

XIII NATURAL HISTORY

II. MAMMALS

IN an earlier chapter we have dealt with the evolution of animals in general, their haunts or habitats, their everyday functions, their behaviour, and what we have called the dawn of mind. Here we select one class, that of Mammals, and, presupposing what has gone before, we shall discuss them in the main from one point of view—how they are suited to the particular conditions of their life.

The genealogical tree of animals splits at the top into Birds and Mammals, and these are on quite different lines of evolution. They are not related to one another, except to this extent, that they have a common ancestry among the extinct Reptiles, as we have already seen. For just as Birds sprang from some uncertain stock of bipedal Dinosaurs, so Mammals must be traced back to another extinct Reptilian stock—the Cynodonts. These Cynodonts (also known as Therapsids) occur as Triassic fossils in Africa and North America, and though they were genuine reptiles they had very mammal-like skulls (see figure). Thus the teeth may be distinguished as incisors, canines, and molars, just as in a dog; hence the name Cynodont or "dog-toothed."

The earliest mammals were small creatures, the largest no bigger than a rat. The teeth of some of them indicate insect-eating, the teeth of others point to a herbivorous habit. The sharp incisors of some types may have been used to pierce the shells of the eggs

of waning Dinosaurs. According to some authorities, many of the early mammals were arboreal, denizens, perhaps, of estuarine and swampy forests. The advantage of such a habitat or mode of life is suggested by the scant vegetation of the arid ground.

During the geological Middle Ages (Mesozoic) the mammals did not make much headway.

Their opportunity was not yet; it was still the Age of Reptiles. The mammals continued a little folk, probably for the most arboreal, keeping out of the way of the huge carnivorous dinosaurs, "stalking terrors such as the world never saw before nor since."

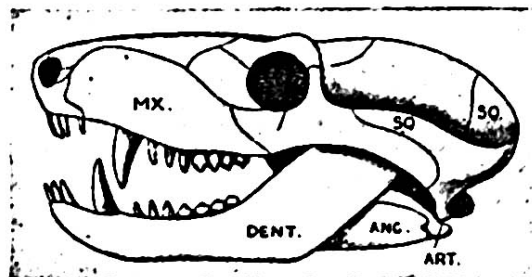
As a matter of fact, however, the giants disappeared, and the pigmies had their innings. With the dawn of the Tertiary time, the mammals began to possess the earth. Their giant enemies had gone, and it is probable that the vegetative conditions became more favourable. The grass began to spread like a garment over the earth.

Progress was at first very gradual; the early Tertiary mammals were still pigmies and with very small brains; but the point is that they began to radiate out into old-fashioned marsupials, carnivores, and hoofed mammals—some of the last attaining elephantine dimensions.

As the primitive and archaic mammals dis-

appeared, there rose up in their

stead the mammals of the modern type—with better brains,



SKULL OF A CYNODONT EXTINCT REPTILE. (After Broom.)

The Cynodonts do not seem to have been very far from the direct ancestors of Mammals. The arrangement of the teeth as incisors, canines, and molars is very mammal-like. But the lower jaw remains a complex of several bones, whereas in mammals there is but one bone on each side. Some of the bones are named: MX. maxilla; SQ. squamosal; DENT. dentary; ANG. angular; ART. articular.

and more plastic feet and teeth. We refer to such families as Cats, Horses, Elephants, and Monkeys. Their original headquarters were probably in some northern or circum-polar land, which enjoyed a warm and equable climate.



Photo: W. S. Derridge.

ECHIDNA OR SPINY ANT-EATER.

This primitive egg-laying mammal ranges from Australia through the Papuan region. There is a related genus, *Proechidna*, in New Guinea. The body is covered with strong spines mingled with hair. There are three massive claws suited for burrowing. The mouth is absolutely toothless; the tongue is worm-like; the food consists mainly of ants and other insects. When the egg is laid, the mother takes it in her mouth and places it in her pouch. The shell is broken by the emerging young one. After a time the mother removes the young one from the pocket and leaves it in a burrow while she hunts at night. But she restores it for feeding purposes. The cerebral hemispheres are well convoluted, and the creature is not stupid. It is imperfectly warm-blooded, and hibernates.

yolk, in their very variable temperature, and in many other ways they betray their affinity with reptiles, and they must be regarded as very primitive mammals persisting from ancient days.

The Duckmole, or Duck-billed Platypus

§ I

There are three strange Australian mammals that occupy a position quite by themselves—the Duckmole (*Ornithorhynchus*), the Egg-laying Mammals. the Spiny Ant-eater (*Echidna*), and another ant-eater (*Proechidna*). They differ from all other mammals inasmuch as they lay eggs, thereby harking back to the habit of many reptiles. In the form of their shoulder-girdle, in their relatively large eggs with much

(18-20 inches in length) lives beside lakes and streams, and grubs at the bottom or among water-weed for small animals, which it collects in cheek-pouches and chews at leisure with its eight horny tooth-plates. For its true teeth do not last for more than a year. Its fore-feet are webbed, and it is a clever swimmer and diver. But the feet are also clawed, and the quaint creature makes a long burrow in the bank, with two openings, one above and one under the

	ELEPHANTS	APES	LAND CARNIVORES	
	UNGULATES	MONKEYS	AQUATIC CARNIVORES	
CETACEANS	RODENTS	LEMURS	INSECTIVORES	BATS
		SIRENIA	EDENTATA	
		MARSUPIALS		
		MONOTREMES		

GROUPING OF THE ORDERS OF LIVING MAMMALS.

At the bottom of the scale are the primitive, egg-laying Monotremes, represented by the Duckmole and the Spiny Ant-eater. Above them are the pouched Marsupials, of which the Kangaroo is a type. The remaining Orders fall within the group of Placentals, in which there is an intimate connection between mother and unborn young. Of these, the Edentates (e.g. the Sloth) and the Sirenians or "Sea-Cows" may be ranked as archaic forms. Higher up we have the Insectivores (e.g. the Hedgehog); the aquatic Carnivores (e.g. Seals) and the terrestrial Carnivores (e.g. Lion), the Rodents (e.g. the Rat); the Ungulates or hoofed quadrupeds, and the Elephants; and, marking extremes of mammalian life, the winged Bats and the open-sea Cetaceans or Whales. Finally, there is the great Monkey stock, including the old-fashioned Lemurs, the true Monkeys, and, highest of all, the Anthropoid Apes.

water. The jaws are flattened like the bill of a duck and covered with soft sensitive skin, expanded into a flexible collar where the bill joins the rest of the skull. The eyes are small; the ear-holes are closed by a flap; the tail is strong and helps in swimming; the brownish fur is short and soft; the animal can roll itself up into a living ball, and sleeps in this attitude. In the recesses of the burrow two eggs are laid, each about three-quarters of an inch long, enclosed in a flexible white shell, through which the young one has to break its way. There are no teats or mammæ for the young one to suck, and the milk simply oozes out by numerous pores on a bare patch of skin on the ventral surface of the mother. It is licked up by the offspring—a very primitive arrangement.

The Spiny Ant-eaters live in rocky regions and burrow rapidly with very strong claws. They seem almost to sink into the ground. When they get among rough herbage they take

firm hold with their feet and are very difficult to dislodge. The snout is prolonged into a slender tube, through which a mobile, sticky, worm-like tongue is protruded on the ants which form the staple food. No traces of teeth are to be seen, even in the embryo. As in the Duckmole, the male has a well-developed spur on the hind-leg, perforated by the duct of a gland, but its use is obscure. The egg seems to be placed by the mother in a temporarily developed pouch, which is said to be comparable to a greatly enlarged teat of the type seen in the cow. Within this pouch the milk oozes out. There are no stranger animals in existence than the Duckmole and the Spiny Ant-eaters. They might almost be called "living fossils."

§ 2

The second grade among present-day mammals is that of the Marsupials, which are now confined to Australia except in the case of



OPOSSUM AND YOUNG. 3

In some of the Opossums, especially the smaller species, the mother carries the young ones on her back with their tails twisted round hers. Azara's Opossum may carry eleven and yet climb quickly. The habit may occur even when there is a pouch, but that structure is generally absent in the Opossum family (Didelphidae). The Opossums are also peculiar in being confined to North and South America.

two families—the American Opossums and Selvas. In most cases the female has a pouch or marsupium developed around the mammæ, and in this pocket the prematurely born young are stowed away and carried about till they are able to fend for themselves. In many opossums the pouch is absent, and the mother carries the young ones on her back, with their tails coiled round hers—a quaint device. In marsupials in general, the young ones are born very helpless, unable even to suck. The mother takes her young one in her mouth, and puts it into her skin-pouch, within which lie the teats or mammæ. The mother adjusts matters so that the mouth of the young one closes on a teat, which then swells a little, and, as the prematurely born offspring cannot suck, she injects the milk down the gullet by contracting a special musculature. The milk might “go down the wrong way” and choke the offspring, were it not that the glottis (the entrance to the windpipe) is shunted forward in the young creature so as to press against the posterior nostrils at the back of the mouth. Thus breathing goes on undisturbed by the injection of milk. A similar adaptation is seen in the Baleen Whale—another mammal—when it is rushing through the water with its great mouth agape, and also in the Crocodile—a reptile, not a mammal—when it is drowning its prey.

As an individual example of a marsupial we may take the Opossum (*Didelphys*)—which Mr. Ingersoll calls a “grey, grunting, snarling, pilfering, dunder-headed, and motherly creature.” It is not a good type, for it is American, not Australian, and in most of the species of the genus the pouch is conspicuous by its absence. But the Opossum was the first marsupial to be known to the civilised world. Opossums are mainly arboreal and insectivorous, but there is considerable variety of habitat and diet. They are notorious for playing ‘possum, and we wish to incorporate what Ingersoll says of a pouched species in regard to this puzzling “ruse” in his *Wild of the Wild* (1921). A mother opossum will face up to an enemy that threatens her half-grown young, and male opossums will fight to the death at the courting time. So the creature does not lack courage! If it detects danger in advance—

The Pouch-bearing Mammals.

and every hand is against it—it will hasten up a tree and hide. So the creature does not lack discretion. “In other cases—just what or when it would be hard to define exactly, but apparently in the presence of something so large as to make resistance idle—the animal, when attacked or cornered, will fall limp and ‘dead.’ You may roll the creature about with your foot, explore the pouch, pick it up and carry it by its tail, offer it almost any indignity, and it will, in most cases, neither resist nor complain; but take your eye off it as it lies upon the ground, and it will soon jump up and scuttle away, or if you pick it up carelessly enough to give it a chance it may nip you savagely.” But the question is inevitable: “Of what service is the ruse?” Would the carnivore or the bird of prey that liked opossum flesh—dogs won’t touch it—care whether the creature is dead or pretending to be dead? Mr. Ingersoll’s ingenious suggestion is that playing ‘possum is an instinct that arose in the geological Middle Ages in relation to the dull-witted big reptiles—as a rule, land reptiles do not feed on carrion—and that it persists nowadays as an anachronism in circumstances where it is oftener fatal than protective.

§ 3

The third grade of modern mammals includes the carnivores, the hoofed animals, the monkeys, and so on—to all of which the term “placental” is applied. In adaptation to the difficulties of terrestrial life, there has been an evolution of viviparous arrangements. The Monotremes, as we have seen, lay eggs; the Marsupials bring forth their young prematurely; the Placentals have established a more or less prolonged ante-natal partnership between the mother and the unborn young. The linking structure between the two is the placenta, which brings some of the blood-vessels of the unborn young (or *fœtus*) into close contact, although not union, with the blood-vessels in the wall of the mother’s womb (or uterus). No solid particle, unless it be a living microbe or a wandering white blood-corpuscle, can pass from the mother to the offspring, but there is a transfusion of fluid and gaseous material between the two partners. What does the offspring get from its mother? Dissolved nutritive material, oxygen, water, salts,

The Placental Mammals.



YOUNG OF COMMON SEAL ON THE BEACH, SHETLAND.

The Common Seal (*Phoca vitulina*) is a sociable animal, living in small herds where the conditions are suitable. On British coasts these safe places are rapidly disappearing, for the young, left on shore by the mothers when they go a-hunting, are often killed. The drawing gives a fine impression of the charming attitudes of the young creatures.

and some subtle chemical messengers called "hormones." What does the offspring give to the mother? Dissolved waste-materials, carbon-dioxide, watery fluid, and again some "hormones." The mother gives much and gets little; but it seems justifiable to say that the internal secretions or hormones contributed by the unborn offspring to the mother assist in her health and enable her to make the most of her food. Before the young one is born, chemical messengers have been carried by the blood to the mother's mammary glands, so that they are stimulated to begin the production of milk. There is much of this physiological telegraphy in the business of living.

It is probable that the long-drawn-out antenatal development has greatly favoured the improvement of the brain. Thus everyone knows how wide-awake a foal is after its long sleep of eleven months within its mother's

womb. But it must be added that the structure of the brain in placental mammals had got on to lines much more promising than in marsupials. Granting this, we seem justified in saying that the prolonged gestation, plainly adapted to the exigencies of terrestrial life, opened up the possibility of being born with an advanced brain equipment. In the same way, the prolonged infancy, familiar in mankind, has its great rewards as well as its great risks.

It is interesting that mammals should bear a name that emphasises the mother's breasts, and this strikes a true biological note. For the success of mammals is wrapped up with their maternal care, taken in conjunction with improved brains. To the difficulties and limitations implied in the struggle for existence, some mammals have answered back by evolving teeth and horns, others by evolving swiftness, others

by evolving armour, others by evolving wings—but the answer back that is common to them all is the maternal sacrifice and devotion.

§ 4

Like the reptiles before them, mammals have sought out many habitats, and have become adapted to as many modes of life. Perhaps it was in the trees that they served their apprenticeship; in any case they have tried all possible haunts, entering every open door of opportunity. This is what Professor H. F. Osborn calls "adaptive radiation," and he distinguishes as many as twelve habitats. (1) There are terrestrial mammals, walking like the elephants, running like the antelopes, jumping like the kangaroos. (2) But some are burrowers as well as runners, as rabbits well illustrate. (3) Then there are thoroughgoing burrowers, like the moles, which have conquered the underground world. (4) Some are as much at home in water as on dry land; we think of the roving otter and the polar bear. (5) Perhaps a separate division may be made for those mammals that frequent streams, after the manner of beavers and the familiar water-vole—which can hardly be saved from its popular name of "water-rat." (6) The shore of the sea is the habitat of seal, sea-otter, and walrus. (7) The open-sea mammals are the cetaceans large and small, from whale-bone whale to porpoise. (8) Professor Osborn

takes the deep-diving finback whales as examples of mammals that actually explore the great abysses, but this is perhaps stretching a point. (9) Then there are the betwixt-and-between mammals transitional between arboreal and terrestrial life, like the macaque monkeys and the gorilla. (10) Strictly arboreal types are well represented by squirrels, tree-sloths, and lemurs. (11) The volplaning "flying squirrels" and "flying phalangers" form another interesting betwixt-and-between group, essaying the conquest of the air in their daring parachuting from tree to tree. (12) Finally, the bats are true fliers—aerial mammals.

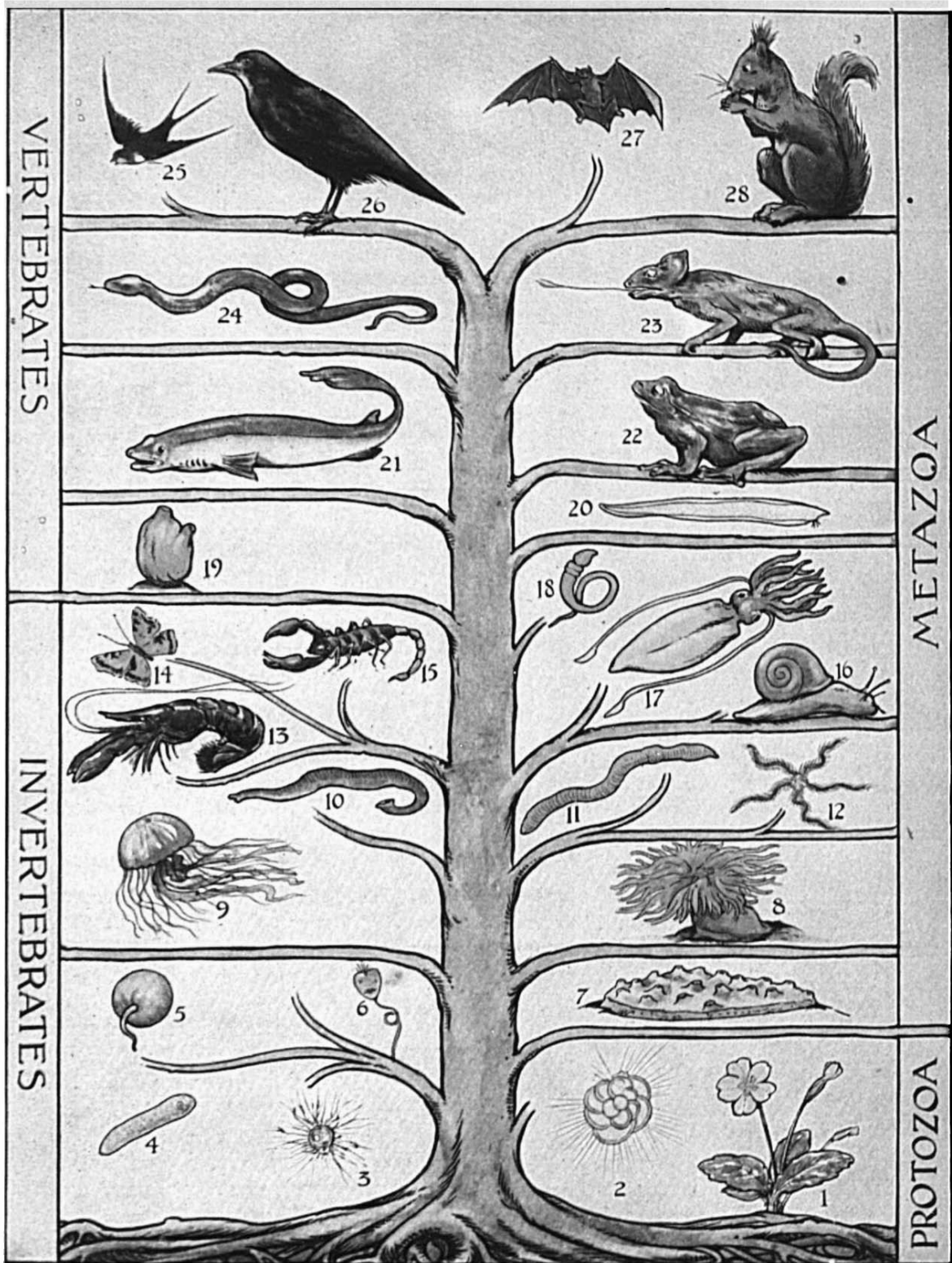
It is useful to recognise this variety of habitat, for it shows how diverse the life of mammals must be, and the impression of diversity grows when we remember that in most habitats there are several distinct possibilities of food-getting. Thus a mole is a carnivorous burrower, while a vole is a vegetarian burrower, a small bat is an insectivorous flying mammal, while a big bat is usually a fruit-eater. It is very interesting to find that almost every haunt and diet illustrated by mammals has also been utilised by reptiles, either living or extinct. This suggests that evolution has proceeded on an ever-ascending spiral.

Birds and mammals have evolved, as we have already said, on entirely different tacks, but it is not unprofitable to notice that they have often made the same kinds of experiments.



YOUNG OF BEARDED SEAL.

As in many other cases, the young of the Bearded Seal (*Erignathus barbatus*) has a uniformly light-coloured coat—in this species practically white. It is retained for some weeks. The young of the Harp-Seals (*Phoca garruloides*) are also called "white-coats." When the young one is lying exposed on the ice there may be protective value, or, more probably, physiological comfort, in being white. The Bearded Seal is a North Atlantic species, occasionally visiting British shores.



PICTORIAL REPRESENTATION OF THE GENEALOGICAL TREE OF ANIMALS.

1. A plant, indicative of the Vegetable Kingdom—on another line of evolution.—2 and 3. Chalk-forming animals or Foraminifers.—4. A parasitic Gregarine.—5. The Night-light Infusorian, Noctiluca.—6. The Bell-Animalcule, Vorticella. All these are Protozoa, unicellular animals. Multicellular animals are called Metazoa.—7. Crumb-of-Bread Sponge.—8. A Sea-Anemone, and 9. A Jelly-fish—both Cœlentera or Stinging Animals.—10. A Leech, and 11. An Earthworm, both Annelids.—12. A Brittle-Star, representing Echinoderms.—13. A Lobster, representing Crustacea.—14. A Butterfly, representing Insects.—15. A Scorpion, representing Arachnids.—16. A Snail, and 17. A Cuttlefish, both representing Molluscs.—18. Balanoglossus, a worm-like type intermediate between Invertebrates and Vertebrates.

Among Vertebrates: 19. A Sea-Squirt or Tunicate.—20. A Lancelet.—21. A Shark (Fishes).—22. A Frog (Amphibians).—23. A Chameleon, representing the Lizard order of Reptiles.—24. A Snake, another type of Reptile.—25. Swallow, and 26. Rook, representing Birds.—27. Bat, and 28. Squirrel, representing Mammals.

The Ostrich is a running bird, the Antelope a running mammal; the Owl is a nocturnal bird, the Hedgehog is a nocturnal mammal; the Storm-Petrel is an open-sea bird, the Dolphin an open-sea mammal;



Photo: F. R. Hinkins & Son.

COMMON MOLE (*TALPA EUROPEA*).

One of the conquerors of the underworld, adapted to its subterranean life in its barrel-like shape, reduction of friction (e.g. no external ears), elongated muzzle, shovel-like hand, strong breast muscles, and powerful neck for tossing the earth. The hair has no "set"; the minute eye is well concealed. The mole is a representative of the dwindling order of Insectivora, but its range still extends from Mull to Japan.

the Sand-Martin is a burrowing bird, the Mole a burrowing mammal; and so on. For a long time there were no flying mammals to vie with the flying birds; but eventually there was the evolution of bats, doubtless from an arboreal insectivorous stock.

It is instructive to consider some of the thousand and one ways in which mammals are specially adapted to the various haunts and conditions in which they live. But only a few illustrations can be given, beginning with aquatic mammals.

Aquatic Mammals.

In whales the tail has been transformed into a propeller, which sculls the water first to one side and then to the other, and great speed is attained in swimming and diving. With these swimming powers is associated the almost worldwide distribution of many cetaceans, like the Sperm Whale and the Southern Right Whale. In seals the hind-limbs are bound up with the tail, a conjoint propeller which churns the water from side to side being the result. In the walrus the hind-limbs are helped by the great paddle-like fore-limbs, which are also used for clambering on the slippery ice. The Common Seal has a remarkable way of moving on land. It arches up its body, bringing the hind-limbs and tail towards the head, and then suddenly straightens itself away, thus jerking the body forwards. In swimming the Beaver uses its trowel-like flattened tail; the Duck-mole has webbed fingers; the Water-Shrew has

special hairs on the sole and toes of its hind-foot, which are spread out like a comb in swimming, but become appressed when the little creature runs on land. The long tail of the Water-Shrew serves as a rudder;

it is somewhat flattened vertically and bears a fringe of long hair on its ventral surface. The adaptations to aquatic life are many: thus there is often a reduction of friction by the disappearance of external ears, as in seal and whale; hair is almost quite gone in cetaceans, though those that remain about the mouth may be very useful in their exquisite tactility; the absence of hair, which normally serves as a non-conducting robe, is compensated for by the development of a layer of blubber—just an exaggeration of the deposit of fat (*panniculus adiposus*) which is formed under the skin of most mammals (the Common Hare a noteworthy exception); the mother whales have an arrangement for giving their baby a huge mouthful of milk at a gulp, for suckling cannot be very easy in the open sea. It is said that the Northern Right Whale may remain under water for an hour and twenty minutes, and in adaptation to this prolonged immersion there is a huge chest cavity, and also a development of wonderful networks (*retia mirabilia*) of arteries which store pure blood and keep the tissues oxygenated when respiration in the ordinary sense has come to a standstill. According to Lillie, a rorqual may remain eight to twelve hours under water, and it is possible that in this case a sort of skin-respiration (familiar in frogs, for instance) is effected by means of numerous very vascular longitudinal ridges on the underside of the rorqual's throat. Besides the positive fitnesses,

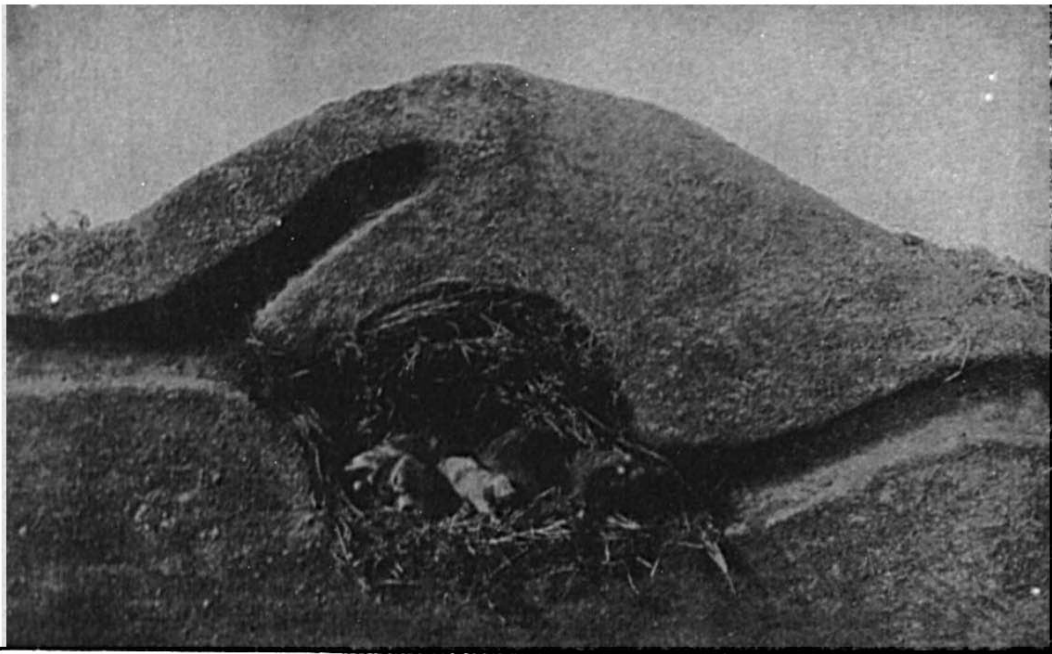


Photo: British Museum (Natural History).

"FORTRESSES" OF THE MOLE (in cross section).

The large mounds of earth noticeable where moles are abundant are the "fortresses," while the smaller mounds are made by the earth thrown up during the construction of the "run." The sexes build separate fortresses, and that of the female—an example of which is shown here in section—is the larger, being used as a nest for the young.

of which some illustrations have been given, there are negative adaptations. Thus, in thoroughly aquatic mammals, such as whales, there can be no smelling, and the olfactory organ is naturally degenerate. For what is useless is rarely conserved. Or, again, the cetaceans, which have their eyes continually washed with water, have no third eyelid—which is used in other mammals, except man and monkeys, for cleaning the front of the eye.

§ 5

As life on the surface of the earth is attended by great risks, which have to be met by special adaptations, it is not surprising that many mammals should seek refuge underground or should combine terrestrial and subterranean habits. Of adaptations to thoroughgoing subterranean life the Mole is perhaps the finest instance. Its hand is turned into a strong shovel, with which it literally "swims" in the earth. To the inside of the thumb there is a special sickle bone, which broadens the digging surface. The breast muscles are like an athlete's, and those of the very short neck are well suited for tossing the

earth. There are no projecting ear-trumpets, for these would be much in the way; the eye, unnecessary in darkness, is reduced to a pin-head size ($\frac{1}{8}$ of an inch in diameter), and is protected from injury by being well hidden in the hair of the head; the position of the nostril rather under the tip of the snout and a lip-fold in front of the mouth serve to keep the earth out; the hair of the body has no "set" and is easily kept clean, moreover it does not get disordered when the burrower moves backwards; the crowns of the back teeth are covered with sharp cusps, most admirably suited for crunching insect larvæ and the like. Truly the Mole is a bundle of adaptations. The Common Mole burrows in soft soil, and its hand is therefore broad; but the Cape Golden Mole and the quite unrelated "Marsupial Mole" burrow in hard soil, and their hands are very narrow, with a great strengthening of two of the fingers. This is plainly as it should be, and the impression of fitness grows when we consider details. Thus the Marsupial Mole, which presses its head into the earth, has its neck vertebræ solidified.

We have mentioned the Mole's adaptation to subterranean life, but this extraordinarily

interesting mammal claims further attention. It is not only a bundle of adaptations, it is an antiquity; it was long ago one of

The Mole. the discoverers of the underworld; it ranges successfully from Mull to Japan; it lives an unusually strenuous life; it has the charm of elusiveness and idiosyncrasies. It has four modes of locomotion. Ordinarily it "swims" deeply in the earth, using its hands to force the earth to either side, and scratching backwards with its hind-feet. It can burrow for a considerable distance without making a molehill.

Secondly, when there is food, e.g. leather-jackets (the larvæ of the crane-fly or daddy-long-legs), to be got near the surface, the mole works along in a shallow groove, often breaking to the open, and leaving a discernible track. In this shallow burrowing, it uses its head and strong muscular neck a good deal, tossing the earth upwards and to the side, in a way that recalls the old name "moudie-warp" or mould-tosser. Thirdly, it can run about on the surface at the rate of about $2\frac{1}{2}$ miles an hour, and the pairing takes place above ground. It must also be able to trot along in those underground runs which have some permanence, e.g. the "bolt-run" from the headquarters. As to this so-called "for-

ress," it consists of a roughly spherical nest about the size of one's head, filled with leaves and grass. Above and around this resting-place there is a mound made of the earth which has been dug out, and traversing this there are tunnels or galleries which were made in transporting the excavated earth and may connect with the bolt-run or other radiating paths. No two "fortresses" show the same plan of galleries; their symmetry and significance have been exaggerated; they are simply the necessary outcome of making a comfortable

resting-place and piling up the excavated material. According to some naturalists, an elaborate "fortress" is made by the males only. The sexes live apart, and the well-lined nest made by the female in May is usually under an inconspicuous hillock. The young ones, usually four or five in number, are pink and naked to start with, and very helpless. But the development is unusually rapid, the infantile period being telescoped down, and the offspring are able in five weeks to follow their mother and begin mining. The full-grown



Photo: W. S. Berridge.

TWO-TOED SLOTH OR UNAU.

This old-fashioned type (*Choloepus didactylus*) lives in the forests of South America, e.g. in Nicaragua. It is highly specialised for arboreal life, moving slowly about back-downwards along the under side of the branches, holding on with the recurved claws on the two fingers and three toes. On the ground it moves awkwardly. It feeds on leaves, and has a stomach with several chambers. The hair is coarse and shaggy and affords a basis for the growth of a unicellular green alga. The teeth are simple pegs without enamel, and seem to be confined to one set. The two-toed Sloth has usually six neck vertebrae and the three-toed Sloth has usually nine, thus illustrating divergence from the normal mammalian number seven.

males are very combative; indeed, there is a good deal of suppressed fury in any mole. Everything they do is done with vigour and zest—moving, feeding, fighting, everything. A mole has been known to displace a nine-pound brick on a smooth surface, which for an animal weighing three ounces is equivalent to a man of twelve stone moving an object weighing 3 tons 12 cwt. (Frances Pitt, *Wild Creatures of Hedge-row and Garden*, 1920).

The Mole's vigour must be correlated with its extraordinarily good digestion. A mole can



Photo: W. S. Hensidge.

AMERICAN GRAY SQUIRREL (*SCIURUS CAROLINENSIS*) COMING DOWN A TREE.

An attractive and beautiful native of North America with habits similar to those of the Red Squirrel. A large nest is built on or in the tree, and there are usually two litters in the year. The creatures show great enthusiasm in hiding stores, including single nuts, in the ground. When pursued they press themselves flat and quiet on a branch, or take daring leaps from tree to tree. Many small colonies have established themselves, sometimes from Zoological Gardens, in Britain; and the diffusion on the shores of Loch Long shows the danger of introduction. The animals are very delightful in the London parks, but they may do enormous damage in woods and forests. The pet of confinement is apt to be the pest of the open.

easily dispose of its own weight of earthworms in a day, and adults require food every three or four hours. A mole that was fed with forty earthworms late in the afternoon was found dead next morning with an empty stomach!

§ 6

Whether the earliest mammals were arboreal or not, it is a mode of life which many have adopted, and it has obvious advantages of increasing the freedom of movement, of securing a relatively safe retreat, and of making a nest a possibility. In many cases, as in a wild cat, the sharp claws are well suited for holding on to the branches.

Arboreal Mammals.

The Squirrel runs up the trunk, gripping with its claws, but looking as if it did not need to hold on; and its bushy tail is of use as a rudder when it takes an adventurous leap from tree to tree. In some cases, however, there are special attaching structures; thus the extraordinary lemur called the *Tarsius Spectre* has disc-like suckers on its fingers and toes. Sometimes there is a splitting of the hand and foot which gives the limb a secure grip of the branch, and the same result may be reached by having an opposable first digit, like our own thumb. The Tree-Sloths show yet another method, for their claws are greatly elongated into hooks, and by means of these they move cautiously along, back downwards, hanging to the underside of the branches. It is interesting to notice how many features of these strange creatures have been altered in relation to their upside-down mode of progression. Thus they can bend their head round so as to look downwards over their shoulder; the neck is very mobile, and in some species has nine instead of the usual seven vertebrae; the shaggy hair hangs down in a unique way, and its suggestion of a mass of fibrous plants may be enhanced by the presence of a green Alga. One of the most

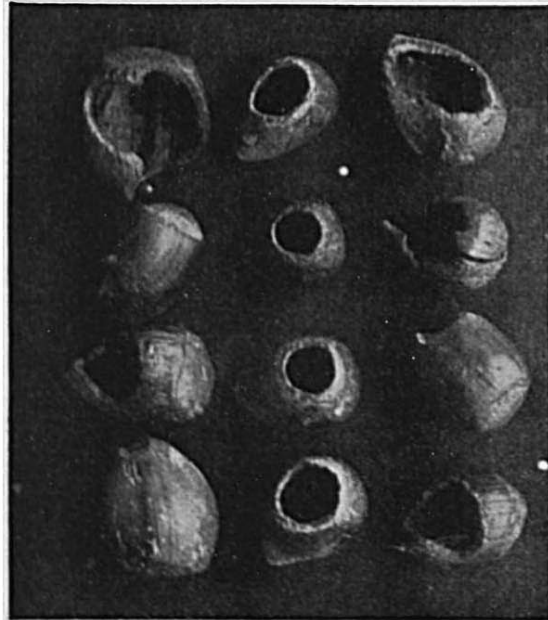
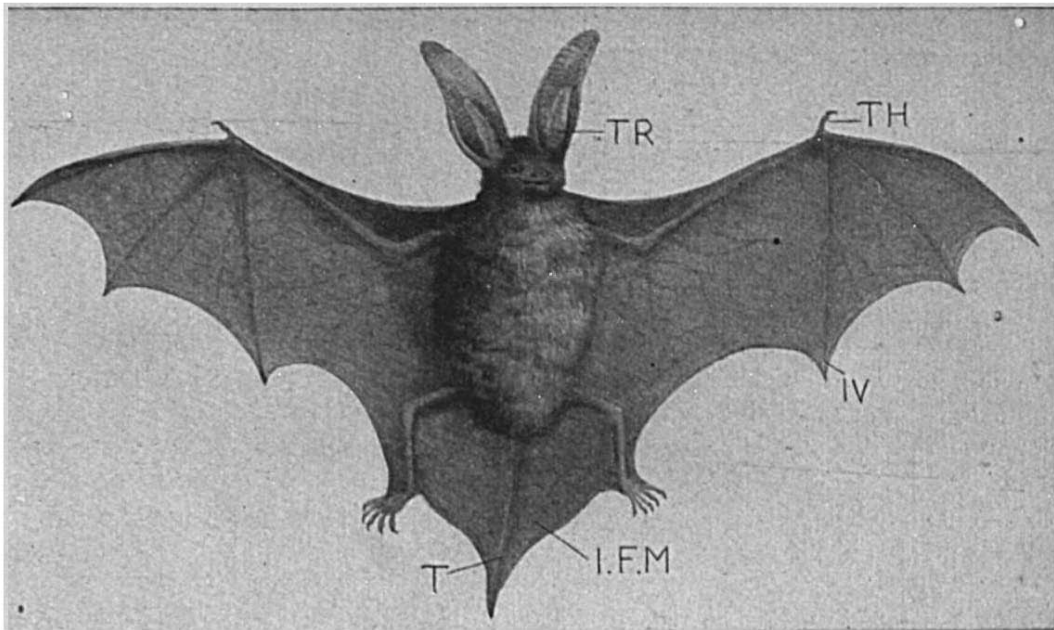


Photo: Douglas English.

NUTS GNAWED BY SQUIRRELS.

The holes in the empty shells show the neat work of the chisel-edged incisor teeth, and also, in most cases, the marked economy, for the aperture is not made larger than is necessary to let the kernel out.



THE LONG-EARED BAT.

Long-eared Bat (*Plecotus auritus*), a common British bat, which does good work in destroying injurious insects. It is a playful creature, not difficult to tame. The ear-trumpet is larger in proportion than in any other animal, and may be 1½ inches long. The body, not counting the tail, is about 2 inches in length. In the ear, as in many other bats, there is a very strong development of the forward flap or tragus (TR), which is represented by a small anterior lobe on our ear-trumpet, guarding the entrance. The projecting clawed thumb (TH) is clearly shown, and the fourth digit (IV), corresponding to our little finger. Between the hind-legs, supported by the tail (T), there is an inter-femoral membrane (I.F.M.), a basket of skin against which the bat presses its insect booty when it is killing them during its flight.

effective adaptations to arboreal life is the most familiar—namely, the prehensile tail of many monkeys. In the Spider Monkey (*Ateles*) the tail is used not only to support the whole body, but actually as a “fifth hand” for grasping the food. Again, we get an impression of the plasticity of animal structure—the same part being turned and twisted to so many different uses.

It may be doubted if there is any climbing mammal with more all-round attractiveness than the Common Squirrel. It is small without being pigmyish; the bushy tail balances the body; the rich brown-red upper colouring is very pleasing; the ear-tufts present during the colder half of the year make the creature look even more alert than it is; its movements take one's breath away.

Its table manners are perfect, for it sits upright, holding its food daintily in its hands; it neatly unshells the kernel of the nut; it even removes the thin outer pellicle before it begins to munch. Everyone knows how the squirrel passes from tree to tree, but it may also press its body against the stem and remain perfectly still. When it sleeps it uses its tail as a blanket.

The security of its life probably adds to the gaiety of its disposition, for it is one of the playing animals, enjoying what looks like “tig” among the branches. Squirrels usually pair early in spring. Two or three blind and naked young ones are born in a large nest of moss and leaves and twigs, which the monogamous parents build among the branches. There is strong maternal care and courage, and when danger presses the mother may carry one baby after another in her mouth to some place of safety. There is considerable instruction in athletics and woodcraft.

When winter comes the Squirrel does not hibernate, though on a very cold morning it may sleep late within the hollow tree. It still finds seeds and shoots to eat, and when these are scanty it searches about for the caches of nuts it made in September and October—and forgot all about! Too much has been made of the Squirrel's thrift.

§ 7

Although the scanty fossil remains of Bats have revealed nothing as to their ancestry, it

seems safe to say that they evolved from an Insectivore stock. Specialised as they are for flight, they show numerous affinities with tree-shrews and the like. The vacillating rapid flight is familiar, and in some bats the power of flight is strong enough to enable them to migrate as birds do.

In relation to the bat's twilight habits, the sense of touch is highly developed on the wing, and about the nose and ears, so that obstacles

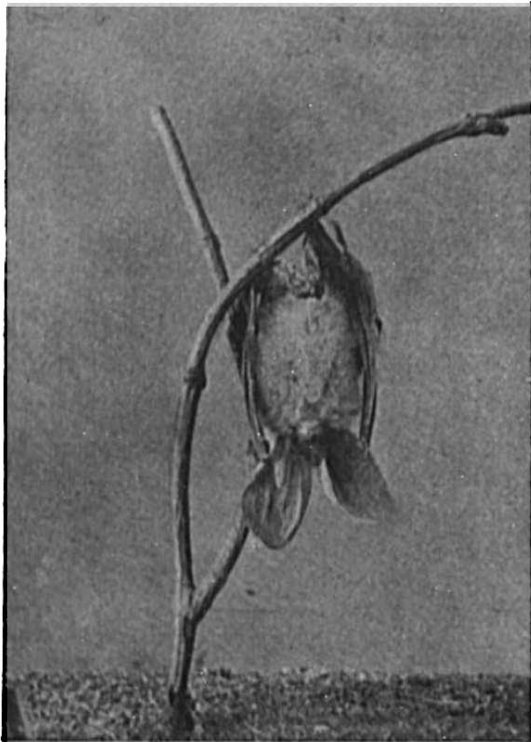


Photo: Aberdeen University Museum.

LONG-EARED BAT IN RESTING ATTITUDE.

In the Long-eared Bat (*Necotus auritus*) the ears are nearly as long as the body! When the animal is resting squat, it folds its long pinnae backwards along its body, and that leaves projecting forward from each ear a strongly developed earlet, or tragus. When the bat hangs itself up to rest (as above) the long ears hang down.

like branches are avoided. Perhaps there is a pressure-sense distinct from touch, for bats often swerve to one side before they are near the obstacle. It has been suggested that the bat's cry of short-length sound-waves has a sort of echo from surfaces, and that this warns the bat from collision. There is, usually, only one young one at a time, an important restriction for a flying mother that has to carry the offspring about with her after birth as well as

before. The back teeth of small bats bear sharp cusps, well suited for crunching insects, and a crowning adaptation may be found in the winter sleep of the bats of northern countries.

The large bats, sometimes called "flying foxes," ranging from Madagascar to Queensland, are all fruit-eaters. The small bats are typically insect-eaters, but some are carnivorous, a few take fruit, and a few are blood-suckers. In the Vampire (*Desmodus rufus*), which feeds on blood, the gullet is so narrow that nothing but fluid could pass down. In his *Edge of the Jungle* (1921) Mr. William Beebe gives a graphic description of the vampires of British Guiana. They entered the bungalow at night and flew about, fanning the faces of the inmates, but for a time never touching. Eventually one would settle down on an exposed foot or arm, and creep on it, pushing with the feet and pulling with the thumbs, after the usual bat fashion, but so gently that the only sensation was a slight tickling and tingling. All this was preparatory to a small bite which would not awaken a sleeper.

British bats are all insectivorous. They congregate in considerable numbers in trees, caves, roofs, and holes in towers; but the sexes usually live apart. While typically nocturnal, they are occasionally seen in daylight; and, similarly, while they typically hibernate in winter, they are often seen if there is a spell of mild weather at that season.

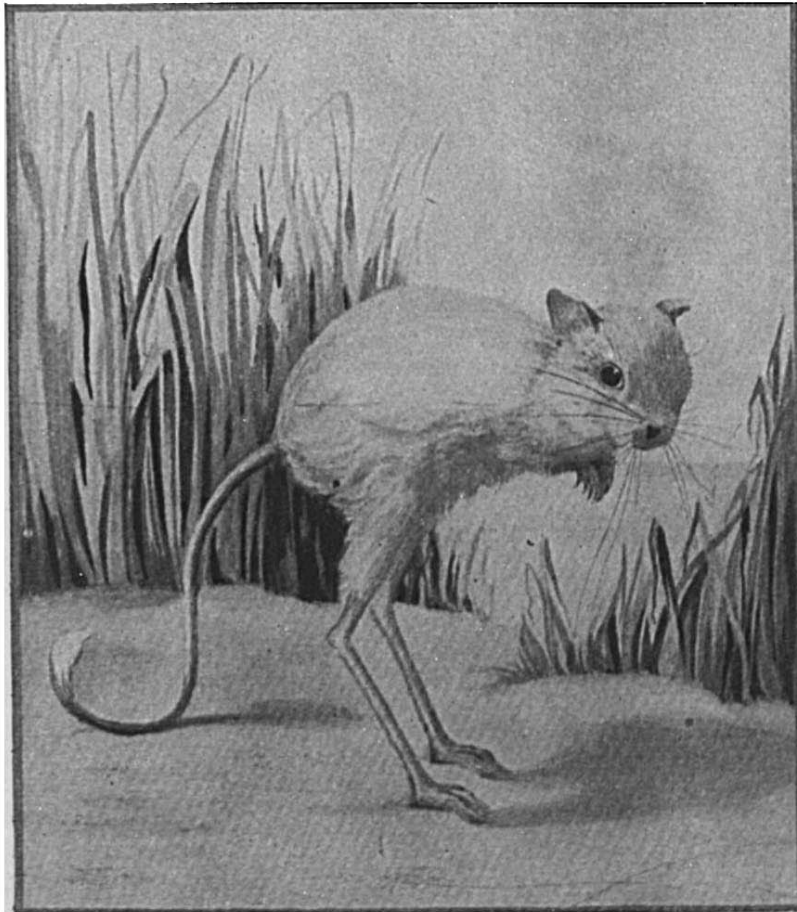
§ 8

The essential quality of dwellers in the desert is a capacity for rapid movements—to find herbage in a new area, to get out of a dry and parched land, and to flee from enemies when there is no possibility of concealment. Thus it is profitable to have long legs, a strong heart, good wind, and keen senses. The fleet Antelope may serve as a type, and there is a touch of perfection in the elusive Jerboa. Its long jumps must be disconcerting to an enemy, and the tuft of strong hair on the foot keeps this attractive biped from sinking into the loose sand, when it alights from its flying jump. Another feature, well illustrated by the Gazelle, is the "spareness" of build; the limbs are "all muscle"—"muscle as hard as steel." There is, however, great elasticity

in the skeleton of the fore-limbs and in the connection of the shoulder-blade to the backbone. It is easy to interpret the reduction in the number of digits as a lessening of friction, and the same might be said in regard to the transformation of claws into hoofs, but some of the peculiarities of desert animals are not so easily explained. Are the markedly swollen nostrils of gazelles and their relatives adapted to facilitate respiration in their racing, or have they to do with filtering the air from the driven sand? Opinions seem to be very discrepant in regard to the protective value of the coloration of desert animals. A sandy-brown shade is certainly very common, and apparent exceptions, such as zebras, may admit of ready explanation. In the open the zebra can look

after itself and show quick heels; in the oasis it may be that the striping is very inconspicuous. It is said that the huge giraffes are very inconspicuous in a grove of acacia-trees.

The two-humped Bactrian Camel and the one-humped Arabian Dromedary show various fitnesses for sandy deserts. Thus the two toes have short nails instead of hoofs, and are almost embedded in a strongly developed expandible sole-pad with an elastic cushion between it and the bones. The result is a surface which expands under pressure, and is well suited for moving over the loose sand. In the closely related Llamas from the Andes each toe has its own sole-pad, which is adapted for the mountain paths. Many desert animals can go for a long time without food or drink, and this is especially



THE JERBOA. (From a specimen.)

A Jerboa (*Dipus*), a biped mammal, adapted for life on the deserts and steppes. The ankle joint is very high off the ground; the foot has a tuft of hair which prevents it sinking into the soft sand; the tail is useful in balancing; the fore-limbs are bent close up to the neck. The length of leap is extraordinary, and the creature vanishes almost instantaneously. Jerboas are also able to burrow. An astonishing feature is the coalescence of the three instep or metatarsal bones into one, presenting a strong resemblance to the tarso-metatarsus of birds. More remarkable still is the "soldering" together of the neck vertebrae. Jerboas of this genus are confined to the Old World.



THE MIDDAY HALT.

Camels are represented to-day by the two-humped Bactrian Camel (*Camelus bactrianus*) and the one-humped Dromedary (*C. dromedarius*), and by the geographically far distant Llamas (*Lama*) of South America. Neither of the Old World forms is now known to occur in a thoroughly wild state. Herds that have gone wild or become "feral" are well known. The spreading out of the third and fourth digits is adapted for treading on soft sand. The paunch has got "water-cells" and smooth walls. A quite unique feature is that the red blood corpuscles are elliptical in contour, instead of circular as in all other mammals.

true of dromedaries. In the paunch of these animals, and in camels, there are numerous side-pockets with narrow openings which can be closed by circular muscles, and these become filled with fluid. But we must not make too much of this, for the water-pockets are also seen in the Llama. Indeed, there are traces of them in the American Peccary, which is related to the family of pigs. What has happened in the case of the Camel and Dromedary is probably that special and adaptive use has been made of what was already present apart from desert conditions altogether. More unique is the development of a hump or of two humps, consisting chiefly of fat. When the animal obtains for a time a considerable quantity of moist herbage, the hump stands up tensely; when supplies are scanty the hump is reduced in size and becomes flabby. Another adaptation may be found in the Camel's power of completely closing its nostrils during a sand-storm.

Really great mountains often show three zones—of forest, of steppe-land with scanty vegetation, and of barren grounds or tundra in the higher altitudes. Thus we find, among mountain mammals, forest forms like Bears and some Monkeys, steppe forms like Chamois and Yak, and tundra forms like Marmots and Snow-Voles. Many of the mountain mammals are of very hardy constitution, with thick fur, with great climbing powers, and with a capacity for enduring severe conditions and a starvation diet. Many are refugees from the low grounds, and some, like the mountain beaver, are very old-fashioned, primitive types.

The Variable or Mountain Hare is a first cousin of the Common Hare, and is nowadays a distinctively northern mammal. When the ice-sheet was thick over the mountains of Central Europe the Variable Hare lived in the low grounds. When

Mountain
Mammals.

The Moun-
tain Hare.

the climate became milder it had to retreat—either further north or up the mountains. It became extinct in England, but has been re-introduced with success. Compared with the Common Hare, it is smaller as a whole, and in its head, ears, hind-legs, and tail; its flesh is whiter; it is a less dainty feeder. It does not seem to have any particular home or "form," but shifts about restlessly from one hiding-place to another. When the snow is deep it is forced to descend to lower levels. In Scotland it usually turns to white in winter, all but the black tips of its ears; in Ireland there is not usually any seasonal change of colour.

One of the most definitely mountain-haunting mammals is the Snow-Mouse, or, accurately, Snow-Vole (*Microtus nivalis*) of the High Alps. It is a little creature about five inches long in body and two more in tail, usually rusty-grey or whitish-grey in colour. Perhaps it has the honour of living a harder life than any other mammal, for it is rare below 4,000 feet, and it ascends from the snow-line to the tops of the mountains. It does not migrate in winter; it does not hibernate; and it does not turn white. In fact, its only adaptation to its snowy retreats is that in the summer it gathers to

its nest among the loose rocks a store of chopped grass and gentian roots. In winter it makes tortuous burrows beneath the snow, mining its way from one Alpine plant to another. It has the reward of freedom from enemies, for even birds of prey are scarce at these heights. The explanation of the habitat is interesting. The snow-mouse used to be one of the "tundra" animals, like Reindeer and Arctic Fox, that frequented the low grounds of Central Europe when the uplands were covered by a great ice-sheet. As the climate became milder and the ice-sheet melted, some of the "tundra" animals, like the Reindeer and Arctic Fox, retreated northwards, but the

Snow-Mouse went up the mountains, higher and higher. Thus we also understand why they have to-day a scattered distribution, separated by extensive mountainous tracts where none occur. This corresponds to some extent to separate migrations from the low grounds; it also has to do with the available vegetation, for the hardy Snow-Mouse must eat something.

§ 9

Mammals show a thousand and one adaptations connected with procuring and utilising

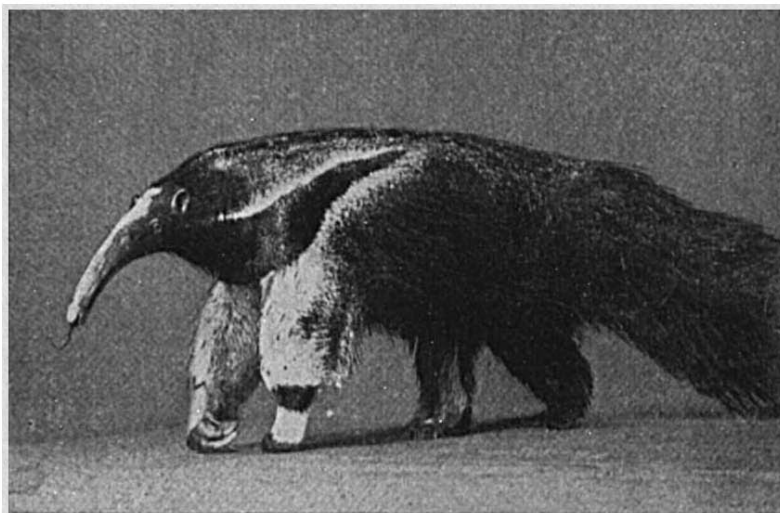


PHOTO: JAMES'S PRESS AGENCY.

GREAT ANT-EATER.

The Great Ant-eater (*Myrmecophaga*) is one of the South American terrestrial Edentates. There is no hint of teeth, but insects are caught by the rapid protrusion and retraction of a worm-like sticky tongue. The powerful claws are used in tearing up the ground or breaking into ant-hills; they are formidable weapons besides. There is shaggy greyish-black hair over the body, a broad white stripe on the shoulders, and a big bushy tail, only partly shown in the photograph. The length from the tip of the greatly elongated snout to the tip of the tail may be over 7 feet.

their food, and we cannot give more than a few illustrative examples.

The Great Ant-eater (*Myrmecophaga*) of South America comes out at night and with its exceedingly powerful claws breaks into the earthen hills of the termites. Then out and in whips the thread-like sticky tongue, drawing hundreds of insects in a short time into the absolutely toothless mouth. The same kind of tongue is seen in other ant-eaters, such as the Aard-vark of South Africa, and in the oviparous Echidna, which is also absolutely toothless.

The whalebone whale, of whatever kind, swims,

Food-getting among Mammals.

open-mouthed through the surface waters, engulfing myriads of small sea-snails and the like in the huge gaping cavern. The small animals are caught on the frayed edges of the baleen plates, exaggerated horny ridges of the palate, which hang downwards from the roof of the mouth. Every now and then the whale raises its tongue and brushes a multitude of the entangled creatures towards the back of its mouth, where they are gripped by the pharynx and swallowed. The water streams out at the sides of the mouth through the sieve of whalebone, but some of it would be apt to "go the wrong way" were it not that the whale shunts its glottis (the opening to the windpipe) forward to embrace the posterior end of the nasal passage. What a contrast is such a mouth to that of a toothed whale, like the Sperm-Whale and the Dolphin, with teeth well suited for seizing cuttlefishes and fishes! Yet it is interesting to notice that the whalebone whale has before birth two sets of teeth, which never cut the gum!

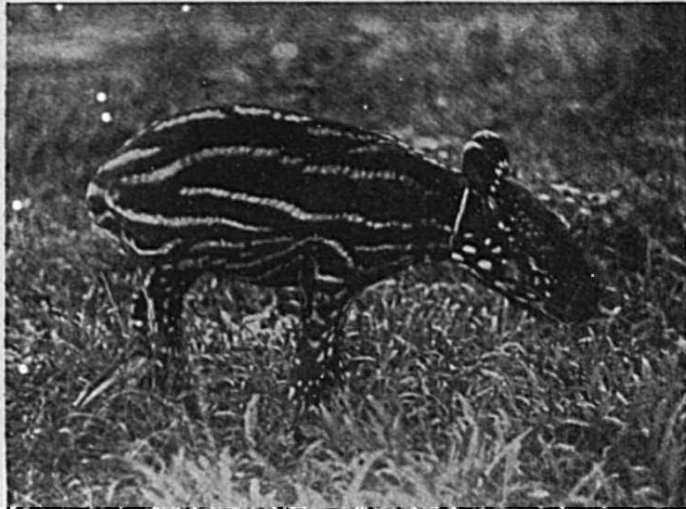
The adaptations of the teeth of mammals to different kinds of food-getting are many; but from a few we may learn all. In the gnawing mammals or rodents, such as rats, beavers, porcupines, and squirrels, the enamel is either confined to the front of the incisors, or it is much more strongly developed in front than it is behind. Thus the posterior part of the tooth wears away faster than the anterior part, so that a chisel edge is automatically formed. The lower incisors strike in behind the upper ones, and this keeps the enamel edge sharp. Moreover, these teeth are "rootless," and go on persistently growing as they are worn away. In the gap behind the incisors, where canines should be, an infolding of the skin into the mouth cavity separates a front portion from a back portion. Thus material which is being gnawed, but not intended to be swallowed, may be kept from going beyond the front region of the mouth. Some of the rodents, like the Gopher, store what they gnaw in capacious cheek-pouches, and grind this with their back teeth when they get into a place of safety.

No one can look at an elephant using its trunk without recognising a new idea—the employment of the nose (and a prolongation of the upper lip as well) as a food-getting organ. This is Nature's way, making an apparently new

thing out of something very old; and it is evident from the remains of extinct elephants that the trunk or proboscis had a gradual evolution, proceeding in correlation with that of the huge tusks which prevent the mouth getting close to things in the usual way. The efficiency of the trunk is greatly increased by a very mobile, finger-like process at the tip, which enables the elephant to handle little things as well as to lift great logs.

The trunk of the Elephant is a masterpiece, and the initial stages may be discerned, not only in the evolutionary history, but in the short proboscis of the Tapir, and even in the sensitive snout of the Pig, which is used for rooting in the earth in search of food. There is a special snout-bone (pre-nasal) in pig and mole; but the risk of hasty interpretation in terms of fitness may be illustrated by the fact that the same bone occurs in the Tapir, which does not root in the earth, and also in Tree-Sloths! The bone in question is probably a primitive feature, for the Tapir, for instance, is a very archaic mammal. In some cases, like the Elephant Shrew, the proboscis is a puzzle: we do not know its use.

The Elephant type, now represented by two species, the African and the Indian, exhibits many zoological peculiarities besides the familiar trunk and tusks. Thus the limbs are quite unique among living mammals in their straightness; they form vertical pillars adapted to support the huge weight of the body. But there is even greater interest in the ways of the creature. According to Sir Samuel Baker (*Wild Beasts and their Ways*, 1890), the African Elephant can charge for a short distance at the rate of fifteen miles an hour, and keep up the rate of ten miles an hour for a long run. The tusks which form the weapons of the males in their furious combats are used by both sexes in everyday life for digging up roots for food. It is said that an elephant does not reach proper maturity till it is forty years old, and that it may live far over a century. It is one of the slowest of breeders and carries its young for twenty-two months before birth. Yet we recall Darwin's calculation that after a period of 750 years there would be nearly nineteen million elephants alive, descended from a single pair. The cerebral hemispheres of the big brain



Photos: by courtesy of Charles Hose.

THE TAPIR OF SUMATRA (*TAPIR INDICUS*).

It will be noticed that the young one (upper photograph) is striped and spotted. These stripes disappear during the first year, giving place to, a well-defined black and white pelage when fully adult (lower photograph). The young one, with its yellowish spots and stripes, is "like a patch of ground flecked with sunlight"; the adult with its two colours is like a grey boulder. Tapirs form a small family of hoofed mammals (Ungulates) related to rhinoceroses and horses. Their modern geographical distribution indicates great restriction compared with that in bygone ages, for some of the species occur in the Far East, the others in South and Central America.

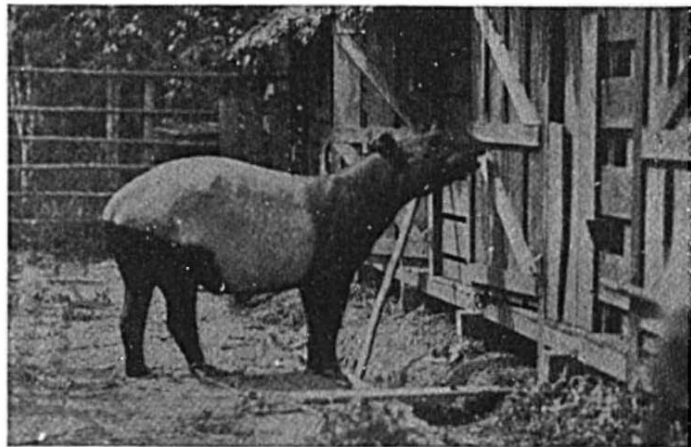
are richly convoluted, and the creature is so intelligent that "elephant storks" are proverbial. Of its memory, of its capacity for learning both in peace and war, and of its practical judgment, there is no doubt.

Some of the hoofed animals, such as cattle, sheep, and deer, illustrate an interesting peculiarity called chewing the cud, or rumination. These

Chewing the Cud.

animals feed, as everyone knows, on grass and herbage, and it is often important for them to eat as much as they can in a short time. A choice patch must be utilised to the full, and there is always the danger of an attack from carnivores. So the ancestors of our sheep and cattle got into the habit of gorging themselves with hastily swallowed grass, and then of retiring to the place of safety—often with their backs against a rock so that they could not be surprised from behind. There, at leisure, they re-chewed their hasty meal.

The so-called stomach of a typical ruminant, such as sheep or cow, consists of four chambers. The first is the capacious paunch or rumen, the internal surface of which is thickly beset with tag-like processes, suggesting velvet pile. It is here that the grass is stored; it is acted upon by the salivary juice which has followed it down, and there is also some bacterial fermentation. The second chamber, the honeycomb bag or reticulum, is marked by a hexagonal



pattern, and it rarely contains more than sappy fluid. The third chamber, the manyplies or psalterium, has numerous plaits filling up its cavity, so that the food has to pass through a kind of filter. The fourth chamber, the reed or abomasum, is the seat of gastric digestion. In fact, it is the true stomach, for the preceding three chambers turn out to be elaborations of the lower end of the gullet or œsophagus. This is known by the minute structure of their walls, for there is no confusing the non-glandular gullet region with the very glandular stomach region.

What happens in rumination? The cow, lying slightly on one side, returns boluses of food from the paunch to the mouth, where they are very thoroughly masticated and moistened with saliva. If we watch a cow we can see these boluses or rounded masses of vegetable matter travelling up the gullet with considerable rapidity. After the thorough chewing,

the food is re-swallowed and passes down for the second time; the muscles of the gullet working in a manner the exact opposite of that exhibited when the boluses pass up. On the second descent the food skips the paunch and the honeycomb bag, there being automatic arrangements for preventing entrance, and travels along a groove into the manplies. Filtering through this third chamber, it reaches

Such disturbance is of course injurious to the animal's health.

§ 10

Many mammals use their teeth, especially their canines, as weapons. The Walrus strikes downwards with tremendous force, the Wild Boar lunges upwards with the canines of both jaws pointing

Weapons
of
Mammals.

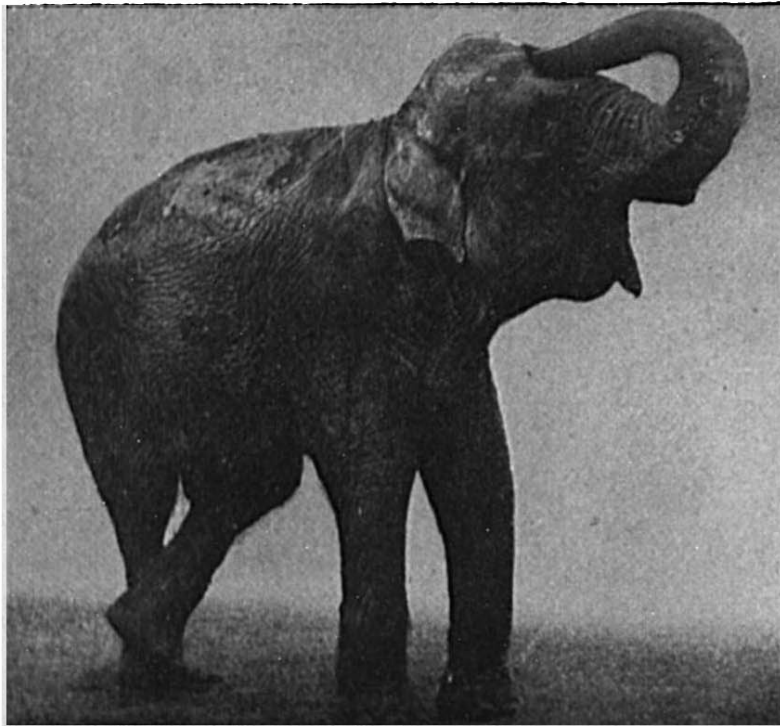


Photo: W. P. Dando.

INDIAN ELEPHANT.

There have been many different kinds of elephants in the course of the ages, but there are now only two, *Elephas indicus* (above) and *E. africanus*. The African Elephant is larger, with much bigger ears, with a more sloping head without the two rounded bosses of the Indian, and the tip of the trunk has two triangular processes, one above and one below. The Indian species is the only one that is used as a beast of burden.

the true stomach and is subjected to gastric digestion.

Overloading a stomach sometimes leads to vomiting—an automatic means of getting relief—and although the paunch is not stomach it is difficult to refrain from suggesting that the first part of the cud-chewing process may be a sort of normalised vomiting. Nowadays the whole series of steps is reflex or automatic, but it is interesting to notice that if the cow is disturbed in the middle of its cud-chewing it is not a little put about, and is often unable to resume the process for a considerable time.

up. In the Asiatic Babirusa the upper canines, though pointing up, are curved so far backwards that they form more of a shield than a weapon. In male Musk-Deer, and in the likewise hornless but quite unrelated Deerlets, the canines are strongly developed and are used in fighting; in Elephants the great tusks are front teeth or incisors. The use of the six-foot long left canine of the male Narwhal remains obscure.

Besides their teeth mammals may use as weapons their claws and their hoofs, and various kinds of horns. The Rhinoceros has a horn that belongs wholly to the skin—like a huge

wart that has become very hard. The horns of cattle, sheep, and deer have a core of bone (growing from the forehead or frontal) covered by an integumentary hollow sheath of horn. In the Giraffe and the Okapi the sheath over the bony outgrowth does not turn into horn.

Antlers deserve a place by themselves. They are restricted to stags with the single exception of the Reindeer, where they occur in both sexes. They are not seen in the buck's first year, when there is only a small, permanent, skin-covered, bony outgrowth on the forehead, called the pedicle, which grows in girth in subsequent years. In the second year there is an extraordinarily rapid multiplication of bone-forming cells on the top of the pedicle, and a short unbranched antler is formed, which carries upwards the hot skin or "velvet." The blood-vessels in the velvet supply the food which admits of the rapid growth of the skin, and they also keep the growing antler tissue suitably warm. The materials for the growth of the antler itself are brought by internal blood-vessels from the pedicle or stalk. Branches from the fifth brain-nerve run up the velvet and make it exquisitely sensitive—an adaptation that saves the stag from knocking the still soft antlers against hard objects.

In ordinary deer the antlers are as transient as the leaves of the forest. They drop off and there is a new growth next year. The second antler has a stem and one branch or tine, and a new tine is added each successive year until the stag reaches maturity, after which the antler growth becomes irregular.

The shedding of the antlers is an extraordinary process. It is prepared for from the start by automatic arrangements which cut off the supply of blood from the velvet, obliterate the internal blood-vessels, and form at the base a soft tissue which loosens the organic connections between the dead antler and the living pedicle. The dying away of the base of the antler would be called disease in other animals; it has become mysteriously regularised in stags. The whole process is extraordinary; the growth of a fine "head," perhaps 70 lb. in weight, takes place in three months—an expensive utilisation of material called into activity by chemical messengers (hormones) from the reproductive

organs. The splendid result is hardly finished before operations begin for its being shed! And after all, the antlers do not seem to be of much practical importance; they are exuberant outcrops of the male's virile constitution. Perhaps they have their counterpart in the male narwhal's spear.

Britain has lost the Reindeer and the Giant Deer, a fine creature of the ancient forests, but it still has the Red Deer (*Cervus elaphus*), which is genuinely wild in some parts of the country. It stands about four feet high at the withers, and the veteran stag has truly magnificent antlers, which are called "royal" when they have over twelve "points" or branches. The stags are very combative at the breeding season (September and October) and may be dangerous to man. They are greatly excited and roar loudly, challenging other males. In their ferocious combats they push with the antlers as a whole, or they stab at the heart and belly with the lowest branch or "brown-tine," which points forwards and upwards. A good deal of use is also made of the hoofs, especially those of the fore-feet. Each stag tries to attach to himself as many females as he can. The fawn is born in May or June, spotted as in most deer; it is carefully guarded by the mother, who teaches it to conceal itself when it hears the danger-signal—a tap with the fore-foot. In the summer months the hinds and fawns usually live apart from the stags, and often at a lower level. Although we associate the Red Deer with the Highland hills, to which they are well adapted in their strength and swiftness of limb, in their close-set coat, and in their wonderfully keen senses of smell, sight, and hearing, they were originally forest mammals rather than mountain mammals. They feed mainly on soft grass and heather shoots, but they have interesting vagaries of appetite such as gnawing at their cast-off antlers. Like the Reindeer of the Far North, they sometimes travel a long distance to get an early morning lick at the rocks on the seashore.

Some of the archaic mammals show a remarkable development of armour. The Armadillos are unique in having a bony skin-skeleton which is almost invulnerable, especially when the animal rolls

The
Story of
Antlers.

The Red
Deer.



MAY 10.



JUNE 6.



JULY 18.

THE GROWTH OF ANTLERS IN THE FALLOW DEER.

The young bucks show the first traces of antlers in their second year, but they do not get beyond mere "snags." During the next four years they become finer and finer. The antlers of the old bucks are usually shed about the beginning of May, and the new growth begins soon afterwards (see May 10). The antlers are rounded at the base, but become flattened or palmated higher up, as the third figure (July 18) well shows. Common report credits the Romans with introducing the Fallow Deer into Britain, but fossil remains have been found in at least one British cave. The general colour in summer is yellowish-fawn above with rows of large white spots; in winter the spots almost disappear.

itself up, thanks to the flexible rings in the armour, into an unopenable ball. Very striking is the tiny Pitschiago from barren grounds in South America. It has a bony carapace above, and on its under parts very beautiful snow-white hair; it has enormous nails on its fingers by which it is able to burrow very rapidly; and its hind-parts have a special very decorative shield. Hardly less striking are the Pangolins (Manis) with the body covered with very hard overlapping scales of horn, suggestive of a reptile rather than of a mammal. There is an Indian Ocean porpoise which has calcified scales all along its back, and, as these are larger before birth than after, it seems safe to interpret them as legacies from a very distant scaly ancestry. It seems that our Common Porpoise has sometimes very hard tubercles in its skin, and perhaps

this also illustrates the hand of the past living on in the present.

But there are other kinds of armour besides scales. The Porcupine has its long spines, the Hedgehog its short ones, and the Spiny Ant-eater is intermediate between the two. Even in the hide alone there may be considerable strength of armour—as in Rhinoceros, Hippopotamus, and Elephant. In many cases no armour is required, for the creature is endowed with relative invisibility, as we have seen in a previous chapter.



SCOTTISH RED DEER (*CERVUS ELAPHUS*).

This head from Inverness-shire, though not very large, is one of great beauty; in symmetry and proportions it is almost perfect. It shows seven points. The first time develops in the third year, so a stag with seven points would be nine years old. The antlers are usually shed in March, and seem to be eaten by the deer themselves. The new ones are completed by July or August.

§ II

Many animals of long pedigree have adopted a nocturnal mode of life, which gives them additional safety in circumstances more difficult than those to which they were primarily adapted. Thus the Otter and the Badger owe

their survival partly to their nocturnal habits, but it cannot be said that they are in any very marked way adapted to walking in darkness.

The Badger (*Meles taxus*) has still a firm footing in various parts of Britain, such as

The Story of the Badger. Devon and the New Forest. It is a thick-set, round-backed, rather bear-like carnivore, somewhat over two feet in length, with an additional seven inches of tail. It has a long muzzle, well suited for its restlessly inquisitive poking into holes and corners; the short rounded ears are not in the way in the brushwood; there are bright bluish-black eyes; there is below the tail an odoriferous gland with a disagreeable smell. The Badger stands alone among British mammals in having the under parts darker than the upper, for the under surface is black while the upper surface is tawny, overlain with grey, darkening here and there. The head is practically white, divided by a broad black band beginning between the nose and the eye and extending back to the ear. In short, the colouring is rather conspicuous, recalling the American Skunk. But the Badger is elusive, and though it has few enemies it will work its way in the dusk down a dry ditch or along the side of a hedgerow rather than cross the open. The heavy body does not seem to be lifted much off the ground, the snout is often

held very low, the soles of the feet are entirely on the ground in true plantigrade fashion. Yet the badger's movements have an easy swing, and the creature does not know what it is to be tired.

When we ask how the Badger manages to survive in a much cultivated and far from friendly country, part of the answer is in the words nocturnal and self-effacing, and, possibly, evil-smelling. We must add, however, that the Badger has strong positive qualities. It is very muscular; it has a strong heart and a good wind; the grip of the lower jaw is unsurpassed in tenacity; the thick coat helps the badger to withstand the cold of winter; it stores a good deal of fat; it is endowed with keen senses, shrewd intelligence, and a capacity for taking things easily without fuss or worry. And yet this is not all. It has an extraordinary catholicity of appetite, which always makes for survival. If one kind of food fails, it can fall back on something else—roots and fruits, nuts and truffles, worms and grubs, frogs and snakes, eggs and young rabbits, the grubs from the wasps' nest (for the badger is impervious to stings), and the honey from the humble-bees' store. Another factor is its burrowing habit, for its "earth" or "set" goes far in and may have several entrances. It is made comfortable

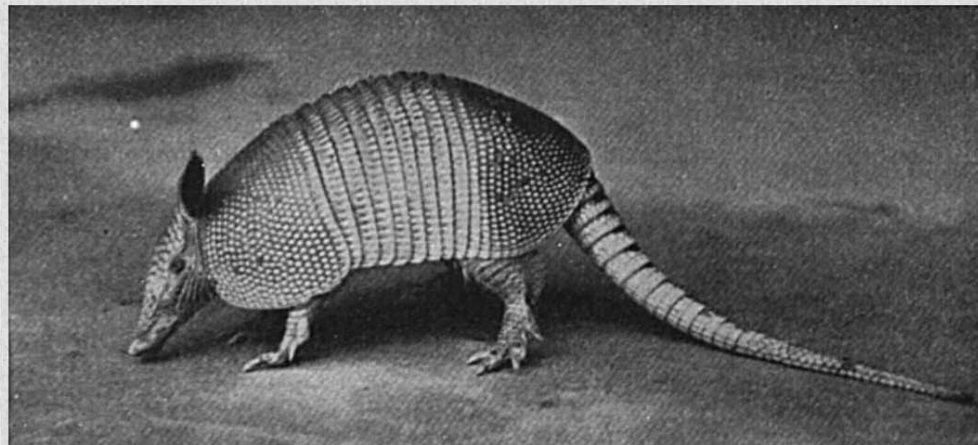


Photo: W. S. Berridge.

NINE-BANDED ARMADILLO OR PEBA.

This strange archaic type (*Tatusia novemcincta*) occurs in arid regions in South America, and extends into Texas. Between the shoulder-shield and the hip-shield there are nine movable bands, but the creature does not roll itself up into a living ball. It is only in Armadillos that plates of bone occur in the mammalian skin; above the bone there are epidermal scales of horn. The teeth are numerous small, blunt pegs, without enamel. The Peba can run quickly and burrow quickly; it uses its claws as weapons. It hunts for insects at night, or at dawn and dusk; during the day it keeps in its burrow, which may descend for 6 feet into the dry soil. Very remarkable is the fact that this Armadillo normally produces quadruplets—four embryos from one egg-cell—and these, as might be expected, are always of the same sex, either all male or all female.

with bracken and herbage, and is kept fairly clean. Moreover, one must attach survival value to the education which the mother badger gives to her silvery-grey cubs. There are usually just two or three of them, born in spring. When they have got their sight, some ten days after birth, and had their usual gastric education on milk, they are taken outside the warren and well groomed. Then comes schooling, and the mother is a stern disciplinarian. She punishes the inattentive and foolhardy, and gradually

the prolonged snout is well suited for probing into holes; there is a wide range of appetite—earthworms, grubs, slugs, and small snails; and the mountain-top-like cusps on the back teeth are well suited for crunching these. The constitution is very tough, and if the Adder—an inveterate enemy of the Hedgehog—gets a bite in, the venom has no effect. Experiments with poisons and with such germs as that of diphtheria have proved the refractoriness of this common creature. Although it has few enemies, it adds to its safety by resting during the day in a well-hidden recess, and hunting by night. There are often two litters (usually of three or four) in the year, and the young one is a curious flat and feeble creature, with soft white spines pointing backwards, and a pale blue-grey skin. It is not for some time able to roll itself up, yet it develops quickly, and is able to follow the mother in a month or two.

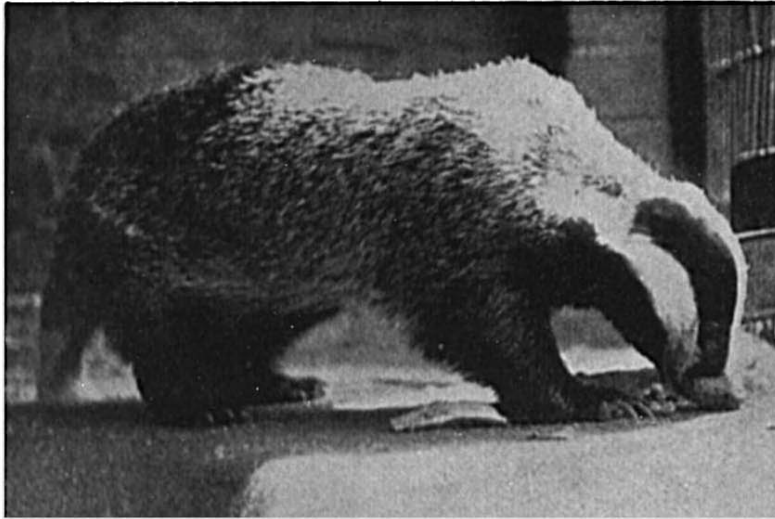


Photo: W. S. Herridge.

EUROPEAN BADGER.

The badger or Brock (*Meles meles*) is somewhat bear-like in its thick-set body, rounded back, short ears, depressed head, and flat-footed gait. It is over two feet in length, not counting the relatively short tail. It ranges through the northern parts of Europe and Asia, and still holds its own in some parts of Britain. Its survival may be traced in part to its vigour of constitution, to its burrowing and nocturnal habits, to its catholic appetite, and to its instruction of the young. The pair live together in the "earth," which is kept clean, although the repulsive smell does not suggest this. Badgers levy a slight tax on the eggs of game-birds, but they do very little harm, and it is a pity that they should be thoughtlessly eliminated.

instructs them in the way in which they should go.

The Hedgehog is an old-fashioned insectivore that holds its own well from Britain to the Ural Mountains. It does so in virtue not of brains or of weapons, but because of other fitnesses. Many of the hairs have been transformed into sharp spines, which are erected by the smooth muscles at their base whenever the animal is touched. They also serve to break the force of a fall when the Hedgehog, a good climber, tumbles from a wall or a tree. A very strong dome of muscle beneath the skin (see page 354) rolls the animal up into an unopenable ball. The senses are acute;

in mammals that we find true hibernation, a very peculiar physiological condition, which is not sleep, nor necessarily connected with winter. It is exhibited by Hedgehog and Hamster, Dormice and Bats, Marmot and Souslik, the Spiny Ant-eater of Australia and the Jerboa of the Kirghiz steppes.

To understand the hibernation or so-called winter sleep of these mammals, it is necessary to recall the main facts in regard to animal heat. Inside the body heat is produced by various chemical processes, but mainly by the muscles; it is of great importance in facilitating the operations of the living laboratory. But the heat tends to be lost by radiation into the outer

§ 12

Many creatures, such as reptiles, amphibians, snails, and insects, pass Hibernation into a lethargic state when winter sets in, and lie low until the spring. But it is only



Photo: Aberdeen University Museum.

THE HEDGEHOG

The Hedgehog (*Erinaceus europæus*) is an old-fashioned insectivore, ranging from Ireland to the Ural Mountains. It survives in virtue of its nocturnal habits, its tough constitution, its armour of spines, its power of rolling itself up, and its capacity for hibernation. The spines are transformed stiffened hairs. The staple food consists of earthworms, slugs, and insects—both larval and adult; the back teeth bear mountain-top-like cusps well suited for dealing with this sort of diet. The pointed muzzle is adapted for probing into holes. The four to six young ones, born in a hedgerow nest or at the foot of a hollow tree, are at first very flat, with white soft spines pointing backwards, with a bluish skin, and without the power of rolling up.

world through the skin, and in the hot breath and in sweating. The non-conducting fur in ordinary mammals and the blubber of whales lessen the loss from the skin, as do the feathers of birds. But there is in birds and mammals a self-regulating system, which keeps the temperature approximately constant, day and night, year in and year out; and this is what is meant by warm-bloodedness. The regulating centre is in the brain, whence orders issue to the muscles, blood-vessels, and skin. If too much heat is being produced or lost, an adjustment is effected. But all mammals are not perfect as regards this heat-regulating arrangement, and it is among these that hibernation occurs. A good example may be found in the Spiny Ant-eater (*Echidna*), whose temperature may vary ten degrees Centigrade according to that of the outside world, whereas our temperature varies only by a fraction of a degree as long as we are in good health. Now the Spiny Ant-eater is a hibernator, and this is the clue we

need: winter-sleeping mammals are imperfectly warm-blooded. When the cold weather sets in, it becomes difficult for them to adjust the debtor and creditor account as regards heat; they cannot produce enough to make up for their loss, and they give up the attempt. They sink back into a state of comparative coldness and cold-bloodedness; they relapse into the ancestral reptilian condition.

But if the imperfectly warm-blooded mammals which we have mentioned were to fall asleep in the open, their body-temperature would go down and down, and they would die. What they must do is creep into some sheltered nook or comfortably blanketed hole where the temperature soon becomes much higher than that of the world outside. To this temperature that of the sleeper's body approximates without there being any fatal results.

Along with the snuggling into a confined space, must be taken the great reduction of internal activities, and here hibernation ap-

proaches the lethargy of frog and tortoise. Income is *nil*, so expenditure must be reduced to a minimum. The heart beats feebly, the breathing movements are scarcely perceptible, the excretion or filtering which is the work of the kidneys comes to a standstill. The hibernating body is like a fire well banked up in its own ashes, and in an animal like the Hedgehog we know that subtle changes come about in the recesses of the tissues.

The gist of the matter is to be found in the three facts: (1) a constitutional imperfection in the temperature-regulating arrangements;



SKINNED HEDGEHOG.

Showing the attitude of the animal when rolled up. Very noteworthy is the great dome of muscle which contracts the animal into a living ball. It will be noticed the muzzle is bent down very nearly to the toes, and that the fingers are touching the toes.

(2) a creeping into a confined space which gets warmed up a little; and (3) a great reduction of expenditure, for even the internal activities come almost to rest. But there are some contributory influences which must be recognised. After the hard work of summer, there is naturally some fatigue and a bodily bias towards rest. Moreover, summer has often been a time of plenty, and the body has accumulated stores of fat and other reserves, which may also incline the creature to somnolence. And once the quiescence has begun, it will tend to continue, for the closeness of the retreat must be soporific, and the cessation of the kidney functions will tend to keep the sleepers sleepy. Just as

drowsiness sometimes sets in when man's kidneys are not working rightly, so in the hibernating mammal there may be a poisoning of the body with its own waste-products—a sort of "auto-intoxication."

Yet this is not all. We must not think of hibernation as an individual reaction merely; it expresses a racial rhythm. In the course of thousands of generations a certain periodicity has been established, like that of our sleepiness at night and wakefulness in the morning, and with the enregistered bodily rhythm there is associated an instinct which prompts the hibernator to seek out a comfortable corner when the weariness or sleepiness sets in. For ages, it must be remembered, our hedgehogs have not known any winter. They have slept through them all, just as the migratory birds have circumvented them all. It must be remembered, too, that the winter-sleep or hibernation of an animal like the Hedgehog cannot be distinguished from the summer-sleep or aestivation of the Tenrec of Madagascar.

Only a few mammals are hibernators, and some of these, like the Dormouse, are "light sleepers," while others, like the Hedgehog, are "deep sleepers." In all cases there is some imperfection in the warm-bloodedness, and what has been wrought out is what we might call a rather neat way of making a strength out of a weakness. There is a relapse to a reptilian condition, but this handicap is counteracted. For it is not merely that the difficulties of the winter—scarcity, cold, and storms—are circumvented; the hibernation gives an opportunity for a long rest, which even the food-canal may be the better for. There may be an opportunity for processes of recuperation or rejuvenescence to stave off the processes of senescence or ageing. Why, then, are there not more hibernators? The answer must be that hibernation is the "answer-back" made by certain creatures with a constitutional peculiarity; other mammals meet the winter in other ways.

§ 13

The contrasts between lion and lioness, between stag and hind, are familiar. They illustrate what is technically called **Sex Dimorphism**, sex dimorphism, i.e. a marked structural difference between male and female. The contrasted characters are called second-

ary sex characters, to distinguish them from primary sex characters, which have to do more or less directly with the reproductive function itself. The males are sometimes equipped with decorations—the manes of lion and bison, the beards of certain goats, the crests along the back of some antelopes, and the dewlaps of bulls. Or they may have weapons which are either absent in the females or represented in less exuberant development. Thus antlers are restricted to the males except in the case of the reindeer; the horns of bull and ram may be much larger than those of cow and ewe; the male narwhal has a spear-like tusk which is not developed in the female. There may also be differences in colour and in odour.

Darwin suggested that when the males fought for the possession of the females, as stags and antelopes do, the males with better weapons would prevail. As they would therefore have most success in leaving progeny, their strong qualities would gradually become racial characters; the males with poor weapons would be sifted out. In regard to sex decorations he suggested that the females would be most interested in, and would give the preference in mating to, the more handsome males, and that the race would therefore evolve in the direction of increased decorativeness. This is, in brief, Darwin's theory of sex selection, which is discussed in the article "How Darwinism stands To-day." But one point must be noticed here. If the quality of having strong weapons or of having handsome decorations is hereditarily transmissible, why does it not appear in the female as well as in the male offspring? How can it be entailed on the male offspring only? The answer must be that the quality is handed on to both sexes, but that it cannot find expression except in a male constitution. Similarly, the foundations of milk-glands are part of the inheritance of both sexes, but normally their development is restricted to the females. There are items in the inheritance of both sexes which are like seeds requiring particular kinds of soil if they are to develop. The male character of antlers or of shaggy mane requires a masculine constitution (including the presence or absence of certain hormones) if it is to develop. This leads to the view that the secondary sex characters are in their origin bound up with

the primary differences of constitution implied in maleness (sperm-producing) and femaleness (egg-producing) respectively.

All theory apart, we return to the facts (1) that the male mammal is often markedly different from his mate, (2) that there are often fierce combats between rival males, and (3) that in certain cases the females seem to show a certain preference, being apparently more excited by some males than by others. It is probably the total get-up that counts rather than any individual item such as an extra long



Photo: Aberdeen University Museum.

THE DORMOUSE.

The Dormouse (*Muscardinus avellanarius*) is in some ways suggestive of a miniature squirrel. It climbs in the herbage and bushes; in the thicket in spring it makes a nest of grass and leaves. The tail is somewhat bushy; the eyes are relatively large. Head and body make up about 3 inches, the tail half-an-inch less; the colour is tawny brown above. The Dormouse frequents the central and southern districts of England. It accumulates fat in the summer, and is a light sleeper during the winter. If wakened too suddenly it is apt to die. If there be a second litter in autumn the young ones are said to die.

beard. The combats of rival stags are sometimes furious, and the antlers are occasionally interlocked with fatal results to both combatants. A male antelope sometimes punishes an upstart youngster so severely that the blood flows from many wounds.

§ 14

Some mammals are monogamous, others polygamous, and others promiscuous. The monogamous forms include the Chimpanzee, the Tarsius Spectre, the Hedgehog, the Elephant Shrew (*Rhynchocyon*), the Pangolin, some antelopes

and small deer, and the Bandicoot (*Perameles obesula*). The polygamous forms include most deer and antelopes, wild cattle and horses, sea-lions and elephants. Not infrequently the males live by themselves except at the breeding season, as in the case of elephants and stags. An experienced old female leads the hinds and the young; a male in his prime leads the stags. Where the pair do not live together throughout the year, and where the care of the family devolves wholly on the mother, the terms monogamous and promiscuous have not much meaning. There is pairing rather than mating. A female mammal may pair with one male one year and with another next year, or with several in one year. But our knowledge of these matters is sadly lacking in precision. It has to be remembered that in most cases the pairing time is sharply punctuated and of short duration.

It is interesting to inquire into family life among apes. The Gibbons (*Hylobates*) of south-east Asia are the smallest of the anthropoid apes, rarely over three feet high. But they have disproportionately long arms, the hands touching the ground when the animal stands erect. They are fond of swinging like acrobats below the branches with their arms above their head. They can swing clear for 12-18 feet with the greatest ease, and pass from tree to tree unwearingly. During the day they keep to the tree-tops, especially on the mountain-sides; towards evening they come cautiously "waddling" down in the open ground searching for fruit. Their voice is extraordinarily strong, especially in the males, and not unmusical. They are sociable and talkative. The Orang (*Simia satyrus*) of the forests of Borneo and Sumatra stands about four feet high and is very strongly built. It is highly intelligent, but somewhat sluggish in habit, climbing slowly, keeping to the trees except at night, when it sometimes searches on the ground for fallen fruit. It uses its arms as crutches or goes on all-fours. It makes for resting purposes a sort of platform nest of branches, but it moves on and makes another every second day or so. The male orang lives apart; but the mother keeps her family with her for some time. The Chimpanzee (*Anthropopithecus troglodytes*) of African equatorial forests

may be five feet high, but it is not so bulky as the orang, and it is as good a climber as the Gibbon. It makes a temporary platform or resting-place among the branches. In disposition it is lively and playful; it is easily tamed, and has a plastic intelligence. The Gorilla, also restricted to Tropical Africa, may be a little over five feet in height, and is of enormous strength in shoulders and arms. It goes much more on the ground than any of the other anthropoids, and has a shuffling, rolling gait, using the hands a good deal, and keeping the body semi-erect. It fights ferociously with hands and teeth, and does not retreat from man. It is said to be gloomy; it beats on its breast when enraged; it has never been tamed. A single adult male usually leads a small company of females and young ones.

Some young mammals are born very helpless—blind, naked, and with little power of movement. This implies some sort of seclusion or shelter, such as a burrow or a nest, as in Fox and Squirrel respectively. In the case of the Rabbit there are both, for the mother makes a bed of her own fur. During the very helpless infancy, the mother mammal is assiduous beyond telling. In some cases, after a period of suckling, the mother brings animal food to her young ones, and that food is not always dead. For the education has to begin early. The play of the kitten (and even of the cat) with the mouse is doubtless wrapped up with the business of early education.

In some cases the young ones are carried about by the mother. Reference has already been made to the marsupials, but there are other instances. A mother hippopotamus is sometimes seen in the Nile with a calf astride on her short neck: the young are precocious, and the mothers very affectionate. Many monkeys carry their babies about with them among the branches, and so does the quair. Tarsius, which belongs to the order of Lemurs. Among bats the young one is carried by the mother as she flies, and the holding on is assisted by the front teeth, which grip the rough hairs. On a somewhat different line are the cases where the mother takes a young one in her mouth and transports it to a place of safety. This is familiar in the case of a cat and her

Care
of the
Young.



Photo: Royal Scottish Museum.

THE POLECAT AND ITS FAMILY.

The Polecat (*Mustela putorius*) is also known as the fchet and the foumart (i.e. foul marten, because of its foetid odour). It is much larger than the Stoat, with looser fur, darkish all over. It lives chiefly in wooded country, feeding on rabbits and birds, but is becoming very scarce in spite of its alertness and courage. A ferret is a domesticated form of the Polecat, and is often an albino with no pigment in the hair or in the eyes (which look pink because of the blood shining through).

kittens, but the squirrel may also shift her young when danger threatens.

In some cases the instruction given by the mother is an important factor in securing the survival of the young ones, and therefore of the race. Thus the Badger instructs its offspring in the art of being elusive and in the diverse ways of securing food. Even better known is the Otter's schooling, for the young are taught all the alphabet of country sounds, how to dive without splashing, how to lie hiding under the bank without betraying themselves, how to catch frogs and skin them, how to guddle for trout and eels, how to eat the eel from the tail and the trout from the head, how to deal with rabbit and moorhen, and how to find their way home without returning on their outgoing track. No doubt there is hereditary instinctive endowment, but there is teaching as well.

§ 15

The Otter (*Lutra vulgaris*) is one of the most elusive of mammals, in great part nocturnal, shy

of repeating itself or returning on its tracks, shifty in its hunting, and very thoroughly amphibious. It is much commoner in

The Story of the Otter. Britain than is generally supposed.

Part of the secret of its survival we have already referred to—namely, the training which the mother gives to her offspring, but there is more. Thus it is always an advantage to have a catholic appetite, and while the otter depends mainly on fishes, it condescends to eat the mussels and limpets on the seashore and the frogs in the marsh; and, of course, it rises to wild duck and rabbit. Another feature of survival value is the otter's nomadism. In his fine study *The Life Story of the Otter* (1915), Mr. Tregarthen calls it "the homeless hunter," "the Bedouin of the wild." It has been known to travel fifteen miles in a night, and not infrequently the holts where it lies up during the day are ten or twelve miles apart. It passes from tarn to stream, from river to shore; it swims out to an island in the sea; it explores the caves on the cliffs; it crosses the hills and hides in a cairn; it is always on the move—a gipsy among carnivores.

In resourcefulness the otter is unsurpassed—lying hidden below the waterfall, wrenching a trap off under the roots of the alder-trees, diving at the flash of a gun, even hunting for pike beneath the ice of the lake. There are savage fights between two dog-otters who desire the same mate; the parents are often severely taxed to provide for the young; but the greater part of the otter's struggle for existence in Britain is in circumventing the difficulties of modern life.

The Common Hare (*Lepus europæus*) might be called a gentle Ishmaelite. Everyone's hand is against it, but it is against no one unless it be greatly roused, for instance by a stoat approaching its leverets at play. Yet it extends all over Europe, except in Ireland, the north of Scandinavia, and the north of Russia. How does it survive? It seeks resting-places or "forms" from which it gets a good look-out over the surrounding country; it has long-sighted eyes, quick ears, and keen smell; it utters a danger-call to its kin by grinding its teeth; its heart is such that it can put on full speed the moment flight is signalled; it rejoices in an uphill race; it criss-crosses its tracks so that even the astute fox is baffled; it disappears like an arrow when it is startled; and even when it is resting among the ferns and herbage, or on a ploughed field, it is almost invisible save as to its wide staring eyes. Much as it dislikes wetting its fur, which is slow to dry, it will swim across a broad river to baulk pursuit or to reach greatly appreciated dainties like musk and camomile. Epicure as it is, fond of tender corn and the sweet trefoil, of wild thyme and the seashore pea, it has a long bill of fare, which always aids in survival, and it will pass from lichens on the rocks, which its cousin the mountain-hare also eats, to the twigs of furze-bushes, and from the leaves of dandelions to the fruits of the bramble. Let us take three more illustrations of the hare's astonishing fitnesses. How simple and yet effective is its habit of taking a great leap from and into its "form" or nest, so that the scent track is interrupted. In his fine study, *The Story of the Hare*, Mr. Tregarthen notes that the doe leaves little scent when the young ones are helpless in the nest, that is, about the month of April. When a particular nest is endangered, it

may be by a hungry vixen, the doe hare will transport its leverets to a safer place, carrying one at a time in her mouth, at dead of night. It is said that if the litter be over two—cases of 4-6 are recorded—there may be a division into two nests! Elusive is the word for a hare, but at the breeding season in March the instinct of self-preservation wanes before sex-passion. The bucks race about at a high speed in the open day and in the open field, searching for the does and fighting with rivals. They box with their paws and kick with their hind-legs, and a common trick is for one buck to jump over another, kicking back as he does so. The buck is a roving lover; he may consort with one doe for a little while, but he soon seeks another. The hare is a high-strung creature, with quick-beating heart, rapid breathing, tremulous ears, but it presents a brave front to persecution, now saving itself by its alertness, and again by its capacity for lying low. As there is no burrow, it is not surprising to find that the leverets are born furry and open-eyed, very different from the naked young of their second cousins, the rabbits.

There are many playing mammals, and the work of Groos in particular has shown that the play is of great importance in the life of the creature. Kittens chase a leaf whirled by the wind; puppies indulge in a sort of sham hunt; young otters and stoats are delightfully playful, and so are humble mammals like the water-shrews, which few people know much about. Lambs have many games, and goats have more; calves and foals have their races; leverets and squirrels their frolics. One may distinguish gambols, races, games like "tig," sham hunts, sham fights, and the endless game of "experimenting" in which monkeys are pre-eminent. Miss Romanes writes of her Capuchin Monkey: "He is very fond of upsetting things, but he always takes great care that they do not fall upon himself. Thus, he will pull a chair towards him till it is almost overbalanced; then he intently fixes his eyes on the top bar of the back; and, as he sees it coming over his way, darts from underneath, and watches the fall with great delight; and similarly, with heavier things. There is a washhand stand, for example, which he has upset several times, and always

The Significance of Play.

without hurting himself." This illustrates the game of experiment.

Similarly, Miss Frances Pitt records a game which two ravens in a yard used to play with a cat. One of the ravens, with a good deal of bluster, would make a frontal attack on the cat. This was met on the cat's part by the usual arching of the back and other expressions of contemptuous irritation. Meanwhile, however, the other raven approached quietly from behind and tweaked the cat's tail. Whereupon a rapid face-round, and the second phase of the game began, in which the ravens exchanged parts. There was no use in the performance; it was only a "ploy" in which the cat had its share.

What is the biological significance of the play of young mammals? It has been said that play is a good safety-valve for overflowing energy and exuberant spirits; it has been pointed out that motion is linked in a subtle way to emotion, and that pleased feelings naturally find expression in pleasant movements; it has been suggested that the playing period affords oppor-

tunity for trying new ways or exercising new gifts before the responsibilities of life become too stringent. There is good sense in each of these suggestions, but the most important idea is that the play period is the time for educating powers which are useful in after life. Play is the young form of work—a rehearsal without too great responsibilities, when mistakes can be made without too severe punishment. As Dr. Groos says, playing animals do not simply play because they are young; they continue young in order that they may play. In the course of ages playing instincts have been established in many mammals, and they make for success.

The Weasel (*Putorius vulgaris*) is one of the northern mammals common to Europe, Asia, and North America. It is a first cousin to the Stoat or Ermine, and an embodiment of virility. The spare sinuous body and the long neck suggest the snake, and the convergence simply means that the Weasel is adapted, like a snake, to making its way through narrow passages. The Weasel,

The Story
of the
Weasel.



Photo: Rilev Fortune, Harrogate.

THE OTTER (*LUTRA VULGARIS*).

This member of the Bear tribe of Carnivores is about 2 feet long, with 16 inches more to the strong tail—which helps in swimming. The fur is thick and soft, deep brown above. The claws are of use in burrowing, but the hands and feet are likewise webbed for swimming. In its present geographical distribution the Common Otter extends from Ireland to India. It holds its own in virtue of strength, strong claws and teeth, keen senses, alert wits, roving habits, versatility of diet and hunting-grounds, resourcefulness when hard pressed, ability to lie for a long time hidden under a bank, and careful education of the young.

succeeds in virtue of a nimble brain, very keen senses, highly developed muscularity without any "spare flesh," and solicitous maternal care; but it would be unscientific to overlook its extraordinary courage. It will face up to a terrier, even to a man. It will leap up and catch a partridge already on the wing. "A pair will stand affectionately and nobly by each other in danger, and a weasel mother will defend her young to the last gasp." A weasel will explore a house and defy the house-cat; it will bluff a

and many more. The chief advantage is in the strength that numbers give against an enemy. The members of the vegetarian herd trample the carnivore to death. A small monkey attacked by an eagle has no chance, but his cries bring a crowd of comrades to his aid, and they may tear the bird of prey to pieces. Moreover, when there is a herd, there is the possibility of having sentinels or outposts, which warn the main body when danger draws near. The Rabbit knocks loudly on the ground with

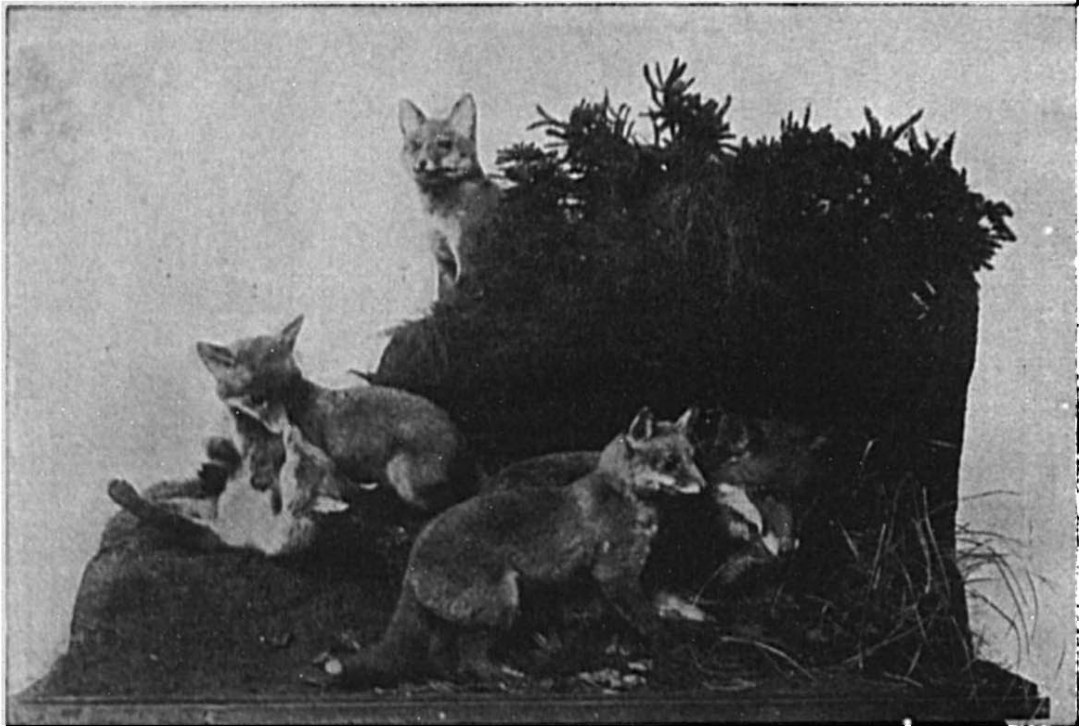


Photo: From Royal Scottish Museum.

VIXEN AND HER PLAYFUL CUBS.

The Fox (*Canis vulpes*) is the only wild member of the Dog tribe of Carnivores now left in Britain. There is considerable variation in size and colour in different parts of the country. Foxes associate in pairs, and the four to seven cubs remain for a considerable time under the care and tuition of the vixen. The young ones are very playful and enterprising. Foxes make "earth" or burrows in hills and woodsides, and most of the day is spent in hiding. They come out at dusk and hunt for small mammals and birds, and a variety of creatures of lower degree—down to shellfish on the shore.

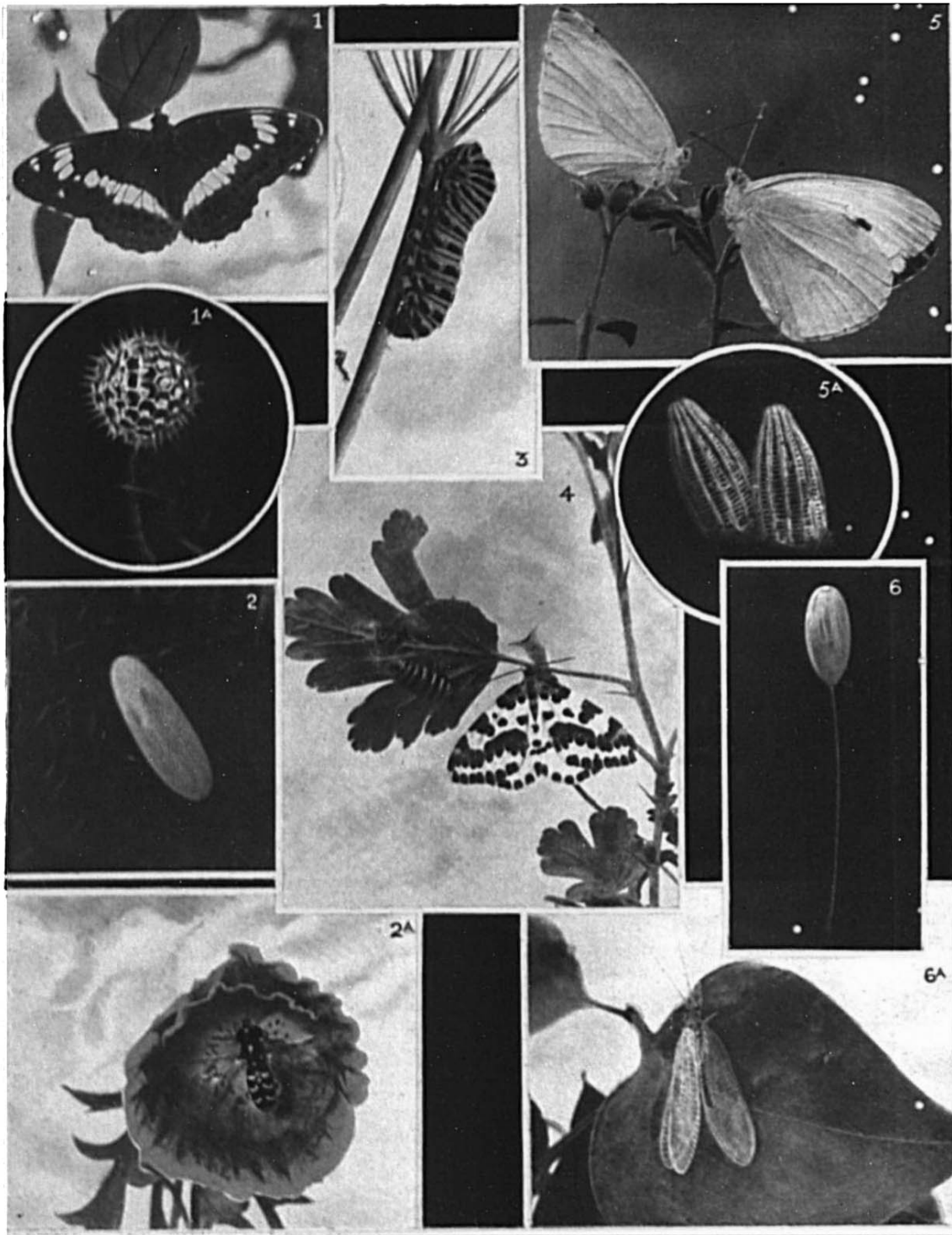
lot of roosting hens that could have pecked it to pieces; whining and daring, snarling and bristling, it will retrieve its young ones from under the feet of man.

§ 16

Many mammals are gregarious and some go a step further and illustrate some measure of communal or corporate life. It is difficult to draw any hard-and-fast line. Gregariousness is illustrated by cattle, deer, wild horses, rabbits, kangaroos,

Social Mammals.

its feet and the Marmot whistles "danger." Whenever there is division of labour there is a sounding of the social note. Thus when baboons are retreating the rear-guard is formed by the old males, and Brehm tells the fine story of the way in which they faced the dogs of his hunting party and kept them at bay while the females retreated. "But one little monkey about half a year old had been left behind. It shrieked loudly as the dogs rushed towards it, but succeeded in gaining the top of a rock before they had arrived. Our dogs placed themselves



Chrome-photos: J. J. Ward, F.F.S.

INSECT LIFE

1, White Admiral Butterfly (*Limenitis abylla*) and, 1A, its egg (magnified 25 diameters); 2A, Hover Fly (*Catabomba pyrastri*) on Poppy flower and, 2, its egg (magnified 30 diameters); 3, Full-fed larva of the Swallow-tail Butterfly (*Papilio machaon*); 4, the Magpie or Currant Moth (*Abraxas grossulariata*) just emerged from its pupa skin—shown on the leaf; 5, Large White Butterflies (*Pieris brassicae*) leaf-making, and 5A, eggs of the Large White Butterfly (magnified 25 diameters), which are deposited on plants of the cabbage family; 6A, the Lacewing Fly (*Chrysopa vulgaris*) and 6, one of its stalked eggs (magnified 3 diameters).

cleverly, so as to cut off its retreat, and we hoped that we might be able to catch it. But that was not to be. Proudly and with dignity, without hurrying in the least, or paying any heed to us, an old male stepped down from the security of the rocks towards the hard-pressed little one, walked towards the dogs without betraying the slightest fear, held them in check with glances, gestures, and quite intelligible sounds, slowly climbed the rock, picked up the baby-monkey, and retreated with it, before we could reach the spot, and without the visibly disconcerted dogs making the slightest attempt to prevent him. While the patriarch of the troop performed this brave and self-sacrificing deed, the other members, densely crowded on the cliff, uttered sounds which I had never before heard from baboons. Old and young, males and females, roared, screeched, snarled, and bellowed all together, so that one would have thought they were struggling with leopards or other dangerous beasts. I learned later that

this was the baboons' battle-cry; it was intended obviously to intimidate us and the dogs, possibly also to encourage the brave old giant, who was running into such evident danger before their eyes."

The Beaver is an aquatic mammal of a very different type, suited for rivers traversing wooded country. • It is a thick-furred, plump creature, about 2½ feet long, with a flat, trowel-like scaly tail. • It swims well with its webbed hind-feet and broad tail; it can remain about two minutes under water; it feeds mainly on bark. Its simplest home is a burrow with an entrance under water, but above the burrow there may be a surface pile of sticks, and from this rough-and-ready shelter there are gradations leading to a well-formed "beaver lodge" of sticks and grass, moss and mud. This includes a comfortable central chamber, with a "wood entrance" and a "beaver entrance." But the architecture varies with individuals and with the severity of

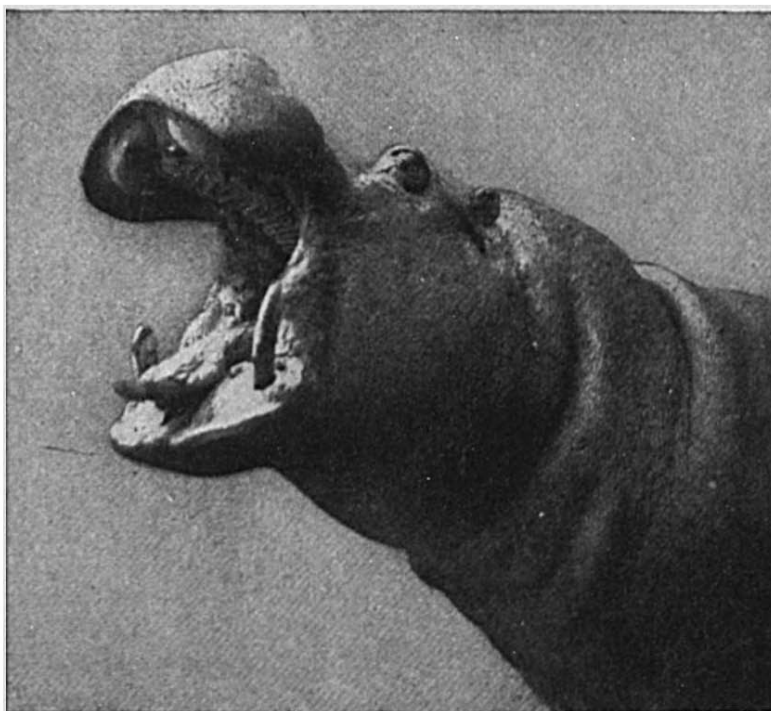


Photo: W. S. Herridge.

HIPPOPOTAMUS.

The Common Hippopotamus (*H. amphibius*) of Africa is one of the modern giants (4 tons in weight, 14 feet long), but there is a dwarf species in Liberia. Their nearest relatives are the Pigs. The huge creature can swim with efficiency, and occasionally "puts out to sea"; it can also walk along the bed of the river, remaining immersed for ten minutes. It is vegetarian. The body is almost hairless. The nostrils are situated high up, as is suitable in an aquatic creature. There is a strange bloody sweat. The hippopotamus is the Behemoth of the Book of Job—"the chief of the ways of God."

the conditions of life. With more leisure, there is more art.

Beavers can cut down trees 10 inches in diameter; they use their chisel-edged incisor teeth, covered in front with orange-coloured enamel, to split off flakes of wood all round the base of the stem, but more towards the side nearer the water. The wind then brings the tree down, and the beaver's object is attained, namely, getting at the more palatable wood on the younger branches. These are cut into suitable lengths and stored in or near the lodge. The barked pieces may be added to the building. There is no doubt that beavers make dams of brushwood, stones, and mud, thereby securing a larger area for their wood-cutting and easier conditions of transport. It is likely enough that some of the dams were started naturally by floods which carried lodges and stores away and deposited them in shallow water; indeed, we can see the beginning of such a dam in many a river in wooded country. But the point is that the beavers strengthen, elaborate, and regulate what the river itself may have begun.

Even more remarkable is the digging of canals, by which the transport of the cut branches is made easier. They may be hundreds of feet long, and they are often about a yard broad and deep. They usually communicate between clumps of trees and the pond above the dam, but they may form a short cut between two loops of the river, or they may go right through an island. In the last case the work would not be justified until there was an open waterway from end to end. In some other cases a moist roadway between the pond and a pool in the wood might be gradually converted into a canal. Instances of "locks" have been recorded, but there is a tendency to forget that animals are more likely to take advantage of what exists or is hinted at in Nature than to discover new ideas or principles!

Beavers are notably gregarious, for there may be many lodges near a suitable wood. When there is overcrowding a migration occurs, the old houses being left to related new couples. Isolated males are often found, and some naturalists say that these have been expelled from the community for laziness or misbehaviour. There are no beavers left in Britain, but they flourish in Russia, in Siberia, and in Canada and

other parts of North America. It is interesting to notice that in many places from which beavers have been gone for centuries, evidences of their work remain as "beaver-meadows" and the like.

Prince Kropotkin did a notable service in his book *Mutual Aid, a Factor in Evolution* (1904).

for he showed in a scholarly way the frequency of gregariousness, combination, co-operation, and sociality among animals. One answer-back that pays in the struggle for existence is to sharpen teeth and claws, i.e. to intensify competition; but another successful answer-back is to practise mutual aid. Even the individualistic carnivores may form packs as in the case of wolves and jackals; but there is more elaboration among the grazing herds. All kinds of beasts and birds of prey have proved powerless against the colonies of Russian sousliks. Combination gives strength to the sociable musk-rats of North America and to the prairie-dogs. "As far as the eye can embrace the prairie, it sees heaps of earth, and on each of them a prairie-dog stands, engaged in a lively conversation with its neighbours by means of short barkings. As soon as the approach of man is signalled, all plunge in a moment into their dwellings; all have disappeared as by enchantment. But if the danger is over, the little creatures soon reappear. Whole families come out of their galleries and indulge in play. The young ones scratch one another, they worry one another, and display their gracefulness while standing upright, and in the meantime the old ones keep watch. They go calling on one another, and the beaten footpaths which connect all their heaps testify to the frequency of their visits." As Darwin said, "the individuals which took the greatest pleasure in society would best escape various dangers; while those that cared least for their comrades and lived solitary, would perish in greater numbers." In short, the line of mutual aid is a trend of evolution, which has borne its finest fruits in mankind.

§ 17

We see the March hares racing over the ploughed field, and the sloths creeping cautiously along the under side of the branches. The porpoises gambol in the sea, and the bats with erratic flight hawk insects in the air. The mole works its

Variety
among
Mammals.

way for the most part underground, and the squirrel leaps adventurously from tree to tree. Whales are mammals of the open sea, and sometimes descend to great depths; monkeys are largely arboreal; antelopes are suited for the plains and the hippopotamus for the rivers. Wild cattle are gregarious, beavers are social, the sea-lion has his harem, the polar bear is solitary. We watch seals resting among the shore rocks, and bats hanging upside down from the rafters. In the winter the wolves join in packs, the stoat turns into the white ermine, the hedgehog sinks into hibernation. There are herbivores, insectivores, carnivores, specialists like the ant-eaters and the fish-eating seals, and others with a catholicity of appetite like badger and otter. A harvest-mouse only weighs about a halfpenny, an elephant's tusk may weigh 188 pounds. The Pigmy Shrew has a body under 2 inches in length, a whale may attain to 60 feet. A common shrew seems often to die in the year of its birth; an elephant may be more than a centenarian. But we need not go further; it is plain that there is extraordinary variety among mammals. This raises the question, what have they all in common?

Mammals are quadrupeds, except that the whales and sea-cows have lost all but vestiges of the hind-limbs, and perhaps another saving clause should be inserted for kangaroos, jerboas, and higher apes, which are more or less bipeds. In most mammals there is a distinct neck and a distinct tail, but the neck is practically obliterated in whales, and the tail is often much reduced (as in bear and rabbit) or practically absent (as in the higher apes).

Hairs are never entirely absent, for even in whales they are present in early stages of life and some, very richly innervated, often persist on the lips. The mammalian skin shows sweat-glands which get rid of surplus water and some waste-products, sebaceous glands which keep the fur sleek (absent in whales), and milk-glands which are normally functional in the females only.

In mammals only is there developed a midriff or diaphragm—a muscular sheet separating the chest cavity (containing heart and lungs)

from the abdominal cavity (containing the stomach and other viscera). This midriff falls and rises in the breathing movements, and is of great importance in increasing and then decreasing the chest cavity, and thus helping the entrance and exit of air from the lungs.

Mammals have many skeletal peculiarities which separate them off from all other back-boned animals. The vertebræ (backbone-bodies) and the long bones have terminal caps which ossify apart from the main part of the



Photo: Douglas English.

HARVEST-MOUSE ON THISTLE.

The Harvest-Mouse (*Mus minutus*) is, next to the Pigmy Shrew, the smallest of British mammals, weighing only about one-fifth of an ounce. It can run up a stem of wheat, and in its descent it uses its tail in a monkeyish fashion. A nest of coarse grass, with a side entrance, is built between three or four stalks of corn, and there live to nine young ones are born—blind and helpless, but developing rapidly.

bone; the surfaces of the vertebræ are usually flat or gently rounded; with four exceptions there are seven neck vertebræ—whether it be in the long straight neck of the giraffe or the compressed inconspicuous neck of the whale; the lower jaw is one bone on each side and works on a bone of the skull called the squamosal; the skull moves by two knobs (or condyles) on the first vertebra, whereas birds and reptiles have only one condyle; the drum of the ear is connected with the internal organ.

of hearing by a beautiful chain of three small bones—the hammer, the anvil, and the stirrup—by which the vibrations are conveyed inwards; there is a complete bony palate separating the mouth-cavity from the nasal passage above; almost without exception there are two sets of teeth in sockets; except in the oviparous mammals the bone of the shoulder-girdle called the coracoid, which is very strongly developed in flying birds and in reptiles, is represented merely by a small process of the shoulder-blade or scapula.

The cerebral hemispheres of the fore-brain are much more developed than in other vertebrates, and their surface is very generally covered with convolutions (see figure on p. 112). The heart is four-chambered; the temperature of the blood remains in most cases practically constant; the red blood-cells are circular discs (except in camels, where they are elliptical in outline as in other Vertebrates), and the nucleus of the mammalian red blood corpuscle disappears as the corpuscle develops; the lungs lie freely in the chest cavity (they are fixed in birds), and inspiration is the active process (the opposite in birds); the vocal cords are at the top of the windpipe (at the foot in birds); the egg-cells are very small except in the egg-laying forms, and, with the same exception, the young are born viviparously, i.e. as living well-formed young ones, which are for a while nourished on milk. This enumeration of salient characters is indispensable if we are to understand how this class of Mammals stands apart from the other great classes of backboned animals, namely, Birds, Reptiles, Amphibians, and Fishes. Aristotle knew that a whale is not a fish; unless we understand the general features of mammals we will not appreciate his insight.

The dominantly successful orders of present-day mammals are (1) the Carnivores (cats, dogs, bears, seals, etc.); (2) the hooped Ungulates

(horses, tapirs, rhinoceros, cattle, pigs, hippopotamus, camels, perhaps also including the elephants); and (3) the monkeys and

Orders of Mammals.

apes or Primates. These represent three great lines of evolution. On the Carnivore line the premium is on teeth and claws, quick senses and alert movements. On the Ungulate line the premium is on swiftness, on the power of covering long distances in search of herbage, and on such weapons as horns and hoofs, rendered more effective still when their possessors are gregarious. On the Primate line the premium is on the power of climbing, the emancipated hand, and the restless brain. Below the level of true Primates are the Lemurs, or half-monkeys—ghost-like nocturnal creatures, mostly confined to the forests of Africa and Madagascar.

Not very far off the Carnivore line of evolution, but much more primitive, is that of the Insectivores (e.g. moles, hedgehogs, and shrews); and the Bats with their power of flight must be regarded as the specialised descendants of arboreal Insectivora.

Balancing the Insectivores there is the somewhat humble order of Rodents, on a quite different evolutionary tack, the rats and mice, squirrels and porcupines, rabbits and hares. The toothed Whales and baleen Whales are mammals that have taken secondarily to marine life, and are as specialised for swimming and diving as bats are for flight. And besides these well-known orders, there are the sea-cows or Sirenians (including nowadays two genera only, the dugong and the manatee), the old-fashioned Edentates (sloths and armadillos, ant-eaters and pangolins), perhaps to some extent survivors of the archaic mammals. But more primitive in their affinities than all these are the Marsupials (mostly confined to Australia); and lowest of all are the egg-laying Monotremes, also Australasian.

BIBLIOGRAPHY

- FLOWER AND LYDEKKER, *Mammals, Living and Extinct* (1891).
 BEDDARD, *Mammals*, vol. x. of *Cambridge Natural History* (1902).
 LANKESTER, *Extinct Animals* (1909).
 LYDEKKER, *British Mammals* (1896).
 JOHNSTON, *British Mammals* (1903).
 HUTCHINSON, *Extinct Monsters* (1893).
 INGERSOLL, *The Life of Mammals*.
 NELSON, *Wild Animals of North America*.