's greatest ingenuity and daring.

Fishes have always provided us with food, but of recent years they have furnished innumerable other products, some of which will be referred to in the following systematic review of the various sub-classes, orders, families, genera and species.

XXXIV

FISHES

General

LIVING fishes are broadly divided into those with a cartilaginous and those with an ossified skeleton, the great majority falling in the latter category. But placed in a separate sub-class from either of these are the Lampreys (sub-class *Marsipobranchii*), Order *Hyperoartii*.

The Lampreys and Hag Fish are regarded as degenerate fish, which, living a semi-parasitic life, have forfeited most of the accepted piscine attributes. In these fish there are no paired fins and the median fins are without rays. There is a single nostril on the crown, gills are represented by pouches, without distinct arches or rakers, and the mouth is a suctorial orifice set with numerous horny teeth.

The Common Hag, *Myxine glutinosa*, is found on both sides of the Atlantic. It owes its name of Slime Eel to the great quantities of mucus its skin exudes, whilst the title of "Borer" refers to its habit, common throughout this sub-class, of boring into the bodies of other fish and sucking their blood. Lampreys and Hag Fish are very destructive, some species eating twenty times their own weight at a meal.

Our three Native Lampreys—the Sea Lamprey, *Petromyzon marinus*, the River Lamprey, *Lampetra fluviatilis*, and the Brook Lamprey, *L. planeri*—differ chiefly in size. The Sea Lamprey reaches a length of nearly 3 feet. It ascends rivers to breed, using its suctorial mouth to overcome obstacles, such as weirs, etc. With the same organ it scoops out a trough in some gravel bed, a pair combining in this labour and depositing adhesive eggs which are covered with sand. The eggs of the Hag are enclosed in horny cases and anchored by bristly filaments. These fish appear to breed but once, and the labour of nest-making so tells upon them that they usually succumb once the eggs have been laid. Lampreys are good eating, but river pollution has long banished them from the Thames, where thirty years ago they abounded.

Sharks, Dog Fish, Rays, Skate and Chimaeras form the sub-class *Selachii*, which is divided into the Orders *Pleurotremata* (Sharks), *Hypotremata* (Rays) and *Holocephali* (Chimaeras).

These fish though so varied in design and habitat agree in having, like the Lampreys, cartilaginous skeletons, but show an advance on those forms in their paired fins, well-formed gills,

and large mouths set with numerous rows of sharp or pavements like teeth. Young may be born alive or deposited in horny egg-cases, anchored to weeds or buried in sand.

Sharks swarmed in all seas long before the bony fishes became predominant. They resemble the large extinct fish-lizards (*Ichthyosaurs*, etc.) in the spiral form of the intestine, and like those reptiles often attain a huge size. Shark and dog-fish are terms merely denoting size rather than fundamental differences of structure, shark being applied usually to only the larger members of the order.

The sharks proper are principally confined to warm waters, and such large forms as the Blue and Tiger sharks are very dangerous. The largest of all living forms is the Whale Shark (*Rhinodon*), which grows to a length of forty feet. Like the Basking Shark (*Cetorhinus*) of home waters, it is quite harmless, and feeds only on very small fish or shoals of pelagic molluscs, etc. Many sharks will attack man, but only the Great White Shark, *Carcharodon carcharias*, of all the warmer seas can be regarded as a man-eater. Unique shark forms are the Thresher (*Alopias*), which uses its tail to round up schools of fish, and the Hammer-head (*Sphyrna*), with eyes set on large pedicular offshoots of the head.

The Monkfishes (*Squatina*) represented in our seas form a connecting link between the sharks and rays. They have compressed bodies suited to a life on the sea-bed. The nearly related Sawfishes (Family *Pristidae*) are not unlike the "monks" in build, but have the skull produced into a flattened beak, with some forty enamelled spikes set in a row along either edge. In large specimens the saw may measure six feet, and is a formidable weapon, though primarily used, it is thought, to unearth King crabs, etc., from the sandy sea floor.

The true Rays and Skate are completely flattened fishes, adapted to a life on the sea-bed. The side fins are flattened into "wings". The mouth and gill-slits are situated on the under-surface of the head. Largest of the order are the Devil Rays (*Mobula*) of Florida, which may span twenty feet, and weigh 1,250 lb. The Whip Rays (*Trygon*) have one or more serrated spines in the tail, and inflict with them very severe wounds. The Electric Rays (*Torpedo*), already noticed, are world-wide in distribution, and reach a length of three feet. About a dozen species of ray occur in our seas, and most are largely fished for food. The egg cases constitute the familiar four-cornered "Mermaids' Purses", so often washed up after a gale. A few ray are viviparous.

Apart from their obvious food value, most of the sharks and rays are of considerable economic importance. As regards

sharks in particular, extensive fisheries have of late years been organised in South Africa and Australia, where the skins are converted into leather, the fat and livers into oil, the bones into fertiliser, etc., whilst walking-sticks are made from the backbones, and various ornaments from the teeth. Sharks'-fin soup has from early times been a delicacy in the Far East.

The Chimaeras (*Holocephali*) are grotesque cold-water fish, most of which come from deep seas. Like sharks they deposit horny egg cases, and the males have bizarre comb-like organs—of unknown function—projecting from the forehead. The long tail ends in a filament. The mouth is toothless. One species (*Chimaera monstrosa*) is found off our coasts.

The bony fishes—Sub-class *Teleostomi*—are divided into twenty-eight orders, have well-formed skeletons and, unlike the preceding, are found in both fresh and salt waters.

The Sturgeons—Order *Palaeopterygii*—are mostly marine, but all ascend rivers to spawn. On these occasions the larger kinds are hunted with nets or spears. The flesh is much esteemed, the swim bladder is converted into isinglass, whilst the roe provides the much-prized caviare. The Great Sturgeon of Russia, *Acipenser sturio*, grows to a length of twenty feet, and to a weight of 3,000 lb. Like all of its class, the skin is reinforced with huge bony plates or scutes, richly sculptured, as used in the making of ornaments. Its fishery is one of the principal industries of the Volga, employing thousands of workers.

The Paddle Fish, or Spoonbill Sturgeon (*Polyodon*), has the pointed sturgeon snout produced to form a long flattened blade, widened at the end, and like the snout of true sturgeons serves as a trowel wherewith to dislodge worms, etc. The tip is highly sensitive and very easily injured. This fish, which reaches a weight of 150 lb., is extensively netted in the Mississippi and its tributaries, both its flesh and roe being much in demand.

The Order *Cladistia* embraces the Sail-finned Fish (*Polypterus*) of Tropical Africa, the Reed Fish of West Africa (*Erpetoichthys*) and the North American Bow Fin (*Amia*). The young of these fish carry external gills, a feature recalling the Amphibians.

The Sail-fin or Snake-headed Fish has the dorsal fin divided into numerous sail-like erections, each with a sharp spine before it. It lives amongst mud and tree roots, subsisting on frogs, crustaceans, etc.

The eel-shaped Reed Fish, *Erpetoichthys calabaricus*, inhabits the swamps of the Senegal and Congo. There is no ventral fin, and it swims with a serpentine movement.

The handsome Bow-Fin, *Amia calva*, reaches about thirty inches, and has remained unchanged since first established in

the remote Miocene period, when it was common in Europe. The male takes upon himself the bulk of the parental duties, making a large clearing in some subaqueous reed thicket, and there not only guards the eggs, but later the fry, until they are strong enough to be self-supporting.

The Gar-Pikes (Order *Ginglymodi*) hail from North America, Cuba and China. All are highly predacious, with long crocodile-like jaws set with numerous sharp teeth, whilst the scales are large and pavement-like. The modified air-bladder aids in respiration, a very necessary adaptation, since the fish frequents waters often subjected to very severe droughts. The American Alligator Gar, *Lepisosteus tristocchus*, reaches a length of fourteen feet.

The Order *Isospondyli* includes many of the most valuable of food fishes.

The Herring, *Clupea harengus*, not only feeds and employs thousands of people, but has gone far to shape European history, many important naval engagements having centred upon the coveted fishing-grounds frequented by the herring shoals. The fish range from Iceland to Western France, and come inshore to breed, the spawning season being increasingly later as the shoals happen to live in more southerly latitudes. This gave rise many years ago to an erroneous belief that the fish travelled in a body from sub-arctic regions southwards, finally disappearing into the Atlantic. About 30,000 eggs are laid per fish, and these are adhesive, and deposited amongst loose stones.

The Sprat, *C. sprattus*, is, apart from its small size, distinguished by the absence of teeth on the roof of the mouth, and its pelvic fin having only seven rays, and not nine as in the herring. It lays pelagic, *i.e.* floating, eggs, and is exclusively a northern species.

The Pilchard, *C. pilchardus*, does not travel north of the Cornish coast. It is best known in its immature stage—a sardine—in which form it constitutes one of the most important fisheries of France.

The Tarpon, *Tarpon atlanticus*, is virtually a giant herring, reaching a length of six feet and a weight of 100 lb. Its flesh is seldom eaten, but it is much prized as a game fish, affording exciting sport, especially off the Florida coast where it is very common, by its habit of leaping high out of water when hooked. Its scales are used in the manufacture of dress ornaments.

Of the members of the Family *Salmonidae*, the most noteworthy are the Trout and Salmon (*Salmo*), the Char (*Salvelinus*), the Whitefish (*Coregonus*) and the Grayling (*Thymallus*). All are

prized as game and food fish, but none more so than the Salmon, *Salmo salar*, which may weigh as much as eighty pounds, and is common in northern fresh-waters on both sides of the Atlantic. Hatched in fresh waters, it later descends to the sea, but when adult again enters its home waters wherein to breed. Both sexes join in excavating a shallow trough for the reception of the eggs, and such obstacles as weirs, etc., are persistently contended with, by leaping, until the spawning bed is gained. Some 15,000 eggs are laid. When first hatched the young are known as fry or "Alevins"; once past the larval stage they are termed "parrs". On arriving at the typical "silvery" stage when they are about to head for the sea they are known as "smolts", and when, the year following, they return from the sea they are termed "grilse". A fish too old for spawning is known as a "kelt". Innumerable ways have been devised for catching salmon, the most destructive being the Canadian "salmon wheel", a device like a waterwheel which hurls the fish by thousands into troughs as they ascend the river to spawn.

The numerous species of trout, unlike the salmon, spend their lives in fresh water and retain a livery of spots and bars. The Salmon-trout or Sea-trout is not specifically distinct from the Common Brown Trout, *Salmo trutta*, of European and Eastern Asiatic rivers. Trout weighing 40 lb. have been caught in Britain.

Artificial salmon and trout rearing is now an extensive industry, these fish, especially trout, having been introduced into all parts of the world where conditions favour their propagation.

An important member of this group is the Smelt, *Osmerus eperlanus*, that ascends rivers, and once constituted a large fishery on the Thames at Chiswick. The flesh is unique in its delicacy and distinctive odour of fresh cucumber.

The *Arapaima* (*Arapaima gigas*) is the largest of all fresh-water fishes. It may measure over 15 feet and weigh 400 lb. It has immense bony scales, amply protecting it against other predacious fish sharing its habitat, namely the Amazon. It is good eating, and part of the palate closely set with fine teeth is used by the natives for rasping the pulp from vegetables.

In contrast to all other members of this order is the little Butterfly Fish, *Pantodon buchholzi*, of the rivers of West Africa. The pectoral fins constitute wings enabling it to take short skimming flights, a faculty useful in evading foes as also in the capture of insects. The first specimen to be brought to Europe was actually caught in a butterfly net.

The members of the Order *Iniomi* are mostly deep-sea forms, although one, the "Bombay Duck" (*Harporodon*), is a shallow-

water species. This fish, which abounds off the coast of India, is dried, and its decidedly odoriferous body used in powdered form as a flavouring to curries.

The Lantern Fishes (Family *Myctophidae*) are small deep-sea fish with luminous spots ranged along their bodies. In the members of one genus—*Diaphus*—the light is concentrated into a head light at the end of the snout.

The Lancet Fishes (Family *Alepedosauridae*) are abyssal forms remarkable for the length of their teeth, which even when the mouth is closed protrude far beyond both lower and upper jaw.

The Gulpers (Order *Syomeri*) are eel-like in form, with vast jaws and highly distensible body walls, enabling them to accommodate prey far exceeding their own bulk. As obtains amongst many abyssal fish they are deep black in colour.

The best-known member of the order Haplomi, or Simple Shoulder Fish, so called from the absence of a bone known as the mesocoracoid arch, is the well-known Pike, *Esox lucius*, which may reach 4 feet in length and a weight of 70 lb. It is often named the Freshwater Tiger, for little comes amiss to it, fish, rats or water-fowl being equally acceptable. It spawns from February to March, depositing about half a million eggs. The fish abounds in rivers and lakes throughout Northern Europe, Asia and North America, and is considered one of the best-flavoured of all "coarse" fresh-water fish. In America an allied form, the Muskallunge, *E. masquinongy*, reaches 6 feet in length, and a weight of 80 lb.

The Mud Minnows, or "Freshwater Dog Fish" (Family *Umbridae*), inhabitants of Europe and North America, are small fish with weak dentitions. They live in the mud. An Alaskan form can survive weeks of incarceration in a block of ice. A frozen specimen swallowed by a dog has been known to revive in the animal's warm interior, and actually wriggle its way out to freedom.

The Order *Ostariophysii* includes such familiar creatures as the Roach, Carp and Cat-fishes. The fins are generally soft, the scales rounded, whilst the interior vertebrae are so interlocked and modified that a series of small bones passing through them connects the air bladder with the fish's ear. Of the two sub-orders, the *Cyprinoidea* and the *Siluroidea*, the former includes the carp.

The Common Carp, *Cyprinus carpio*, is of Eastern origin, but has long been naturalised in Europe and elsewhere. Familiar members of the group in home waters are the Crucian Carp,

Carassius carassius; the Goldfish, *C. auratus*; the Barbel, *Barbus barbus*; the Gudgeon, *Gobio gobio*; the Tench, *Tinca tinca*; the Minnow, *Phoxinus phoxinus*; the Chub, *Leuciscus cephalus*; the Dace, *L. leuciscus*; the Roach, *Rutilus rutilus*; the Rudd, *Scardinius erythrophthalmus*; the Silver Bream, *Blicca bjoernka*; the Common Bream, *Abramis brama*; and the Bleak, *Alburnus alburnus*. Many of these freely interbreed in the wild state, whilst the Goldfish, from China, has lent itself to the production of innumerable varieties, such as the Fan-tail, Veil-tail, Telescope-eye, etc. The Common Carp is notoriously hardy, and can travel long distances packed only in damp weeds, or even walled up in a block of ice—which method is often used in the transport of carp in bulk for food purposes. As might be expected of a hardy fish, it is also long-lived, and specimens of forty inches long and sixty pounds weight may be close upon half a century old. In China and Japan the carp has from remote antiquity been regarded as a lucky fish, and the subject of much folklore and many religious beliefs. In the latter country, the Annual Festival of baby boys is celebrated by the flying of gigantic paper carps from flag poles, even the poorest homes flaunting such trophies.

The Loaches (Family *Cobitidae*) are small bottom-haunting fish, with three to six, instead of one, pairs of barbels as seen in the carp. The air bladder is enclosed in a bony capsule, and the fishes are very susceptible to atmospheric changes. This is markedly the case in the Thunder Fish, *Misgurnus fossilis*, of the Continent, which becomes very agitated when thunder threatens, and is often kept as a pet for its barometric properties.

The *Characidae* form a huge family, characterised by the non-protrusible mouth, which is, however, often furnished with exceedingly large, razor-like teeth.

The Tiger Fishes of Tropical Africa are typical of the group, being as large as salmon, and so ferocious that they are known as "Dogs of the Water". Still more deadly is the little razor-toothed fish of the Amazon known as Caribe. The scent of blood attracts great shoals of these fish in a few moments, and no large animal they encounter in the water can hope to escape with its life. Though individually no larger than an average perch, a shoal has been known to cut to pieces a man and his horse, leaving only clothes and saddlery to tell of the tragedy.

The Electric Eel, *Electrophorus electricus*, dealt with in the introduction, is a native of Brazil, and relies entirely on its powerful batteries for the capture of prey.

The members of the sub-order *Siluroidea* are known as Catfishes. These fish are widely distributed, and are characterised by the simple formation of the skull, and the often grotesquely elongated barbules. Some have accessory breathing organs enabling them to withstand droughts. Certain marine species (*Tachysurus*, etc.) are silvery fishes with erectile pectoral fins. The eggs are as large as peas and are incubated in the mouth of the male.

Of the American freshwater species, *Ameiurus nebulosus* is a typical example. The sexes combine to make nests in mud banks, the male, however, undertaking the "nursing", which he does with all the care of a domestic hen. This species is very common, and a staple food of the poorer classes.

The Wels, *Silurus glanis*, of Central Europe is also a common food fish, and the largest member of the entire family, measuring ten feet and weighing 400 lb. Like most of the order it is nocturnal, and when on the prowl shows a remarkable appetite. Remains of big dogs, and even of a human child, have been found in large examples. Specimens of this fish are still alive in the lake at Woburn Park in Bedfordshire, where they were introduced over sixty years ago.

Other notable members of the family are the Electric Catfish (*Malapterurus*), already dealt with, and the Armoured Catfishes (*Callichthys*, etc.), in which the body is wholly encased in large inter-locking plates of mail.

The Eels (Order *Apodes*) are elongated fishes, abundant the world over. Their vertebrae are very numerous, their scales minute. The fins, apart from the pectorals, form a continuous series. The Common Eel, whose amazing breeding habits are fully dealt with in the previous chapter, is a member of this order.

The Conger, *Conger conger*, reaches a length of 9 feet, and spends its entire life in the sea, preferring rocky ground. Like the common eel, it breeds in the deeps of the Atlantic, depositing floating eggs, which hatch into transparent leaf-shaped larvæ similar to those of the common species.

The Marbled Eels (Family *Muraenidae*) are tropic and sub-tropic forms, with flattened, handsomely marked bodies, and long poisonous teeth. A Mediterranean species (*M. helena*) was assiduously cultivated in special ponds by the Roman epicures.

The members of the Order *Synentognathi* are intermediate between the soft and spiny rayed fishes. The air bladder is without a duct and the lateral line forms a ridge on the ventral surface.

The Gar Fishes (Family *Belonidae*) are temperate and tropical fish, with very elongated jaws set with minute teeth. A striking feature is the green colour of the bones, due to chlorophyll, which often—quite unjustifiably—prejudices people against eating these excellent food fish. The common species, or Mackerel Guard, *B. vulgaris*, visits our shores in large numbers during warm weather.

The Flying Fishes (Family *Exocoetidae*) are of many species, some with the pectoral, and others with both pectoral and ventral, fins enlarged to form planes, by means of which the fish can skim considerable distances through the air, though with little, if any, capacity to direct their flight. The initial "take-off" for such flights is effected by the tail. Some can cover as much as five hundred yards, and are commonly induced to fly aboard a craft at night by the display of a lighted lantern.

The majority of the members of the order *Microcyprini* are small freshwater species, only a few entering the sea. The *Cyprinodontidae* include many of the kinds now popularised amongst aquarists. The Four-eyed Fish (*Anableps*) of tropical America is a remarkable form. The eye is divided transversely by a bar, and the pupil and retina, being thus split, the fish commands two separate views of the world, one above, the other below water-level.

The "Millions" Fish (*Lebistes*, *Gambusia*, etc.) swarm in the West Indies, and have been extensively farmed in various warm countries, since they are notorious foes of the mosquito. They place a valuable check upon the increase of that fever-spreading pest.

In the small Mexican Swordtail fish, *Xiphophorus*, the male is distinguished by a sword-shaped elongation of the tail. The viviparous female, having been delivered of several broods, sometimes changes sex and becomes an active male.

The Family *Amblyopsidae* includes the famous Cave Fish (*Typhlichthys*, etc.) of the Mammoth cave in Kentucky. These fish are entirely or almost eyeless, and quite colourless. They contrive, however, to steer a course amongst the intricate subterranean waterways by means of sensitive papillae which cover every part of their skin.

The fish belonging to the order *Anacanthini* have spineless fins, and the mouth or chin usually bears one or more barbels. The Common Cod, *Gadus morrhua*, ranks next in food value to the herring. It may measure 6 feet when adult, and weigh 60 lb. It is omnivorous, and haunts the sea-bed and mid-water throughout the North Sea and Northern Atlantic. The

flesh has a high water-content, but the liver is only surpassed by that of the halibut as regards the oil it yields. Other important members of this group are the Whiting, *G. merlangus*, the Ling, *Molva vulgaris*, and the Hake, *Merluceus vulgaris*.

The fish of the order *Allotriognathi* are very diverse in form, and come from all latitudes. Outstanding examples are the elongated Ribbon Fishes (*Regalecus*), reaching a length of 25 feet, with spiny crests upon their heads and a remarkable silvery sheen. They are rare, and when seen swimming at the surface have doubtless been responsible for many "Sea Serpent" stories.

In striking contrast are the Sea Horses (*Hippocampus*) and the Pipe Fishes (*Syngnathus*). The former suggest Knights of the Chess board, and like the elongated Pipe Fish are encased in a bony armour. Pipe Fish are common off our shores, the Sea Horses being confined to somewhat warmer waters. In all these fishes the eggs are carried in a brood pouch situated on the male's abdomen, and remain there until hatched. The fish are feeble swimmers, and largely drift about coastal waters. They attach themselves to seaweeds by their prehensile tails. Some tropic sea horses are secured from foes by a striking camouflage, the body bearing long skinny appendages which exactly resemble the surrounding seaweeds.

The members of the Order *Berycomorphi* are mostly perch-like fish of vivid coloration, some of which sometimes reach our markets. The most familiar of the order is the golden John Dory, *Zeus faber*, known also as St. Peter's Fish. The name refers to the spherical blotch near each pectoral fin, since according to legend this fish produced the tithe money referred to in the Bible, the blotch being the imprint of the Apostle's thumb and forefinger.

The Order *Percomorphi* includes the Perches, Mackerel, Mulllets, Tunny and allied forms. Most are torpedo-shaped fish, capable of great speed, and abound in warm seas as well as in fresh water. It is a very extensive order, embracing well over a thousand members.

The Common Perch, *Perca fluviatilis*, reaches a weight of five pounds, and lays long scarf-like strings of eggs which may often be seen tangled amongst reeds in lakes and rivers. The Common Perch, like the others of this order, is very voracious. Amongst the sea perches may be mentioned the common Sea Bass, *Morone labrax*, our chief marine "game fish". Allied to it is the famous American Blue Fish, *Pomatomus saltatrix*, one of the most destructive fishes afloat. It eats its own weight of fish at a

single meal. Blue Fish travel in shoals in pursuit of other fish, and bite pieces out of such as they do not devour whole. Another well-known species from Central and Southern America is the Jew Fish, *Stereolepis gigas*, which grows to a length of 12 feet, and is taken on rod and line in Florida.

Amongst the tropic fresh-water species are the Cichlids (Family *Cichlidae*) of America, Africa and Asia. The majority excavate basin-like nests in sand and gravel wherein to deposit their eggs. In the East African Mouth Breeder, *Haplochromis strigigena*, the female retains the eggs, about 50 in number, in her mouth until they are all safely hatched.

Of the many other marine forms may be mentioned the Coral Fishes (*Amphiprion*) which hide in the interiors of large Sea Anemones, the Wrasses (*Labrus*, etc.) of our own shores, noted for their gay colours, and the slender-mouthed Archer Fishes (Family *Toxotidae*) of the Far East. These last can squirt jets of water with such force as to bring down flies, etc., sitting upon bankside vegetation. To this order belong also the poisonous Weevers (Family *Trachinidae*) already mentioned in the introduction, and the Dragonets (Family *Callionymidae*), which are small gaily-coloured fish common on our sandy coasts. The male is specially gorgeous in its courting dress, and erects a high back fin, like a vividly painted sail. The Barracudas (Family *Sphyranidae*) of the tropics are long elongate fish with jaws filled with enormous teeth, capable of inflicting fatal injuries to bathers, and are in striking contrast to the allied Grey Mullet, *Mugil capito*, of our shores, a fish having an all but toothless mouth capable of eating only the softest food.

The Mackerels (Family *Scombridae*) are torpedo-shaped, and capable of immense speed. Our native Mackerel, *Scomber scomber*, is a miniature model of the huge 10-foot Tunny, *Thunnus thunnus*, which in summer visits the Northern coasts of England. In warmer seas it is not only fished on lines, but also taken in huge trap nets.

The Sail Fishes (Family *Histrophoridae*) and the Sword Fishes (Family *Xiphiidae*) are both recognised by a sharp elongated upper jaw or beak which may measure over a yard long. They are the swiftest fish afloat. Swordfish weighing over 500 lb. will charge small vessels, and have been known to drive their huge "swords" deep into the woodwork. In the young both jaws are equally developed. In the sail fish the dorsal fin forms an immense sail.

The Dolphins (Family *Coryphoenidae*), like the preceding, grow to a length of 6 feet. They are fast-swimming fish with large spineless dorsal fins that use their great speed to overtake and devour flying fish. They should not be confused

with the dolphin of classic sculpture, which was often inspired by a whale-like mammal.

The Climbing Perches (Family *Anabantidae*) of Southern Asia and Tropical Africa are small compact fish which can struggle over dry land or even ascend the lower branches of trees by means of spines on the gill covers which act as climbing irons. Accessory breathing organs enable them to live out of water for some considerable time.

The Chinese Paradise Fish (*Macropodus*) and the Siamese Fighting Fish (*Betta*) are small fresh-water fishes that, as mentioned in the introduction, construct bubble nests. The males of the latter are highly pugnacious, and in Siam are pitted against each other, extravagant wagers being laid on the issue of a contest.

The Blennies (Family *Blenniidae*) include many species common on our shores, the males of which undertake the incubation of the eggs, ensconcing them beneath rocks, or within empty mollusc shells.

The Wolf Fishes (Family *Anarhichadidae*) are giant blennies, exemplified in the "rock salmon" of our fish shops. They are common off Iceland, where they are called "Stone Beaters", in allusion to the formidable power of their jaws and teeth.

The Gobies (Family *Gobiidae*) are small fishes with the eyes set on top of the head. They affect shallows, and those tropic species, the Mud Skippers (*Periophthalmus*), which abound at the mouths of rivers in the East and Tropical Africa, spend most of their lives wriggling about on land and climbing the branches of trees in search of their insectivorous prey. The enormous protruding eyes of these fish are independently mobile.

A certain Goby, *Typhogobius californiensis*, frequenting rock crevices off the coast of California, is colourless and blind.

Very remarkable fish are the Shark Suckers and Remoras (Family *Echeneididae*) of tropic seas. The dorsal fin is modified to form a powerful sucker covering the head, by means of which the fish attaches itself to other large fish, or even ships' keels. Attached to a line, it is sometimes let over the side of a boat, and used for capturing turtle, the fish holding so tightly to the reptile that both are easily hauled aboard.

Twenty families are included in the Order *Scleroparei*, embracing a great variety of forms. The Scorpion Fishes (Family *Cottidae*) are represented on our coasts by the Sea Bull-head, *Cottis bubalis*, which has a big head covered with sharp spines. The males guard the eggs—placed beneath a boulder—with the greatest pugnacity. It is represented in our rivers by the nearly related Miller's Thumb, *C. gobio*.

In the massive Lumpsuckers (Family *Cyclopteridae*) the breast

fins are modified to form a powerful sucker, and one of these fish placed in a pail of water will adhere so firmly as to permit of its being lifted by the tail, with the pail attached. In these fish the male guards the eggs.

The Gurnards (Family *Triglidae*) are well represented in our waters. The fish have big heavily-armoured heads, and breast fins which can be used as feet whereby to scramble up rocks. The gurnards are brilliantly coloured, and in one species the very large pectoral fins can be used for "flying" as in the true flying fishes.

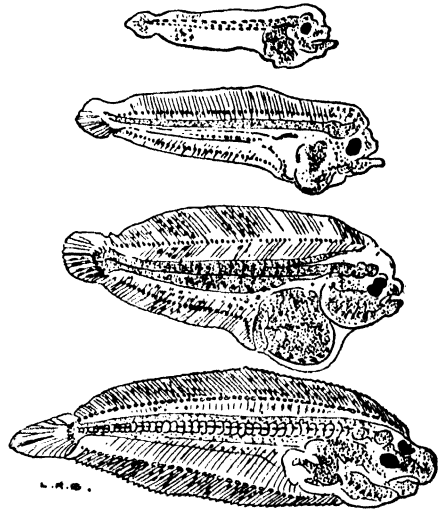
The Sticklebacks (Family *Gasterosteidae*), of which three-spined species *Gasterosteus aculeatus* of our ditches is known to all, are mostly small freshwater or brackish-water forms. The males make nests of vegetable oddments, and guard the eggs until hatched.

The Flat Fishes (Order *Heterosomata*) undergo a unique transformation in their early days. Although appearing as "normal" fishes when

first hatched, one eye gradually travels across the top of the head to meet its fellow, and the fish, as though to accommodate itself to this state of affairs, tilts over until it rests upon one side, the upper side only becoming pigmented. As noted in the last chapter, the power to change colour is very marked, the coloured side being right or left according to the kind of flat fish, but always constant in that particular species. Our chief British species are the Plaice, *Pleuronectes platessa*; the Sole, *Solea solea*; the Lemon Sole, *Microstomus microcephalus*; the Halibut, *Hiptoglossus vulgaris*; the Turbot, *Bothus maximus*; and the Brill, *Bothus laevis*. The halibut reaches a length of nearly 8 feet and a weight of over 300 lb.

The fishes of the Order *Plectognathi* are all tropic or sub-tropical, notable for the reduced gill openings, and reduction or loss of the pectoral fins.

The Trigger Fishes (Family *Balistidae*) have small, rough,



Development of Sand Sole

closely-packed scales, and small but powerful teeth with which they nibble coral branches. The spiny dorsal fin can be erected suddenly by a spring-trigger arrangement of the muscles. The flesh of all is charged with poisonous alkaloids.

The Coffe Fishes and Cow Fishes (Family *Ostraciontidae*) have the body cased in a box-like cuirass, with the armoured tail separately jointed. They are also coral feeders, and some have a horn-like projection jutting out abruptly over each eye.

The Puffers (Family *Tetraodontidae*) have the body flexible to a degree, so that it can be inflated until spherical in form. In those species which have spine-covered skins, the prickles upon inflation stand erect like the quills of a hedgehog or porcupine.

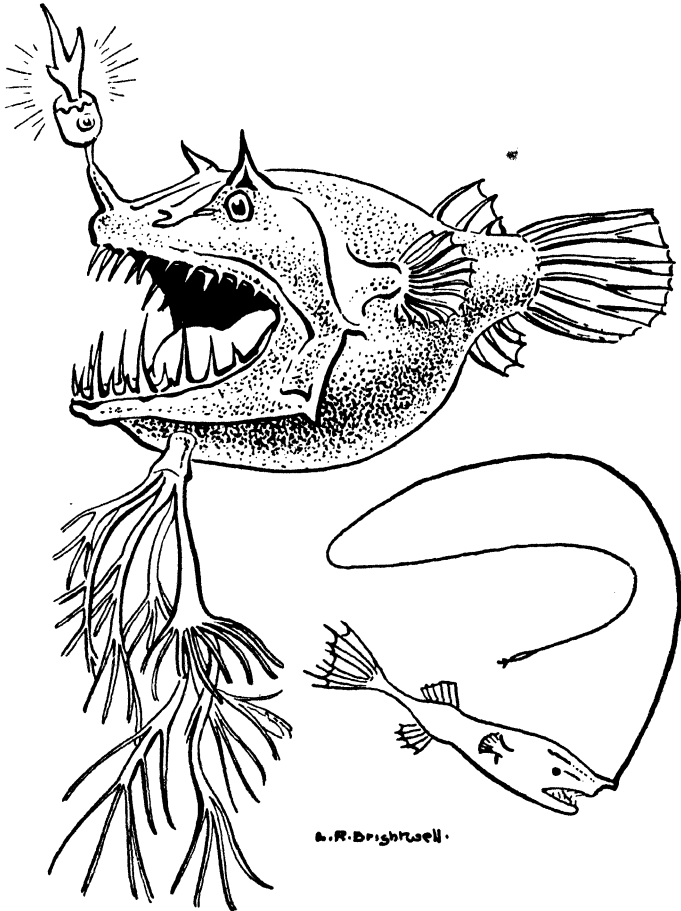
The Sun Fishes (Family *Molidae*) have the hinder portion of the body so truncated that the tail has been suppressed, the fish appearing as a laterally compressed sphere or ovoid. The caudal fin merges into the anal and dorsal fins. Despite their clumsy form these fish are capable of considerable speed, chasing such fast creatures as the squid and mackerel. The common species (*Mola mola*) is a summer visitor to our waters, and may measure 8 feet in length and attain a weight of 1,200 lb. It owes its buoyancy to a dense covering of fat, but is of little economic value, and has a peculiarly offensive smell. The "fry" of this fish are even more bizarre than the adult form, being covered with enormous spines.

The Cling, or Sucker Fishes (Order *Xenopterygii*), are small marine fishes found in temperate and tropic waters. Of the four British forms, the commonest is the Cornish Sucker (*Lepadogaster*), which bears a typical sucking disc, formed by a fold of skin between the ventral fins. With this it securely anchors itself to weeds and rocks.

The members of the Order *Symbranchii* are eel-shaped fishes living in the rivers of tropical America and the East Indies. A typical example is the Snake fish, *Amphipnous cuchia*, found in the water-logged rice fields of India. The gills are reduced, but their reduction is compensated for by a lung-like sac on each side of the body, just behind the head, which is richly furnished with blood-vessels.

The Anglers, or Fishing Frogs (Order *Pediculati*), are large-headed marine fish, found in all seas, and often at enormous depths. Their leading characters are the reduced gill opening behind the hand-like pectoral fins, the enormous mouth, which

literally bisects the head, and the highly mobile rays of the dorsal fin, which are modified to form fishing-rods with lures, whereby other fish are enticed within reach of the mouth. The enormous mouth is ringed with several rows of long movable

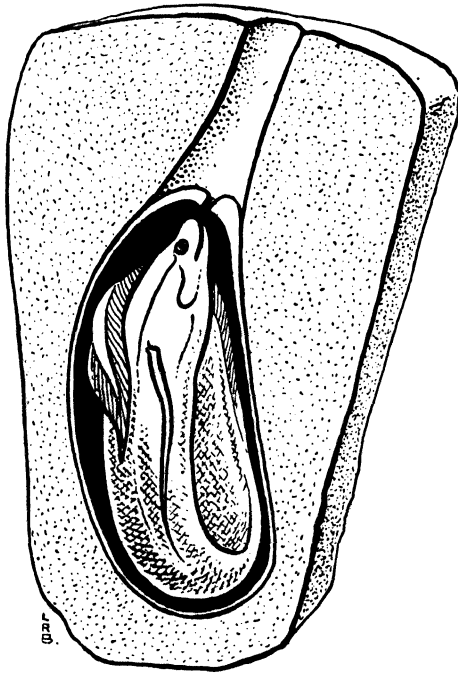


“Bearded” and “Whiplash” deep-sea Angler Fishes

teeth, over which its prey can easily pass, but can never hope to repass and regain its liberty. The Common Angler Fish, *Lophius piscatorius*, is fished off the coasts of Britain and North America, coming to market, minus the head, as “Rock Salmon”. Many of the abyssal anglers have the “lure” furnished with a luminous bulb, and in some there is a large, many-branched beard, also highly fluorescent. Most remarkable of all Anglers is a species

lately discovered in the North Atlantic. The female is large, but the males are quite minute and become attached by the head to their bulky consort. Thus established there, the grafted male's blood-stream joins that of the female and constitutes its sole source of nourishment.

The Frog Fishes (Family *Antennaridae*) are small tropic shallow-water anglers, of very unfish-like form. They crawl about upon sand banks by means of their pectoral and ventral



African Lung Fish lying dormant in a cell of sun-baked mud

fins. One species, the Saragossa Fish, *Pterophryne histrio*, lives amongst the floating Gulf Weed, which it utilises to make a nest in which the eggs are deposited.

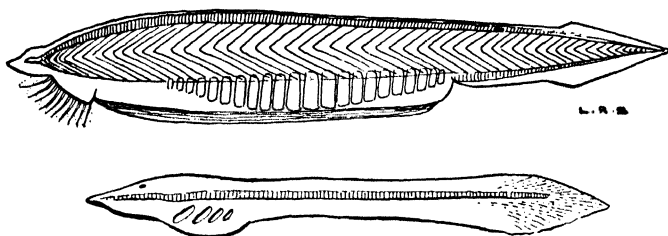
The Lung Fishes of the Sub-class *Crossopterygii* (Order *Dipneusti*) are survivals from Palaeozoic times, when they frequented tropic and sub-tropic rivers the world over. The fins are very simple, and the air bladder more nearly approximates to a lung than in any other fishes. As a result, all can withstand prolonged droughts.

The family *Ceratodontidae* is represented by a single species, *Neoceratodus forsteri*, of Queensland. It attains a length of six feet.

The family *Lepidosirenidae* is known by several species distributed throughout certain rivers of Tropical Africa and South America. These fishes—represented by the genera *Protopterus* and *Lepidosiren*—aestivate in hot weather. As the water of their native rivers departs in the dry season, the fish ensconce themselves in a mucous-lined cell deep within the mud, a narrow tube affording their only access to the air above. Here the fish lie dormant in the sun-baked soil for several months together. “Walled-up” specimens sent to the Zoo in their iron-hard mud cells are liberated with the aid of a chisel and hammer. The males of the three African species guard the eggs laid in shallow circular pools, and aerate the ova by fanning them with their tail fins. The “fry” suggest frog tadpoles, having large external gills. In the South American Lung Fish, *Lepidosiren paradoxa*, the eggs are laid in an underground burrow, where they are guarded by the male who encircles them with his body.

THE LANCELETS, TUNICATES AND
HEMICHORDATESClasses *Cephalochordata*, *Tunicata* and *Hemichordata*

THE dividing line between the backboneed and the invertebrate animals is not as definite as might at first be supposed, and a number of animals once variously described as worms, etc., are now placed in a "half-way" division since they show certain characteristics both of vertebrates and invertebrates. These animals may be divided into three classes known as (1) The *Cephalochordata*—the Lancelets; (2) The *Tunicata*—the Tunicates or Sea Squirts; and (3) The worm-like *Hemichordata*.

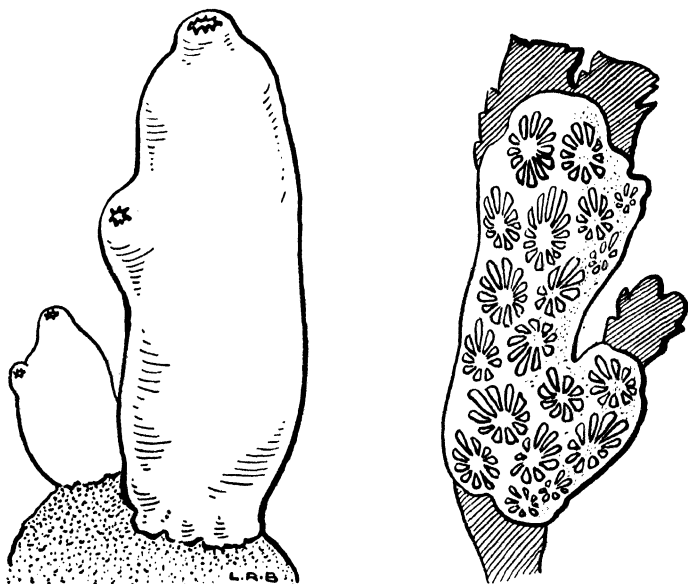


Lancelet : Adult (above), Larval form (below)

The Common Lancelet, *Amphioxus lanceolatus*, is a semi-transparent leaf-shaped animal about two inches long found in the North Atlantic and Mediterranean. It lives half-buried in the sand, where it gathers food into its interior by means of a ring of lashing hairs surrounding its gill-slits. It has a notochord which extends along its entire length. The animal can swim in an eel-like manner, but usually lies obliquely on its back, with only the mouth appearing above the sand. Allied forms are found the world over.

The Tunicates, or Sea Squirts, are world-wide marine animals, presenting an infinite variety of structure, yet all possessing certain features in common. The body is enclosed in a gelatinous sheath or tunic, having two openings leading into the interior. The one takes in food and sea water by means of lashing hairs, as in the lancelet; the other ejects waste matter. The circulatory system is unique in that the heart beats in one direction for a short period, and, after a pause, pumps the blood in an opposite course. On being touched the animals

usually contract, ejecting a stream of sea water, hence the popular name. Most sea squirts are anchored for life to rocks, weeds, etc. Some may be large single individuals, others form colonies of animals united into an encrusting mass. All, however, agree in their remarkable metamorphosis. They form colonies by budding or produce eggs which hatch into minute tadpole-like creatures with a tail supported by a notochord, which represents the backbone of higher animals, a nerve chord, a brain of sorts and an eye. After a few hours or days spent in this form, however, the larva attaches itself by its head to some



Tunicates: "Flask" and "Golden Star"

stable object, and gradually loses all but a few essential organs. These degenerate animals are abundant round our shores, and can be found in almost all situations.

The most conspicuous of the solitary forms is the Flask Sea Squirt, *Ciona intestinalis*, a large milky-white species some eight inches high. A conspicuous sea squirt which forms colonies is the Golden Stars, *Botryllus violaceus*, often seen encrusting weeds and stones, each "star" being a cluster of animals.

The *Hemichordata* are represented by a number of worm-like animals. One species, *Balanoglossus sarniensis*, which is fairly common in the Channel Isles, is from one to three feet long. It

lives buried in silt, and is worm-like superficially. The forepart of the body may become much swollen with water. Internally it presents many vertebrate features, including a short notochord. The larva is commonly found in the open sea off Devonshire and Cornwall.

XXXVI

INVERTEBRATES

THE Invertebrate Animals, as understood to-day, are all those forms of life which have no hard, articulate internal skeleton. As amongst the various groups of vertebrates, each of the main groups is linked to the others by intermediary forms. The invertebrate animals, however, are not so sharply defined as are the vertebrates. All worms, for example, cannot be identified as such as easily as a bird can be distinguished from a mammal or a reptile. Until within relatively recent times naturalists often confused the various groups, and even to-day the precise positions of many invertebrate animals is a matter for discussion.

CRUSTACEANS, SPIDERS, INSECTS

Class *Arthropoda*

THE Arthropoda are all to be distinguished by having an external skeleton or rather a thickening of the outer muscles, reinforced with carbonate of lime or siliceous matter, and intricately jointed, like the armour of a medieval knight. A large number of arthropods undergo a metamorphosis. They abound in every part of the globe, but tend to reach their maximum development in warm latitudes. The outer integument or armour is frequently cast or moulted to admit of the animal's expansion.

The members of the sub-class *Crustacea* are to the water world what insects are to the land. The group reached its highest development in the Devonian epoch, when such creatures as the giant sea scorpions measured 6 to 9 feet in length. Crustacea are all obliged to periodically cast their outer integuments, or "shells", since these do not grow, as do the muscles and soft internal organs. The young are usually produced from eggs carried by the female parent. There are several orders and sub-orders. The sub-order *Branchiopoda* includes the minute "water fleas" (*Daphnia*) common in stagnant ponds, etc., where they are often so abundant as to tinge the water a rusty red, and such shrimp-like forms as *Artemia*.

The members of the sub-order *Ostracoda* are minute crustacea, and are enclosed in bivalved shells showing infinite variety of form and ornament. There are fresh-water and marine forms.

The *Copepoda* is a sub-order consisting of small, free-swimming fresh-water or marine creatures, the latter constituting much of the surface-swimming ocean life collectively known as plankton, which feeds on minute floating plants. It forms a basic part of all fish food and so is of paramount importance to the general economy. The bodies are divided into segments and some of the legs are adapted for swimming. The *Copepoda* carry long, feathery plumes which help to keep them afloat. *Cetochilus*, the "whale food" of the right whale, is bright red in colour and, where it occurs in vast shoals, may colour the sea red.

Calanus is a very important copepod since it forms the food of young herrings.

The Barnacles (Sub-order *Cirripedia*), known to all seaside visitors, closely resemble copepod crustaceans when first hatched. In this form they live free-swimming lives for some time until they settle down upon a rock, ship's keel or similar object. All the organs then undergo important changes. The shell becomes a six-sided, limey tower with a movable lid enclosing the animals, and the legs are merely put forth to rake the water for food. When adult they are fixed by the head and resemble molluscs rather than crustaceans.

The Acorn Barnacles, which cover almost every rock between tide marks, are known by about a dozen species. The largest is some 4 inches high and attaches itself to ships, whales, etc.

The Goose Barnacle, so called from the ancient belief that it was the young of the barnacle goose, anchors itself to solid objects by means of a long flexible stem. From being found on floating timber it was supposed by the old naturalists to grow on trees, to drop off into the water and hatch into geese. A curiously degenerate barnacle (*Sacculina*) may often be found attached to the abdomen of the shore, and other, crabs. This barnacle in maturity discards all limbs and other appendages, and is virtually a stomach which absorbs nourishment from the crab by sending out threads into every part of its host's body.

One form of barnacle, *Tubicinella*, sometimes burrows into the skin of whales.

The order *Malacostraca* includes all the better-known crustacea such as the numerous shore "lice", the sand-hoppers, crabs and lobsters. In all these animals the body is divided into numerous segments, each of which bears a pair of appendages. They may be found to serve innumerable functions, some being used for progression, others for feeling, chopping up food, seeing, etc.

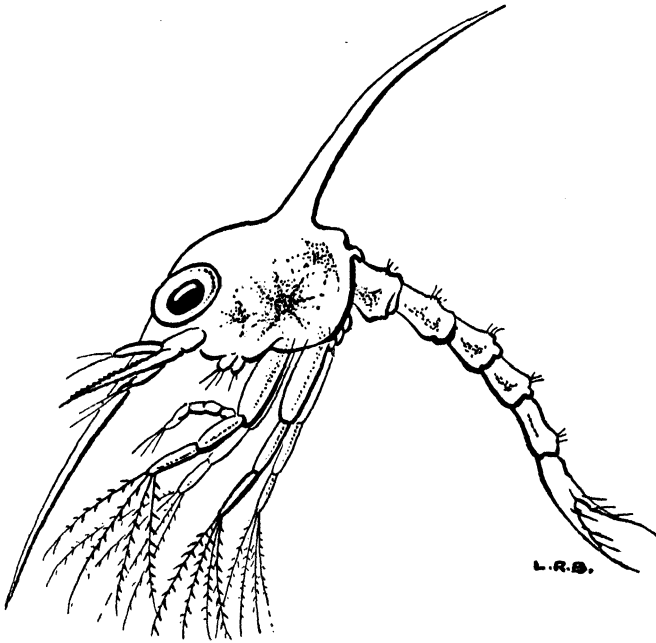
Of the Sea Lice (Sub-order *Isopoda*) the best known are the Sea Woodlouse, *Ligia oceanica*, often found on break-waters, and the Gribble, *Limnoria lignarum*, which undermines all wooden substances, reducing harbour piles and ships' sides to a spongy mass. The common land woodlice, slaters and pill-bugs are members of this group.

The sub-order *Amphipoda* includes the well-known Beach "Fleas", or Sand Hoppers, and the Fresh Water Shrimps, small flattened creatures which act as valuable scavengers upon beaches, stream beds, or wherever else they occur.

The sub-order *Stomatopoda* is represented by the transparent marine Mantis Shrimps (*Squilla*) with huge scythe-like fore limbs recalling those of the praying mantis, an insect allied to the locust.

The mantis shrimp is much prized as food in Italy, where it is known under the name of "Scampi".

The *Decapod* sub-order of crustaceans—Prawns, Lobsters, Crabs, etc.—are all distinguished by having ten walking legs,



Larval Stage of Edible Crab

two of which are usually converted into pincers. The young are hatched from eggs carried on the underside of the female's tail, which organ is permanently bent under the body in crabs, but in prawns, etc., is very mobile, and by violent contraction can propel the animal backwards. The sub-order is divided into Long-tailed and Short-tailed forms and the *Anomura*—Hermit Crabs, etc.

Prawns are Long-tailed forms found in all seas and at all depths, and usually swimming in shoals. They have large paddle-shaped "swimmerets" on the hinder part of the body. Most are edible and of considerable food value. Like most decapods they are omnivorous, eating animals and plants

either fresh or far advanced in corruption. Many prawns are vividly coloured, and some deep-sea forms can eject clouds of luminous fluid which serve as a smoke screen to cover retreat.

The Crayfishes, *Astacus*, etc., are lobster-like animals found in rivers, mountain streams, etc.

The Lobsters (*Homarus*), etc., include our common species and the larger American kind, a single claw of which may weigh as much as 10 lb. The large crushing claw, which may be either right or left handed, and its other limbs grow again when lost, a useful provision since these animals are very pugnacious, and frequently find it necessary to discard a claw in order to escape when defeated in battle.

The so-called Dublin Bay Prawn, *Nephrops norvegicus*, often seen for sale, is a small lobster from deep water. It occurs in the Mediterranean and in Northern European seas.

The Rock Lobsters, the "Langoustes" of the French (*Palinurus*), are without powerful "nippers". They have remarkably long antennae or "horns", and the basal joints of these, when rubbed against the central "beak", give out a loud grunting sound. The young of most lobsters closely resemble the parents; those of the Rock Lobster, however, are transparent, leaf-like animals, known as "glass crabs".

The members of the sub-order *Anomura* are regarded as an aberrant offshoot of the lobsters. The tail may be short and tucked beneath the body as in true crabs, but often it is long, and unprotected by armour. Such forms are known as Hermit Crabs and the unprotected tail, together with the rest of the animal, is invariably tucked in the discarded shell of some univalve mollusc such as a whelk. Hermit crabs are astonishingly active and pugnacious. Some tropic forms even come ashore at night and climb low trees in search of birds' eggs.

The large Coconut Crab, *Birgus latro*, of Christmas Island, is a giant hermit which has discarded the shell. Instead, it hides by day in burrows excavated at the foot of coconut palms. It climbs the trees in search of the nuts on which it habitually feeds, opening them with its powerful claws.

In the true crabs (Sub-order *Brachyura*) the abdomen is short and folded under the body, and the carapace is broad and flat. They abound in all seas, at all depths. Some crabs have invaded rivers, etc., and a few are largely terrestrial.

The Swimming Crabs, etc., have the hind legs flattened to form paddles, by means of which the crabs swim with great rapidity.

The Spider Crabs have rough pear-shaped bodies and long thin legs. They are lethargic, and rely for safety upon

camouflage, dressing themselves up in seaweeds, sponges, etc., which find an anchorage upon their warty backs. The Spider Crab, *Macrocheira*, is the largest living crustacean. It comes from Japan and has a leg span of 10 feet or more.

The Shore Crabs, exemplified in our common crab, *Carcinus maenas*, are active and predatory forms.

The Land Crabs are tropical forms, often living many miles from the sea. They make annual excursions to the sea for breeding purposes, travelling in armies of some millions strong, and surmounting all obstacles, even houses, which may be encountered *en route*.

The Calling Crabs (*Gelasimus*), of tropical and semi-tropical seas, are distinguished by the claws of the male, one of which may exceed the entire animal in bulk. It is often brilliantly coloured, and when the crab is courting is flourished with much violence before the prospective bride.

The Pea Crabs (*Pinnotheres*) are very small degenerate forms. The female crab often seeks shelter within an oyster or mussel. The male is active and independent, visiting his consort only during the breeding season.

The *Trilobites* are to-day known only as fossils, but in the Palaeozoic period were a dominant form of life in the seas, and are known by several thousand species. They were flattened, segmented animals, rather suggesting woodlice, and, like those crustaceans, could roll up into a ball.

Their nearest living relatives are the King Crabs (*Limulus*) which are believed by some to stand midway between the Trilobites and the Scorpions. King Crabs abound in Far Eastern seas, and are also found off the eastern North American coast. Their segmented bodies suggest animated military "tin hats", the animals' limbs being entirely covered with a dome-shaped shell. A long, thick, movable tail projects from the hinder end. King Crabs are a survival from remote geologic times, and owe their present existence to the fact that they are of no commercial value, and have few enemies, only a few of the larger sharks and rays eating them. They are members of the Order *Xiphosura*.

The True Scorpions (Order *Scorpiones*) are elongated terrestrial animals, breathing by means of lungs, with four pairs of legs, two lobster-like claws, and a jointed tail having a sting at the tip. The majority are desert forms, but some live in forests. The young are born alive, and carried for a time on the maternal back. Scorpions abound in all hot countries, are omnivorous feeders, and the sting may at times have fatal results to human beings. Some Indian species reach a length of a foot.

The Spiders (Order *Araneae*) are relatives of the scorpions, distinguished by a pair of venomous fangs, or "palps", taking the place of pincers, and by their compact bodies, the front part of which is separated from the back part by a "waist". The end of the abdomen usually bears a pair of spinnerets which secrete the well-known "silk", used in making the web. The silk can also be used to line burrows. Some minute spiders parachute through the air by letting a strand of their silk float upon the breeze. The Water Spider, *Argyronetta aquatica*, makes of its silk a hollow diving-bell. This it inflates with air bubbles, and uses as a receptacle for the eggs. Spider silk is exceedingly strong and in some tropic forms has been utilised by man to construct fishing nets and even articles of clothing. The Bird-eating Spiders (*Mygale*) are huge, hair-covered tropic species capable of killing and eating small birds and mammals.

The related Trap-door Spiders (*Actinopus*), etc., make burrows lined with silk, which are guarded by a movable lid which can be closed or raised by the spider from within the burrow.

The majority of spiders make large and complex webs, ranging in design with the species. They are carefully repaired when torn by victims caught in them, the silk also being used not only to manacle animals caught, but also to fashion cocoons in which to conceal the eggs. The House Spider, *Tegenaria civilis*, builds a large funnel-shaped web—responsible for the unpopular "cobwebs" we all know. This spider, if kept supplied with flies, will live the year round in an open jam jar, evincing no desire to escape, until it feels the autumnal impulse to migrate.

The so-called "Harvest" Spiders (Order *Opiliones*), though suggesting spiders, are distinguishable by the head, chest and abdomen being combined, there being no apparent "waist". They also differ in having no spinning organs. They are related to the mites and ticks which infest man and other animals. Some species also inflict injury to plants. The entire group is indeed of great economic importance. Notorious species are the tick-fever mite, *Spirillois*, the cattle-tick, *Margaropus*, the itch mite, *Sarcoptes*, causing "scabies", and the unpopular but harmless cheese mite, *Tyroglyphus*.

The members of the order *Pycnogonida*, or "Sea Spiders", are common in all seas, at all depths, where they live among sponges, weeds, etc. The body is so reduced that offshoots of the internal economy are housed in the exaggerated legs. The sea spiders have long beaks with which they suck the juices

of anemones, etc. The eggs are carried and incubated in a special sack by the male parent only.

The Pentastomids (Order *Pentastomida*) are peculiar elongated animals which at first sight might be mistaken for worms or slugs. They are parasitic creatures with a few hooks on either side the mouth by means of which they attach themselves to the nasal cavity of their hosts—mammals, birds, and reptiles. The Pentastomids have no respiratory or circulatory organs.

The order *Onychophora* is represented by the tropical, subtropical *Peripatus*, a long, soft-bodied animal with a number of short legs like a caterpillar's, a pair of jaw-appendages, and a velvety sheen suffusing its entire surface. It breathes by means of air-tubes. It lives under stones, and subsists on small insects caught in a sticky secretion which it shoots out in the form of threads. There are many species of *Peripatus*, some viviparous, others oviparous. These strange animals were unknown prior to 1873, and are now regarded as connecting the jointed animals or arthropoda with the leg-bearing marine worms.

The order *Myriapoda* includes the well-known millipedes, centipedes, etc.

The Millipedes (Sub-order *Diplopoda*), are terrestrial arthropods, breathing air, as do spiders and insects, by means of tubes. All are quite harmless and live on vegetation. The largest species come from tropic countries, and may measure nearly a foot long. The number of legs varies in the different species, but none display the traditional "thousand".

The allied Centipedes (Sub-order *Chilopoda*) are active and predacious. Some tropic forms reach a foot in length and are highly poisonous. Our single native species, common in gardens, lives on earthworms and insects. Its bite is quite appreciable.

Hundreds of thousands of species of living insects are known. Insects (Order *Insecta*) are small animals whose bodies are divided into three regions: head, thorax, and abdomen. They breathe by means of tracheae or air tubes distributed throughout the body, and have six legs, arranged in three pairs attached to the thorax. The head bears a pair of compound eyes, antennae, and various mouth parts. There are one or two pairs of wings rising from the thorax. Some fossil forms show traces of three pairs. Usually the young are hatched from eggs and pass through a less complex metamorphosis than those of crabs, etc. Insects abound everywhere between the poles, gaining their maximum

in species, numbers and size near the equator. Normally the eggs hatch into larvae, which pass into a quiescent or "chrysalis" (pupal) state, this giving rise to the imago, or perfect insect. No insects to-day are as large as certain fossil forms, one of which was a dragonfly with a 2-foot wing span.

Insects are of paramount economic importance. Many are dangerous parasites, conveying deadly diseases to man and other animals. Others infest crops, whilst others again provide us with such commodities as dyes, honey, silk, etc. Of recent years the wars fought between one species of insect and another have been turned to account. In all civilised countries are established research laboratories where insect life histories are studied in detail. By this means it has been possible to discover insects which feed on other dangerous insects, or even upon noxious weeds, and to export such insects in bulk to countries where their services are needed. Thus, ichneumon flies are farmed to destroy caterpillars, "lady-bird" beetles to devour green-fly, and cochineal insects and a certain moth to eat up the prickly pear cactus. Certain mammals, birds, reptiles and fish are also protected for the service they render in keeping a check upon insects harmful to man, his crops or farm stock.

It may, indeed, be truly said that the insects, small though they often are, have made and marred all man's undertakings. Even to-day some such as the Tsetse-fly and mosquito have made it almost impossible to colonise certain areas where they abound.

Insects are very broadly divided into the sub-orders *Aptera* (Springtails), *Orthoptera* (Locusts, Cockroaches, etc.), *Isoptera* (White Ants), *Neuroptera* (Alder flies), *Ephemeroptera* (Mayflies), *Odonata* (Dragonflies), *Trichoptera* (Caddis flies), *Mallophaga* (Bird lice), *Lepidoptera* (Moths, Butterflies, etc.), *Hymenoptera* (Ants, Wasps, Bees, etc.), *Diptera* (Flies), *Coleoptera* (Beetles), *Rhynchota* (Bugs, etc.).

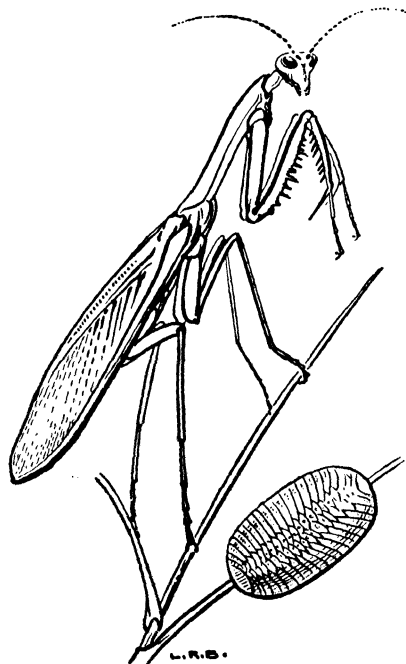
The *Aptera* are small and very primitive insects, represented by the springtails, fish insects, etc.—abundant in houses, where they feed on all kinds of substances. The "Baker's Brat" (*Thermophila*) is common in London Bakeries. These insects do not pass through a complex metamorphosis.

The *Orthoptera*, or leathery-winged insects, like the foregoing, betray their primitive origin in that the young closely resemble the parent form, only lacking wings on emerging from the egg.

The distribution of Cockroaches (Family *Blattidae*) is world-wide. Many are highly ornamental. The common "black beetle"

(*Blatta*) was introduced to this country from the East some centuries ago, whilst the big American species (*Periplaneta*) is now also common in greenhouses, etc. Cockroaches do vast damage to all substances, nothing being inedible to them. They are also carriers of disease.

The various species of Praying Mantis (Family *Mantidae*) are at once known by their spiny fore limbs held in a "praying" attitude. They can be shot forth at lightning speed, transfixing the quite large insects on which the mantis feeds. The members of this family occur in warm countries, one species being found in the South of France.



Praying Mantis and Egg-case

The Grasshoppers and Locusts have earned worldwide fame since early times for the ravages they commit on arable land, orchards, etc.

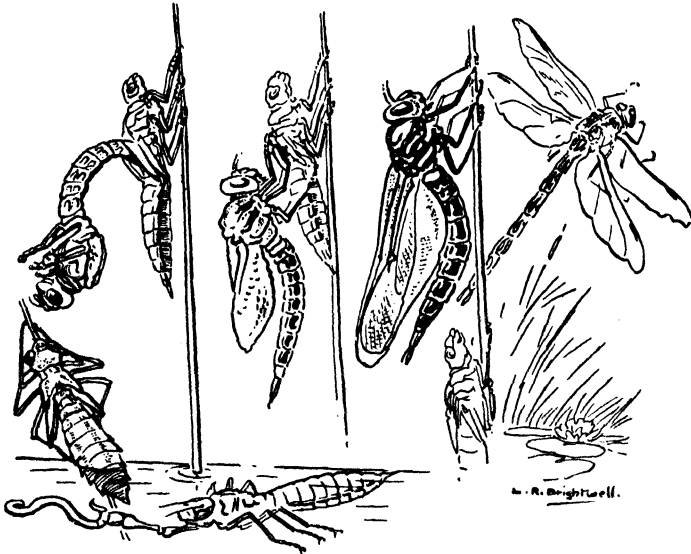
They often appear in vast numbers, actually blotting out the sun, and having descended upon farm land, leave behind them utter devastation. The eggs are laid in the earth, and these, hatching into creeping, wingless larvae, similarly cause irretrievable damage. Of late years poison gases, liquid fire, etc., have been enlisted to combat a scourge still as dreaded as in the days of Pharaoh.

The remarkable Stick Insects and Leaf Insects (Family *Phasmidae*) of the tropics so closely resemble twigs or living leaves as to defy detection. Further, their eggs often so resemble the seeds of plants that even expert botanists have been deceived. In these insects males are of very rare occurrence. A male may be the father of many successive broods after but a single mating.

The sub-order *Isoptera* includes the White Ants or Termites, famous for the damage they do to all woody substances in tropic lands, and for the vast earthen "nests" they erect. These

are often veritable hills capable of supporting large trees. Termites live in vast communities, consisting of wingless soldiers and workers, and special sexual forms with wings. The queen of the community can lay hundreds of thousands of eggs at a session.

The sub-order *Neuroptera* includes the soft-bodied Alder Flies, Lace Wings, etc., carnivorous insects which often spend their larval stage upon the bed of a stream or pond. The Lace Wing Flies (*Chrysoptera*) feed wholly upon greenfly and are now farmed for this purpose. The Ant Lions (*Myrmeleo*) are



Development of a Dragonfly

similar to lace wings in the perfect form. The larva is a strange, big-jawed animal that makes a conical pit in loose sand, and in it lies in wait to capture such insects as tumble into the pitfall.

The May-flies that dance on the surface of the water (Sub-order *Ephemeroptera*) and are known to all fishermen, spend the larval stages submerged. Some forms burrow in the mud, others live amongst weeds. In the winged state the insect usually lives only a few hours. The life of the larva, however, is long, some species spending years in the aquatic state.

The big gaudy Dragonflies (Sub-order *Odonata*) are highly predacious, and in the aquatic larval stages even kill small fish. The under-surface of the head carries a jointed prehensile

organ, the "mask", which seizes insects and bears them to the mouth. Dragonflies are exceedingly fast on the wing. They are unable to crawl but use their limbs for climbing the stems of plants. The eggs may be laid under water. When the larva, which is colourless, stops feeding, it attaches itself to a plant above watermark. Its hard cuticle then splits and the dragonfly forces its way out.

The members of the sub-order *Trichoptera*, the Caddis Flies, are known by the larvae which conceal their soft bodies in tubular protective cases made of leaves, gravel, sticks, shells, etc. The larva carries hooks on its abdomen by means of which it anchors itself in its case. In aquaria many species can be induced to employ coloured beads in the manufacture of their cases. The tube is sealed with a "drum head" of silk during the period of pupation. The larva of a marine species employs coralline and sea-weed in the formation of its case. The adult insect is moth-like.

The members of the sub-order *Mallophaga*, or Bird Lice, are small wingless flattened insects which change little in general form through life. They are parasitic upon birds and mammals. One, *Trichodectes*, infests the dog. They feed on their host's skin but do not suck blood.

The Butterflies and Moths form the sub-order *Lepidoptera*. Of the butterflies, about forty-six species occur regularly in Britain and over 2,000 of the moths, but these figures are insignificant compared with those of tropic lands. There is a well-marked metamorphosis—egg, active feeding larva, quiescent chrysalis, and perfect insect. The latter is often gorgeous to a degree, the colours being supposed to be of use to the insect for the purpose of sexual attraction or protective mimicry. In the case of some vividly coloured but unpleasant tasting forms, such as the Cinnibar Moth, it is a "warning". The tongue is ribbon-like, and coiled in a spiral. It can be extended and used to extract the nectar from flowers. Often the chrysalis stage is spent—as in some hawk-moths—underground, concealed in wood, suspended from a wall, or attached to a grass stem. Frequently—as in the valuable silk-moth—it is concealed in many layers of silk, which the moth eats through when ready to leave the chrysalis shell. The bulk of caterpillars live on fresh green stuff, but some—like that of the Goat Moth—tunnel into wood. The largest member of the order is the Atlas Moth of India with a wing span of about 12 inches. Caterpillars often appear

in vast swarms, doing great damage, and some species make large communal cocoons in which all pupate together.

The Beetles (Sub-order *Coleoptera*) are readily known by the single pair of wings folded beneath two horny sheaths which meet in a straight line down the centre. Usually, but not always, they conceal the entire abdomen. The larvae are usually soft bodied, and may spend some years in a semi-helpless condition before pupating. Those of the aquatic forms are usually very active and predacious.

The Ground Beetles (Family *Carabidae*) are common everywhere. One genus, *Brachinus*, can, when molested, exude a volatile fluid that explodes in smoke and has earned the group the name of Bombardier Beetles.

The members of the families *Gyrinidae* and *Dytiscidae* are aquatic species, the former, known as "whirligigs", being very active on the pond surface in mid-summer where they spin round in circles. Our largest native water beetle, *Hydrophilus piceus*, attains a length of nearly two inches. This beetle, known as the Great Water Beetle, is a vegetarian, but its relative, the Tiger Water Beetle, *Dytiscus marginalis*, which is nearly as large, eats worms, frogs and fish. Even its elongate larval form sucks the blood of various animals.

Sexton Beetles (Family *Silphidae*) bury dead mammals etc., and conceal their eggs in the interred carcasses, thus ensuring their larvae abundance of food.

The members of the family *Coccinellidae*, or Ladybirds, are notorious as foes of the destructive Aphis, or greenfly.

The large brown Cockchafers (Family *Scarabaeidae*) are nocturnal, and their grubs may live in the ground for three years. Some members of the family lay their eggs in dung which they roll into balls. The sacred Scarab Beetle of Egypt is represented thus in mural paintings, etc., and embodies "Life" perpetually renewed from an egg.

In the members of the family *Lucandiae*, the Stag Beetles, the jaws of the males are enormous and branched. The grubs spend several years tunnelling into trees. The Worm-Hole or Furniture Beetles (Family *Anobiidae*) are very destructive. One of these, the Death Watch Beetle, works havoc amongst the beams, etc., of old buildings.

Another destructive family is that of the Weevils (*Curculionidae*), whose members attack crops of all kinds. Scarcely less esteemed are the larvae of many Longicorn Beetles, which also live almost exclusively upon timber, both growing and prepared.

Beetles are the bulkiest of all insects, the largest known being

the Hercules (*Dynastes*) of South America, measuring six inches long. The Fire Flies (Family *Cantharidae*) are highly luminous night-flying beetles, and in South America are used as hair and dress ornaments by Society belles. Our native Glow-worm (*Lampyris*), luminous in every stage from egg to imago, is nearly related. In our common native glow-worm the female is wingless and most luminous at the extremity of her body. Its food consists chiefly of snails.

The light described by Gilbert White as "amorous fire" serves a purpose in advertising the glow-worm's presence to a member of the opposite sex.

The sub-order *Hemiptera* includes the Plant Bugs, Bed Bugs, Pond Skaters, Water-boatmen, etc. The majority are diurnal and are plant feeders, tapping the sap with their sharp probosces. The latter organ may also be used for sucking.

The Bed Bugs (Family *Cimicidae*) suck blood but live chiefly on the moisture from wood, etc., and in slums abound behind old wallpaper, where they subsist on the glucose in the paste.

The carnivorous Pond-Skaters (Family *Gerridae*) glide about on the water surface and are prevented from getting wet by a thick coat of hairs with which their under-surfaces are covered.

The Water-boatmen (Family *Notonectidae*) have flattened legs fringed with hairs. These latter are used as oars, the insects floating on their backs and rowing themselves about with them.

Included in the sub-order *Homoptera* are the musical Cicadas of warm countries. The larvae of a North American species appear at intervals of seventeen years, the nymph stage being spent for the whole of that period underground. The perfect insect lives for a short time high up in trees. Many have an oscillating device on the abdomen by means of which they maintain a loud singing sound.

To this order belongs the little Froth Bug, or Cuckoo Spit, of our gardens. The larva does the plants little harm, the froth being merely sap infused with air.

The Lantern Flies (Family *Fulgoridae*) are not luminous, but owe their name to their habit of secreting a waxy substance used in making candles.

The members of the family *Aphididae*, the small green or brown-green flies, are highly destructive to roses, vines and various kinds of trees. Related to them are the Scale Insects (Family *Coccidae*). Some species provide the valuable dye known as cochineal, others a waxy substance of commercial value. The cochineal insect is an inhabitant of Mexico and lives on cactus plants. The male is a slim, active flying insect,

but the female, from the body of which the famous dye is obtained, is little more than a bag of skin with a few legs. When young she attaches herself to a plant and never moves again. She remains in the same position until fertilized, when she lays her eggs—and dies.

Ants, Wasps, and Bees (Order *Hymenoptera*) are essentially sociable insects, living in large colonies which are usually divided into three distinct grades—sexless workers, non-productive males or drones, and egg-laying females or queens. In the ants there are still other grades, such as soldiers, with big heads and powerful jaws, designed to protect the community or to raid other colonies.

The Ants (Family *Formicidae*) are legion both in numbers of individuals and species, and abound everywhere save at the poles. Almost every human activity is mimicked by these insects, which excited man's wonderment from early times. Though seeming to display almost human intelligence, they are in reality largely automatons, living and toiling within certain narrow limits, displaying little initiative or ability to adapt themselves to altered circumstances. Huge nests may be constructed below or above ground, or attached to tree trunks and branches. Some ants construct homes of leaves cunningly sewn together, the larva secreting sticky threads used in the sewing. Others, such as the Leaf Cutter Ants, employ scraps of leaves to form mushroom beds, the packed leaf fragments being used to harbour cultures of minute fungi on which the community feeds. In the Honey-pot Ants certain workers store nectar in their greatly distended abdomens, such strangely modified creatures being "parked" in special galleries, where they are "tapped" by other members of the colony as the promptings of hunger dictate. The notorious Driver Ants of Central Africa embark upon periodic migrations, moving in military formation of many thousands strong, sweeping all before them and compelling even the largest animals to flee from their line of march. In these mass movements the soldiers flank the ranks of workers, whilst the Queen moves in their midst. The Queens are literally egg-laying machines, sustaining no other function save that of maintaining the population at the necessary strength. The so-called ants' eggs used for feeding birds and fish are actually cocoons containing ants lying dormant in the chrysalis stage. Unless quite fresh, such "eggs" have little nutritive value. The largest ants known are the Great Black Ants of Brazil, which measure upwards of an inch in length. These ants not only bite but, like our common species, can inject a poison—formic acid.

Despite their seeming invincibility, ants are imposed upon by all kinds of other insects, fully two hundred species subsisting wholly by filching food from the ants' store-houses, and even intercepting morsels that are being passed from a worker to an immature ant larva "at nurse". Such parasites are seldom treated with resentment, or, if they are, evade just retribution by superior cunning and agility.

The Wasps (Family *Vespidae*), abundant in all the warmer regions, similarly form colonies or hives of varying size, such communities invariably building honeycomb-like structure either hidden below ground or attached to grasses, tree branches, etc., or even hidden in hollow trees. Wasp colonies consist of workers, drones, and Queens, the entire labour of the community usually devolving solely upon the sexless workers. The nest is almost invariably made of paper, which is manufactured by chewing wood until reduced to a pulp. Wasps are largely scavengers, and although disliked for the damage they do to fruit, they also render useful service in removing carrion and destroying quantities of harmful insects. Beetles, caterpillars and spiders are thus partially paralysed by the sting—which is a curious modification of the ovipositor or egg-laying organ—and are stored within the nest, for the nourishment of the wasp grubs when they hatch. The largest wasp in our islands is the Hornet, *Vespa crabro*, which constructs papery combs in hollow logs.

The Bees (Family *Apidae*) are short, compact, hirsute insects of world-wide distribution, several dozen species inhabiting our islands. The best known is the Common Hive Bee, *Apis mellifica*. Hive bees have been long cultivated by man, and the management is now a complete industry. Normally the worker insects construct masses of six-sided cells made of wax, in which nectar and pollen are stored, the latter being carried in special basket-like formations of hair upon the hinder legs, which are also of a trough-like formation. Nowadays the scientific bee master provides ready-made combs, thus enabling the bees to devote all their energies to gathering food. In addition to the workers are numbers of males, or drones, and at the close of the honey season these are stung to death by the workers, and their bodies flung out of the hive. Once a year a Queen is literally created by feeding a selected bee grub on a mysterious compound called "Royal jelly". The Queen lays the eggs which ensure next season's population. The fertilisation of the eggs is effected by the so-called "nuptial flight", the Queen soaring high in the air, pursued by the drones. Only the strongest drone succeeds in reaching her, and having paired, all its organs are wrenched from its body, and the drone, a

mere empty shell, its work done, falls to earth. The impregnated Queen gathers the community about her, and the "swarm" following her, sets about hive-making in the place of her selection. The honey varies much according to the flowers supplying it.

Our numerous species of Bumble or Humble Bees (*Bombus*) form relatively small colonies, usually building their nests in banks, hollow trees, etc.

The largest bees known are the Tropical Carpenters which construct complex homes in tree trunks, using wood pulp, and excavating large cavities with their powerful jaws.

Our native Leaf Cutter Bees (*Megachile*) are responsible for the semicircular sections often seen defacing rose leaves.

XXXVIII

MOLLUSCS

Class *Mollusca*

THE *Mollusca* include such animals as the snail, slug, oyster and octopus, creatures which, though appearing to have little kinship, possess certain features in common. The group is nearly related to the segmented worms, and, like them, molluscs have soft bodies. In all molluscs there is a muscular foot which serves for locomotion, though it may be modified to perform other functions. In the mussel it spins the threads which anchor the creature to rocks, etc. In the octopus it is split into eight sucker-clad arms. The body of a mollusc is enveloped in a loose covering of skin, called the mantle, which nearly always secretes a shell of some kind. This may be large enough to enclose the entire animal, or reduced to a minute internal vestige. Molluscs have a complex nervous and circulatory system, and the majority produce their young from eggs. They are found on land and in all waters, fresh or salt. Some of the largest, as well as some of the smallest, forms exist in northern latitudes. About 60,000 living species are known.

Molluscs are of great economic importance. Many of our great land masses are formed of their shells, and some are of direct value to man. From earliest times the shells of many have been used as currency. Shells also are of value in innumerable ways as ornaments, for the manufacture of porcelain, poultry foods, gravel walks, etc. Some few molluscs provide dyes and other chemicals, and the majority are edible. Over sixty species are eaten by the coastal populations of our island, though only about half a dozen species are regularly sold in the large towns. The most famous of all molluscan products, pearls, can be formed by many shell-making species. A pearl is merely a minute foreign body which the animal automatically covers with mineral matter to allay the irritation caused by it chafing the sensitive body wall.

Molluscs are broadly divided into the following orders :

1. *Amphineura* : Coat of Mail Shells.
2. *Gasteropoda* : Limpets, Whelks, Slugs, Snails, etc.
3. *Scaphopoda* : the Elephant's Tusk Shells.
4. *Lamellibranchia* : Scallops, Oysters, etc.
5. *Cephalopoda* : Squid and Octopus.

The Coat of Mail shells, or Chitons, suggest wood lice as seen upon the shore, but on examination prove to be primitive

limpet-like creatures, with soft bodies covered by jointed shell-plates, that allow them to roll up when molested. Like all molluscs, mail shells, have ribbon-like tongues, with thousands of horny teeth ranged upon them in regular rows. In the chitons these teeth are used only to rasp seaweeds from the rocks, but in many molluscs they can drill holes in thick shells, and eat out the occupant. Like all aquatic molluscs, the chitons breathe by means of gills.

The Gasteropods include many thousands of species, abounding everywhere, and attaining to great size and beauty.

The Limpets (*Patella*) have conical shells which fit tightly to rocks, and when left exposed at low tide retain enough moisture to support the animal until again submerged. Limpets usually return to their same "roost" after wandering for a while in search of food. The adherent power of the animal is great, a limpet one inch across holding on with a "pull" of over 30 lb.

The Top Shells (*Trochus*) often reach great size and richness of ornament and colouring. As in many other gasteropods, the mouth of the shell is closed by a trapdoor, or operculum. Like most of the gasteropods, the animals have a prominent snout—containing the ribbon-like tongue—well-formed eyes and a pair of "horns" used for probing the ground in front of the animal.

In the ear-shaped Ormers (*Haliotis*) the margin of the shell is pierced with a series of openings and through these the gills are extruded. Ormers are excellent eating, and the "mother of pearl" of the inside of the shells is employed for decorative purposes.

The River Snails (*Viviparus*) are represented by two species in home waters. The young are not hatched from eggs but are born alive. Twenty or more may be contained in a parent shell a little larger than a winkle's.

The Marine Winkles (*Littorina*) are world-wide. The Common Periwinkle, abundant in our waters, is common on the East Coast of North America, where it was introduced from England in 1855.

The Slipper Limpets (*Crepidula*) were introduced from America to this country about fifty years ago. They multiply fast, and by smothering oyster spat, cause great damage in this direction.

The Cowries (*Trinia*) have beautiful rounded shells which are still used as a form of currency in certain parts of Africa.

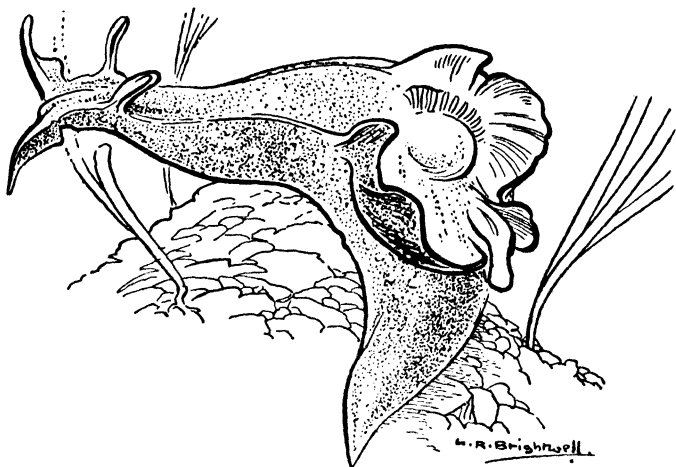
The most massive of all sea-snail shells are the Fountain Shells (*Strombus*) of the tropics. The animals do not glide like

snails, but hop or scramble over the sea floor. Like our native whelks, they are highly predacious, feeding on other molluscs as well as carrion.

Amongst the Rock Whelks (*Murex*) is a Mediterranean species which secretes the famous "Tyrian purple", once the prerogative of Roman potentates; when first extruded it is pale yellow, but turns purple on exposure to light.

The Trumpet Shells (Family *Fasciolaridae*) reach a very large size, one from the coast of South Carolina having a shell 2 feet long.

The world's most valued shell is found amongst the Cones



Common Sea Hare (*Aplysia punctata*)

(Family *Conidae*), of which five hundred species are known. The Glory of the Sea Cone was once priced at over a hundred pounds. Only about a dozen specimens are known to exist. The cones are unique in that certain species are poisonous. The animals have fangs communicating with poison glands, and with these can inflict dangerous wounds.

The Sea Slugs (Sub-order *Nudibranchia*) are shell-less and often recognised by the exquisite plumes—actually breathing and other organs—ranged on their backs. In the embryo stage these molluscs have shells provided with operculums. Nudibranches feed on sea anemones, hydroids, jelly fish, and sponges. The egg masses are often ribbon-shaped.

The sub-order *Euthyneura* embraces certain forms that are intermediate between the shelled sea-snails and the Sea-Slugs. One of these is the Sea Hare, *Aplysia punctata* of our coasts,

so called from its resemblance to a crouching hare. It is dark, velvety brown in colour and feeds on sea lettuce. Its gills are protected by a thin shell which is covered by two flaps of skin, a divided mantle. The animal, when irritated, ejects quantities of a purple fluid which obscures the water surrounding it.

The sub-order *Pulmonata* are represented principally by terrestrial forms, though the group also includes a few marine species, and the numerous pond snails. Our native forms include such species as the Pond Whelks (*Limnaea*) and Ramshorn shells (*Planorbis*). The animals are mostly vegetable feeders, and lay gelatinous egg masses on plants, stones, etc.

The Land Snails are known by over 10,000 species ranging in habitat from the tropics to altitudes of 12,000 feet. Some even live in deserts, where they can survive enforced fasts of two years or more. The land snails are most abundant and ornamental in the Philippine Islands, but reach their maximum size in Central Africa. *Anchatina* has a shell a little larger than a whelk's and lays about a score of eggs, each nearly as large as a pigeon's. This snail can eat a whole lettuce at a meal, and is itself valued as food, since it can be carried for many weeks "on trek" by the natives without losing condition by abstinence from food. The Roman Snail, *Helix pomatia*, which is common on the chalk downs of Southern England has been farmed for food purposes since remote antiquity.

The marine Tusk Shells, or Tooth Shells (Order *Scaphopoda*), are elongate shells, closely suggesting miniature tusks. The animal burrows in sand, with the wider end of the shell pointing downwards. It feeds on microscopic animals and plants.

The great order of the *Lamellibranchia*, the "Bivalves", includes all those molluscs which have the shell divided in two distinct pieces, united by a leathery hinge and ligament. The animal has a stomach, gills, heart, sometimes eyes, but no distinct head. It retains its position in the shell, and also opens and closes it at will, by means of two powerful muscles. These chiefly constitute the edible portion of the popular scallop. Many bivalves attach themselves to solid objects by cementing the shell to the same, or anchoring themselves by a mass of silken threads. Others burrow into sand, a few tunnel into rocks and timber, whilst one form crawls about almost as actively as a snail. Bivalves, almost without exception, feed on minute plant life, which is swept into the stomach by delicate vibratory hairs—*cilia*. The food reaches the interior in the first place *via* one of two pipes, the inhalent siphon. The other siphon ejects waste matter and sea water after the latter

has been conveyed to the gills and there deprived of its oxygen.

Bivalves are divided into four main groups or sub-orders founded on internal peculiarities. The members of the sub-order *Protobranchia*, popularly known as Nutshells, are small, smooth-shelled molluscs, very abundant in northern seas. They are of great commercial value since they form—with other small bivalves—80 per cent. of the food of the plaice and other important food fishes. They are provided with a large flat foot and primitive gills.

The Mussels are known throughout the world and are representatives of the sub-order *Filibranchia*. The animal spins a silken anchor by means of its foot. In the huge Fan Mussels (*Pinna*) this silk has been made into articles of clothing.

The Pearl Oysters (*Margaritifera*) are tropic shells, famed, like the univalve Top Shells and Ormers, for the “mother of pearl” which lines the shell’s interior. Any foreign body entering the shell is covered with nacre, even small fish besides grit, pebbles, etc., which are there incarcerated. The manufacture of the pearls is effected by placing some small rounded body, like a bead, in the mantle cavity. Over forty thousands pearls are thus obtained annually by one firm alone in Japan, each pearl taking about four years to evolve. Pearl oysters are also dredged on the chance of finding marketable pearls, over 80,000,000 being taken annually off the coast of Ceylon.

The members of the family *Spondylidae*, or Thorny Oysters, are the most beautiful of all bivalves, their spine-clad shells vying with the brilliance of the coral reefs to which they are attached. The scarcely less brilliant Scallops (*Pecten*) are mobile in a unique way, since by “flapping” the two valves of the shell the animal can take “boomerang” flights through the water.

The members of the sub-order *Eulamellibranchia* include the true Oysters (*Ostrea*), which have from prehistoric times been valued as food, and were probably first “farmed” by the Romans. Some millions of minute eggs “spat” are ejected during the summer months. The spat settles down upon the sea bed, each little mollusc attaching itself to some stable object. About four to five years is needed for an oyster to reach edible size. Our native oyster, unlike the elongated Portuguese oyster, or the American oysters, periodically changes its sex.

To this sub-order belong the Fresh-water Mussles (*Unio*), the well-known Cockles (*Cardium*), and the true Clams. These last often live embedded upon coral reefs.

The Giant Clam, *Tridacna gigas*, has a shell three or four feet long. Divers have been caught by the foot between the gaping

valves, which, automatically closing, have held the victim until drowned. In Polynesia the shells are commonly used as baths and rain-water cisterns.

Common Clams of our own sandy shores are the Gapers (*Mya*) and the Razor Shells (*Solen*), which live in deep upright burrows.

The Piddocks (*Pholes*) are remarkable, since although the shells are very fragile, they habitually tunnel into the hardest limestone. The file-like sculpture of the shell, which the animal causes to oscillate by muscular contractions, makes this tunnelling possible.

The Ship "Worms" (*Teredo*) are nearly related, but excavate only in timber. The animal's siphons are protected by a long worm-like tube of carbonate of lime. This mollusc was responsible for the eventual breaking up of Drake's "Golden Hind".

The sub-order *Cephalopoda* is represented by such famous animals as the Octopus and Squid. They are divided into two main groups—the *Dibranchia* and *Tetrabranchia*. The first includes the Octopus, with eight arms only, and the Decapods, with ten, the two extra arms of the decapods being tucked away in special pockets when not in use.

The arms, as already stated, are merely a modification of the "foot", and are studded with circular discs that can adhere tightly to any object they happen to touch. In the Common Octopus there are 300 such discs—arranged in two rows—on each arm. In the two extra arms of the decapods there are usually suckers on the club-shaped tip only, though a few may be present on the arm itself.

The tongue is in the form of a horny beak, not unlike a parrot's. Water is conveyed to the gills by a siphon pipe protruding from under the mantle, and when it is exhaled violently, the animal is automatically shot through the water backwards, unless it anchors itself by means of its arms. The eyes are very large and powerful. The skin is loose and richly endowed with pigment cells, which automatically adapt themselves to the animal's surroundings and also reflect the passing emotions of the moment. Cephalopods produce their young from eggs, laid in bunches of horny capsules. They are incubated by the parent, who aerates them by squirting water over them. The nuptials of the Octopus are most remarkable. The male element is stored in an extension of one of the tentacles which becomes detached and leads an independent existence until it comes into contact with a female animal.

The Octopus (*Octopus*) abounds in all seas. The common

species attains about seven feet across the arms, and the largest kinds from Australia about forty feet. Only the latter can be regarded as dangerous.

The Squids (*Sepia*, etc.) vary enormously in form and size. Some deep-sea species bear coloured light organs, and the "pocket arms" may be many times the animal's entire length. The Giant Squid of Northern seas, *Archiluthis princeps*—the *kraken* of Norse legends—has a total length of 40 feet. It is largely eaten by the Cachalot Whale. All squids are primarily fish eaters, whilst the octopus lives solely on crustaceans and molluscs. Both have an internal shell, that of the octopus being reduced to two small stylets.

The Paper Nautilus (*Argonauta*) of tropic seas is unique in that the female has a delicate shell, which is hidden by two wing-like expansions of two tentacles. It serves as a brood chamber for the eggs, and is discarded when incubation ceases. The male never develops a shell.

The group *Tetrabranchia* is to-day represented only by *Nautilus*—a relative of the fossil Ammonites, that once dominated life in the seas. The nautilus has several suckerless arms which are used for crawling. They can be withdrawn into sheaths. The animal lives permanently in a chambered shell, the chambers containing largely nitrogen gas. This Nautilus abounds in the Western Pacific; it sometimes swims at the sea surface, but usually haunts the bottom, where it subsists on crabs, sea snails, etc. In Polynesia, it is largely fished for in specially constructed traps, and used by the natives as food. A feature it shares in common with other cephalopods is the possession of an ink sac. This stores a dark fluid (*sepia*) which can be ejected, *via* the siphon, as required, and by creating a "smoke screen" effectually covers the animal's retreat.

XXXIX

LAMPSHELLS

Order *Brachiopoda*

THE *Brachiopods* or Lampshells live in the sea in deep water. They are still grouped with some uncertainty. They were classed by early naturalists as bivalve molluscs, but whereas the shells of a bivalve mollusc are placed one on either side of the animal in the Branchiopods they are placed back and front, so that one shell is on the back and the other underneath. A leathery thong passes through a hole in the back of the upper shell, anchoring the creature to a rock or other object. On each side of the mouth is a coiled, feathery arm which collects food and also serves as a gill.

Many thousands of fossil forms are known, but to-day the order is represented by comparatively few examples—the remnant of a vanishing race. One species is common in deep water off the north of Scotland. Its shell is colourless, very unlike the tropic *Lingula* which is greenish blue.

XL

ECHINODERMS

Class *Echinodermata*

THE Echinoderms are all marine animals and are known by such forms as the Starfish, the Sea Urchin and the Sea Gherkin. Though varying much in form, they are characterised by the tube feet by means of which they progress. These are obvious on the under side of the Starfish or Sea Gherkin, whilst in the living Sea Urchin they can be seen protruding through small holes in the shell. These feet are made like the fingers of a glove and can be distended with sea water pumped into a system of complex internal canals. The more water forced into the tube feet, the longer and more active do they become. In addition to this, the outside of an Echinoderm is often covered with numerous other tubes—*pedicularia*. These are of many patterns, but generally suggest a pair of pincers mounted on a stick. They are very active and serve to clean the animal's exterior and to collect food. In Sea Urchins and Starfish they pass food direct to the mouth. The Starfish can, however, also push out its stomach and engulf a big whelk and its shell entire. Reproduction is effected by eggs which hatch into free-swimming larvae, often very like the parent form.

The true Starfish (Order *Asteroidia*) are found, like other Echinoderms, in all seas and at all depths. They vary much in size and form, the largest measuring two to three feet across, but all agree in having five arms of equal length. In common with many of the lower forms of life Starfish can reproduce lost parts. The Starfish, upon losing one or more arms, soon grows others, whilst single arms in time produce four more which become eventually the same length as the original.

The Brittle Stars (Order *Ophiuroidea*) willingly discard their arms, escaping easily from an enemy who is usually attracted by the gyrations of the discarded arm, thus allowing the animal itself to decamp.

The Rosy Feather Star, *Antedon bifida*, of home waters is specially interesting during its early stages, when it is mounted on a stalk as were the giant Crinoids, a race of Echinoderms long extinct but once abundant in all seas.

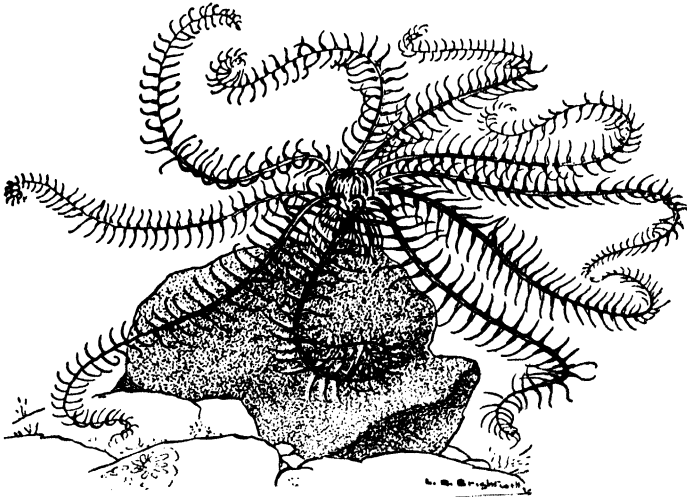
The Spherical Sea Urchins (Order *Echinoidea*) show greater uniformity than the Starfish though the spines which usually

cover the shell may vary from mere thorns to defensive spikes as long and as thick as cigars.

The Heart Urchins (*Echinocardium*) do not creep about rocks like most of the tribe but burrow in the sand.

The Shield Urchins or Sand Pennies (*Echinarachinus*) are almost as flat as their names suggest. They can glide over sand by means of the tube feet on their under side. Sand Pennies are in some parts of the world ground up to make an indelible ink.

The Sea Gherkins (Order *Holothuria*) are elongated Echino-



Rosy Feather Star (*Antedon rosacea*)

derms with numerous hard spines reinforcing their soft bodies and a ring of ten short arms surrounding the mouth. The arms collect small food particles from the sea water. Sea Gherkins abound in all seas, some frequenting rocks, some burrowing in the sand, others living amongst coral reefs. Amongst these latter are the Holothurians known as *Bêche-de-mer*, which form an important fishery on the Barrier Reef. They may reach two feet or more in length. The animals are cleaned, dried and smoked and the bodies are then exported to Oriental countries, where they are used for making a highly glutinous soup. Many kinds of Sea Gherkins cover home waters. The Cotton Spinner, *Holothuria niger*, is a large chocolate brown animal which, on being irritated, shoots out from its hinder portions long white threads so adhesive that they completely entangle any creature that becomes involved amongst them. A big

lobster can thus be rendered helpless in a few moments. The threads rot and lose their efficacy in the course of an hour or so. In common with many other species, the Cotton Spinner can on occasion discard most of its internal organs and renew them as required.

MOSS ANIMALS

Class *Polyzoa* ·

THE *Polyzoa* form one of the most puzzling groups in the entire animal kingdom. They abound in all seas, encrusting weeds and shells. A few fresh-water forms are known. Externally, many may suggest moss or lichens, but others resemble weeds or sponges, whilst a few might be mistaken for masses of stony coral. Whatever the form of the community, it is composed of numerous minute animals, each living in a horny or limey shell, sometimes closed by a lid. The animal, at first sight, may suggest a coral polyp, but is more highly constituted, having a nervous and alimentary, although not respiratory or circulatory systems. The arms or "petals" of the polyp are covered with vibratory hairs which sweep minute foodstuffs into the mouth and do not clutch or sting like the tentacles of an anemone. There is a free-swimming larval stage, and reproduction is effected by "budding".

Of the many kinds of *Polyzoa* found in our seas, the best known are the common Sea Mat (*Flustra*) and the Ross (*Lep-ralia*). The former looks like a seaweed, whilst the latter forms large stony foliaceous masses often several feet in diameter.

WORMLIKE ANIMALS

Class *Vermes*

THE term worm is generally applied to a large number of animals having little in common save that all are of elongated form and are without a nerve cord, shell, or limbs. They exist everywhere, in soil, fresh and sea water, and many are parasitical in and upon all kinds of animals. In the highest worms there is a blending of two central nerves united to form a cord running the entire length of the animal through segments communicating with the body cavity. Though the term worm has passed into our language as an expression of opprobrium, some worms are a vital, if unobtrusive, part of the general economy. They purify soil, constitute some of the food of useful fishes and birds, whilst a few are actually eaten by human beings or used medicinally.

Worms are divided into six main orders. The marine Bristle Worms (Order *Polychaeta*) are often not far removed from the *Arthropoda*, or jointed animals, the body being divided into segments or rings each of which bears hooked and horny bristles or short legs used for locomotion and other purposes. There is a conspicuous head bearing feelers and gills, the latter often plume-like and coloured vivid red by the creature's blood.

The Lug Worms (*Arenicola*) abound wherever there are sandy bays and live by continually passing sand through their entire length, extracting nutriment in the process. In an acre of sand an average worm populace brings to the surface about two thousand tons in the course of tunnelling and feeding operations. The burrows excavated are U-shaped and may attain a depth of two feet.

The Peacock Worm, *Sabella*, builds tubes of sand stuck singly to the sea floor.

The Honeycomb Worm (*Sabellaria*) builds tubes which may form solid reefs two or three feet deep. In these two worms the gills protrude at one end of the tube in the form of vividly-coloured plumes spread out in flowerlike formation, but they are withdrawn at lightning speed upon the least alarm. The Hermit Crab Worm, *Nereis fugata*, invariably tenants shells occupied by a Hermit Crab, living upon such scraps of food as fall from the crustacean's frequent banquets.

The stoutly-built burrowing Sea Mouse, *Aphrodite aculeata*, is densely covered with long rainbow-hued hairs or bristles which serve to collect sand and so eventually hide the animal.

The Common Earthworms (*Lumbricus*) are the best-known representatives of the order *Oligochaeta*. Earthworms are found almost the world over and render invaluable service in tilling the soil. Darwin stated, in fact, that it was doubtful if any other animal had played so important a part in the earth's history. Although disliked by gardeners and golfers, soil would soon foul and become unproductive but for the existence of earthworms. The swelling often observed near the worm's head is the portion which holds the eggs. The largest earthworm measures five feet in length.

The Leeches (Order *Hirudinea*) are exemplified by the Medicinal Leech, *Hirudio medicinalis*, still in use for blood-letting. It was once extensively farmed in this country and still is in many parts of the Continent. Leeches have a strongly adhesive sucker at the hinder end, whilst the mouth is ringed with strong teeth which quickly tap the capillaries and smaller veins of animals. Normally Medicinal Leeches feed upon the blood of fishes and more rarely water-rats, otters, etc. Like Earthworms, Leeches are hermaphrodite and the cocoons containing the eggs are deposited in bankside burrows. One of our largest native leeches measures some six inches long and is found attached to skates and rays.

The Thread Worms (Order *Nemathelminthes*) are long, slender and threadlike, and the great majority live parasitically in other animals. They have unsegmented bodies; some are viviparous, others oviparous. One form lives on growing wheat ears causing a kind of gall. Important parasitic members of the order are the Round Worm (*Ascaris*) and the Guinea Worm (*Dracunculus*), which burrows into human flesh deep below the skin. Many of these parasitic worms favour more than one host in completing their life cycles. The King Worm, for example, is also dependent upon the water-flea, which it infests and so gains access to man in drinking-water. Again *Filaria* is dependent in the first instance on certain mosquitoes, and eventually gaining the human interior, causes the disease known as Elephantiasis.

The Worms of the order *Nemertinea* are long, thin, unsegmented creatures with distinct sexes, the eggs being deposited by the female in gelatinous capsules. Most of the species are marine—one, *Lineus longissimus*, known as "Bootlaces", being common on our shores. It sometimes measures ninety feet in length when fully extended, but when resting beneath a boulder looks like a mass of calves' liver.

The Flat Worms and Flukes (Order *Trematora*) are mostly small and all of parasitic habit, attaching themselves to their

hosts by means of suckers or hooks. The common sheep disease known as liver rot is due to a fluke which lives in its host's liver.

The Tape Worms (Order *Cestoda*) are elongated worms carrying hooks and suckers. They start life in the bodies of various animals. Eventually a segment of the worm, charged with eggs, forces its way to the exterior, where the eggs are disseminated and finally taken up by some other animal. This accomplished, growth starts in earnest, the worm finally attaining perhaps a length of many yards.

Related to the worms but placed in a separate sub-class are the Wheel Animalcules (*Rotifera*). They are minute fresh-water forms free-swimming or parasitic and varying from one-eighth to one-five hundredth of an inch in length. They take their name from a circle of hairs on the front of the body, such hairs carrying them through the water with a rotating motion. These simple creatures have no blood system.

XLIII

JELLYFISH, ANEMONES AND CORALS

Class *Coelenterata*

THE *Coelenterata* or hollow-bodied animals comprise the anemones, coral polyps, sea firs, jellyfish and kindred creatures. They abound everywhere, but are most abundant in the tropics.

The typical coelenterate is a soft-bodied animal consisting of little more than a stomach surrounded by hollow tentacles which can be distended with sea water when they can capture other animals and pass them into the gastric cavity. Coelenterates of this kind are commonly called Anemones and live singly attached to rocks, etc. Other coelenterates live in colonies and can extract mineral substances from the sea water and use them in a varying degree to form structures. The polyp's life span is usually short, but after death its house remains, and since other polyps are hourly being born and at once construct homes, a structure of vast magnitude, such as a sea fir 10 feet high or a coral reef, may in time be formed. Many such polyps reproduce by laying or discharging eggs that hatch into minute "jellyfish" that eventually settle down and build homes as sedentary polyps. Other coelenterates live permanently in the jellyfish stage, sometimes attaining a great magnitude.

All coelenterates are provided with stinging organs. They are microscopic, and often stud the tentacles in great numbers. Each such "sting", called a nematocyst, is virtually a barbed dart with a long thread attached, and can be fired out at will when it enters the animal chancing to touch the trigger which liberates the dart. Very small animals are killed instantaneously and large ones are temporarily paralysed.

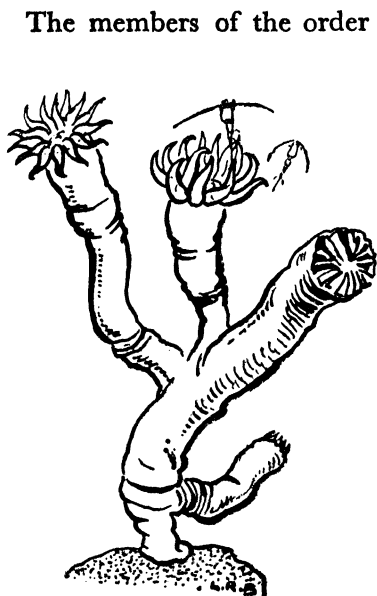
In the order *Hydromedusae* are Hydroids and smaller Jellyfish. A representative of the former is the fresh-water polyp, *Hydra viridis*, of our ponds and ditches. The animal, when in its contracted form, is a mere blob of jelly, but after feeding, reveals itself as a long cylindrical creature having one end anchored by a sucking disc, and the other bearing six to twelve tentacles surrounding the mouth. These tentacles, which are hollow and connected with the body cavity, when touched discharge poisonous threads.

The Hydra have two methods of reproduction. They may be a sexual reproduction—sperm and ova developing in the same individual—or there may be reproduction by fission. To be

torn in half does not spell destruction to the Hydra, but the reverse, the disjointed fragments in time developing those portions which they lack.

The largest-known Hydra (*Branchiocerinthus*) is four feet long and comes from Japan.

The various Sea Firs, Hydroids which may be more suggestive of plants than animals, give rise to minute jellyfish which later settle down and form the nucleus of a sea fir colony.



A Stony Coral (*Dendrophyllia ramea*)

The members of the order *Siphonophora* are delicate, transparent creatures abundant in tropic seas, a few only reaching our shores in warm weather. *Siphonophores* are free-swimming colonies of animals performing various functions—feeding, reproducing, stinging, etc.—but usually united to an inflated float or bell which carries them along at the mercy of wind and wave. A notable example is the Portuguese Man-o'-War (*Physalia*). It suggests a beautifully tinted glass globe with a pink coxcomb on top and long blue streamers—virulent stinging organs—which trail beneath it. In southern climes it is almost more dreaded than the shark.

The large true Jellyfish (*Scyphozoa*) are common in most seas. One found off our coasts, *Rhizostoma pulmo*, may measure eighteen inches across the "umbrella", which may give shelter to the fry of the horse mackerel.

The order *Anthozoa* includes sea anemones and corals. Sea anemones are solitary polyps abundant on all rocky coasts. Over fifty species are common to our shores. They reproduce by fission, that is dividing, each half becoming a separate individual, or by giving forth from the gastric cavity complete individuals of minute size. All are highly predacious, engulfing any animal they can overpower. Since there is no alimentary system, refuse is ejected through the mouth. The tentacles are complete with stinging organs and many throw out long stinging

threads from the main column. The largest known species (*Discosmoa*) measures 2 feet across. It comes from the Barrier Reef.

Closely related to the anemones are the Corals—flexible and hard. Flexible corals are those which, although held together by a skeleton structure, do not contain enough mineral matter to be entirely solid. Many such are found in our seas, notably the sea fan (*Gorgonia*) and the sea fingers (*Alcyonium*). One solid coral only is found in home waters. This is the Devonshire Cup Coral (*Caryophyllia*), a structure about half an inch high which houses a single rosy polyp. In tropic seas, hard corals abound wherever they find sufficient protection from the waves. The precious coral of commerce has been fished from remote antiquity in the Mediterranean. Other reefs abound off the east coast of Africa, India and Australasia. Coral formations may present themselves as barrier reefs which form groups of islands at some distance from land, fringing reefs which occur close in shore and atolls, the last being circular in shape with a central lagoon. The Great Barrier Reef, which is a thousand miles in length, shelters an infinity of useful fisheries, *bêches-de-mer*, pearls, etc., and the solid coral rock itself is in demand for building purposes.

The last of the coelenterata are the Stenophores or Comb Jellies. These are delicate glassy organisms found only in the open sea, where they are thrust through the water by innumerable little organs arranged to form semicircular combs. A common British species is the Sea Gooseberry. It looks like a small glass globe with two long filaments trailing behind it. These latter secrete a gluey substance and serve to capture active fishes which are drawn up to the animal's mouth. Comb jellies are unprovided with stinging cells. Many are highly phosphorescent at night. The most beautiful of all is the ribbon-shaped Venus's Girdle (*Cestus*) which is common in the Mediterranean. The glassy combs of the girdle cause a constant succession of rainbow colours to sweep across the animal which may measure between 4 and 5 feet in length.

XLIV

SPONGES

Class *Porifera*

SPONGES are found in all seas and at all depths and may be propagated from eggs or "Cuttings". They suggest plants rather than animals, but reveal their true identity if dried and burnt, when nitrogen fumes—always associated with animal matter—result. Internally, the sponge consists of numerous chambers lined with lashing hairs which draw in the water through small pores in the exterior, dredge it of edible matter, and then sweep it out through a complex system of galleries to the exits—the large openings observed in every sponge. If one of our native sponges, such as the "bread crumb" (*Halicondria*), be placed in sea water and a little carmine added, this circulatory activity, which never ceases, can be clearly observed. Sponges are held together by a skeleton framework of mineral matter which often takes the form of minute wheels, anchors, darts, etc., inseparably interlocked. The "skeletons" of the Glass Sponges are built up of large six-rayed spindles which combine to form a variety of beautiful designs.

The best-known of all sponges is, of course, the Bath Sponge (*Spongia*). From remote antiquity its chief fishery has been off the coast of China, though of late years an important sponge station has been opened in the West Indies. Sponges are collected by divers, cleansed by beating and afterwards dried in the sun and wind.

THE SIMPLEST ANIMALS

Class *Protozoa*.

THE *Protozoa* or simplest single-celled animals, though frequently invisible to the naked eye, and always extremely small, are powerful factors in the world's economy, effecting all things for good or evil. They swarm in the air, soil, and waters both fresh and salt. They are divided into four main sub-classes of which the first, the *Rhizopoda*, is abundantly represented in stagnant water by the varied species of *Amoeba*. The typical *Amoeba* is a mere blob of jelly about a rooth of an inch in diameter. It can move in any direction, throwing out portions of the body in finger-like extensions and takes any nourishment by literally surrounding small particles of matter.

The representatives of the order *Foraminifera* are minute gelatinous creatures like *Amoeba* which, however, enclose themselves in a horny or calcareous shell which often mimics the shell of some higher creature such as a mollusc. This shell is often pierced with holes through which the creature extends thread-like appendages which it uses both for progression and for gathering food. The shells of dead *Foraminifera* form chalky deposits over vast areas of the ocean floor, our well-known chalk hills being largely built up of such.

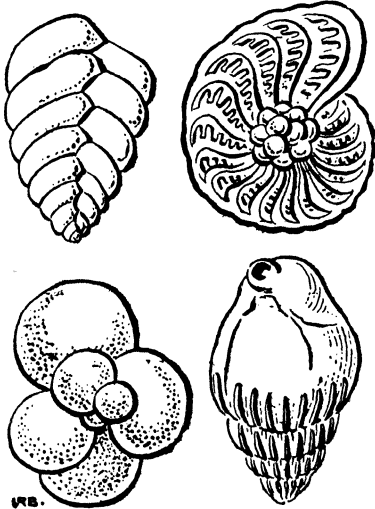
The members of the order *Radiolaria* collect silica from sea water wherewith they construct more or less globular structures. The structure of one of these creatures differs from that of the *Foraminifera* in that it is not an external but an internal capsule that surrounds the nucleus. The creatures collect food by thrusting out thread-like extensions of their bodies through orifices in the structure. The ooze which covers vast areas of the Pacific and Indian Oceans is composed of the minute forms of different *Radiolarians*.

The members of the sub-class *Flagellata* are characterised by possessing numerous fine hairs or whips which continually lash the water, sweeping food into the creatures' interior and propelling them here and there. An interesting example is the "Night Light" (*Noctiluca*) which swarms in the open sea and is largely responsible for the phosphorescence which illumines the waves on hot summer nights.

Many *Flagellata* are parasitic on higher organisms. A notori-

ous form is the *Trypanosoma gambiense*, which, being conveyed to a human host through injection by the Tsetse fly, gives rise to the disease known as sleeping sickness.

The *Infusoria* are aquatic forms common in stagnant water which has become infested with decaying matter. A typical example is the Slipper animalcule, *Paramecium*, common in pond water, rain barrels, etc.



Protozoa Shells of Foraminifera

The members of sub-class *Sporozoa* are all parasitic forms, some being fairly harmless, whilst others destroy body tissues by repeated multiplication. Malaria fever in man, Texas fever in cattle, Coccidiosis in rabbits, etc., are due to various *Sporozoans*. Malaria is conveyed by the anopheles mosquito, which injects the human blood with the germ, or spore, *Plasmodium*. This little spore is a spindle-shaped body

which attacks the red blood cells, later dividing up into numerous other spores which in turn subdivide again. The periodic production of this spore marks the recurrent crises in the fever.

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