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ZOOLOGY

A BOOK FOR INDIAN STUDENTS

BY

REV. I. PFLEIDERER,

Manager of Christian High School, Udipi,

Author of "Glimpses into the Life of Indian Plants".



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PREFACE

THE author of this book is deeply interested in Indian teachers and students, hence anxious for their welfare and progress. In order to guide them in their studies he has, with much zeal and toil, written this book.

Those who have read "Glimpses into the Life of Indian Plants" know something of MR. PFLEIDERER'S enthusiasm for botany and kindred sciences, and will welcome, with gratitude, this new work. Students will never know how much it cost the author in this further endeavour to assist them. Doubtless, all will be grieved to learn that ill-health prevented him from reading the proofs and writing this preface.

When Mr. Pfleiderer asked me to read his manuscript, and later, to read the proofs, I could not deny him this little service. Readers, who may find errors in these pages, will be lenient, when they know that the author was not able to watch over them, as they passed through the press. When a second edition is called for, it is to be hoped that it will be possible for him to attend to it.

HASSAN, MYSORE STATE,
December 1915.

A. Brockbank.

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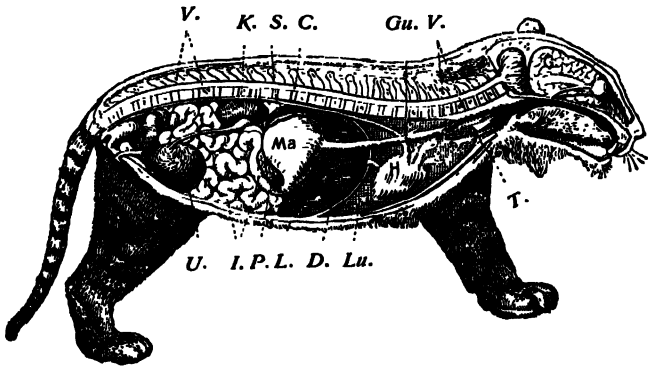
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First Division—Vertebrates (*Vertébrata*).

1. PLAN OF STRUCTURE.—The body of the vertebrate animals can be divided by one section into two similar halves which correspond with each other in the same way as an object and its reflection in a mirror: The vertebrates are **laterally symmetrical animals**.



Longitudinal section through the body of a vertebrate animal.

C. Spinal cord. D. Diaphragm. Gu. Gullet. G. Brain. H. Heart. I. Intestine. K. Kidney. L. Liver. Lu. Lungs. Ma. Stomach. P. Pancreas. S. Spleen. T. Trachea. U. Urinary bladder. V. Vertebral column.

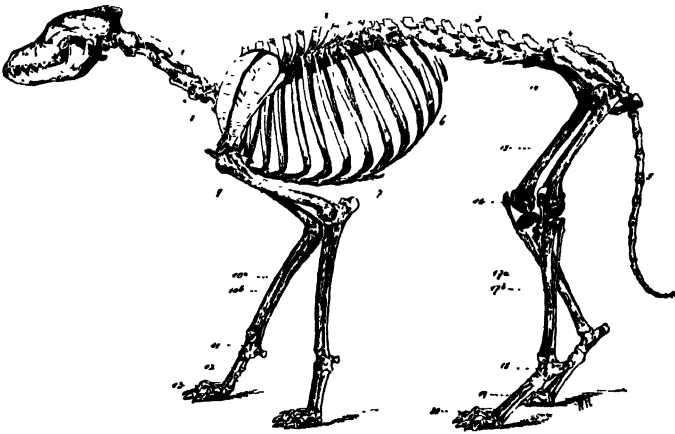
The two halves balanced against each other are found to be of equal weight. Animals would be impeded as well as awkward in their movements, if the body-halves did not exactly balance each other.

Conspicuous is the **cylindrical** body of the vertebrates. We know that the air and the water are cleft easiest by a cylindrical body. To the vertebrates, therefore, a body of this shape is of the greatest advantage.

2. SEGMENTS OF BODY.—The body of each vertebrate animal consists of **head, trunk, and limbs**. The first two parts

are usually connected by a neck, which represents a movable stalk and support for the head. As a rule, there are four limbs: in some cases there are only two, in others even no limbs.

3. SKELETON --The body of a water-living animal is on all sides supported by the water and, therefore, may be soft and weak. Most of the vertebrate animals live on land or in the air: hence their bodies require a greater amount of solidity, which is attained by an inner **bony**, or **cartilaginous**, **framework**, namely the **skeleton**.



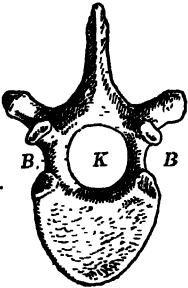
The skeleton of a dog.

1. Cervical, 2. Dorsal, 3. Lumbar, 4. Sacral, 5. Caudal Vertebrae. 6. Ribs.
7. Sternum. 8. Scapula. 9. Upper arm bone. 10. Lower arm bones (*a.* Radius,
b. Ulna). 11. Carpals. 12. Metacarpals. 13. Fingers. 14. Pelvis. 15. Upper
thigh bone. 16. Knee-cap. 17. Lower thigh bones (*a.* Tibia, *b.* Fibula).
18. Tarsals. 19. Metatarsals. 20. Toes.

But the skeleton is usually not composed of one rigid mass. Such a structure would hinder the animals from moving about freely. So it consists of numerous parts, the **bones**, being made to move in the **joints**.

The chief support of the body is formed by the **backbone**, traversing through the whole length of the trunk. The backbone is composed of numerous bones which are called **vertebrae**, and these fit into each other so as to form a chain, or column of bones. By means of this chain of bones men and animals can turn, move, or bend their backs and necks freely (*vertebra*

from Latin *verto* = I turn). Animals possessing such a backbone are therefore called vertebrates.



A vertebral bone seen from above.

B. Arches. K. Hole.

Each vertebra consists of a solid body from which two arches extend dorsally which coalesce and form a ring. The holes of all vertebræ are related to each other, so as to form one continuous tube or canal, which encloses the spinal marrow or cord. On the ventral side of the vertebral column the organs of respiration, circulation and digestion are placed. In many vertebrate animals long bones called **ribs** are connected with the vertebræ of the trunk. They act as a supporting framework for the walls of the cavities in which the internal organs (heart, lungs, intestines, etc.) are situated. Several ribs are connected with a flat bone in front, the **breastbone**, or sternum.

The upper part of the spinal canal opens out into the great cavity of the **skull** which holds the brain. The bones encasing the brain are called cranial bones. The other bones of the skull are the facial bones.

The **limbs** are connected with the vertebral column by special bones,—the fore-limbs by the **shoulder-girdle**, and the hind-limbs by the **pelvis**.

4. **MUSCLES**.—The 'flesh' of the animals consists of numerous smaller or larger bands of **muscles**. These muscles terminate in strong cords,—the tendons,—which are attached to the bones.

The muscles have the power of contracting, *i. e.* of changing into less bulk. Now, if a muscle which is connected with a bone, is shortened, it necessarily follows that the bone also must move. In this way all **movements** of the animals are brought about.



Muscles of the human arm.

5. **NERVOUS SYSTEM**.—The chief parts of the nervous system are the **brain** and the **spinal cord**. From both there pass out

numerous **nerves** which like the branches of a tree spread in finer and finer ramifications over the whole body. Certain nerves (motor nerves) cause the muscles to contract, whereas others (sensory nerves) transmit impressions received from without. The latter are at their exterior ends connected with the **organs of sense** (eye, ear, nose, tongue, and skin).

6. RESPIRATION.—No animal can continue to live, if its respiration is interrupted for any considerable time. When we examine the air breathed out from our lungs, we find that it contains more carbon dioxide and less oxygen than the air we breathe in. So we conclude that respiration consists in the **absorption of oxygen** by the body and in the **discharge of carbon dioxide** from the body. The exchange of the two gases is effected either by **lungs** or by **gills**, according to the way the animal derives the air either direct from the atmosphere or from air dissolved in water.

7. CIRCULATION.—The **blood** carries the oxygen gas taken up by the lungs into all parts of the body. There it unites chemically with the particles of the muscles, nerves, etc. We know that when wood or oil burns, carbonic acid gas is the result of the union of carbon and oxygen, and heat is always produced by this chemical action. The same process takes place in the living body. This is the **physical heat** of animals.

The poisonous carbon dioxide gas must be removed from the body. This is done by the lungs or gills to which the gas is carried by the blood. For this purpose the blood is constantly conducted through the whole body in countless canals which run side by side and are called blood-vessels or veins. The centre of this vascular system from which the blood is driven into all parts of the body, as from a force-pump, and to which the blood again returns, is a hollow muscle, called the **heart**, which expands and contracts in regular intervals. The vessels that conduct the blood away into the several parts of the body are called **arteries**, but those which convey the blood back to the heart are called **veins**. Between the fine terminations of the arteries and the smallest veins are the **capillaries**, which maintain an unbroken connection between the arteries and the veins.

The particles of the body which by combustion eventually perish, must be replaced again. This also is effected by the blood, which obtains new material from the organs of digestion.

8. DIGESTION.—The food is seized and generally divided and masticated also by the **jaws** and **teeth**. Thence it is conveyed through the **gullet** into the **stomach**. From this it passes into the **intestine** which terminates at the **anus**.

The absorbed food is on its way through the body mixed with various liquids, which are secreted by the **salivary glands** (saliva), the **stomach** (gastric juice), the **liver** (bile), and the **pancreas** (pancreatic juice). By these juices the food is converted into such a form that it can be absorbed by the walls of the intestine. There it passes into vessels (blood- and lymphatic vessels) which conduct it to the blood. The undigested food is thrown out in the form of excreta or fæces.

9. ORGANS OF EXCRETION.—As after the combustion of wood ashes remain, similarly oxidation in living bodies leaves a residue which is not only useless, but also harmful to the body and therefore must be expelled or excreted. We have already become acquainted with one of these substances, the carbon dioxide gas which is separated from the body by the **lungs**. Other waste products are excreted by the **kidneys** as urine, and by the **skin** as sweat.

10. The **skin** of the vertebrates consists of two layers, the **epidermis** and the **derma**.

11. SYNOPSIS OF THE VERTEBRATES.

| Classes | Examples |
|-----------------|------------------------------------|
| I. Mammals | Cat, Horse, Whale. |
| II. Birds | Eagle, Fowl, Duck. |
| III. Reptiles | Gecko, Cobra, Crocodile, Tortoise. |
| IV. Batrachians | Frog, Toad, Newt. |
| V. Fishes | Shark, Sardine, Flat Fish. |

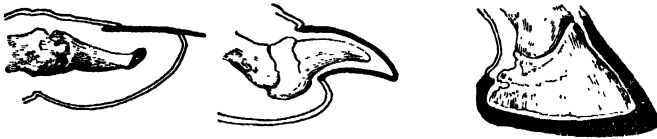
First Class: MAMMALS

(*Mammalia*).

1. **PHYSICAL HEAT.**--As in man so also in mammals the action of the nerves, muscles, etc., goes on well only at a certain temperature of the heat of the body. If the heat of the blood rises high (fever) or sinks considerably below the normal temperature, the animal will die.

2. **BODY-COVERING.**—Such being the case, animals require a covering, preventing an excessive diffusion of the body-heat into the external medium. This covering is generally provided in the form of a **coating of hair**.

The terminal joints of the fingers and toes are protected by peculiar horny tissues. If they lie on the upper surface of



1. Nail of man. 2. Claw of cat. 3. Hoof of horse.

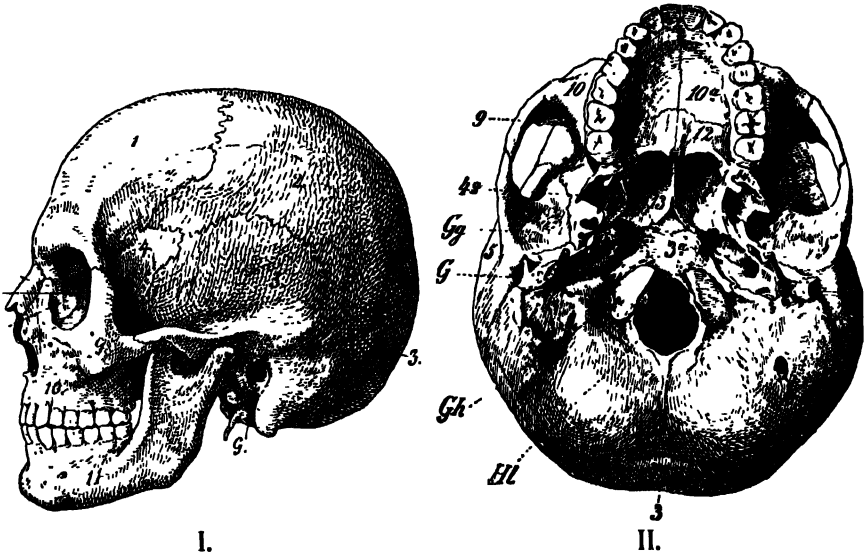
the joint as flat and broad shields, they are termed **nails** (man, monkey); when they are arched, pointed, and laterally compressed, they are called **claws** (beasts of prey); and when they encase the last joint like a shoe, they are called **hoofs** (horse, cattle).

3. **SKELETON**—The skeleton of the mammals differs from that of other vertebrates in the following points:—

a) The **skull** is the same as that of man which is illustrated on the following page. There are two protuberances in the occipital bone which fit into two cup-like surfaces of the first vertebra, called the atlas. The latter turns round a peg on the second vertebra, called the axis. By this means the head can be moved from side to side.

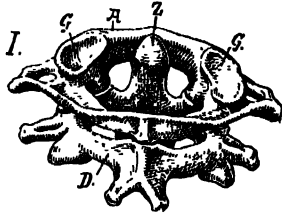
The **upper jaws** are firmly united with the bones of the skull. They are connected by the **intermaxillary bone** in which

the upper cutting teeth are inserted. The lower jaws are connected with the skull by joints.



Human skull - I. seen from the side, II. seen from below.

1. Frontal. 2. Parietal. 3. and 3a. Occipital with the articular processes (*Gh*) and the great foramen (*Hl*) for the spinal cord. 4 and 4a. Sphenoid. 5. Temporal with the articular cavity (*Gg*) of the lower jaw. 6. Nasal. 7. Lachrymal. 8. Ethmoid. 9. Malar. 10 and 10a. Upper jaw. 11. Lower jaw. 12. Palate. 13. Ploughshare bone.



The two first cervical vertebrae of the skeleton of a mammal.

- A. Atlas with its articular cavities (*G*). D. Axis with its peg (*Z*).

b) The **spinal column** is divided into cervical (*neck*), dorsal, lumbar, sacral and coccygeal vertebrae. Only the dorsal vertebrae carry ribs.

c) The **shoulder-girdle** consists of a shoulder-blade, on each side. Animals with specially active fore-limbs possess collar bones in addition. These not only strengthen the shoulder joint, but also serve as protecting arches over the blood-vessels.

d) The bones of the **pelvis** are all joined together to a firm structure.

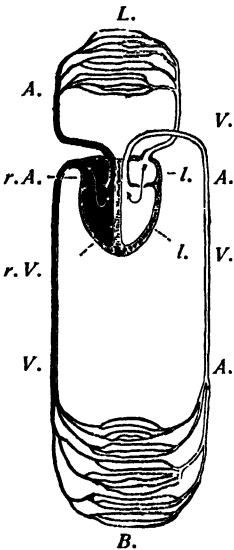
e) The **limbs** are differently formed according to the manner in which the animals move. But they always consist of the following parts:—

The fore-limbs of the upper arm bone, the forearm (made up of ulna and radius), and the hand (with the carpal bones, the metacarpal bones, and the finger bones).

The hind-limbs of the thigh-bone, the tibia and fibula forming the leg proper, and the foot with the tarsal, metatarsal and toe-bones. The knee-joint is protected by the knee-cap.

4. Most mammals possess **TEETH** in both jaws. These are fixed in special **sockets** in the jaws. The exposed visible part of the tooth is called the **crown**, the part buried in the jaw, **root**.

Each tooth consists of the bone-like **dentine**. The crown is mostly covered with **enamel**, a very hard, white substance, which frequently penetrates into the dentine in the form of folds. The interior of the tooth contains a cavity with nerves and blood-vessels.



Circulation of the blood in mammals.

r. A. and l. A. Right and left auricle. r. V. and l. V. Right and left ventricle. A. arteries. V. Veins. L. Capillaries in the lungs. B. Capillaries in the body.

According to their various functions the teeth have various forms. They are cutting teeth or **incisors**, eye or **canine teeth**, and grinders or **molar teeth**.

5. **RESPIRATION** is always carried on by **lungs**, to which the air is conducted by the windpipe or **trachea**. The upper part of this tube is the vocal organ or the **larynx**. An important part in breathing is played by the **diaphragm**, a flat muscle separating the thoracic from the abdominal cavity.

6. The **HEART** is divided into two halves by a longitudinal partition. Each of those consists of two parts, an anterior (**auricle**) and a posterior (**ventricle**) chamber. The marginal diagram shows the way in which the blood circulates through the body, and how in mammals, (and birds), the arterial blood is completely separated from the venous blood.

7. The urine excreted by the **KIDNEYS** is conducted by two canals into the **urinary bladder**, which is periodically emptied.

8. **REPRODUCTION**.—With the exception of the duckbills all mammals bring forth living offspring. The helpless young

are fed with **milk** by the mother until they are able to feed themselves.

9. SYNOPSIS OF THE MAMMALS.

| Orders | Examples |
|------------------------|--|
| 1. Apes | Orang-Utan, Makaki, Hanumanta. |
| 2. Beasts of Prey | Cat, Hyæna, Dog, Marten, Bear. |
| 3. Bats | Nose-leaved Bat, Flying Fox. |
| 4. Insect-Eaters | Shrew, Hedgehog. |
| 5. Rodents | Squirrel, Beaver, Rat, Bandicoot, Hare. |
| 6. Proboscidiæ | Elephant. |
| 7. Even-Toed Ungulates | Non-Ruminants: Wild Boar. Ruminants: Zebu, Buffalo, Sambar, Giraffe, Dromedary. |
| 8. Odd-Toed Ungulates | Horse, Ass, Zebra, Rhinoceros. |
| 9. Whales | Fin Whale, Dolphin. |
| 10. Seals. | Common Seal, Walrus, Dugong. |
| 11. Toothless Mammals | Ant-Eater, Sloth, Armadillo. |
| 12. Pouched Mammals | Kangaroo. |

I. Order:—APES (*Pithéci*).

The Apes or Monkeys are provided with hands and prehensile hind-limbs; fingers and toes with flat nails, eyes directed forwards, face more or less devoid of hairs.

THE ORANG-UTAN (*Simia satyrus*).

A. ITS HOME AND NAME.—The Malay name “Orang-Utan” (*i. e.*, man of the woods) aptly designates this animal as a man-like inhabitant of the forests. Its home is in the aboriginal forests of Sumatra and Borneo.

B. APPEARANCE.—Young animals look very much like men; the older ones, however, have a very ugly appearance; the jaws are very prominent, almost like a snout; the nose is flattened; over the small eyes are large round callosities, and a huge pouch hangs from the short neck. The males possess ordinarily a red beard and broad cheek callosities.

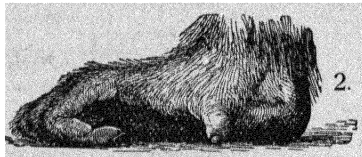
C. HAIRY COVERING.—The body is covered with long shaggy hair. The only hairless parts are the face, its small almost human ears, the huge neck-pouch, the hands and the feet. All these parts are of a bluish-black colour. Its posture being semi-erect the animal exposes its back, the shoulders and

the upper arms to the rain. These parts are clothed with long thick hair.

D. HABITATION AND BODILY STRUCTURE.—

The Orang-Utan dwells in the tops of the trees. It is a **truly arboreal animal**.

1. Its **hands** are very similar to those of a man. The thumb excepted, the fingers are very long. Consequently the animal is able to obtain a strong and sure grip of branches of even more than common thickness.



Hand (1) and foot (2) of the Orang-Utan.

2. The **feet** also are constructed on the plan of the hand, *i. e.* the large toe

is opposable to the other toes, just as the thumb is to the other fingers. The soles of the feet are not turned downwards as the sole of a man's foot, but obliquely inwards. The animal is thus enabled to grasp or embrace stems and lianas with great surety.

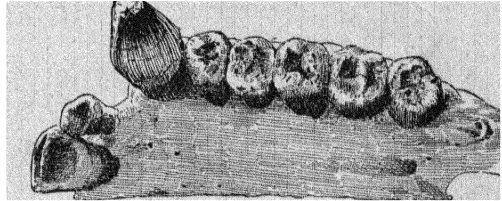
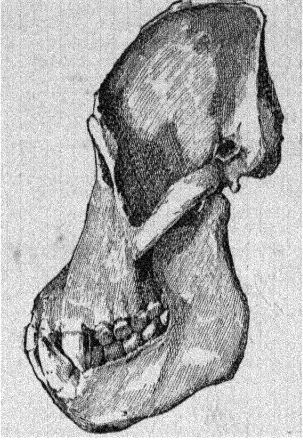
3. In climbing the Orang-Utan chiefly uses its **arms**, the great length of which enables it to move quickly and to jump across to neighbouring trees. It is also able to pluck leaves or fruits from branches which could not bear its weight.

4. Its **legs** are shorter and weaker than its arms. In walking the animal is obliged to support itself on its hands. In consequence of its hand-like feet and the inward direction of the soles of the feet, its movements on the ground are very awkward. It is, however, but rarely obliged to descend to the ground, for the trees provide it with its necessary food, while the rains which fall daily in its haunts supply it with the necessary amount of water.

5. The Orang-Utan does not pick up food with its mouth like the cow, but uses its hand and feet to seize the food and convey it to the mouth. Hence the **neck** is short.

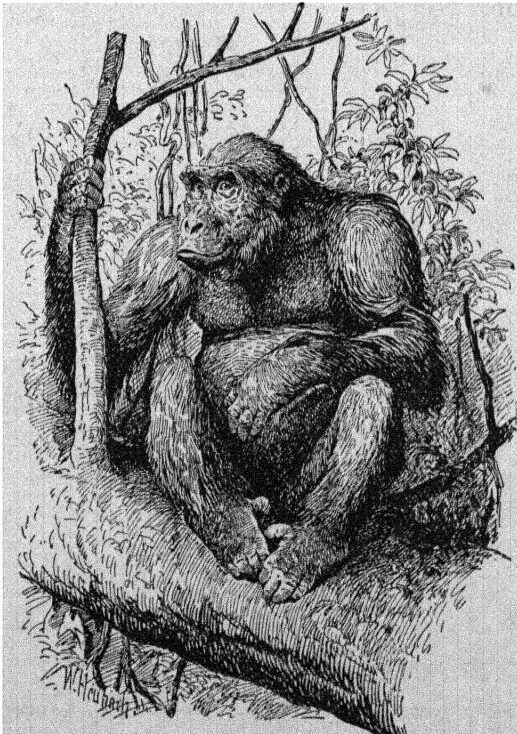
E. FOOD AND STRUCTURE OF DENTITION.—The food of the Orang-Utan consists of young leaves, juicy buds, and all sorts

of fruit. It does not reject birds' eggs and small birds. In captivity, like all other apes, it takes food prepared by human hands. Its dentition bears great resemblance to that of man, the incisors (four in either jaw) form, as it were, knives with which morsels are cut off, and the molars (five on each side of either jaw) possess broad crowns which are neither as pointed as those



Skull and teeth of the Orang-Utan.

carnivorous nor as blunt as those of herbivorous animals. The canines represent formidable daggers.

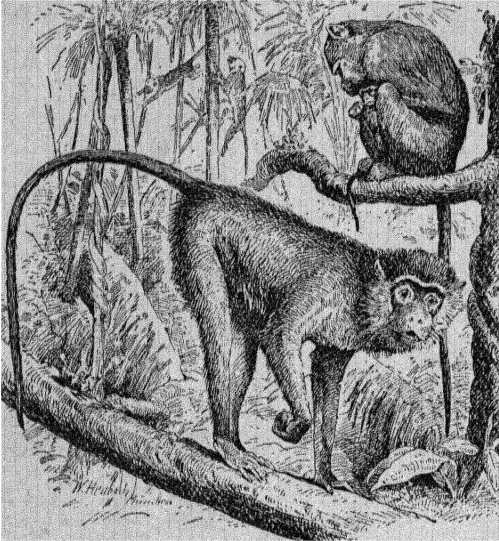


Gorilla, old male.

F. ENEMIES AND FAMILY-LIFE. — The Orang-Utan need not be afraid of any other animal. Possessed of such great muscular strength and such savage teeth it can easily attack others.

Generally the Orang-Utan is met with singly, rarely in company with others. The female nurtures its young with the greatest tenderness, and defends it at the risk of its own life. The same kind of maternal love, often in an exaggerated form, we meet with in all the

monkey tribe. Every evening each member of the family builds a **nest** for itself out of branches and leaves in the fork of a tree, in which it passes the night.



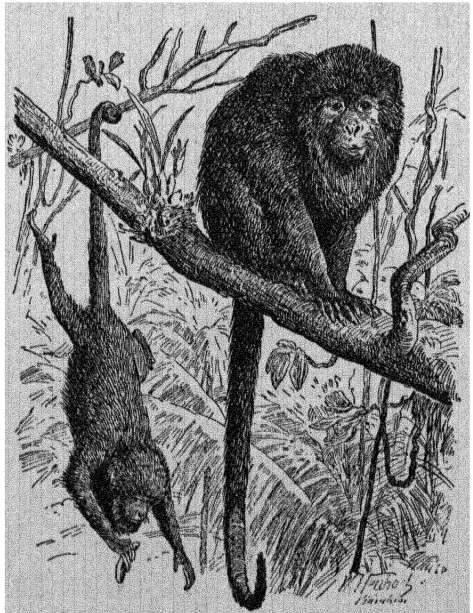
Long-tailed Monkey (*Cercopithecus*).

OTHER APES

The **Gorilla** (*Gorilla gina*) and the **Chimpanzee** (*Simia troglodytes*) resemble the Orang-Utan very much in structure and habits. Both live in the forests of West Africa. The Chimpanzee is a little smaller than man, whereas the Gorilla surpasses him in height and strength. The ugly and malicious **Baboons** (*Cy-*

nocéphalus) are terrestrial animals. By reason of their short and

powerful limbs they are nimble mountaineers. The **Mandril** (*C. Mormon*) whose home is in Guinea, with its yellow beard, blue cheek callosities, red anal callosities and red nose, is the impersonation of repulsive ugliness. The **Howling Monkeys** (*Mycetes*) are inhabitants of the forests of Brazil. Their long and muscular tail is a prehensile organ serving, in fact, as a one-fingered hand! Morning and evening they hold riotous concerts in the forests.



Howling Monkeys.

The commonest monkeys of India are the long-tailed **Makaki** (*Macacus sinicus*), and the black-faced **Hanumanta** (*Semnopithecus entellus*) renowned in Indian legend for having aided Rama in his expedition to Ceylon in pursuit of Ravana, the ravisher of Sita.

II. Order:—BEASTS OF PREY (*Carnivora*).

The beasts of prey feed principally on flesh. They possess strong canine and more or less sharp cutting molar teeth. The limbs are provided with four or five toes, invariably ending in claws.

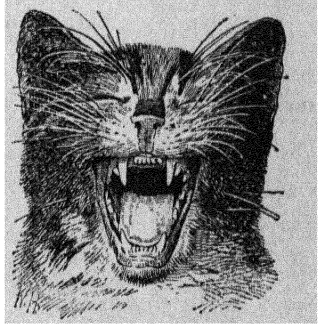
FIRST FAMILY: CATS (*Félidæ*).

THE DOMESTIC CAT (*Félis domestica*).

We keep the cat in order that it may clear house and court of mice and rats. It carries on the pursuit of these chiefly at night.

A. HOW THE CAT BECOMES AWARE OF ITS PREY.

1. Snugly rolled up the cat lies asleep in the kitchen near the fire. Suddenly it rises, creeps towards the open door of the adjoining storeroom, and, before even a few minutes have passed, holds a mouse struggling within its paws. This shows that it is possessed of an uncommonly fine **sense of hearing**, as is further indicated by the movable muscles of the ear.



Head of Cat
with opened mouth.

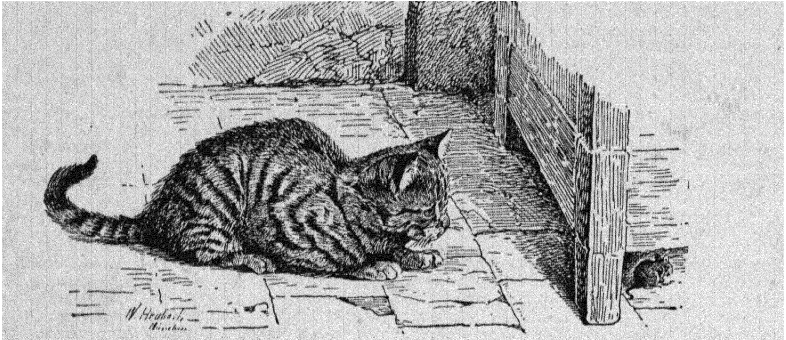
2. The **eyes**, too, are sharp-sighted. As it gets darker and darker, and fewer and fewer rays of light enter the eye, the pupil correspondingly dilates. Against brilliant light the pupil is contracted until it forms a narrow vertical slit.

3. On perfectly dark nights or in very dark places a cat can no more see than man. It is then guided by another sense, a fine **sense of touch**, which has its seat especially in the roots of the long hairs of the upper lip.

B. HOW THE CAT CAPTURES ITS PREY.

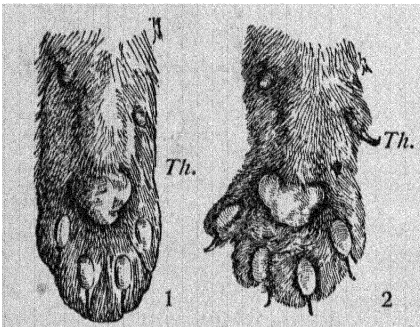
1. On perceiving its prey it glides close up to it. It

touches the ground only with the **toes**, of which there are five in the fore-feet and four in the hind-feet. There are soft pads beneath the toes which deaden the sound of the tread. Thus the cat can walk so **silently** that its approach is unobserved by its prey.



Domestic Cat catching mice.

2. On approaching the prey close enough it tries to seize it with a pounce. By first bending and then suddenly straightening the **legs** the body is projected. The greater portion of this work is done by the long and muscular hind-legs.



Fore-foot of the cat

with retracted (1) and protracted (2) claws. *Th.* Dwarfed thumb.

3. When the cat crouches down before leaping, it bends the **backbone**. As soon as it jumps away, the backbone is suddenly straightened. This peculiar movement adds to the force of the leap. The flexible and elastic body facilitates also climbing and enables it to creep through chinks or to fall on the feet even from a moderate height.

4. The long powerful **tail** serves as a rudder.

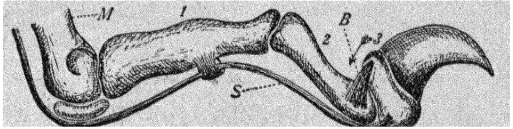
5. When the cat pounces down upon its prey to seize it, the velvet paws are suddenly turned into terrible weapons of attack, the toes are spread wide and the sickle-shaped **claws**, the points of which are sharp like needles, penetrate deeply into the body of the prey. If the claws are not used, they are drawn

up and concealed in a fold of the skin like a dagger in its sheath. They never touch the ground and hence do not become blunt.

• These pointed claws enable the cat also to climb trees and walls, and serve it as a much-dreaded weapon of defence against its enemies.

C. HOW THE CAT KILLS, TEARS AND EATS ITS PREY.

1. After seizing its prey the cat generally kills it with a few sharp bites, the long and pointed **canine teeth** entering the body like knives; and as the mouth is big and wide, the teeth can be driven deep into the flesh of the victim.

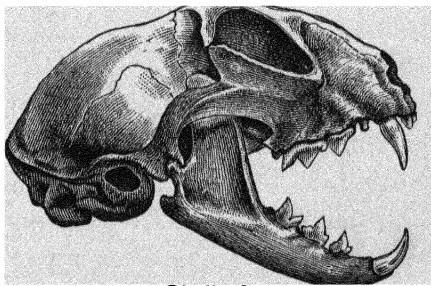


Toe of the foot of a cat, with claw retracted.

M. Metatarsal. *1, 2, 3.* Finger bones.

The claw can be protracted by the tension of the tendon (*S*); when the tension ceases, the elastic ligament (*B*) pulls the claw up again.

2. This done the cat carries the killed animal to a suitable place where it may consume its prey without being disturbed.



Skull of cat.

Now, the **molar teeth** are put into action, of which there are four on either side of the upper and three in the lower jaw. The first and the last in the upper jaw are, however, small and of little importance. All other molars have sharp-pointed dentate edges. This is specially the case with the third

tooth, the so-called **carnassial tooth**. In closing the mouth the upper carnassials glide closely along the outer surface of the lower ones, and in this way form the saw-like blades of two pairs of shears. By means of these the cat tears its prey into pieces and also easily crushes smaller bones. As the molars glide past each other they do not wear away but remain sharp and efficient.

3. A pair of scissors keeps good as long as the rivet is tight. The joints of the lower **jaw** represent such a tight rivet and, hence, are very firm. The jaws being short, the shape of the skull is roundish.

4. The small **incisors** (six each in the upper and lower jaw) are not used for biting off large pieces of flesh, but merely for gnawing the bones. The **tongue**, too, is of use for the same purpose, as it is provided with many sharp horny spines. The cat uses the tongue also for licking blood, milk and other liquids and for cleaning its soft fur.

5. The food of the cat being highly nutritive, the **intestine** is accordingly short. The young kittens are not able to eat flesh. They are suckled by their mother during the early weeks of their existence.

6. To succeed in the pursuit of its prey, the cat must not only be stronger than its victim, but must also excel it in **mental capacity**. Patiently it sits for hours in front of a mouse-hole. With great cunning it allows the mouse to slip out of its hiding place, and with accurate decision it chooses the right moment for springing on to its victim. It is, however, not free from bloodthirstiness and cruelty.

OTHER CATS

The **Lion** (*F. léo*) is a denizen of the greater part of Africa and of Southern and Western Asia. It is met with chiefly in the steppes; but it lives also in forests, in marshy swamps, and in the desert when it can get its food there. On account of its size (up to three feet at the shoulders), its noble form, its majestic bearing and its immense power, it has been named “the king of beasts”. The slender body is covered with short, light-yellow hairs. A darker-coloured mane overhangs the breast and shoulders of the male, like a royal mantle. When the sun has set, the lion rouses himself for his murderous activity. All kinds of cattle as well as antelopes, giraffes, and zebras are his prey. With a stroke of his strong paw he kills the victim and with one single bite he crushes its neck bones. With seemingly shy mien the “king of the desert” makes way for the “lord of the earth”. But after once discovering man’s physical weakness he prefers human flesh to any other food and becomes a “man-eater”.

The **Royal Tiger** (*F. tigris*) inhabits Southern and Eastern Asia. The red or yellow colour of its fur is tinted with black

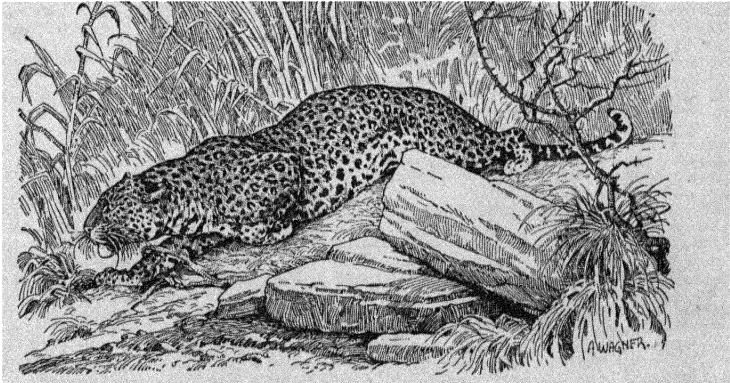
transverse stripes. It is not inferior to the lion either in size or strength, while in ferocity and fearlessness it surpasses the “king of beasts”.

The **Panther** (*Félis párdus*), which is widely distributed in India, has an ochre yellow skin with black spots. It is a formidable enemy to all mammals, and even to man.



The Royal Tiger.

The **Hunting Leopard** (*Cynælurus jubatus*) is generally known as Cheetah, but this name is quite as often applied to the panther also.

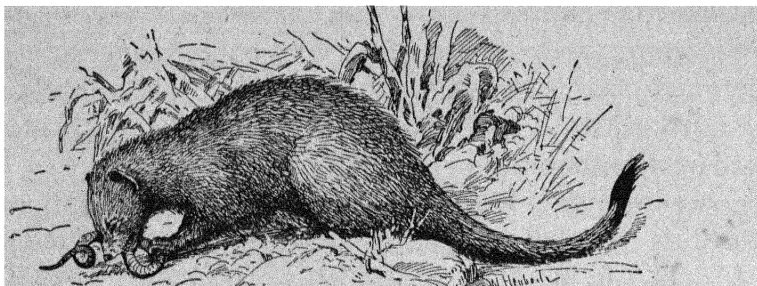


The Panther stalking the deer.

The two largest cats of the Western World are the **Jaguar** (*F. onca*) and the **Puma** (*F. cóncolor*). The fur of the former resembles that of the panther, whereas that of the puma is of uniform gray.

The **Toddy Cat** (*Paradoxúrus*), common in India, has a long tail and a dark fur (nocturnal habits!) and lives on small animals and also fruits. Not infrequently it comes into houses.

The **Mongoose** or Ichneumon (*Herpestes mungo*) is a near

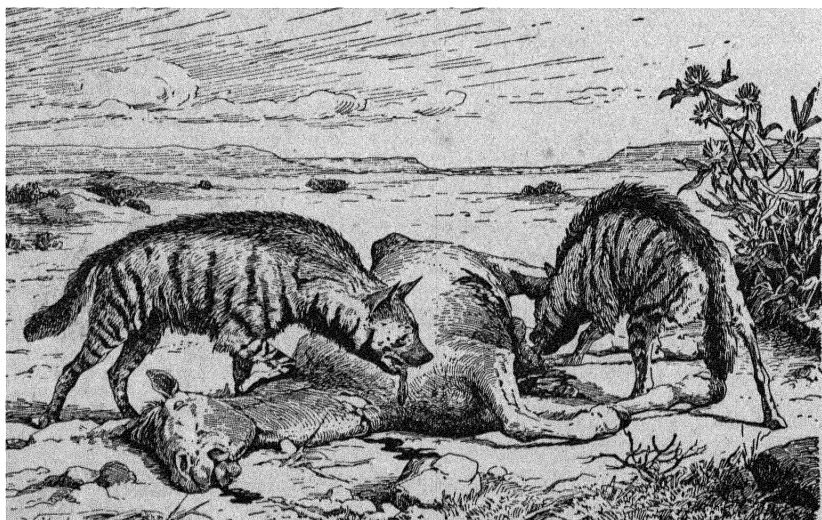


The Mongoose eating a snake.

ally of the cat family. It is often kept in our houses to rid them of vermin.

SECOND FAMILY: HYÆNAS (*Hyænidæ*).

The **striped Hyæna** (*Hyæna striata*), a denizen of Africa and Western Asia, is about the size of a large dog. The



Striped Hyænas feeding.

yellowish-gray skin is striped with black transverse lines. The nape of the neck and the sloping back are provided with a bristly mane. The front legs being considerably longer than

the hind legs, it cannot run rapidly or for any considerable time (like the dog), nor is it able to creep or leap (like cats), and consequently the hyæna can only seize upon animals that are sick or those which are unable to defend themselves, *i. e.* sheep, goats, etc. As a rule, it has to be content with carrion, which, by the help of its keen sense of smell, it can scent from a great distance.

The **Spotted Hyæna** (*H. corcúta*) the skin of which is dotted over with dark spots, is found in South and East Africa.

THIRD FAMILY: DOGS (*Cánidæ*).

THE DOMESTIC DOG (*Cánis familiaris*).

A. ORIGIN AND VARIETIES.—The domestic dog seems to be the descendant of various species of wolf and jackal. Ages ago man came to recognize the good qualities of these animals. He tamed some of them and invariably selected the fittest for



Common breeds of the Dog:

1. Pointer.
2. Bull-dog.
3. Crooked-legged Terrier.
4. Pug.
5. Russian Grayhound.
6. Bernardine.
7. Lap-dog.
8. Pomeranian.
9. Poodle.
10. Sheep-dog.

his purposes. Thus when man required a helper for hunting, he would take with him the dog which had the finest sense of smell, or was the best runner, and so on. From the descendants

of this animal he again selected the fittest, and so, by degrees, the pointer was developed. This constant selection of the fittest, perhaps, explains the development of all our various breeds of dogs. The same method is still employed at the present day to produce new breeds.

In shape and size, in the form of different parts of the body (head, ears, tail, legs, etc.) as well as in the length and colour of the hair the various breeds differ considerably. We are all acquainted with the keen-scented pointer, the snarly bulldog, the intelligent fox-terrier, the crooked-legged terrier, the lazy pug, the fleet-footed grayhound, the noble Bernardine, the tiny little lap-dog, the faithful Pomeranian, the clever poodle, the watchful sheep-dog, and many more.

B. THE DOG AS THE FRIEND AND HELPMATE OF MAN.— Wherever on the earth we meet man, there too we find the dog. Lasting affection, fidelity, and ready obedience to its master have made its service almost indispensable to man. Now it acts as a faithful guardian of house and home; now as a careful protector of the flock; now as an untiring supporter of the chase after game; and again as a willing helpmate when harnessed to a cart; now as a good-natured playmate of the children; and again as the faithful companion of its master.

On the other hand, if attacked by hydrophobia it can become a source of danger to man. It is not safe to allow one's hand to be licked by a dog, because in this manner the eggs of a tape-worm, peculiar to the dog, can be conveyed to man.

C. HOW THE DOG IS ENABLED TO RENDER MAN THESE SERVICES.—

1. **Its sense of smell** is of astonishing acuteness. A dog will discover the scent of its master out of hundreds and even thousands of other scents. By means of the scent he is able to recognize his master even after many years of separation. Long before man sights the game the dog scents it. The least possible trace of scent left on the ground by the game becomes a sure guide to it, and the track once discovered is usually pursued to the end. By means of this sense the sheep-dog becomes aware of the approach of a beast of prey. In a healthy dog the **nose is always moist**, since odours cannot be perceived when the nose is dry.

2. **Its sense of hearing** is developed almost to equal

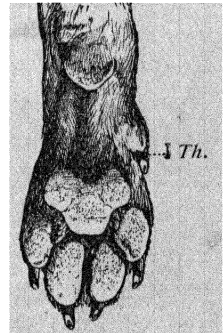
perfection, and it is for this reason that the dog is employed as a watcher. Even when asleep it hears the stealthy footsteps of an approaching thief. All watch-dogs (Pomeranians, sheep and house dogs) have erect ears, such being better adapted for catching the sound.

3. Dogs used for hunting (grayhound) and for protection of the cattle, are very fleet. The **body** is compressed laterally, and while running the head is stretched forwards, thus forming, as it were, the point of a wedge. In this way the body offers less resistance to the air. (Any cyclist will tell us that the air offers great resistance to a swiftly-moving body. When riding fast, especially if against the wind, the rider bends his body forwards, so as to offer the smallest possible surface to the air.)

4. The **legs** of the runner are long.

Only its **toes** touch the ground in walking or running. There are five toes in the front feet and four in the hind feet. Animals that walk on their toes are lighter-footed and swifter than those which walk on their soles. The former raise their feet from the ground with ease, whereas the latter roll them, as it were, from the heels to the toes.

5. With its sharp strong **teeth** the dog defends its master and his property. In its dentition the dog very nearly resembles the cat. The teeth being larger and blunter than in the cat, it can break with ease even the strongest bones. On each side of the upper jaw there are six molars, and seven on each side of the lower jaw. The posterior ones have broad crowns for crushing and grinding up the food. The structure of the teeth enables the dog to eat vegetable substances (bread, etc.) also. Compared with the dentition of the cat the extension of the jaws of the dog is corresponding to the greater number of the teeth.



Left forefoot of the domestic dog.

Th. Dwarfed thumb.

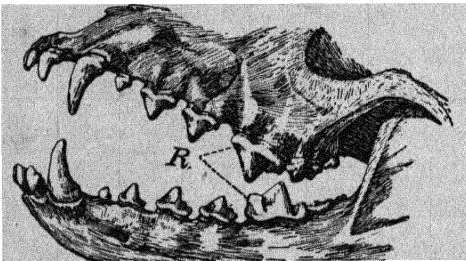
OTHER DOGS

The **Wolf** (*Cánis lupus*) resembles somewhat a sheep-dog, but reaches the height of a bull-dog and bears a gray or blackish fur which is thicker and longer in those of northern countries

than in those of the south. It is met with throughout northern



Wolves following the scent of a stag.



Teeth of the Wolf. R. Carnassial teeth.

Europe and Asia. A smaller species is found throughout the Indian Peninsula. The wolf pursues its prey running; in fact, it hunts it down. To make its hunts more successful, it unites with others of its kind into a pack. When pressed with hunger, wolves will even attack human beings.

The Jackal (*C. au-rëus*) is a near relative of the wolf. It is found in Asia, North Africa and Southern Europe, and in India it is one of the commonest and most familiar animals. He is the scavenger of towns and



Howling Jackals.

villages and feeds on carrion and offal, but occasionally kills poultry and steals fruit and sugar-cane. The animals hunt in packs, and their long wailing howls followed by a succession of usually three yelps, often repeated, annoy sleepers.

The **Indian Fox** (*Vulpes bengalensis*) has the size and shape of a middle-sized dog, but its head is pointed and its legs are shorter

than those of the dog. The tail is long and bushy with a black tip and the fur of a grayish colour. The vertical oval pupil points it out as a nocturnal animal (see under Cat). Its food consists chiefly of mice. Occa-



The Fox.

sionally when it has an opportunity, it seizes a young fawn or a hare, or partridge, plunders birds' nests, or captures a fowl or two. The cautiousness, cunning, and slyness of the fox have become proverbial. The home of the fox is generally a burrowed-out hole or natural recess in the forests. Though not so common as the jackal, the fox is found in all open parts of India.

FOURTH FAMILY: MARTENS (*Mustélidæ*).

THE MARTEN (*Mustela foina*).

A. HOME AND COAT.—The marten inhabits dense forests of Western Asia and Europe and there leads a truly arboreal life. The fur, coloured like the bark of trees, does not betray its presence. Nor does the lighter colour of its throat and chest make it conspicuous, as in creeping about after its prey it presses its body close to the stems and branches.

B. FOOD AND STRUCTURE.—The marten preys upon all animals which are its equals in size. When it gets a chance to enter a poultry-yard it destroys all it sees.

With its elongated and flexible body it is able to creep easily through the densest thicket and the most entangled branches. The pliant eel-like body and the short legs indicate its stealthiness. The under-side of the toes being covered with soft hair its walk is rendered inaudible to animals ever so quick of hearing. The broad ears indicate a keen sense of hearing. The marten is further an excellent jumper by reason of the springy pliancy of the body and of the great length of the hind legs. The bushy tail serves as a rudder in the act of jumping. It is also an accomplished climber, being aided by the suppleness of its body, short legs and sharp claws. In short, the marten is a truly arboreal animal and an accomplished robber.

OTHER MARTENS

The **Sable** (*M. zibellina*) is an inhabitant of the cold regions of Siberia. Its fur is highly prized.

The **Polecat** of Tibet (*Putorius larvatus*) is useful as a destroyer of rats and snakes, but it also actively preys on poultry.

Weasel (*Putorius vulgáris*) is of a reddish-brown earthy colour. Its elongated pliant body and the short legs enable it to slide into the holes of mice. The Great Weasel or **Ermine** (*P. ermineus*) changes its earth-coloured coat in the autumn into a white winter fur. Only the tip of the tail remains black.

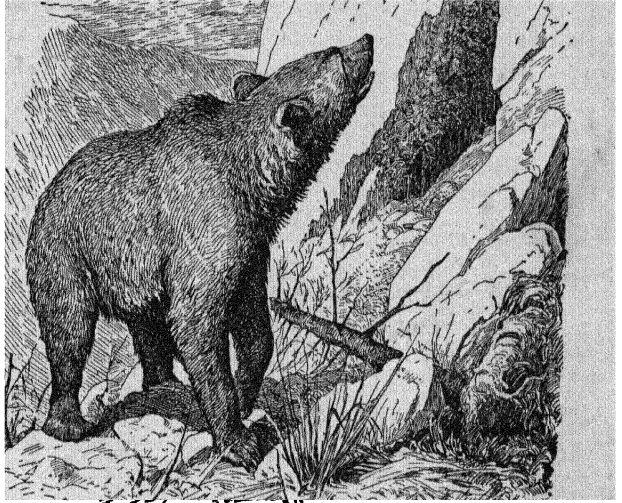
The **Badger** (*Méles táxus*), a denizen of the forest, is about the size of a dog. The plump body is coated with earthy-gray bristly hair. The head has black and white stripes. In walking the badger touches the ground with the entire sole of the foot; hence it is unable to run swiftly, nor can it creep or leap or climb. It cannot prey on quick-footed animals and must be content with other food. It is, in fact, an omnivorous animal. It lives in a burrow, which it digs itself.

The **Otter** (*Lútra vulgáris*) lives near the water, where it preys upon frogs and crayfish and largely upon fish. It is an excellent swimmer and diver. Otters are easily tamed and, in several parts of India, are kept by fishermen to chase fish into nets.

FIFTH FAMILY: BEARS (*Ursidæ*).

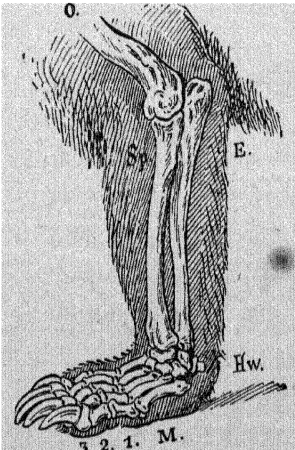
THE BROWN BEAR (*Ursus arctus*).

1. The bear inhabited the whole of Europe and Asia in former times, but is now only found in high mountain ranges, e. g. in the higher Himalayas above the forests. Even there it is keenly pursued on account of its depredations among game and cattle. Its brown shaggy fur is highly valued by the hunter.



A Brown Bear scenting a flock of sheep.

2. The bear has a **clumsy** and **stout body**. It treads on the whole



Forefoot of the Bear.

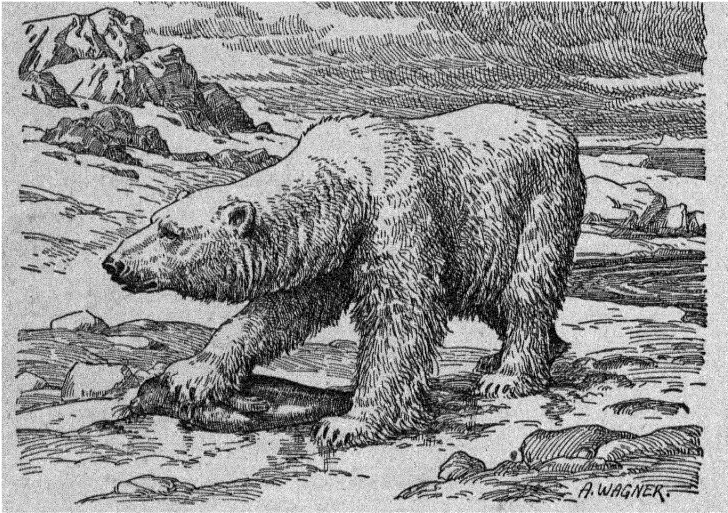
O. Upper arm. E. Ulna.
Sp. Radius. Hw. Tarsals.
M. Metatarsals. 1. 2. 3. Toes.

surface of its naked soles. It cannot, accordingly, run as fast as those carnivores that tread on their toes, nor is it able to **feed on prey** only, but must live on **vegetable** also. It preys upon all animals from the horse and cattle down to insects, worms and snails. But its chief food consists of grass, cereals, berries, mushrooms, fruits and nuts. Its favourite delicacy is honey.

3. In the search after food the great **mobility of its limbs** and its enormous **bodily strength** are of good avail. It can walk on its hind legs and keep the forelimbs free to use them like arms.

The bear is also a skilful climber in virtue of the mobility of its limbs and its long strong claws.

4. A glance at its enormous jaws will also show us that the bear's diet is not limited to flesh. The canine **teeth** are, indeed, great and formidable weapons. But the molars have broad crowns and blunt tubercles. Hence they are more adapted for crushing vegetables than for tearing flesh. The great incisors form good instruments for biting off grass and herbs.



A Polar Bear that has taken a seal.

5. In winter when the chief source of its food-supply is cut short, the bear retires to a cave and indulges in a **winter sleep**, the duration of which changes according to the duration of the cold season.

OTHER BEARS

The bear of the Indian Peninsula and Ceylon is called the **Sloth Bear** (*Mélursus ursinus*). It is smaller and has fewer teeth, but more powerful claws than the brown bear. It is black and covered with long coarse hair, but appears not to be very sensitive to heat.

The **Polar Bear** (*Ursus maritimus*) is bigger than the brown bear. It inhabits the icy coasts and islands of the Arctic

Ocean. It is protected against the fierce cold of its home by a thick fur and a thick layer of fat beneath the skin. The white colour of its fur which cannot be distinguished from that of snow and ice, is a great help in the pursuit of its prey. The sea, however, is its principal hunting ground.

III. Order:— BATS (*Chiróptera*).

A flying membrane extends between the long forelimbs and the short hind limbs. They are nocturnal in their habits.

THE NOSE-LEAVED BAT (*Rhinólophus sp.*).

The locomotion of these animals differs greatly from that of other mammals. They are able to fly in the air. Hence the structure of their body is also quite different from that of other mammals. At first glance they appear as very strange and peculiar animals, but on closer examination we shall find that they are perfectly adapted to their mode of life and habits.

A. STRUCTURE OF BODY AND LOCOMOTION.

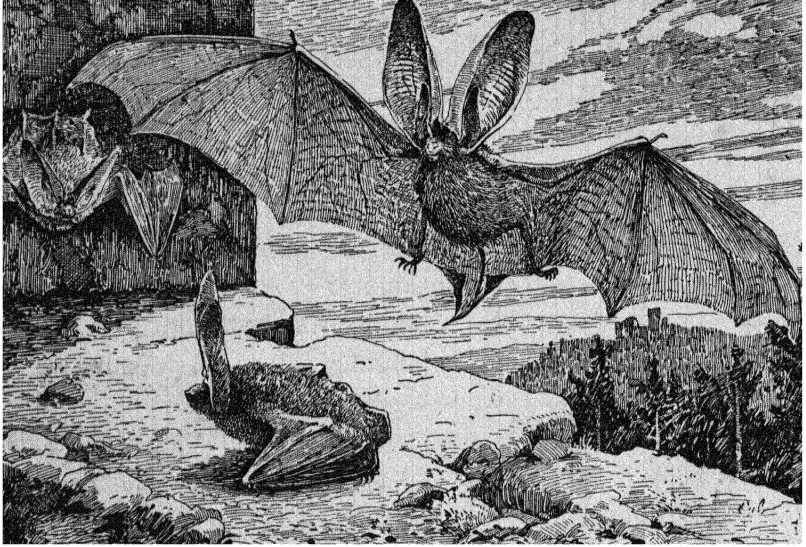
1. A wing-membrane is spread on each side of the body between the fore and hind limbs, and the tail. The **wing-membrane** is very broad in the front. In accordance with this the bones of the arms and fingers are likewise elongated. And like ribs of an umbrella, they keep the membrane stretched.

In the act of fluttering the bat alternately raises and lowers its arms. The membrane is carefully lubricated every time before the animal sets out for flying. As a result, it is always kept highly elastic.

2. But the bat cannot be said to be an aerial creature in the same degree as for instance the fish is spoken of as an aquatic animal. In order to rest it is obliged to descend on solid objects. Its limbs accordingly are also instruments for creeping and climbing. The **thumbs** and the **hind feet** are **not included in the membrane**. By means of the claw-shaped thumbs the bat hooks itself on to the ground and then pushes its body forward with the feet. When at rest it suspends itself by the feet, head downwards, from beams and projecting objects. If it allows itself to drop while in this position, it can at once expand its wing-membrane.

B. STRUCTURE OF BODY AND FOOD.

At sunset the bat begins its nightly excursions in search of food, which consists of flies, gnats, beetles, and more especially night-moths. Thus the bat is a nocturnal **insectivorous creature**.

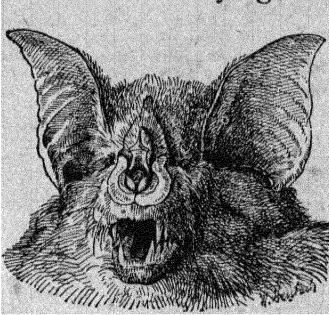


The long-eared Bat.

One of the animals is flying, one creeping, one resting.

1. As may be gathered from the smallness of the **eyes**, the bats are not sharp-sighted. Its **sense of touch**, however, is extremely keen. Thus, bats whose eyes had been covered with sticking plaster were set free in a room with a number of threads stretched across it. The bats all flew between the threads without touching them, drawing their wings closely against their sides to avoid them. It may be assumed that they felt the vibrations of the air caused by the strokes of their wings and reflected from the surrounding objects. Similarly, they certainly become sensible also of air-vibrations, faint though they may be, caused by a flying insect. This extremely fine sense of touch has its seat in the wing-membrane in the delicate exterior parts of the ears and, most probably also, in the shield-like skin processes, called nose-leaves, arranged round the nostrils.

2. The prey is caught by the bat with its widely opened mouth while flying or it is arrested by the wing-membrane.



Head of the leaf-nosed Bat.

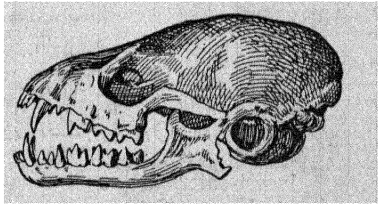
The insect thus captured in this 'net' will be taken out by the mouth or by the feet.

3. The **teeth** have the appearance of rows of needle-points. They can pierce through strong wing-covers and the armours of larger insects from which blunt teeth would easily glide off.

4. The bat is comparatively **small**, the body measuring not more than 4 inches in length. A large animal could not obtain enough insects to satisfy itself.

C. THE BAT IN ITS RELATIONS TO MAN AND TO OTHER ANIMALS.

1. Flying requires a much greater muscular effort than any locomotion on the ground. The more force an animal expends, the larger the quantity of food it must take in order to recoup lost energy. Hence bats are very **gluttonous creatures**.



Skull of a Bat.

And, as bats live mostly on moths whose larvæ spoil our fruit and forest trees, they must be considered to be very useful to man. Hence they ought to be protected and spared.

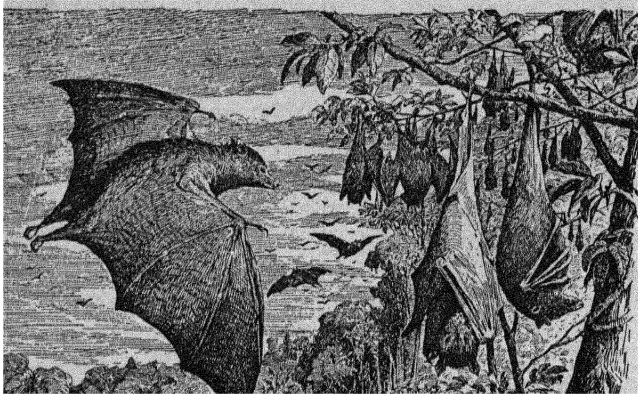
2. **Enemies:** Owls pursue the bat during its flight, cats and martens while it is at rest. But it manages to protect itself against these enemies by choosing for its refuge places difficult of access. Its gray colour also is a protection. A sleeping bat may almost be mistaken for a dusty spider's web.

OTHER BATS

The **Pipistrelle** (*Pipistréllus abrámus*) is a small bat appearing on the wing rather early in the evening.

The **Flying Fox** (*Ptéropus medius*) is much larger than the common bat, measuring about four feet across the expanded wings. These bats live on fruit and are often seen hanging in trees during the day, many hundreds often occupying one particular tree. Their molar teeth have blunt tubercles.

The **Vampire** (*Vámpyrus spectrum*) of South America has a short, pointed nose with small “nose-leaves”. It is princi-



Flying Foxes.

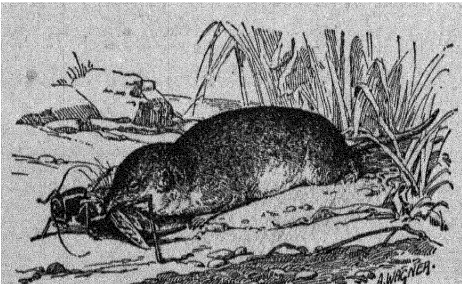
pally an insect-eater, and only rarely attacks a bird or a mammal to suck their blood.

IV. Order:— INSECT-EATERS (*Insectívora*).

Insect-eaters are small animals walking on their soles and provided with five clawed toes. All three types of teeth are represented. The molars have pointed prominences. The nose is prolonged into a proboscis.

THE GRAY MUSK SHREW (*Crocidúra cærúlea*).

This little animal, also known by the name of Musk Rat, is nocturnal in its habits and is found all over India, in houses or in clefts or cracks in the soil. The velvet-like coat of fur, the small size of the eyes, the fact that the ears are capable of being closed, and the long snout, are adaptations to its mode of life.

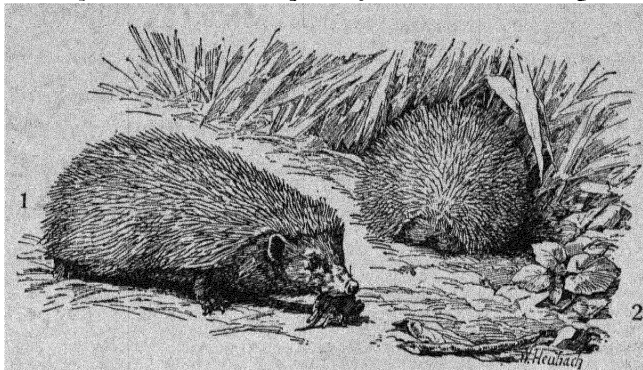


Musk Shrew.

It has a peculiar musky smell due to secretions from certain large glands. The shrew feeds on cockroaches and other insects, never on grain or vegetables. Its teeth resemble those of the bats.

Another insect-eater is the **Hedgehog** (*Erinaceus*) found in India but rarely. It is provided with a prickly armour covering

the upper portion of its body. On the approach of danger it rolls itself together into a ball, the head, the legs and the under side of the body, which are without spines, are drawn inside covered by the



Hedgehog.

1. Animal stretched, 2. rolled up.

spiny skin of the back; thus the animal can present a thousand tiny spears towards its assailants.

The **Moles** (*Talpa*) are denizens of northern countries. Their small eyes in a short-necked pointed head, cylindrical shape of the body, the shovel-like forelimbs and the velvet-like fur, all point to a life in the ground. They feed on insects and other small animals, such as snails, earth-worms and the like.

V. Order:—RODENTS (*Rodentia*).

Rodents possess a pair of chisel-shaped incisors in each jaw. Canine teeth are absent. Toes are provided with claws.

THE GRIZZLED SQUIRREL (*Sciuropterus macrurus*).

A. THE SQUIRREL AN ARBOREAL ANIMAL.—The dense trees of the forest are the squirrel's home. There it has its airy way from one tree-top to the other, from one branch to another.

1. By virtue of its **long and sinewy hind legs** and its **supple body** it can jump over distances of 12—15 feet. The tail, which is almost as long as the body and which is covered with a tuft of grizzly hairs, forms an excellent rudder. Moreover it acts as a parachute, breaking the force of the fall, if the animal happens to drop down from the tree or glides to the earth from the swaying branches when trying to escape its enemy.

2. The **toes** are long and not connected with each other,

but free like the fingers of our hand. Consequently the animal can grip the boughs of trees and seize the twigs.

3. The long, sharp **claws**, by which it can firmly hook itself to the bark of trees, enable it to climb with great agility.

B. THE SQUIRREL A RODENT.—The trees provide the squirrel with food also. This consists of nuts and seeds, young juicy shoots, buds, fruits, and the bark of trees.

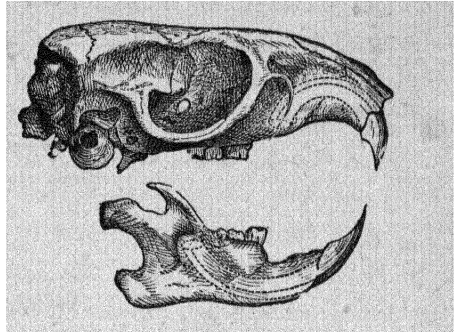


Squirrels.

1. But how is it enabled to get at the sweet seeds inside the hard kernels of nuts, and how can it cut off small bits of the hard bark of trees? For this purpose it is provided with **incisors**, of which there are two in the upper and two in the lower jaw. These teeth are just **like small chisels**. For, (*a*) if it is desired to cut small strips from the flat surface of a board with a chisel, the tool must be placed at as acute an angle as possible. As the incisors of the squirrel are strongly curved, they form an acute angle with the object to be gnawed; (*b*) the chisel must be deeply set in the handle. Those parts of the incisors which are inserted in the jaws are, therefore, very long. (*c*) All tools are worn out by constant use. In the same way the incisors of the squirrel gradually wear away, and would finally become useless. To avoid this they are constantly renewed at their inner ends. (*d*) In a chisel only the cutting-blade is of hard steel. Similarly the front of the incisor

teeth of the rodents is much harder than the hinder part and, as the hard enamel resists wear the longest, it always keeps a sharp cutting edge, like a carpenter's chisel.

2. If the incisors were close to the other teeth, as in man, they could not be used for penetrating hard substances. They are separated from the molars by wide gaps. As the squirrel is a herbivorous animal there is **no need of canine teeth.**



Skull of a rodent.

3. All vegetable substances must be carefully ground, before they can be digested. The lower jaw, in chewing, moves from behind forwards, and so the **molars** act like files which grate up the food.

4. The mouth is narrow, but to protect the lip v gnawing, the **upper lip is divided** (hare-lip) and the i are exposed.

5. In order to open a nut the squirrel holds i⁴ forepaws, using them like hands.

C. THE SQUIRREL AND ITS ENEMIES.—Foxes, 1⁴ and many other animals are enemies of th though he takes pleasure in the various 2 has long found out that the squirrel is a 3 hence he also incessantly pursues the squirrel protected against its numerous

1. The squirrel being an arborea⁴ fox can follow it to its lofty domain. **agile.**

2. As long as the squirrel d noticed. Its **gray coat** has almos of trees. The lower part of its b

3. Its **senses are keen.** escape its fine ears; and with continuously surveys its surroun

4. By the aid of its hand build a **protective nest**, in wh

warm and soft bed of moss. This cosy home also serves as a nursery.

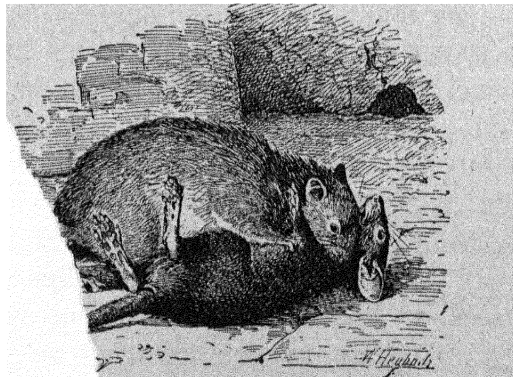
5. In spite of all these means of defence many squirrels succumb to their animal foes. And one might almost suppose that this animal would be easily exterminated. Indeed, but for its extraordinary **fecundity** this would be the case.

OTHER RODENTS

The **Marmot** (*Arctomys marmotta*) and the **Beaver** (*Castor fiber*) are rodents of cool climates, the marmot being also found in the Himalayas. The beaver is as much at home in the water as on land. It has a thick coat of fur. The hind feet are webbed, and the tail is broad and covered with scales. Mouth, ears and nostrils can be closed so that in the action of swimming and diving all water is kept out. The beaver feeds on the bark and the leaves of various trees and shrubs. If it wants to get at the branches of a tree, it gnaws round the trunk until it bends and falls. It has a remarkable and inimitable habit of building its dwelling-places of trees and brushwood, lined with grass and moss and plastered over with mud.

MICE (*Muridæ*).

The **Indian Rat** (*Mus rattus*) and the **Common Rat** (*Mus musculus*) are the best-known, and at the



2. Indian Rat fighting.

members of the rodent family. These rats eat up everything; only hard stones

and metals withstand their sharp, destructive teeth. They multiply to an almost incredible extent. Their gray fur renders them invisible in the dark. Their great agility and their sharp claws make them very skilful in climbing. For this the long and slightly haired tail also is of great advantage.

The **Indian Bandicoots** (*Nesócia bándicota*) are rats of large size. They dig their holes with their sharp, strong claws, throwing up small heaps of earth.

The **Porcupine** (*Hystrix leucúra*) is allied to the rats. It is provided with strong quills, which like the prickles of the hedgehog can be raised and serve as a means of protection in times of danger.



Porcupine with appressed and raised quills.

HARES (*Leporidae*).

The **Black-necked Hare** (*Lépus nigricóllis*).

A. The hare is a MUCH-PERSECUTED denizen of our fields and open places. All beasts of prey, the majority of the birds of prey, and even the raven constantly persecute the hare. With such a number of enemies, amongst which man must also be included, it is surprising that the hare has not long since been exterminated. How is the hare protected against these numerous foes?

1. Though its sight and smell are not well developed, the **hearing sense** is uncommonly acute. The least noise—a rustling leaf, a lizard slipping past—will arouse it from sleep. Its large ears can be moved in all directions.

2. The **colour of its skin** is in perfect harmony with that of its surroundings. Even professional hunters may miss it on account of its protective colouring.

3. In time of danger the hare will sit still as long as possible. When, however, it is no longer able to conceal itself,

it takes to flight, **leaping off** with great alacrity. By suddenly stretching its long and strong hind legs the body is propelled a considerable distance. The vertebral column is very flexible. Whenever it jumps, it bends its body and stretches it again. By means of the powerfully clawed toes the hare is able to obtain a firm foothold in the ground. The great flexibility of its body also enables the hare to alter suddenly the direction of



Hares in a cabbage garden.

its course—to ‘double’ as it is called—when pursued by an enemy.

4. All these protective arrangements could not prevent the extermination of the hare, were it not for its astonishing **fecundity**.

5. Being weak and helpless the hare is a **timid** creature. At daytime it generally rests in a secure hiding place or in a shallow depression in the ground called “form”, which it digs with its strong claws.

B. FOOD.—The hare feeds chiefly on roots and underground stems, but it does not despise other food, as vegetable and fruits of the field. Its teeth are like those of the squirrel. But besides these teeth it possesses two small incisors behind the large incisors of the upper jaw. The upper lip is divided, like that of the squirrel, but the feet having the form of paws, the hare cannot hold its food as the squirrel does. The hare is a swift runner, and so it would be hindered in running were the feet constructed like hands.

The **Rabbit** (*L. cuniculus*) lives in underground burrows which it leaves at nightfall and within which is the room set apart for the nursery, lined with fur plucked by the mother from her own body. It has been domesticated, and is kept as a pet. Its fecundity is marvellous— as many as sixty young ones are produced in a single year.

VI. Order:— PROBOSCIDIANS

Large animals having their snout prolonged into a proboscis. The upper incisors are long and are called tusks.

THE INDIAN ELEPHANT (*Elephas asiaticus*).

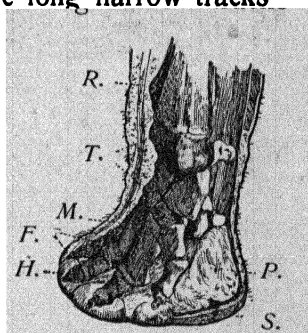
A. ITS HOME.— There are extensive forests in India, Further India, on the islands of Ceylon, Sumatra, and Borneo. These are the haunts of the elephant. Most of the mammals of these forests dwell on the branches of trees. Those which live on the ground are either so small that they can creep through the thicket, or huge giants capable of forcing their way through the tangled jungle. Such a **giant animal** is the elephant. The long narrow tracks which are the only ones leading through the aboriginal forests are made by **herds** of elephants. When they take to flight, they leave these tracks and break through the thicket.

B. HOW THE ELEPHANT PENETRATES THE FOREST.

1. The elephant attains a height of ten feet and a weight of more than three tons. The **tremendous bulk** of its body renders it very powerful. Lianas as thick as a man's arm are broken by its onrush.

2. The **body is slightly compressed** at its sides and thus forms a strong wedge able to break the thicket through.

3. The gigantic weight of the body is supported by **pillar-like legs**. Even the feet, in which small hoof-like nails may be recognized, appear like bases of these pillars. With their circular soles they resemble those rammers which are used to ram in the stones in streets. Without any difficulty the elephant stamps down the underwood barring its way.



Foot of the Indian
Elephant.

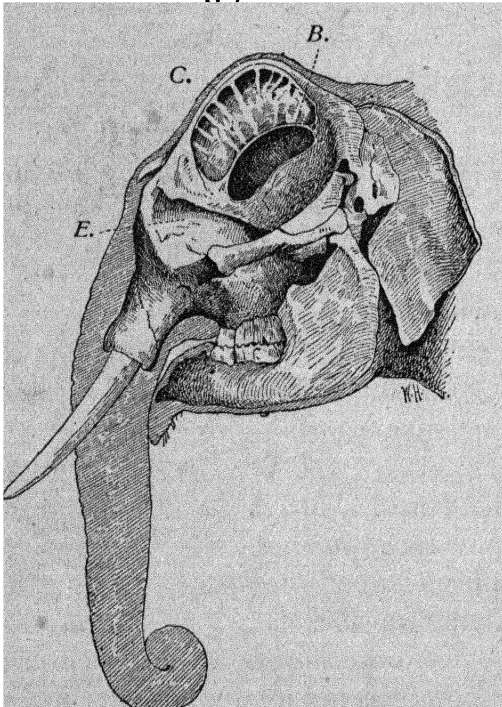
R. Radius. T. Tarsals.
M. Metatarsals.
F. Finger-bones. H. Hoof-
like nails. P. Pad.
S. Horny sole.

4. The **eyes** are **small** and lie deep in their sockets, so that they cannot be hurt while the animal brushes against the trees.

5. The **skin**, too, **hard** like a board, is not pierced by thorns or broken branches. It is gray and almost without hair. If there were hair, it would soon be brushed off when the animal rushes through the thicket. Moreover, living as it does in hot countries, the elephant needs no special coat for the preservation of the heat of its body.

C. THE ELEPHANT AS A HERBIVOROUS ANIMAL.

1. The elephant feeds on various kinds of vegetable matter. Twigs, which he devours entirely, are his favourite



Skull of the Indian Elephant.

E. Socket of the eye. *B.* Opened cavity of the brains. *C.* Cavities in the bones of the skull.

food. To obtain them, he uproots trees of moderate size. If he cannot fell the trees by means of his trunk or by pushing with the mighty two-humped forehead, he splits them with his **tusks**. These project far out from the mouth and are the incisors of the animal. They may have a weight of one hundredweight each. These tusks furnish the valuable ivory, from which ornamental objects are carved.

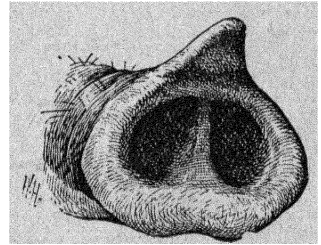
2. The elephant crushes his food with his gigantic **molars**. There is, however, only one of these teeth in each jaw

on either side. But its length may be $1\frac{1}{4}$ feet. As these teeth are worn away by constant use, they are replaced by others.

3. Teeth of such size must be fixed in gigantic jaws and can only be set to work by very strong muscles. The **head** of the animal is, therefore, strikingly **large**.

4. Animals that take their food from the ground have either a long neck so that the mouth can reach the ground, or they have hand-like forelimbs by which they can convey their food to the mouth. The neck of the elephant is short and the stout forelegs are not adapted for performing work of that kind. But such work is assigned to the **trunk** or proboscis which is nothing else but an elongation of the nose, and which can be turned and moved in all directions. A large number of ring-like folds of the skin increase the extraordinary mobility of the trunk.

The trunk ends in a **finger-like appendage**, which can be moved towards the opposite edge of the trunk just as we can move the thumb against the remaining four fingers of our hand. This makes the trunk a very useful prehensile organ. By its aid the elephant can pick up tiny objects from the ground and also break strong branches. It is used for conveying the food to the mouth as well as for drinking. He sucks up water into it and then squirts it into his mouth. Thus, the trunk is to the elephant nose, finger, and arm combined. It is indispensable to the animal.



The tip of the trunk of the Indian Elephant.

D. THE ELEPHANT AND MAN.

From man the elephant retreats with shyness. But if attacked, he erects his large fan-shaped ear-flaps, sets up a yelling trumpet-signal and charges the assailant whom he tries to seize with his trunk and then to trample under foot.

The tamed elephant is a useful **helpmate** to man in carrying loads, and can be trained to do many things, such as piling up wood with its trunk. In India, Burma, and Ceylon the elephant is employed extensively by timber contractors to drag heavy logs out of the forests.

Other proboscidians are the **African Elephant** (*E. africanus*) which is unsparingly hunted and shot down for the sake of its tusks. Large quantities of ivory are also obtained from the extinct Mammoth, skeletons and tusks of which are found in the frozen soil of Siberia.

VII. Order:—EVEN-TOED UNGULATES (*Artiodáctyla*).

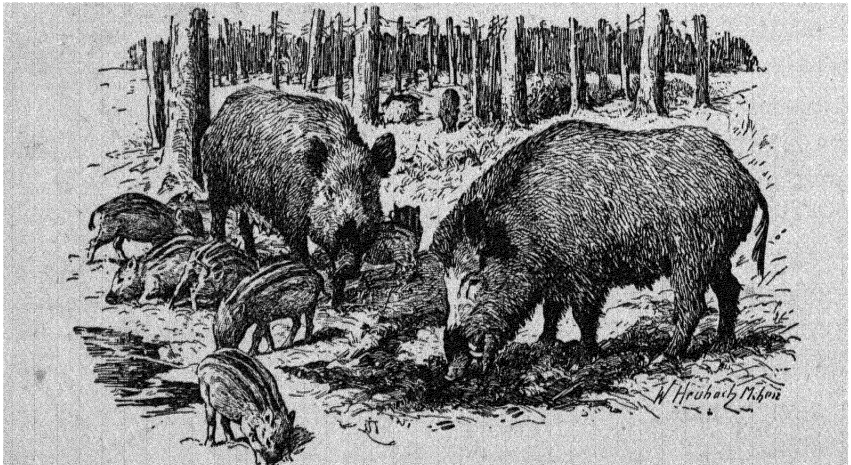
Two or four toes touch the ground in walking. The terminal joints of the toes are hoofed. In regard to their mode of feeding they are divided into two large suborders: Non-ruminants and Ruminants.

I. SUBORDER: NON-RUMINANTS (*Artiodáctyla non-ruminántia*).

THE INDIAN WILD BOAR (*Sus cristátus*).

A. The Wild Boar is AN INHABITANT OF THE JUNGLE. It prefers for its habitat swampy forests.

1. By virtue of its **cone-shaped head** and of its **laterally compressed body** it is enabled to rush through thickets which are quite impenetrable to other animals. In doing so it puts its short, strong legs firmly against the ground. The two middle toes which only touch the ground, are encased in strong hoofs as in shoes of horn.



A family of the Wild Boar.

2. Now imagine, for instance, a sheep forcing its way through the thicket, it would soon lose all its hair. This is not the case with the **coating of bristles** which covers the skin of the boar. Similarly, the **thick and tough skin** and the small deep-set eyes are hardly ever hurt by a rush through the thicket.

B. The Wild Boar as an INHABITANT OF THE MARSH.

1. When the boar treads on marshy ground, the two **middle toes** separate and sink in. But at the same time the **two smaller hind toes** reach the ground and give the animal further support.

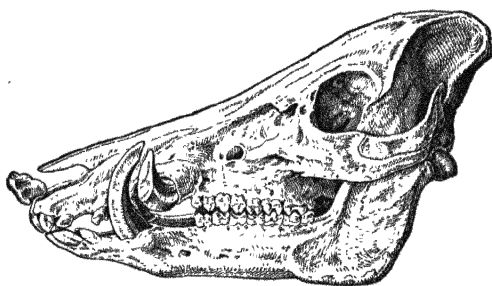
2. Under the skin is a thick **layer of fat** which, being a bad conductor of heat, enables the animal to welter in swamps for hours without the danger of the body being cooled excessively.

3. On account of the **dark colour** of its skin, the animal when reposing in the hole, which it digs out for itself, is apt to be overlooked even by the hunter. The young, which are very numerous, have light stripes along the back.

C. The Wild Boar as an OMNIVOROUS ANIMAL.

Its food consists of anything that is eatable—roots, mushrooms, nuts, fruits, insects, snails, worms, mice, and even carrion.

1. This is in accordance with the structure of its **teeth**. The four anterior molars are sharp as in carnivores, whereas the three hinder ones are broad and almost as blunt as in herbivorous animals. The incisors, of which there are six



Skull of the Wild Boar.

above and below, are large and hence adapted for biting off pieces from large objects.

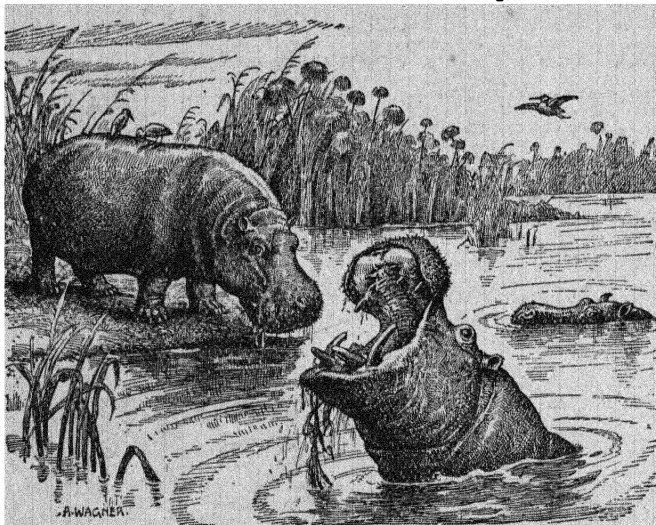
2. The sense of **smell** is keen and enables the animal to detect anything eatable to be dug out from the ground. The sense of **hearing** too is well developed. The **sight**, however, is weak.

3. But how can the animal dig out underground stems, tubers and larvæ? The wedge-shaped head with the prolonged snout and powerful **tusks** serve it as plough and crowbar combined. The tusks, which are all directed upwards, are, moreover, powerful weapons.

D. THE WILD BOAR AND MAN.—No animals do more damage to crops than the wild boar. It is, therefore, persecuted everywhere by man.

RELATED SPECIES AND GENERA

There is no doubt that the common **Tame Pig** of India is descended from the wild boar. The manifold uses of the domesticated pig are well known. But as the host of the trichina and of the scolex of a tape-worm, it may become a



The Hippopotamus.

The **Hippopotamus** (*Hippopotamus amphibius*) is a denizen of the well-watered districts south of the Sahara (Africa). Its true home is in the water. And it is only there that

such a huge, unwieldy body can be moved with any speed.

II. SUBORDER: RUMINANTS (*Artiodáctyla ruminántia*).

FIRST FAMILY: HORNED RUMINANTS (*Cavicornia*).

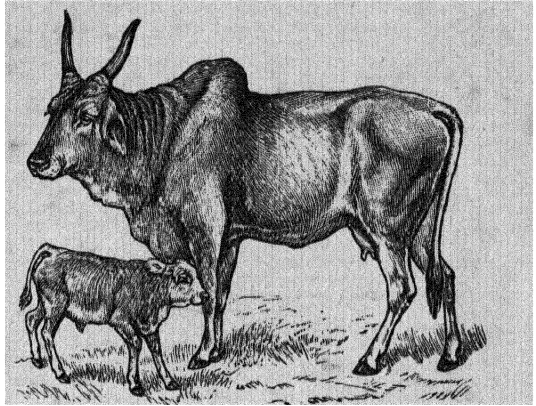
THE ZEBU or HUMPED OX (*Bos indicus*).

A. ORIGIN AND IMPORTANCE OF THE OX.—The origin of Humped Cattle is unknown. No similar animal exists now or is known to have existed in former times in a wild state.

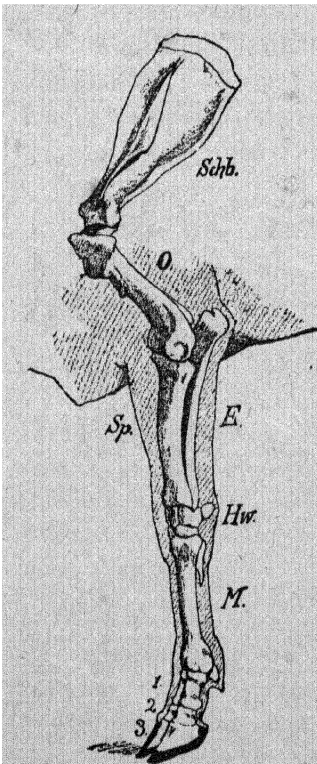
It is the **most important of all domesticated animals**. The value of cow's milk to man, of butter and cheese and the many other ways in which it is useful (its bodily strength, flesh, hide, horns, and manure) are too well known to require any description.

B. THE OX AS A HERBIVOROUS ANIMAL.

1. Vegetable substances being less nutritive than animal products (flesh, milk, blood, etc.), the ox **requires a large amount of food.** When the cattle is on the pasture, it spends a great part of the day in feeding. In this act it cannot, like carnivores, lie down, but must continue to move on slowly. For this



A Zebu Cow with calf.



Foreleg of the Cow.

Schb. Shoulder-blade.
O. Upper arm. Sp. Radius.
E. Ulna. Hw. Carpals.
M. Metacarpals. 1, 2, 3. Toes.

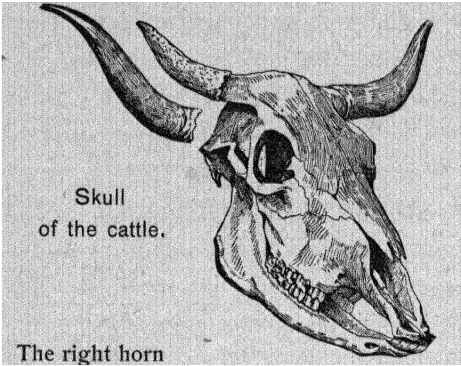
purpose it is furnished with strong legs, supporting the heavy body like strong pillars. It touches the ground only with the tips of its toes, two on each leg. These being covered with horny shoes, *i. e.* hoofs, it can also climb steep slopes with ease. The two hind toes on each leg do not reach the ground.

2. The **neck** is long enough to allow the mouth to reach the grass on the ground. The fold of skin loosely hanging down from the neck is called the dew-lap. The strong muscles of the neck enable the animal to keep its head down for hours while feeding.

3. Should the animal have to cut off grass blades singly, it could not satisfy its hunger. With the aid of its long and rough **tongue** it seizes bunches of grass and conveys them to the mouth.

4. The eight large sharp **incisors** of the lower jaw press the bundle of grass tightly against the edge of the

toothless and hard cartilaginous upper jaw, and with a jerk of the head, the tuft of grass is detached. Canine teeth are not needed.



is removed from the bony outgrowth.

moved from one side to the other, thus grinding the food. The joints of the lower jaw are not globular, as for instance in the cat, but roller-like and can be moved also laterally. The molars, moreover, have broad crowns and blunt tubercles, and are numerous, six on each side above and below.

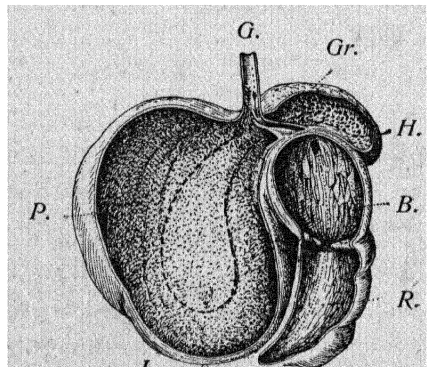
6. The long row of these teeth and the big gap between the molars and the incisors necessitate the **elongated** shape of the cattle's **head**.

7. When the vegetable substances are swallowed, they are not yet sufficiently crushed to be digested. The food, therefore, after some hours is once more forced up into the mouth to be masticated a second time. Let us study this **act of ruminating** a little more carefully.

The food passes through the gullet into the first great division of the stomach, the **paunch**. From this big reservoir it passes into the second compartment, called the **honey-comb stomach** (called thus from the character of its lining). After

5. The nutritious elements of vegetable substances such as starch, sugar, albumen, etc., are enclosed in hard cases, cell-walls. In order that the food contained in these cells may be digested, the cells must be crushed.

This is done by the **molars**, which may be compared to millstones. The lower jaw is constantly



The stomach of the Ox.

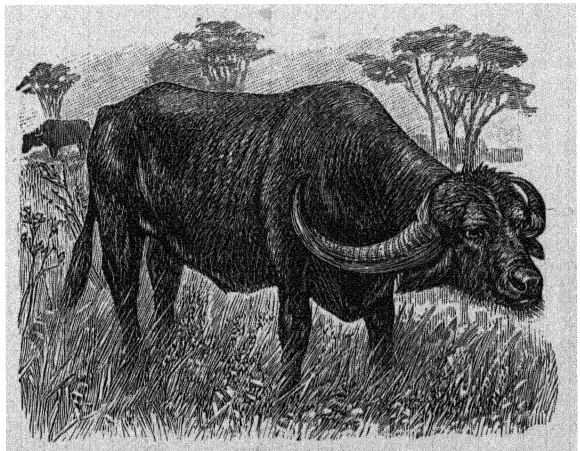
G. Gullet. P. Paunch. H. Honey-comb stomach. Gr. Groove in which the chewed cud is carried into the book (B.) R. Rennet stomach. I. Intestine. The striated line indicates the path of the coarsely masticated food, the dotted line, however, that of the chewed cud.

having taken a sufficient quantity of food, cattle generally lie down to chew the cud. The food which has been well sodden in the stomach, now returns into the mouth in small boluses. It is for a second time carefully chewed and swallowed. But this time it is conveyed into the third division of the stomach, called **the book** or “manyplies” (*psaltérium*), the mucous membrane of which possesses numerous leaf-like folds. Digestion proper does not take place till the food enters the last section, the **rennet stomach** or the tubular reed (*abomásum*), which contains the gastric juice and communicates with the small intestine. From here the food passes into the intestinal canal which is twenty-two times as long as the body of the animal, and there the process of digestion is completed.

C. THE CATTLE AND ITS ENEMIES.

1. The worst enemies of the cattle are poisonous plants. It detects them, however, by the aid of its keen **sense of smell**. The nostrils always widely distended are kept moist as in the dog. (The large eyes are dull and indicate feeble sight. The ears are movable and so can be pointed in the direction whence a sound proceeds.)

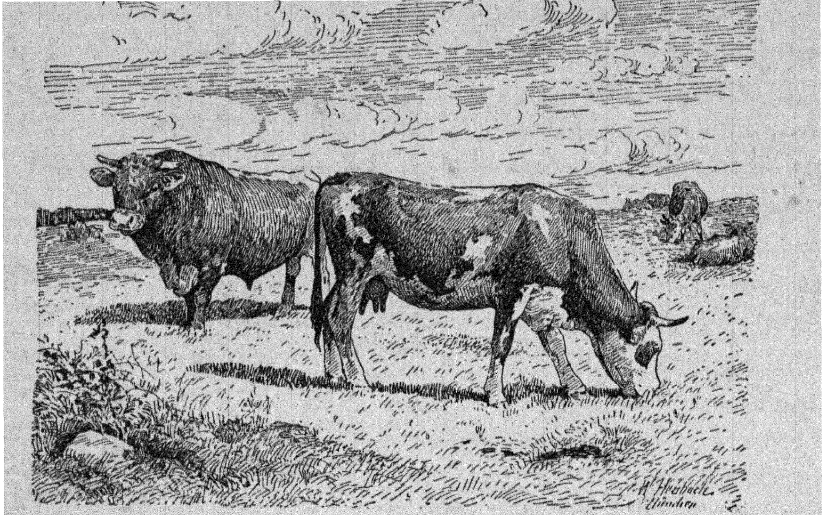
2. Among the smallest but nevertheless fiercest enemies of the cattle are the flies; for instance, the Gad Fly, which is a formidable blood-sucker. By lashing its **tail** or convulsively twitching its skin or moving its external ears it endeavours to drive away these tormentors.



The Indian Buffalo.

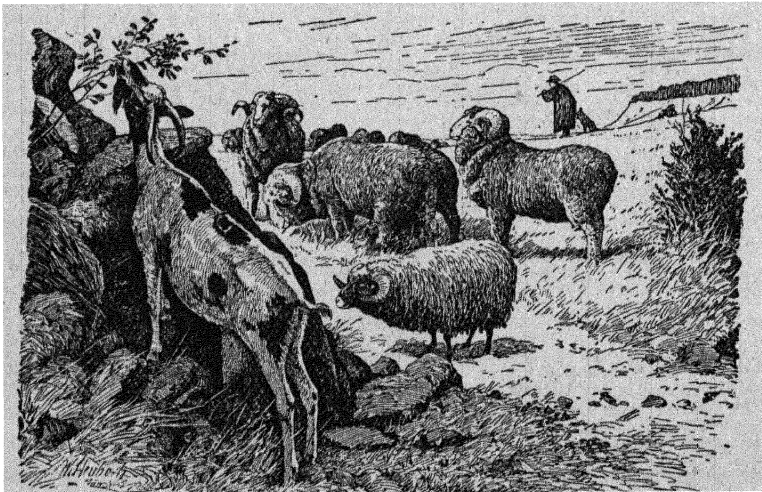
3. The **horns** are organs of defence against attacks from larger animals. They are hollow and form sheaths of large bony outgrowths developed from the frontal bone. The bones

of the head are unusually thick and can endure the hardest blows. The chief strength of the ox lies in his neck.



Cattle grazing.

Other horned ruminants are the **Asiatic Buffalo** (*Bos bubalus*) so useful to the Indian farmer; the **Gaur** or **Bison** (*Bos*

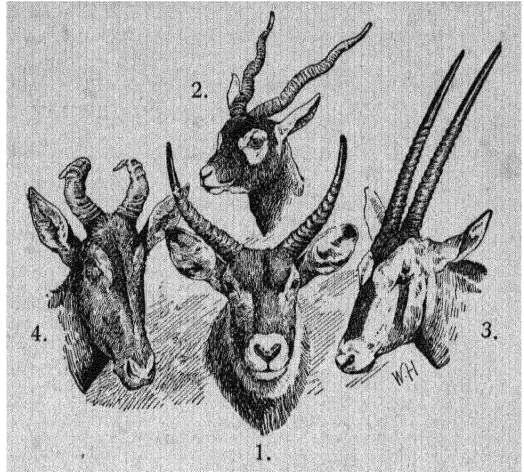


Goats and Sheep.

gaurus), found in all the hilly forest tracts of India, the **American Buffalo** (*Bos americanus*) that once inhabited the vast plains of North America in numerous herds, but is now rapidly dis-

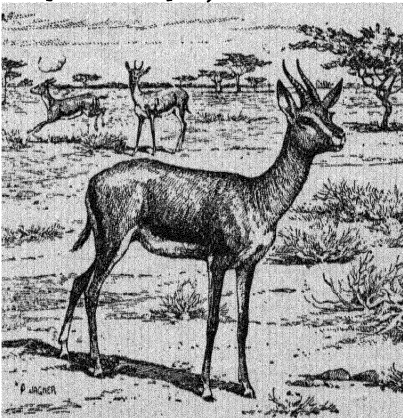
appearing, the **European Ox** (*Bos taurus*) and the **Yak** of Tibet (*Bos grunniens*).

Further allies are the **Sheep** (*Ovis aries*) and **Goat** (*Capra hircus*) both being descendants of animals inhabiting mountains. Hence they are expert climbers. Their manifold uses are well known. The goat has aptly been called "the poor man's cow". It is, however, also a dangerous enemy to the forest, where it eats off all young buds within its reach. The **Black Buck** or **Indian Antelope** (*Antelope cervicapra*) is found



Heads of Antelopes.

1. Water Buck (*Cobus unctuosus*).
2. Indian Antelope or Black Buck (*Antelope cervicapra*).
3. Beisa Antelope (*Oryx beisa*).
4. Hartebeest (*Bubalis cadma*).



Gazelles.

in many parts of India. Its slender body and its long but strong legs render the animal a runner swift as the wind. The **Indian Gazelle** (*Gazella bennetti*), the **Ibexes** of Arabia, Abyssinia, North Tunis, and the Alps of Europe, and the **Chamois** (*Rupicapra*) are some other animals belonging to this group.

SECOND FAMILY: ANTLERED RUMINANTS OR THE DEER FAMILY
(*Cervina*).

THE SAMBAR (*Cervus unicolor*.)

The Deer has many enemies among which the tiger is the most terrible. Against these and other carnivores the deer is protected by:

1. Its **habitat**. The forest densely overgrown with under-wood is in itself a good hiding place. Moreover, the **colour of its skin** is such that it resembles closely the colour of the forest soil so that it is not discernible from a distance.

2. By means of its keen **sense of smell** the deer is enabled to scent its hunter at a great distance. The acuteness of this sense is indicated by the wide, open nostrils and by their moist surface (compare with the dog). The **sense of hearing**, too, is very good. The long ears, in shape like paper-bags, can be turned in any direction and are exceedingly mobile. The slightest sound attracts the animal's attention. The **eyes** are large and bright. In the interior angle of each eye there is a pit, called the lachrymal pit, which is often filled with a substance similar to the ear-wax.

3. No sooner does the animal perceive its enemy than it takes to flight. It is a swift runner and a skilful leaper. The **body** is slender and cuts through the air with ease, especially as the animal when running stretches its head forward. The **legs** are graceful, light and long. By means of its sharp-edged, hard **hoofs** the hind, in defending its young ones, deals out severe blows to any assailant.

4. The stag possesses a formidable weapon in its **antlers**. This is primarily used in fights with other stags. The two antlers are developed from two projections from the frontal bone. These projections continue during the whole life of the animal, while the antlers are dropped and renewed annually. During their period of growth the antlers are covered with a hairy skin, known as "velvet", which is exceedingly sensitive and well supplied with blood; when the period of growth is completed, the velvet dries up, and is rubbed off on stems of trees and branches by the animal, leaving the head-bone bare.

In the first year the animal possesses two knob-like ends only, from which in the second year two spear-shaped antlers, "the beams", are developed. In the next year a new pair of antlers, each with a lateral addition, is grown (forked), and in the next change of antlers each of the beams bears two branches, the whole now having six points. By subsequent additions of lateral branches as many as eight, or in exceptional cases even ten prongs may be developed in some other

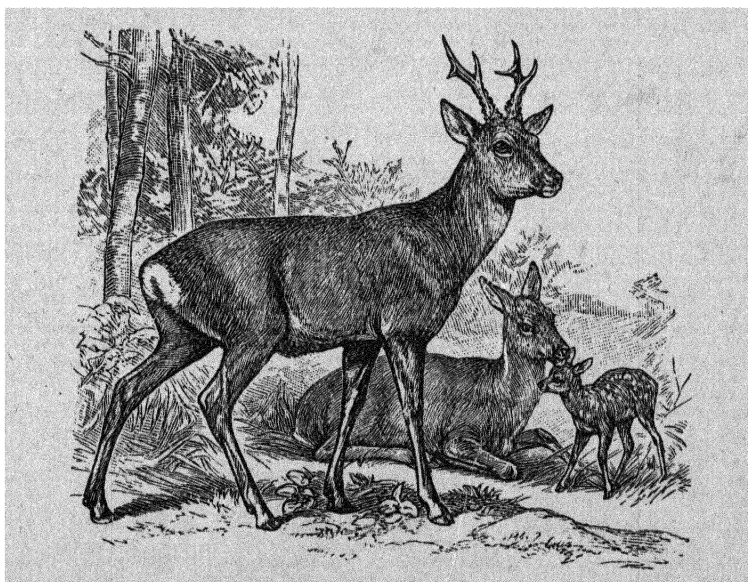
species. The Indian sambar, however, develops only six points in its antler.

5. As compared with a beast of prey the sambar must be considered a somewhat defenceless animal. It is, therefore, **timid**, and, as a rule, seeks safety in speedy flight.

6. Its food consists of the leaves and buds of all sorts of trees and of their fruits. It rarely leaves the seclusion of the forest for open pasture grounds.

OTHER SPECIES AND GENERA OF DEER

The most beautiful of Indian deer is the **Spotted Deer** (*Cervus axis*). The **Muntjak** or Barking Deer (*Cervulus muntjac*), the hornless **Musk Deer** (*Moschus moschiferus*), and the very small **Mouse Deer** (*Fragulus meminna*) are pretty common.



The Roe Deer.

The **Roe Deer** (*Cervus capréolus*), the **Red Deer** (*C. élapus*) and the **Fallow Deer** (*Dama vulgaris*) with palmated horns are common in Europe and other parts of the temperate zone.

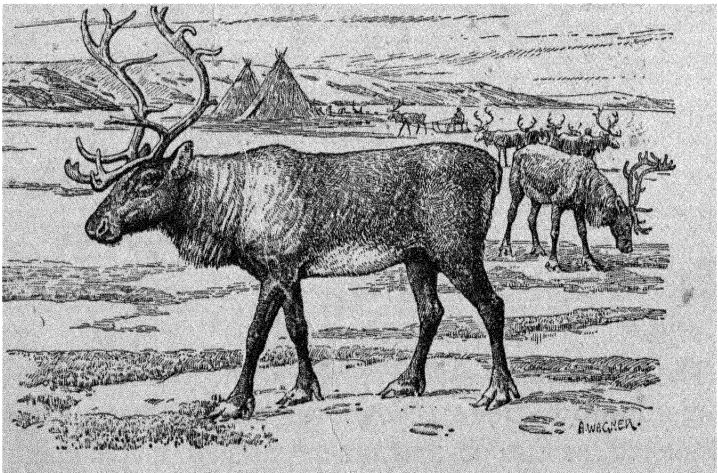
The **Reindeer** (*Rangifer tarandus*) is a true denizen of the North. The dark and thin summer fur is exchanged for a white and thick winter coat with the approach of the cold season. The broad hoofs, which can be spread widely apart.

as well as the posterior toes which touch the ground, enable the animal to cross the marshes and immense snow plains of



The Red Deer.

its home. Its chief food, especially during winter, is the reindeer-lichen which it can often get at only by scraping away



The Reindeer.

the snow with its hoofs. The Esquimaux have domesticated the animal and keep it in numerous herds. It is their one and

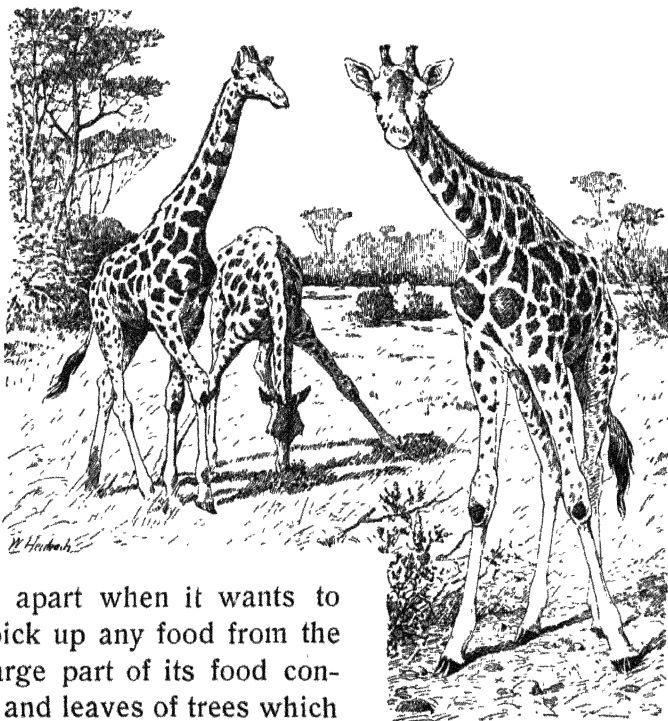
all; it is their draught-animal; it supplies them with clothing and leather; its flesh, milk, and blood supply them with their most important articles of food; of its tendons they manufacture thread for sewing, of the intestines ropes for binding, of the bones and horns spears for fishing and other useful articles.

THIRD FAMILY: GIRAFFES (*Devéxa*)

THE GIRAFFE (*Giráffa camelopardalis*).

The steppes of Central and Southern Africa are the home of the Giraffe. Its extremely long neck that raises the head to a height of about eighteen feet above the ground, its sloping back,

and its fawn-coloured skin with many dark spots have always excited much curiosity. Although the length of its neck corresponds to that of its fore-legs, the animal is obliged to spread its



Giraffes.

forelegs wide apart when it wants to drink or to pick up any food from the ground. A large part of its food consists of twigs and leaves of trees which it seizes with its long worm-like tongue.

On the approach of danger it takes to flight, and its long legs enable it to run very swiftly.

A rather strange animal of this family is the **Okapi** (*Okápia johnstóni*), which has been discovered but a few years ago in the jungles of Central Africa. While the body shows a vivid red-brown colour, the legs are, like the zebra, striped in black and light yellow.

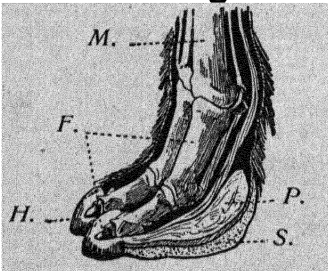
FOURTH FAMILY: CAMELS (*Camelidæ*).

THE ONE-HUMPED CAMEL OR DROMEDARY (*Camelus dromedarius*).

A. HABITAT AND IMPORTANCE.—From times immemorial the camel has been a domesticated animal in North of India, Persia, Arabia, Syria, and the whole of North Africa. It is this animal which makes the barren steppes of those countries habitable for man; for it provides its master with all the necessaries of life (flesh, milk, fat, hair, and even the dung is of use as fuel). And only by its aid it is possible for man to cross the dreadful and vast tracts of desert, and to convey the merchandise from one shore of the sandy ocean to the other. With good reason, therefore, has the Arab called this animal

B. THE SHIP OF THE DESERT. Let us imagine ourselves accompanying a caravan across the desert.

1. Heavily laden the camels pass on their way; for, being animals of **large size** and consequently of **great strength**, they are capable of carrying burdens up to eight hundredweights. (On long desert journeys they are, however, burdened only with about three hundredweights.)



The foot of the Dromedary.

M. Metacarpals. F. Finger-bones. H. Hoof. P. Pad. S. Horny Sole.

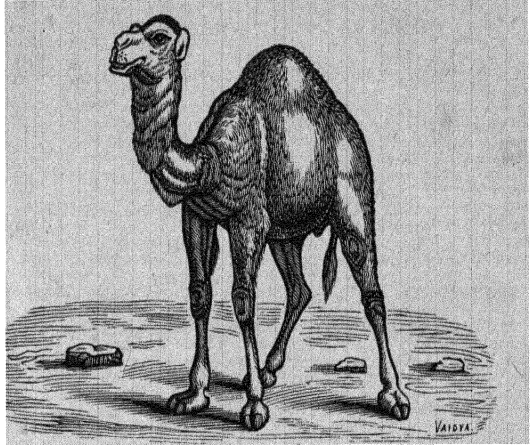
2. The two toes are not enveloped in horn, and they have only on the last joint a somewhat short and hooked nail. The part of the feet that touches the ground is not the tip of the terminal joint. Were it so, it would sink deeply in the soft sand. Its toes are covered at the bottom with a hard and durable

broad sole enabling the animal to walk with ease in the loose and hot sand.

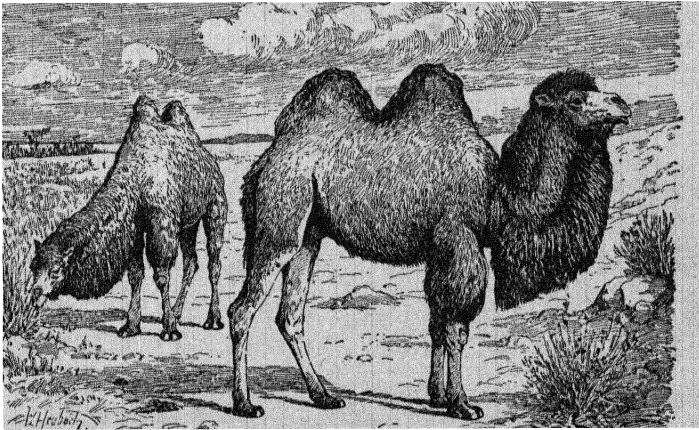
3. The **callosities of the skin** on its breast and on the joints of its legs serve the camel as cushions when it lies down for rest.

4. The camel is **easily satisfied** and its wants are few. A few handfuls of grain is all that it gets from its master. What it requires beyond that, it is obliged to seek for itself. None

of our domestic animals could eat the thorny and hard shrubs of the desert as the camel does. Its lips and the hard-skinned mouth seem to be insensible to pain. In chewing such tough and hard food the animal is assisted by its powerful teeth. And the long neck enables it to pick up food from the ground, also to tear off branches from trees. The hump consists of a reserve supply of fat, to be used in time of starvation. For, its ordinary fodder would certainly not suffice to support its life. The fat is stored up during the time of superabundance.



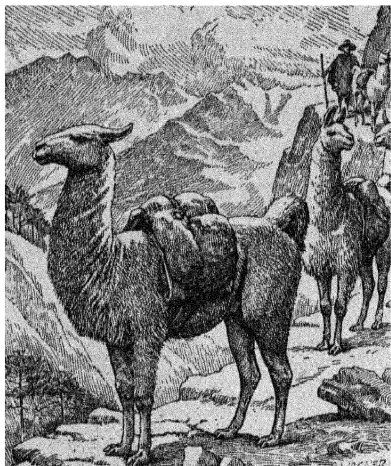
The Dromedary.



The Two-humped or Bactrian Camel.

5. None of our domestic animals could exist without water for a long time; and for this reason alone they could not be used in desert countries. The camel will often **walk** for eight or ten days **without drinking water**; but when the poor animal after such a long fast scents a well, it doubles its pace,

and on arriving at the long-desired place it drinks for the past, the present and, alas! too often, for a long future.



Llamas, crossing the Andes.

6. Only a **swift animal** is able to cross the arid desert. With its long legs the camel can walk with great speed, and is not easily tired out.

7. The desert abounds in dangers. The camel, by virtue of its high head, is able to **command a wide horizon**, and its keen **sense of smell** enables it to detect water from a considerable distance. Even the approach of the hot winds of the desert, so much dreaded by travellers, is scented by the camel much sooner than by man.

Redoubling its pace it endeavours to reach a place of safety, and thus it has often saved the life of its master.

Related species and genera are the Two-humped or **Bactrian Camel** (*C. bactrianus*) of Tibet and Central Asia, and the **Llama** (*Lama glama*) of the South American Andes.

VIII. Order:—ODD-TOED UNGULATES (*Perissodactyla*).

The Odd-toed Ungulates walk on an odd number of toes. The terminal joints are covered by hoofs. Foreteeth in both jaws.

THE HORSE (*Equus caballus*).

A. THE HORSE AS A HELPMATE OF MAN.—Of all the animals the Horse is the most important that man can employ for the saddle and for draught. It has, indeed, become man's friend and indispensable helpmate in peace and in war.

According to the different kinds of service for which man requires the horse, he has bred several varieties or breeds of horses, *i. e.* the Saddle-horse, the Carriage-horse, the Draught-horse, the Race-horse. The different breeds vary in size and

colour. By what means, then, is the horse enabled to become a helpmate of man?

1. It is a big and **strong** animal. This is true especially of the cart-horse, in which the weight is made to act on the broad, powerful chest. The saddle-horse, too, is strong; with ease it bears the rider on its firm, gently-curved back.

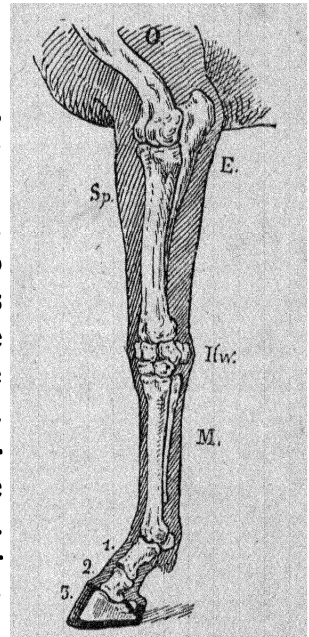
2. As a fleet steed it is distinguished by its slender shape. When running or racing it stretches its head and neck forward. The latter is laterally compressed and adorned with a mane. Thus, the body has the shape of a wedge, with which the runner cuts through the air.

3. Of greater importance is the structure of the **legs** to the runner. These are long, light, and at the same time very powerful. They touch the ground only with the tip of **one** toe each. The last joint of this toe is enveloped in a **hoof** like a shoe. By means of the hoof which has very hard edges, the horse obtains a firm hold even on bad, unlevelled roads. In order to prevent excessive wear of the hoof, horses are shod with iron. The gait of the horse is easy and graceful and this is due to the angle at which the joints of the leg are set.

4. Last, but not least, it is its **intellectual qualities** that make the horse such an invaluable helpmate of man. Without any objection it allows its master to draw in the reins; with the utmost exertion it draws the heavy cart; and with astonishing endurance it bears its rider. It obeys the call of its master, understands praise and rebuke, recognizes the sound of a trumpet; and with a fearless spirit it carries the rider into the battle. Even after the lapse of several years it is able to recognize its former master.

B. THE HORSE AS A HERBIVOROUS ANIMAL.

1. As the horse is a herbivorous and large animal, it requires daily a **big quantity of food**.



The foreleg of the Horse.

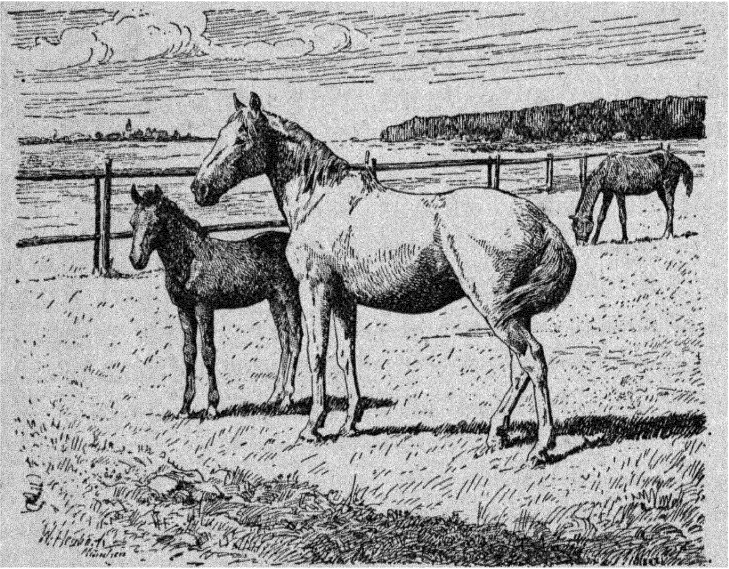
O. Upper-arm bone.
Sp. Radius. E. Ulna.
Hw. Carpals. M. Meta-
carpals. 1, 2, 3. Finger-
bones.

2. Its **neck** being long, the animal can easily reach the ground, and the strong muscles of the neck support the movements of the heavy head.

3. By the aid of the very movable **lips** the horse can snatch a bunch of grass and force it into its mouth. The tongue is shorter and not so rough as that of the ox.

4. The **foreteeth** are broad, long, directed obliquely forward, and widely separated from the molars. By their aid the horse can crop even short grass from the ground.

Unlike the ox, the horse has six incisors, not only in the lower jaw, but also in the upper one. There are also small



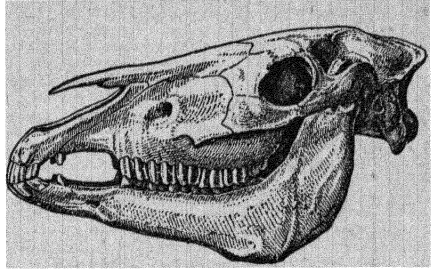
Horses grazing.

canine teeth, but these are generally absent in the mare. It is in the space between the foreteeth and the grinders that the bit is placed. By the state of the foreteeth, *i. e.* whether they are the first or the second ones, and by the amount of wear the permanent teeth have undergone, the age of the horse can be ascertained.

5. The food of the horse must be thoroughly ground, and this is done by the numerous **grinders** which are square and have several folds of hard enamel. The movement of the jaws is in the transverse direction as in the case of the ox.

6. The great **length of the skull** is accounted for by the long row of teeth which are set in the jaws.

7. For the reception of so large a quantity of food the horse has a large stomach as well as long intestines. It does not, however, ruminate like cattle.



The skull of a male Horse.

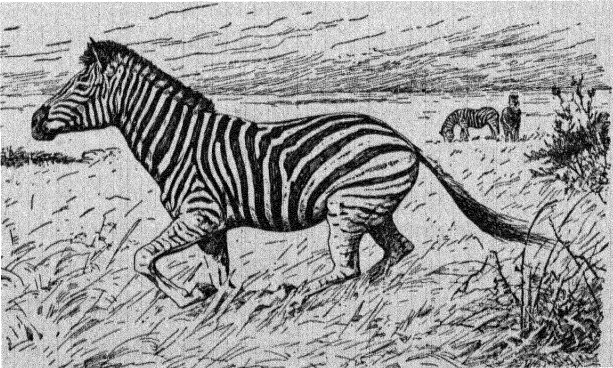
C. THE HORSE AND ITS ENEMIES. — The domesticated horse has no enemies except

the flies which it chases away in the same way as does the ox. In its wild state it had many enemies, of course, and the means of defence are still seen in the domestic animal. Its very keen **sense of hearing** warns it of danger. It can **bite** with its foreteeth and **kick** with its hind legs.

ALLIED SPECIES AND GENERA

The **Ass** (*E. asinus*) resembles the horse except that it is smaller in size, and different in colour. Other points of distinction are the long ears and the presence of a tuft of hair on

the tail. The ass is a very obstinate, but at the same time a weak animal.

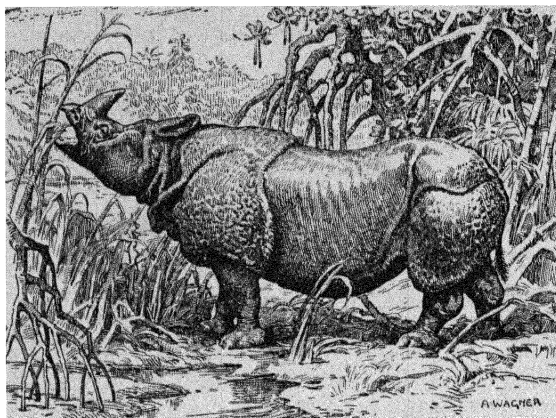


The Zebra in the steppe.

South and East Africa is the home of the **Zebra** (*E. zebra*), the skin of which is white, striped with black or red.

The **Rhinoceros** (*Rhinóceros indicus*) lives in swamps. Its feet have three toes. In the size and structure of its ponderous body, the pillar-like legs and the horny and thick skin it resembles the elephant. Like this

animal it can force its way through the most intricate jungle.



The Indian Rhinoceros in a swamp.

In the horn on its nose the rhinoceros possesses a dangerous weapon.

The **African Rhinoceros** has even two horns on its nose.

The **Tapir** (*Tápirus*) inhabits swampy forests of South America and South Asia.

IX. Order: — WHALES (*Cetáceæ*).

Hairless, fish-like mammals. Hind limbs absent, forelimbs fin-like, tail-fin horizontal.

THE FIN-WHALE (*Balænoptera sibbaldi*).

The Fin-whale inhabits the cold parts of the ocean round the North and South Poles. Whales of tremendous size have also been seen in the seas around India. One of them has received the name *B. Indica*, and it is not rare off the Baluchistan coast.

A. **SIZE.**—In a land-mammal the body is supported on four legs, like a bridge on its pillars. If the bridge is made very long the arch collapses on account of its own weight. This is different in a boat-bridge. Since the latter is supported on the water at all points, it can be made of any length. From this comparison we may understand that **water-animals may attain a size which no land-animal could reach.** The Giant-Whale is the largest of the whales, its length being often ninety feet and its weight about 150 tons (*i. e.* equal to that of about 200 heavy oxen).

As the boat-bridge does not require to be so firm and strong as a pillar-bridge, the body of the whale need not be so strong and rigid as that of land-animals. If a whale is accidentally

washed on shore, the activity of its lungs, its heart, and other internal organs will be so much disturbed by the pressure of the collapsing mass of flesh and fat, that the animal soon expires. Hence the whale can live in water only.

B. PRESERVATION OF HEAT.—No coat of hair, however thick, would be able to protect the animal from excessive loss of body-heat. This is done by a **layer of fat** one to two feet thick, which underlies the naked skin and envelops the whole body.

C. LOCOMOTION.—1. The whale, like the fish, has the **form of a boat**, and cuts through the water with ease. The long and pointed head passes straight into the cylindrical elongated trunk, and this again tapers into a long tail. For this reason the whale has been considered erroneously to be a fish.

2. The tail, as in the fish, is the most important means of locomotion. It ends in a large horizontal fin. When the animal sets this fin in rotating motion, it is propelled like a steamer by its propeller. An upward stroke of the tail causes the animal to ascend and a downward stroke to sink.

Near the tail-fin there is a small triangular dorsal fin.

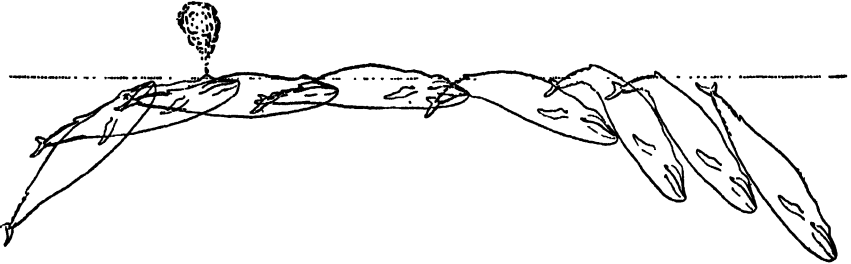
3. The **forelimbs** act as oars and help to steer the body, but there are no external hind limbs.

4. By the large quantity of **fat and oil**, permeating the porous bones, the weight of the gigantic body is considerably lightened, because fat is lighter than water.

5. The **surface** of the body being **smooth and rounded** the friction caused while gliding through the water is not exceptional. External ears are absent. The eyes which are about the size of a man's fist are situated not far from the angles of the mouth.

D. BREATHING.—Like all mammals the whale breathes the free atmospheric air. For the purpose of breathing it rises to the surface every three and half minutes. The whales have their **nostrils**, which are like narrow slits, on the top of the head. They have, therefore, only to raise the head a little above the surface of the water when they want to breathe. They then expel the used-up air through the nostrils, with a noise audible for a considerable distance. As the water-vapour, with which the air from the lungs of the whale is saturated, becomes visible in the cold atmosphere of the extreme latitudes, it appears as if a huge jet of steam was ejected from the *nostrils* of the animal.

The remarkably large **lungs** can take in an immense quantity of air, so that the animal requires to breathe only at regular intervals. When diving the nostrils are shut.



The Whale, rising up to the surface of the sea, breathing, and then again diving.

E. FOOD.—The whale feeds on small crabs and snails, of which there is great abundance especially in the cold seas. In order to satisfy itself such a huge animal is obliged to consume unlimited quantities of these little creatures. The toothless mouth is the instrument with which it catches the food. A row of narrow horny plates, which are called flakes or plates of baleen (whale-bone), is suspended from each side of the palate. On the inner side these plates are split into hairs which form a long and tufted sort of fringe. The lower part of the mouth is filled by the immovable enormous tongue. When the whale opens its mouth, the tongue is pressed down, the folds of the throat are smoothened, and the mouth is widened to a space which could easily accommodate a small boat.

When the whale seizes its food, it lowers the under-jaw, spreads the tongue well on the lower maxillary plate and advances quietly into the midst of a swarm of the minute creatures which it is about to swallow. The water with the animals contained in it enters into the mouth. When the whale then raises the lower jaw and distends the tongue in such a way that it fills the whole space of the mouth now closed, the water is gently pressed out; whereas the victims are caught in the fringes of the whale-bone plates and are forced into the gullet by the tongue. Thus the mouth forms an extensive fishing-net.

This adaptation of the mouth explains the large size of the head.

F. PROPAGATION.—The whale gives birth to a single young

one at a time which like the offspring of all mammals is suckled with milk for a period. The teats lie within deep pouches on the abdomen.

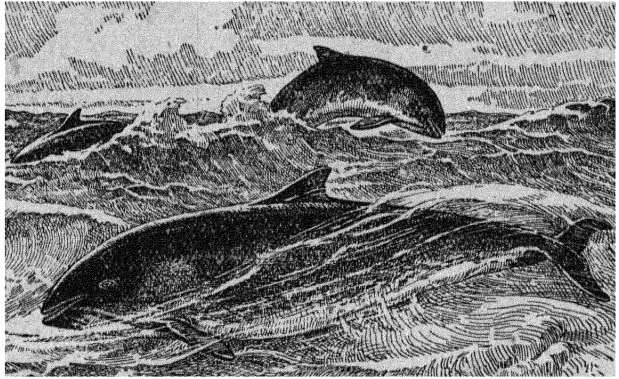
RELATED SPECIES AND GENERA

The Greenland Whale has whale-bone like the Giant Whale. But there is a group of whales with teeth, to which belong

the **Grampus** or Killer (*Orca gladiator*),

and the well-known **Porpoises** or **Dolphins** (*Phocaena Delphinus*)

which abound in the seas around India. Though their



Porpoises or Dolphins.

playful antics provide much entertainment to passengers on ships, they are detested by fishermen for plundering and tearing their nets. Another extraordinary member of the order is the **Narwhal** (*Mónodon monócerus*), the male of which possesses in the upper jaw a long straight tooth, in many cases even nine feet long. The **Sperm Whale** (*Physéter macrocéphalus*), which inhabits warm oceans and is occasionally seen in the Indian Ocean also, has a fatty substance deposited in the cavities of its enormous head. This fat is called spermaceti and is used in manufacturing candles, soaps, and ointments.

X. Order:— SEALS (*Pinnipédia*).

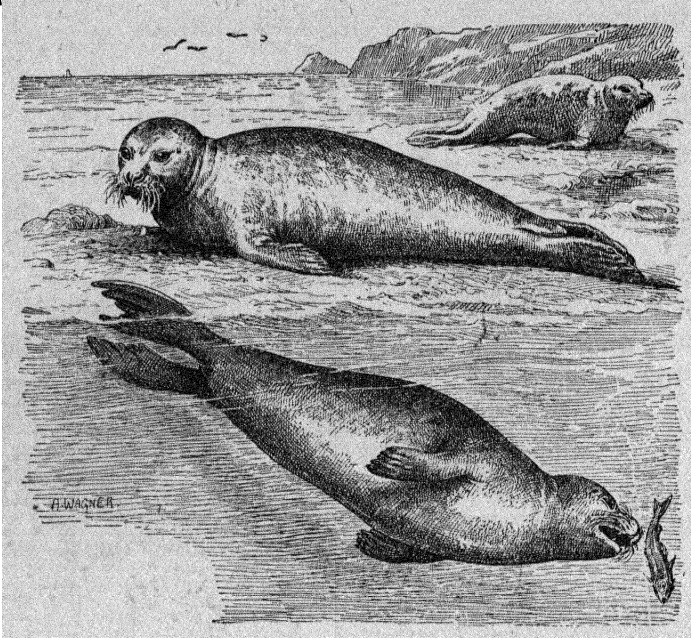
Hairy animals, leading chiefly an aquatic life. Body torpedo-shaped; fore and hind limbs fin-like.

THE SEAL (*Phoca vitulina*).

The Seals do not inhabit tropical regions, but are found on the coasts of polar seas. They live in water as well as on land, and, accordingly, combine the habits of land and water animals.

A. THE SEAL AS A WATER-ANIMAL.

1. Like the whale the seal is a **good swimmer** and diver. Its body has the form of a torpedo: its hands and feet form



Seals.

broad, fin-like plates. The feet are directed backwards. By striking them forcibly together the water lying between them is pushed back and thus the body driven forward. The forelimbs act as means of steering the body.

2. A thick **layer of fat** lying under the skin protects the seal from loss of body-heat. At the same time it lessens the specific weight of the body.

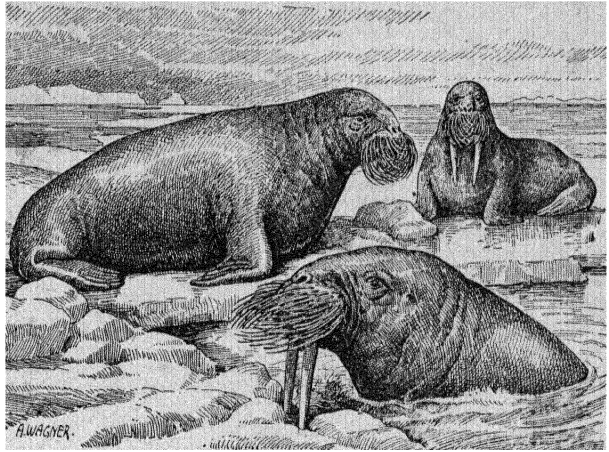
3. The **food** which the seal requires is supplied by the sea: it consists mainly of fish. Its rapidity and agility in swimming, its power of diving for long intervals, the keenness of the senses of sight and touch make the seal a successful robber. The dentition is similar to that of the beasts of prey.

B. THE SEAL AS A LAND-ANIMAL.

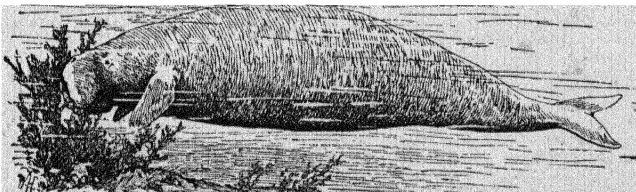
The shortness and direction of the feet make the movements of the seal on dry land very awkward. Consequently it is there helpless against its enemies (Polar bear and man) and as soon as it perceives their approach, it makes for the shelter of the sea.

RELATED SPECIES AND GENERA

The **Sea Lion or Walrus** (*Trichecus rosmárus*) has somewhat longer limbs than the seal and it can, therefore, walk, though awkwardly, like land animals. It possesses a powerful weapon in its two large tusks. These furnish a good kind of ivory. The skin and the fat of this big animal are, as those of the seal, turned to account by man.



Sea Lions or Walruses.



The Dugong or Mermaid.

The **Dugong** (*Halicore dugong*) inhabits the shores of the Indian Ocean feeding on vegetable substances. As it yields excellent

meat and a valuable oil, and is also defenceless, it has almost been exterminated in Indian seas.

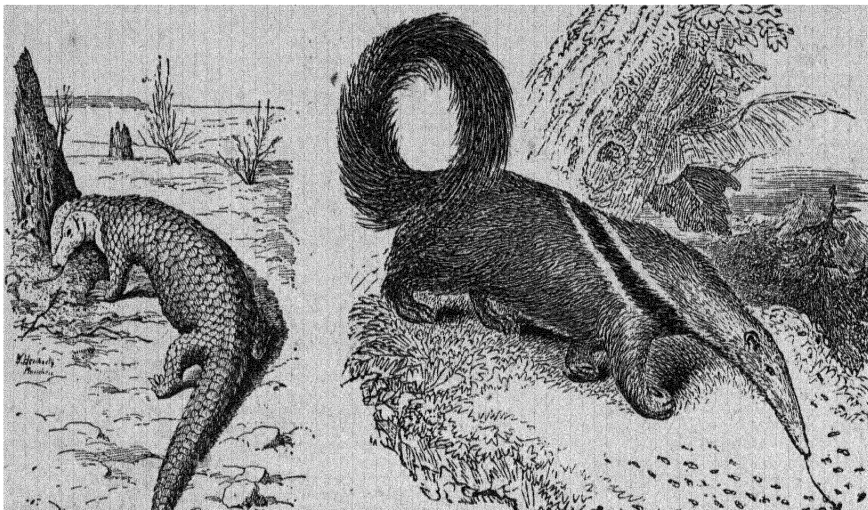
XI. Order:—TOOTHLESS MAMMALS (*Edentata*).

Teeth either absent or reduced. Digits very long and ending in long claws.

THE SCALY ANT-EATER OR PANGOLIN (*Mánts pentadactyla*).

The Ant-eater lives in India and Africa and feeds chiefly on ants and termites. With its powerful claws on the forefeet it opens the nests of those insects, and thrusts its long worm-like tongue into the struggling masses of ants. When these adhere to its sticky tongue, it draws it back into its mouth. This mode of feeding explains the tubular form of the face,

which is like a sheath for the tongue, the small opening of the mouth and the complete absence of teeth. This Ant-eater is covered with large imbricate horny scales. When alarmed it



The Scaly Ant-Eater.

The American Ant-Eater.

rolls itself up into a ball like the hedgehog, so that the sharp edges of the scales are presented in defence.



A family of the three-toed Sloth.

RELATED GENERA

South America possesses another **Ant-eater** (*Myrmecóphaga jubáta*) covered with gray bristles. The forefeet are turned inward when the animal walks, and are thus protected from wear. The **Sloth** or **Ai** (*Brádypus tridáctylus*) and the **Armadillo** (*Dásypus*) are also denizens of America. The habits of the Sloth are arboreal.

By means of its long, sickle-shaped claws it climbs up trees or hangs for days together on a branch with its back turned downward. With its long arms it detaches leaves and fruits which constitute its food.

XII. Order:— POUCHED ANIMALS (*Marsupialia*).

Mammals provided with an abdominal pouch, in which the young are suckled during their early life.

THE GREAT KANGARU (*Macropus giganteus*).

This animal is an inhabitant of the bush and the grassy plains of Australia. The hind limbs much exceed the forelimbs in size and power. The Kangaru, accordingly, moves by a series of leaps. When reposing, it sits on the hind legs using the tail as prop. Only when it licks up food from the ground, while limping slowly forward, it supports itself also on the weak forelimbs, which at other times are used like hands.

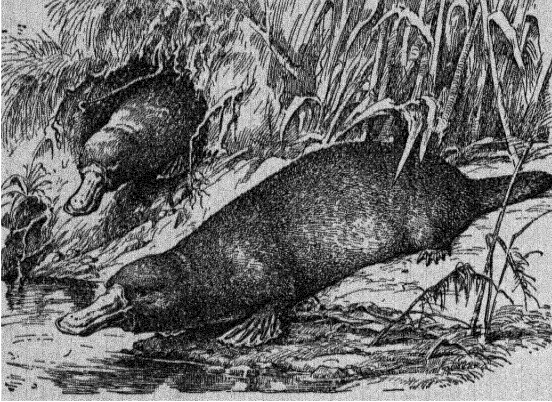


The Kangaru.

The dentition is that of a herbivorous animal. The head resembles that of the deer.

The young of the kangaru are born in a very imperfect state. Although the full-grown animal attains the height of a man, a young one at birth is not even an inch long. It is perfectly naked, blind, and possesses very rudimentary limbs. The helpless creature is still in need of special care, and this is provided for by the mother which carries it about in a pouch on the under side of its body.

Pouched mammals like the kangaru, the **Wombat**, the **Pouched Wolf**, and others are characteristic of Australia. Geological discoveries prove that these animals in long-past ages were common all over the world. But they were exterminated in their struggle with more evolved and stronger animals.



The Duck-Mole.

mammal with a beak like that of a duck. It lays eggs instead of bringing forth the living young.

Only in the isolated continent of Australia were they able to survive up to the present day, because no other large mammals have existed there.

Another strange animal characteristic of the Australian fauna is the **Duck-Mole** (*Ornithorhynchus anatinus*), a

Second Class: BIRDS

(*Aves*).

Birds differ from one another in various respects; but all agree in their most essential features: with few exceptions **all have the power of traversing the air by flight.**

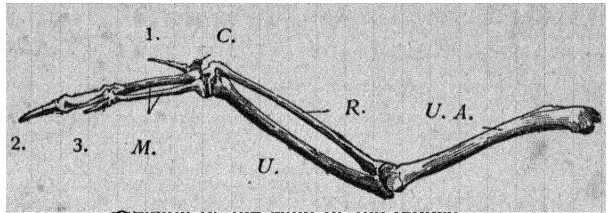
1. **BODY.**—As a ship ploughs its way through the waters, the bird cleaves the air. Its body has the shape of a torpedo.

2. **THE TAIL** serves the bird as a rudder.

3. **THE FORELIMBS** consist of the same number and kind of bones as those of the mammals. But they are transformed into wings, *i. e.*, into the oars of an air-ship, admirably adapted to propel the bird forward in the air. Flight is the most

difficult addition of n to carry weight. The for this plied l tive m breast the b ably

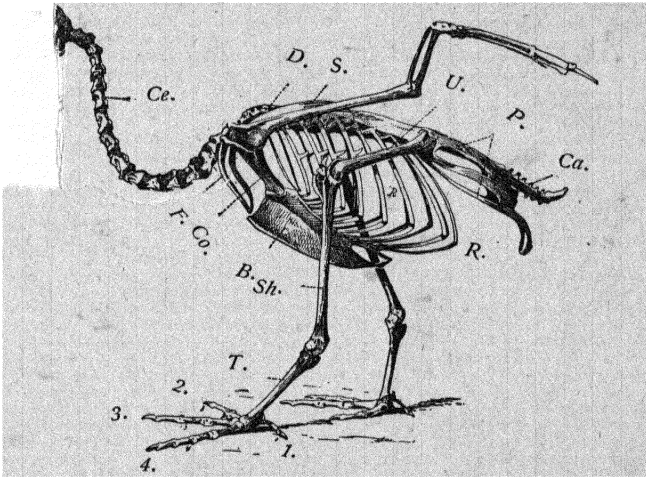
l kinds of motions, for the flying animal in exer- has hole ody. ired sup- fec- the to



Skeleton of the wing of the Goose.

U. A. Upper arm. R. Radius. U. Ulna. C. Carpals.
M. Metatarsals. 1, 2, 3. Fingers.

, the surface of which is increased by a remarkable or crest.



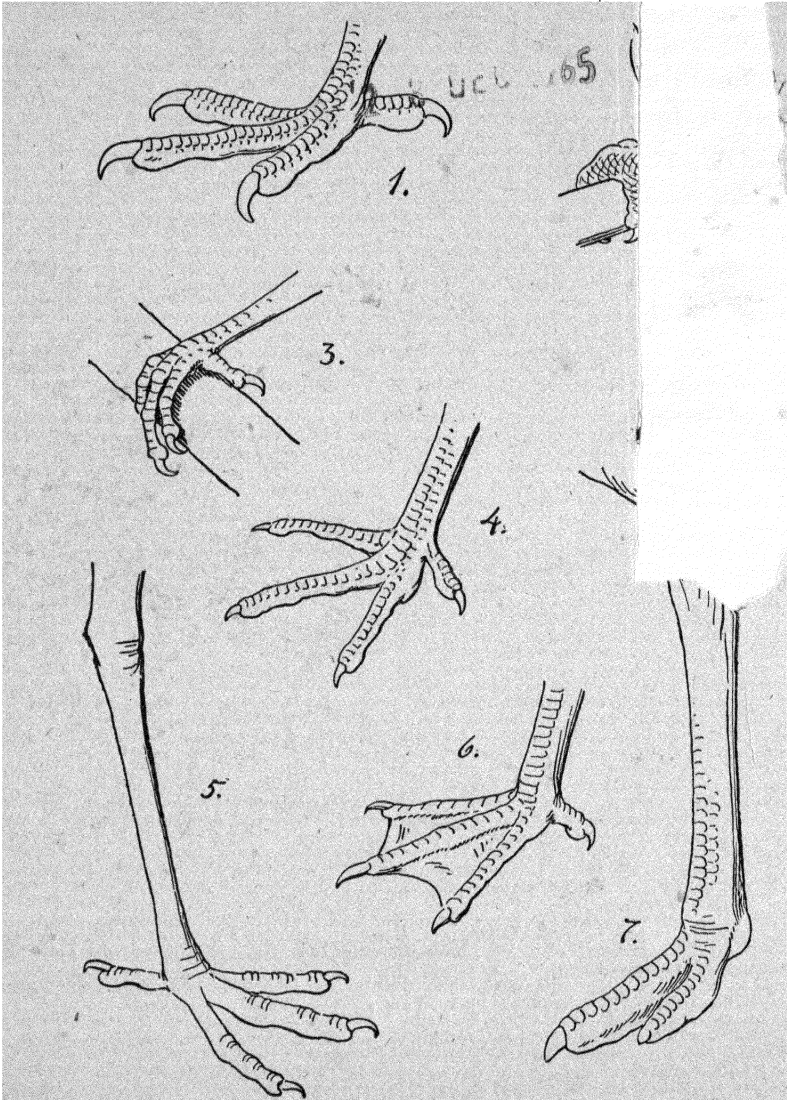
Skeleton of the Goose.

Ce. Cervical, D. Dorsal, Ca. Caudal Vertebrae. S. Shoulder-blade.
Co. Coracoid. F. Forked bone. B. Breastbone with its crest. R. Ribs. P. Pelvis.
U. Upper thigh. Sh. Shank. T. Tarso-metatarsus. 1, 2, 3, 4. Toes.

4. THE HIND LIMBS are instruments for locomotion on the ground and in water or for obtaining a hold on solid objects. Accordingly, they are not developed into wings, but take the form of legs. The parts of the bird's legs are the same as in the mammal; the metatarsal bones, however, coalesce and form a long tubular bone. All birds walk on their toes, and as these are very long and can be widely spread, the surface of support is enlarged. Since the birds stand only on two limbs, the surface

of support is naturally small, and it is of great importance to it that this surface is thus enlarged.

nce to it



Feet of different birds.

1. Seizer (Eagle).
2. Climber (Parrot).
3. Percher (Sparrow).
4. Scratcher (Hen).
5. Wader (Crane).
6. Swimmer (Duck).
7. Runner (Ostrich).

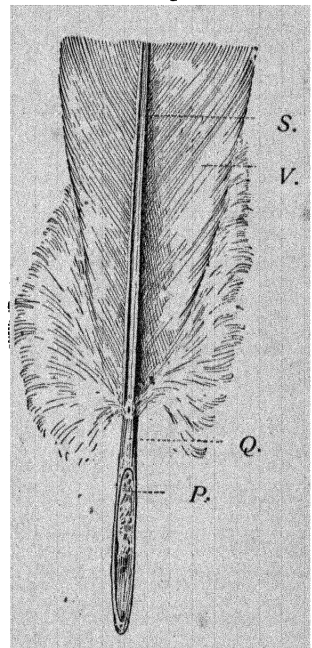
5. HEAD AND NECK.—As the legs are primarily used for the purpose of locomotion like the wings, they are little adapted for other functions, such as the collection of food, the building

In the absence of teeth the task of crushing the food is performed by the **stomach**. This is either a very muscular bag, as the **gizzard** of the pigeon, which grinds the food like the stones of a mill, or it is a membranous sac as the **retort-stomach** of the kite in which the food is dissolved by acid gastric secretions.

9. THE HEART is constructed on the same plan as in mammals.

10. FEATHERS.—Birds are warm-blooded creatures and the heat of their blood must be kept at an even temperature. If the heat of their blood sinks considerably below the normal temperature, the vital activity of the body is interrupted or ceases. Hence birds, like mammals, require special means for the preservation of their body-heat, and these are provided by the feathers which are so arranged as to leave numerous spaces between them and thus encase the air.

a) KINDS OF FEATHERS.—The plumage consists of two kinds of feathers, namely: **down-feathers** which form an under-coat, and larger **clothing-feathers** constituting an upper covering. The latter shut off the layer of warm air enclosed by the soft down from the outside. The large feathers at the posterior margin of the wings are called **flight-feathers**, those at the tail **tail-feathers**.



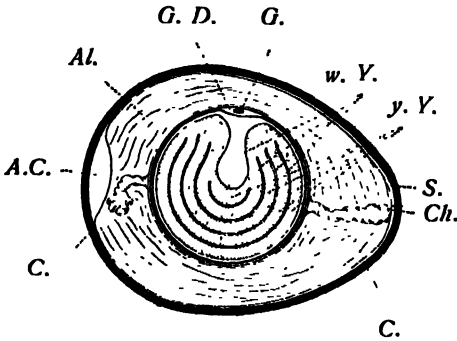
Lower portion of a
Quill Feather.

S. Shaft. Q. Quill.
P. Pith. V. Vane.

b) PARTS OF A FEATHER.—Each fully developed feather consists of the following parts: a firm **stem** and a broad flat blade or **vane**. The lower part of the stem is generally transparent and hollow and is known as the **quill**, whereas the upper part, the **shaft**, contains a pith-like substance. The (vane) blade is made up of numerous horny plates, the **barbs**, placed obliquely along the shaft, and hooked together at their flat sides by extremely delicate oblique filaments, the **barbules**.

c) **MOULTING.**—As a rule, birds **change their plumage** in certain seasons. This process is known as moulting.

d) **LUBRICATION OF PLUMAGE.**—If the feathers were wetted by rain, they would increase the weight of the body and be disturbed in their function of conserving the body-heat. To prevent this, the bird lubricates its feathers from time to time with a fatty or oily substance secreted by a special gland found in all birds at the root of the tail. The length of the neck enables the bird to use the beak as comb and brush combined.



Structure of the Hen's egg.

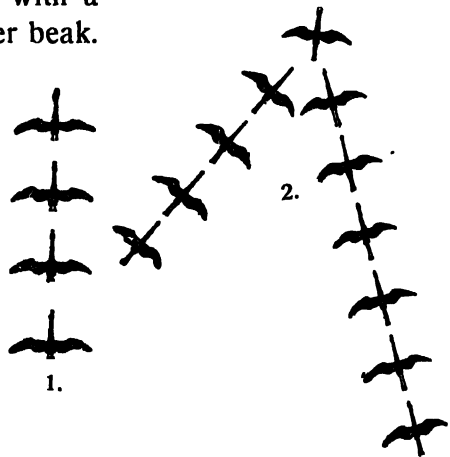
G.D. Germ-disk with the Germ *G.* *w.Y.* and *y.Y.* white and yellow Yolk, surrounded by the Yolk bag. *Al.* Albumen, the white of the egg. *C.* Cords which hold the yolk in position. *Ch.* Chorion, a fine membrane within the calcareous shell *S.* *A.C.* Air-chamber.

11. REPRODUCTION AND CARE OF THE BROOD.

All birds are born from eggs. These are laid in nests more or less artistically constructed and hatched by the physical heat of the female or of both parents. When the young is sufficiently developed, it chips the calcareous shell with a sharp tooth that is on the upper beak.

The young are either helpless and depend for a time on parental nurture, or they are independent from the moment of their liberation from the egg.

12. **CHANGE OF HABITAT.**—Dearth of food impels some birds to migrate. Thus in India we get many winter-visitors from cold northern countries. Others rove about the country mostly in flocks in search of food.



Common order of flying of

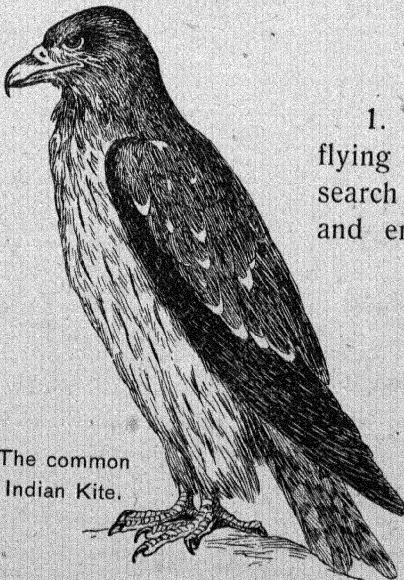
1. The Wild Duck. 2. The Crane.

13. SYNOPSIS OF THE BIRDS.

| Orders | Examples |
|---|---|
| <p>a) Aerial Birds:</p> <ol style="list-style-type: none"> 1. Birds of Prey 2. Woodpeckers 3. Cuckoo-like Birds 4. Parrots 5. Swift-like Birds 6. Sparrow-like Birds 7. Pigeons <p>b) Ground Birds:</p> <ol style="list-style-type: none"> 8. Fowl-like Birds 9. Cursorial Birds <p>c) Water Birds:</p> <ol style="list-style-type: none"> 10. Wading Birds 11. Swimming Birds | <p>Common Kite, Vulture, Owl. Golden-backed Woodpecker, (Barbet). Indian Cuckoo, Koel, Crow Pheasant, (Bee-Eater, Hornbill, Hoopoe). Paroquet, Cockatoo. Swift, Salangane, Goatsucker, Humming Bird. Sparrow, Swallow, Sun-bird, Lark, Warbler, Wagtail, Magpie, Robin, Fly-catcher, Maina, Oriole, Shrike, Drongo, Bulbul, Crow. Domestic Pigeon, Turtle-Dove.</p> <p>Domestic Fowl, Peacock, Pheasant, Quail. Ostrich.</p> <p>Adjutant, Stork, Paddy Bird, Snipe, Lapwing, Crane, Moorhen. Domestic Duck, Flamingo, Pelican, Sea-Gull, Penguin.</p> |

I. Order: — BIRDS OF PREY (*Raptatōres*).

Upper mandible hooked at the end and overlapping the lower. Feet with large curved talons. Young helpless.



The common Indian Kite.

FALCONS (*Falconidae*).

THE COMMON INDIAN KITE

(*Milvus Gōvinda*).

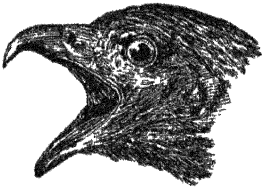
1. The Indian Kite is often seen flying about villages and towns in search of food. Circling high in the air and emitting the well-known squealing call, it surveys its hunting ground. Nothing that passes on the ground escapes the **keen eye** of this bird. It is the special enemy of our domestic chickens.

2. When the opportunity offers itself, the bird

approaches its prey with great rapidity and swoops down upon it,

head foremost and using the forked tail as parachute. The bird is provided with powerful **wings**, which when extended measure about four feet. In an instant the prey is seized and carried away.

3. The kite seizes the prey firmly with its long and powerful **toes**, three of which are directed forward and one backward. The sharply pointed, long claws pierce the body of the victim like daggers. Thick pads under the toes prevent these weapons from becoming blunt when the bird alights, and the upper side of the toes as well as the front side of the legs are covered with a strong armour of horny yellow plates, so that bites of the captured animal cannot hurt it.



Head of the Indian Kite.

4. The struggling victim is finally killed with a few powerful strokes of the curved and pointed **beak** on the skull. As the upper half of the beak projects beyond the edges of the lower, the two halves with their sharp edges form two pairs of scissors. If the victim is not small, as for instance a crow, the kite holds it fast with its feet and tears it into pieces.

5. Small animals, such as mice, are swallowed whole. Indigestible materials, such as hairs, feathers, etc., are vomited in the form of pellets.

6. The **nest** of a kite consists of a few dried sticks clumsily put together in a lofty tree. Being a strong bird it is seldom attacked by others except by crows and then only by a large number so that it has no chance of success in the struggle.



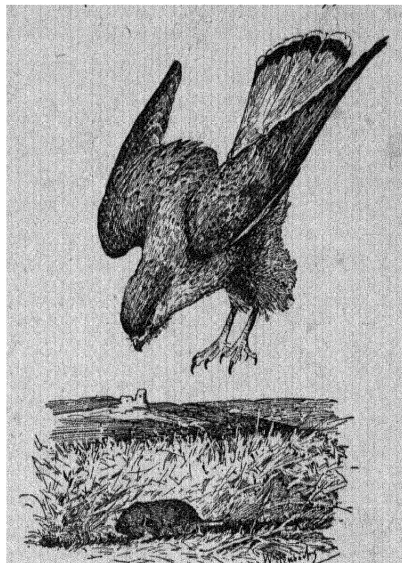
The Goshawk on its nest.

RELATED SPECIES AND GENERA

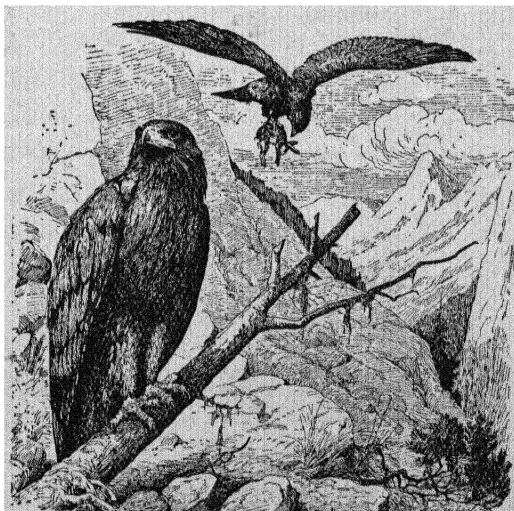
A number of kites, harriers, hawks, falcons, and eagles are

found in India, whose mode of life is very much like the one which we have described above, so the **Brahmany Kite** (*Haliastur indus*), **Common Buzzard** (*Buteo desertorum*), the **Goshawk** (*Astur palumbarius*) and **Sparrow Hawk** (*Accipiter nisus*), the **Peregrine Falcon** (*Falco peregrinus*), and the **Kestrel** (*Tinnunculus alaudarius*).

The **Sea Eagle** (*Pandion haliaëtus*), the **Golden Eagle** (*Aquila chrysaëtus*) and the **Bearded Vulture** (*Gypaëtus barbatus*) are of large size. The Sea Eagle feeds exclusively on fish and is found in well-watered places. Its plumage is brown above; the head, neck, and under surface are white with many brown spots. The Golden Eagle inhabits the mountains of Asia and Europe and is found in the Himalayas. Its size, its handsome, dark-brown plumage,



The Common Kestrel, perching on a rat.



The Golden Eagle.

its bold, fiery eye, its powerful claws, and its majestic flight fully entitle it to be called the “king of the air”. As the symbol of strength and power, this magnificent-looking creature figures in the coat of arms of many royal dynasties.

VULTURES (*Vulturidae*).

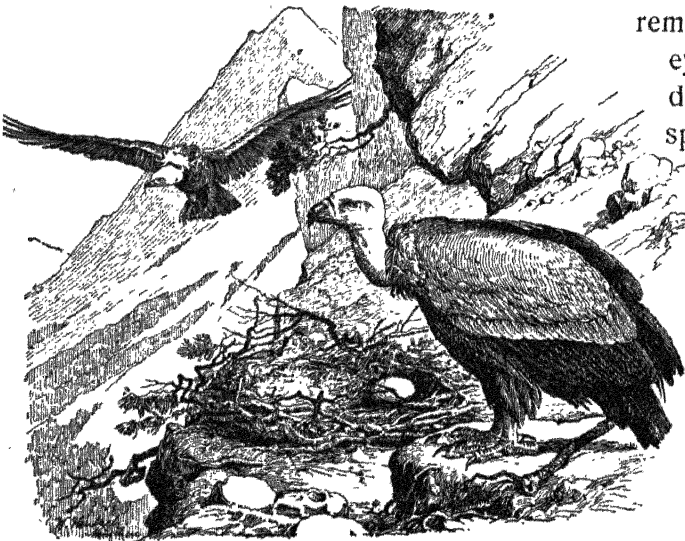
THE CONDOR

(*Sarcorhampus gryphus*).

This gigantic bird inhabits the Andes of South America. Its plumage is black, only the large flight-feathers and the downy ruff are white.



The Condor, near a carcass.



The White-necked Vulture or Griffon. (*Gyps fulvus*).

The male has a red fleshy comb on the forehead. The weak toes with their short and blunt claws indicate that the Condor is not a true raptorial bird. It feeds on carrion like all other vultures. Its enormous wings enable it to traverse wide distances in but a short time and to rise to a height, in which it appears to the human eye only as a small speck. Having sighted a carrion with its remarkably keen eye, the bird descends in spiral curves. By the aid of its strong beak, which terminates in a sharp hook, it tears the carcass open and thrusts the

long naked neck into the cavity of the dead body. Vultures generally alight on a carcass in flocks and each bird devours as much as it possibly can on the spot, since there would be nothing left on the morrow and it may be days before another feast is provided. Scarcely able to move, the birds then rest a while, and afterwards fly to the water in order to drink and clean their blood-smeared feathers.

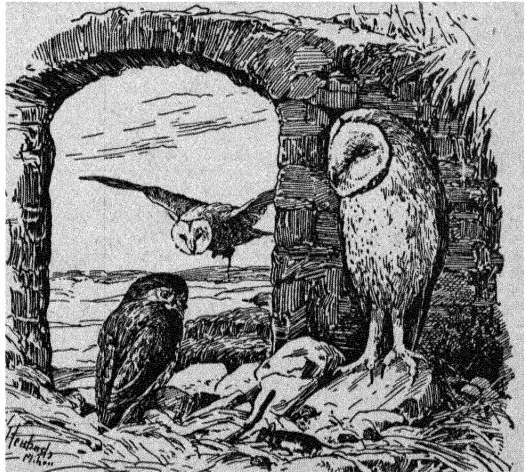
Vultures abound throughout India. The commonest are the **Black Vulture** (*Otogyps cálvus*), the **White-backed Vulture** (*Pseudogyps bengalénsis*), the **White Scavenger Vulture** (*Neóphron ginginiánus*), and the **Griffon** (*Gyps fúlvus*).

OWLS (*Strigidae*).

THE BARN OWL (*Strix flámmea*).

The Barn Owl of world-wide distribution feeds chiefly on rats and mice and ought, therefore, to be protected. The structure of its body is peculiar, but is well adapted to its mode of life. Like the kite it possesses a hooked beak and raptorial feet, but being a **nocturnal bird** of prey its structure differs from that of diurnal birds in many points.

1. It spends the day asleep in some safe hiding place, such as a barn, a rock cavern, a temple or an old building. Its **dusky plumage** makes it almost indistinguishable in those dark places, and quite unnoticeable at night. It is gray on the back, rufous below and speckled with white and black spots. Around the eyes the feathers are arranged in a heart-shaped veil.



The Barn Owl and the Little Owl (*Athéne nóctua*).

The bird also breeds in these hiding places. It does not, however, build a nest, but simply lays its eggs on the ground.

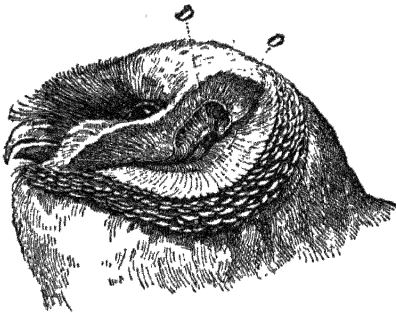
2. With the approach of night the owl is roused to acti-

vity. Its **eyes** are very large, and the pupils can be dilated to a considerable extent. Accordingly they are able to receive a sufficient amount of light-rays even at night. While engaged in pursuit of prey, the owl flies rather slowly and at a small height above the ground. Both eyes being **directed forward**, and hence turned downward to the ground when flying, it can easily search for prey on the surface of its hunting ground.



The foot of the Barn Owl.

3. Another aid in hunting is afforded by the acute sense of hearing. The **large openings of the ears** are closed with **membranous flaps** which during flight are turned forwards. The feathers of the veil together with the opened flaps act as receivers of sound like the external ears of mammals.



The Head of the Barn Owl with opened ears.

D. Ear-cover. O. Opening of the ear-passage.



The Spotted Owllet.

4. The flight of the owl being very silent, the least sound does not escape its notice. This noiseless flight is due to the thick, **soft and loose plumage**.

RELATED SPECIES AND GENERA

The largest owl is the **Huhua** (*Bubo maximus*) which even attacks rabbits. It has a tuft of erect feathers on the ears.

The **Rock Horned Owl** (*Bubo bengalensis*), so often seen sitting on rocks or trees in hilly country, the **Scops Owl** (*Scops giu*) and the **Spotted Owlet** (*Athene brama*) are widely spread in India.

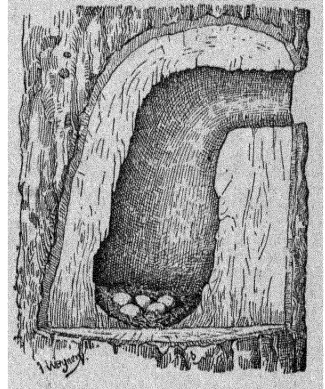
II. Order:—WOODPECKERS (*Pici*).

Beak straight, long, chisel-shaped. Tongue thin, capable of being widely stretched forward. Feet scansorial. Young helpless.

THE GOLDEN-BACKED WOODPECKER (*Brachypternus aurantius*).

1. **PLUMAGE.**—This handsome bird derives its name from the colour of the plumage on the upper back which is beautiful golden yellow. The head and crest are crimson and the lower back and tail are black, whilst the wing feathers are black and yellow.

2. **HABITS.**—It is exclusively arboreal in its habits. Trees provide its breeding place as well as resting place at night. After finding a hollow tree it makes with its beak a neat round passage leading to this hollow. The eggs, which are white, are deposited in this cavity and incubated alternately by both parents. Trees also provide it with food; this consists of all kinds of insects and their larvæ, which burrow in the bark and wood of trees.



The nest of the
Spotted Woodpecker
(*Dendrocopus*).

3. **STRUCTURE.**—The woodpecker is remarkably well adapted to do the work which nature has given it.

A tree longitudinally cut.

a) Its **toes** are armed with sharply-pointed claws, which can hook themselves into the smallest crevices of the bark.

The **feet** are **scansorial**, *i. e.*, they are adapted for climbing. Two toes are directed forwards and two backwards. Whilst the body is, as it were, suspended by the former, the latter support it and prevent it from gliding down.

b) The **tail** serves as a prop for the body acting almost as a third leg, when the bird hangs at the side of a trunk.

This is possible because the tail-feathers are very strong and stiff.



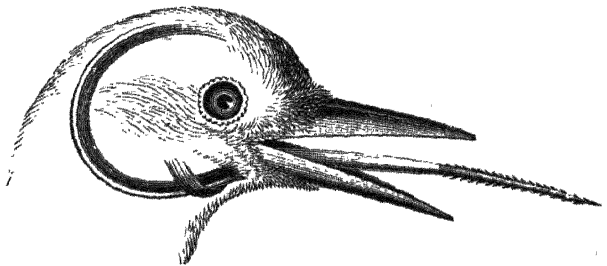
The golden-backed
Woodpecker.

c) To get at the insects below the bark and in the wood it hammers at it with powerful blows. Its **head** is the hammer and the beak its chisel. With this excellent instrument it is able not only to peel off the bark, but also to split open hard wood. This bird is, therefore, aptly called the “hewer of wood”.

d) The **beak** is long, straight and wedge-shaped. The upper mandible is specially strong and projects over the lower, terminating in a sharp and hard chisel.

e) The short **neck** enables it to deal well-directed blows, the force of which is enhanced by the weight of the hammer—the head—to which the beak is rigidly fixed.

f) Even more useful than the beak as a weapon is the woodpecker's **tongue**. It is extremely long and can be stretched out widely. It is, moreover, very thin and flexible so that the woodpecker can insert it into the borings of grubs and follow their windings. Larger insects



Head and neck of a Woodpecker, showing the
structure of the tongue.

are pierced by the horny tip of the tongue which is studded with barbs. Smaller insects are glued to the tongue by a very sticky saliva covering the whole tongue.

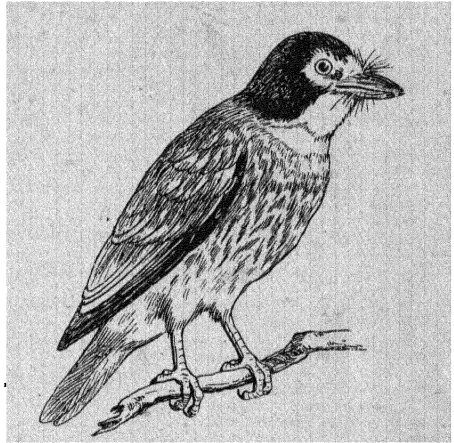
4. There is no other creature which is equally capable of

destroying the insects so injurious to trees. The woodpecker, therefore, well deserves our protection.

RELATED BIRDS

Other well-known woodpeckers are the **Wryneck** (*Jynx torquilla*), the **Pied Woodpecker** (*Dendrocopus*) and **Green Woodpecker** (*Gecinulus*), found in the hill tracts. Another common Indian woodpecker is the **Yellow-fronted Pied Woodpecker** (*Liopicus Mahrattensis*).

The **Barbets** (*Capitonidae*) resemble the woodpeckers in having two toes, the first and fourth, directed backwards, but differ in several structural characters as well as in appearance and habits. They are fruit-eating birds. One of them, the **Green Barbet** (*Thereiceryx viridis*), is often found on banyan trees looking for their figs and is to be recognised by its disyllabic call sounding like *kutru, kutru*. Another common Barbet is the **Crimson-breasted Barbet** or **Copper-smith** (*Xantholæma hæmatocéphala*), which has a monosyllabic call.



The Copper-smith.

III. Order:—CUCKOO-LIKE BIRDS (*Cuculidæ*).

Beak usually long. Tongue short and fleshy. Feet scansorial or of the perching type with reversible toes. Young helpless.

THE INDIAN CUCKOO (*Caculus micropterus*).

The Indian Cuckoo is distributed all over India, and its well-known call is frequently heard in the months of April and May. It sounds somewhat like *uppu pope* (fa, me, fa, ray). On account of its shy habits one rarely gets a sight of this bird.

It is about the size of a dove. Its plumage is ash-gray above and grayish-white with many black transverse bars on the under side. One of the three anterior toes can be turned back-

wards, so that the bird is able to maintain an equally firm hold on either thick or thin branches. All sorts of insects, largely the long-haired caterpillars, form its food. Accordingly, it possesses a rather weak bill. Since these insects are very injurious to the forests, and the cuckoo destroys immense quantities of them, it is a very useful bird.

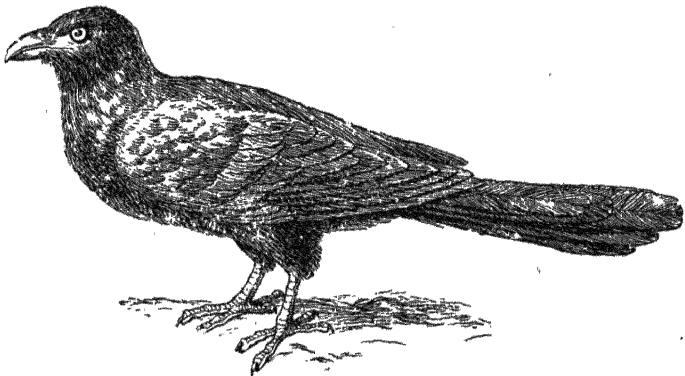


The Cuckoo.

A great peculiarity in the cuckoo is that it is **parasitical**, which means that it does not build a nest of its own, but lays its eggs in the nests of other birds, one in each, and leaves the task of hatching

them to the owners of those nests. The young cuckoos are reared and fed with small caterpillars by the foster-parents along with their own progeny. Gradually the young intruder grows so much that it requires more room and ejects its foster-brethren from the nest. Having become fledged it leaves its foster-parents for good.

One of the best known Cuckoo species of Southern India is the **Koel** (*Eudynamis honorata*), the male being glossy-black



The Crow-Pheasant.

and the female black and spotted white. It is a bird of many cries, the commonest of which is a crescendo *kuil, kuil, kuil*,

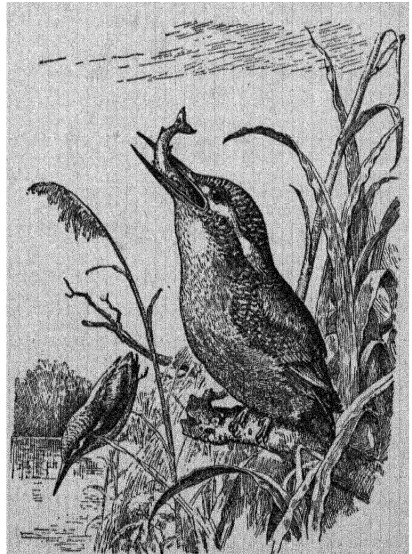
and from this the bird derives its name. Another cry is uttered like *kuk, kuu, kuu, kuu, kuu*. The loud note of this bird may be heard from March to July, especially about dawn. The koel lays its eggs in the nests of crows. Another common cuckoo is the **Hawk Cuckoo** or Brain-fever Bird (*Hierocócyx várius*), so called from the monotonous repetition of its call-note in the hot season, commencing low down the musical scale and then ascending higher and higher.

The Coucal or **Crow-Pheasant** (*Centrópus sinénsis*) is distinguished by having a long hind claw. Its call-note sounds like *kupulu*. The bird is of pretty large size and a fair imitation of a pheasant. It is not unfrequently seen in hedges hunting insects and reptiles.

Distant relations of the Cuckoos are the following common birds:—The **Bee-eater** (*Mérops viridis*), a beautiful little green bird of gregarious habits, often seen sitting on telegraph wires. The two middle feathers of the tail project as two black bristles a couple of inches beyond it. There is also a blue-tailed species (*M. Philippinus*) of larger size, and with a rusty-coloured throat, usually found near water.

Of the Kingfishers the common **Kingfisher** (*Alcédo ispida*)

is distributed generally in India. It is a very handsome bird: the upper side brilliant metallic-blue; the lower side orange-rufous; chin and throat white; feet brick-red; beak black. As its food consists of fish, crabs and water-insects, it lives near the water. It sits motionless on a branch above the surface of water, when suddenly it dives into the water, head foremost, to catch a fish, which it can hold fast with its large sharp-edged beak. The feet are adapted for perching: there are three toes directed forwards and one backwards.



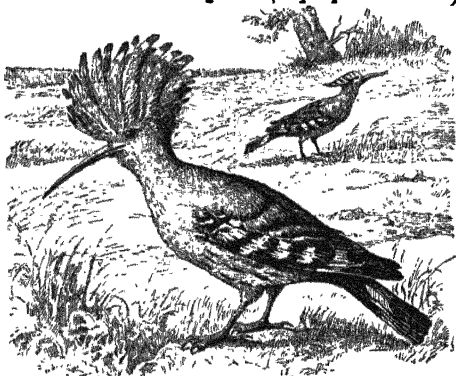
The Kingfisher (*Alcédo ispida*).

Other kingfishers are the **White-breasted Kingfisher**

(*Halcyon smyrnensis*) and the **Brown-headed Kingfisher** (*Pelargopsis gúrial*).

The **Gray Hornbill** (*Lophoceros biróstris*) is a frugivorous bird, breeding in hollow trees. On its beak are large horns.

The **Hoopoe** (*Upupa indica*) frequents pastures in order to



The Hoopoe (*Upupa epops*).

pick up larvæ from the dung of cattle. The general colour of the plumage is brown, wings and tail are black, transversely banded with white. When lying on the ground, as it does at the approach of danger, it is hardly distinguishable from the soil. The head bears a crest of feathers which the bird can erect at will.

The **Indian Roller** (*Coracias indica*) is a familiar bird, conspicuous by its blue plumage.

IV. Order:— PARROTS (*Psittaci*).

Upper mandible less in length than in height, very movable. Lower mandible short and broad. Tongue thick and fleshy. Feet scansorial. Young helpless.

THE ROSE-RINGED PAROQUET (*Paldeornis torquátus*).

The Green Paroquet is a well-known Indian bird. Its ordinary haunts are the forests, where it builds its nest on trees.

1. The **plumage** is green. Hence the paroquets are rendered almost invisible in the dense crowns of the trees.

2. Their **flight** is swift like an arrow's, and while they fly they utter loud screams. But within the tops of trees such flight is impeded. There they **climb** from branch to branch. Their feet are constructed like those of the woodpecker and the cuckoo. The beak, the upper mandible of which is hook-like curved and projects considerably beyond the lower, is of great service in climbing.

3. Its **food** consists exclusively of fruits and seeds. By the aid of its strong beak it can crack the hardest nuts and

seeds. The thick, fleshy, mobile tongue makes the peeling of seeds easy. And should the objects be somewhat large, even the feet are used, like hands, for the purpose of holding the object.

4. Paroquets are not much liked by the farmer, because they do great **mischief** in fields and fruit gardens, which they invade in large numbers. "They destroy more than they eat, since they have a way of breaking off a head of corn, eating a few grains, and then attacking another head."

5. On account of their beautiful plumage, their amusing antics, and their capability of imitating words and even sentences, they are kept as **cage birds**. And, in fact, they thrive exceedingly well in captivity.

ALLIED GENERA

The best talker is the **Gray Parrot** of West Africa (*Psittacus erithacus*). The **Araras** of South America are distinguished by their great intelligence, variegated plumage in which blue and red predominate. The home of the **Cockatoos** (*Cacatuidæ*) which have a light-coloured plumage and an erectible crest of feathers on the head, is Australia. The neat little **Love Birds** (*Psittacula passerina*) are known for the great affection they show for one another.



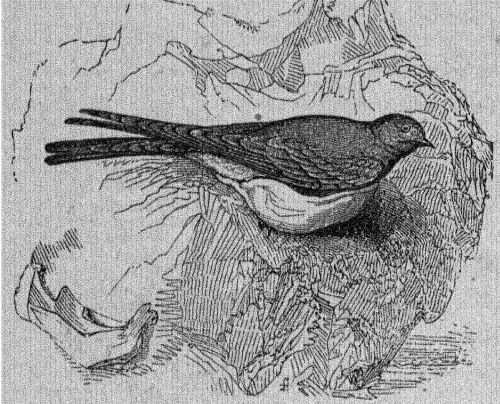
The rose-ringed Paroquet.

V. Order:—SWIFT-LIKE BIRDS (*Macróchires*).

Beak broad and short, or slender and long. Wings very long. Feet very short. Unable to climb, hop, or run, but excellent flyers. Young helpless.

1. The **Indian Swift** (*Cypselus affinis*) resembles the swallow in structure and habits. The wings are very long and

sickle-shaped, the tail deeply notched, the plumage dark. It is, like the swallow an exceedingly good "sailor", and captures its food, consisting of small insects, on the wing. But its feet, unlike those of the swallow, have all the four toes pointing forward, which does not permit the bird to walk on the ground,



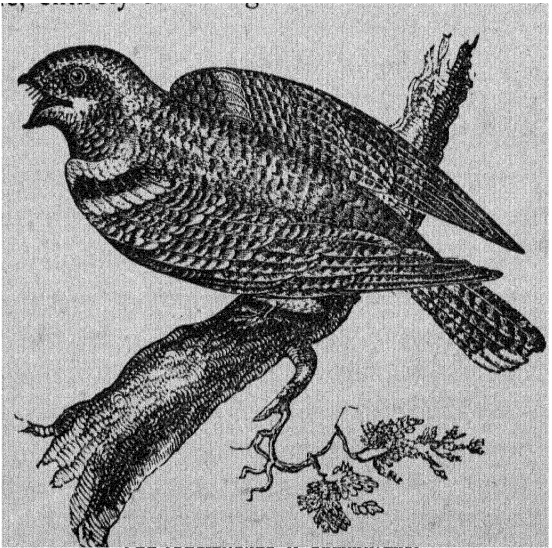
The Salangane.

or to perch on trees. It can only use its feet to hook itself on to walls and palings. The nest is a cup-shaped structure usually built on the side of a wall or a cliff, of grass, straw, feathers and the like snatched by the bird while on the wing and cemented together by its saliva.

2. Salanganes (*Collocalia*) build their

nests, which are edible, entirely of their glutinous saliva. Their home is the Sunda Islands.

3. The **Nightjar** or **Goatsucker** (*Caprimulgus*) is nocturnal in its habits, like the owl. It, therefore, resembles in its structure partly the latter, partly the swift. A characteristic feature is the deeply cleft mouth and a very short beak.



The Goatsucker (*Caprimulgus*).

4. The **Humming Birds** (*Trochilidae*) are small birds of America with resplendent plumage. Their habits are like those of the Indian Sun-bird.

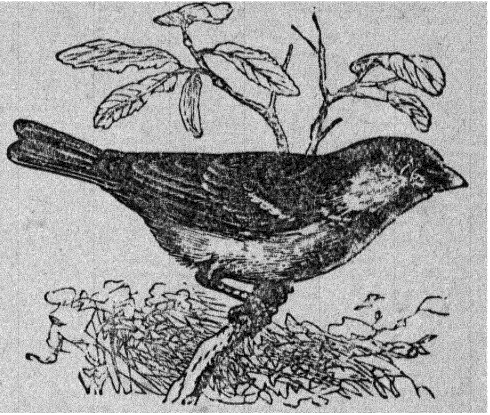
VI. Order:— SPARROW-LIKE OR SINGING BIRDS (*Pásseres*).

Legs unfeathered, covered with horny plates. Foot with three anterior and one posterior toe, the two outer toes united at the base of the first phalanx (adapted for hopping). Lower larynx well developed, most of these birds being capable of singing. Young helpless.

FIRST FAMILY: FINCHES OR SPARROWS (*Fringillidæ*).

THE SPARROW (*Pásser domésticus*).

a) The House Sparrow associates itself universally with the dwellings of man and is found all over the world. Its food consists chiefly of grains which it can easily pick and unhusk by means of its short, thick, and conical beak. Its young are fed with caterpillars, grubs and other insects, which the parent birds also largely feed upon. The feet, in which three toes are directed forwards and one backwards, are exceedingly well adapted for perching on branches. The



The House Sparrow.

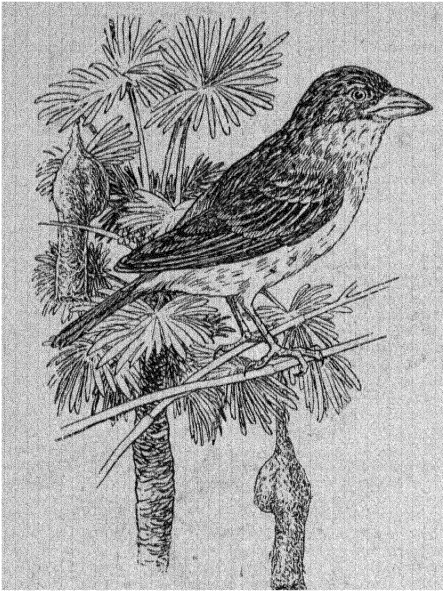
sparrow is a sturdy little bird and hops along the ground instead of walking. The brown-gray plumage is in the male distinguished by a large black spot at the throat. The untidy nest is preferably built under gables.

b) The familiar **Canary** (*Serinus canarius*) has its original home in the Canary Islands. The wild bird has a greenish-yellow plumage with black stripes, whereas the tame bird is uniformly yellow. The change of the plumage is the result of breeding.

c) Of other finches, the **Bull-finch** (*Fringilla*) and the **Crossbill** (*Lóxia*) inhabit higher regions, whilst several **Buntings** (*Emberiza*) are winter visitors to Northern India. The **Munias** (*Uroloncha striata*) which are common in Southern India, live gregariously.

d) A relation of the Sparrows is the **Weaver Bird** (*Plóceus báya*). It looks much like the sparrow and passes as such with

many people. The cock is, however, ornamented with golden yellow at the head and bright yellow at the breast at the time of courting. Its food consists of grain and the beak is well adapted for biting hard nuts and getting out the seeds.



The Weaver Bird.

The **nest of the Weaver Birds** is one of the most wonderful things in nature. They usually build in company and mostly on branches overhanging water. The nests are all suspended from the extreme tips of branches or from the tips of palm-leaves, so that they are out of the reach of squirrels, lizards, or snakes. But they are so strongly fixed to those objects that no storm can detach them. The nest

has the shape of a hanging flask and is constructed of thin strands of grass leaves, plaited together in a most skilful way. The upper part is a bell-shaped structure and forms the roof of the nursery. Half of this structure is prolonged into a more or less long neck, which becomes the entrance; the other half is rounded up below and forms a chamber in which the eggs are laid. Both spaces are separated by a strong cross bar rising about one and a half inches high. The entrance to the nest is from below. Probably to balance the nest, the bird also sticks clay to the inner wall of the nest.

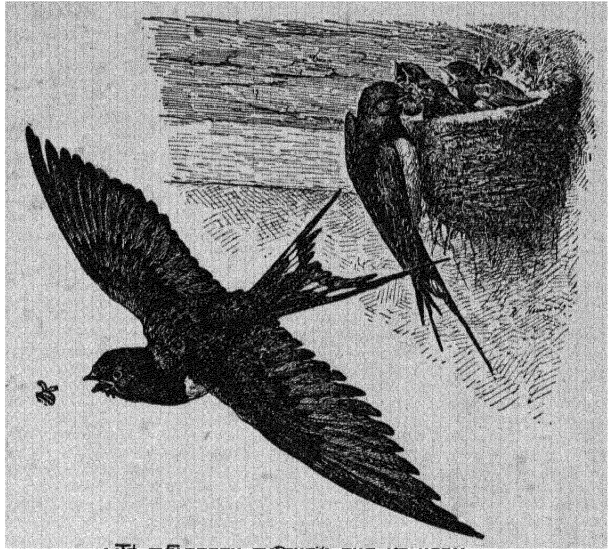
Besides these nests, which are built for the hatching work of the hen, the cocks construct for themselves additional nests, with a loop at the base of the bell-shaped structure, which serve as roosting chambers. These have not got the long hanging structures.

SECOND FAMILY: SWALLOWS (*Hirundinidæ*).

The **Nilgiri House Swallow** (*Hirundo javanica*), which is seen in hilly tracts, builds its nest of clay under the roofs of

houses just like the **European Swallow** (*H. rustica*) which is a winter visitor everywhere in India.

Its food consists of small insects, especially flies and gnats, which it catches on the wing. The swallow is an extremely skilful flier, a true “navigator of the air”. This is possible because of its long and strong wings as well as its forked tail, which forms an excellent rudder.

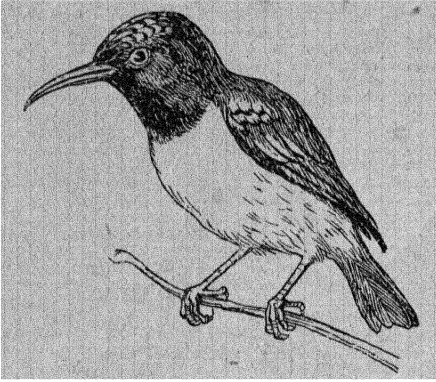


Its smooth plumage being in close contact with its body, friction in speeding through the air is lessened. Its legs being short, the weight of the body is reduced. The former are so weak that the bird cannot walk or hop, but it is capable of perching, and with its sharp claws it can cling well to its nest when feeding its young. The swallow, in fact, is exclusively adapted to an aerial mode of life. Its beak is too small for the seizing of insects. This is compensated for by the mouth being deeply cleft.

THIRD FAMILY: HONEY-SUCKERS OR SUN-BIRDS (*Nectariniidæ*).

Like the Humming-birds of South America, the Honey-suckers or Sun-birds of India have adopted a manner of living similar to the butterfly. As the name suggests, they feed on the nectar of flowers. The long thin beak, which is curved downwards, and the long tubular and protrusible tongue are finely adapted for this habit. The tip of the tongue being covered with a viscid saliva, it attaches to itself various small insects that happen to be in the flower when visited by the bird.

When the flower cannot be reached from a perch, the little bird will hover in the air on rapidly vibrating wings in front of the flower like a hawk-moth and extract the sweets from the flower. The size of these birds is small. Honey is found in very small quantities, and little insects cannot constitute a very nourishing diet.



The Yellow Sun-bird.

Their plumage, especially that of the cock, is resplendent with the most brilliant colours. Some species of these birds are the **Loten's Sun-bird** (*Arachnéchthra Loténia*) and

the **Yellow Sun-bird** (*Arachnéchthra zeylánica*).

FOURTH FAMILY: LARKS (*Alaudidæ*).

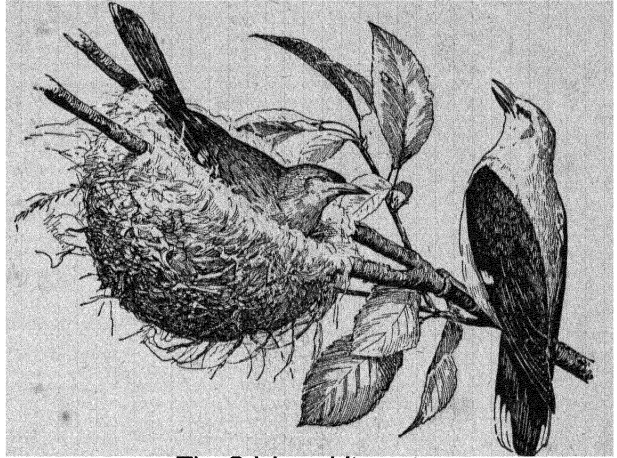
The **Indian Skylark** (*Alauda gulgula*) is a bird of the fields. Its earth-coloured plumage renders the bird indistinguishable from its surroundings at even a short distance. Its nest, too, which is constructed of grass-leaves and roots, and the earth-coloured eggs in it are not easily discoverable. The bird's food consists of anything which the fields can supply: tender plants, insects, grains of corn, and other seeds. Having to seek its food on the ground, the lark is the best runner among the song-birds. When it ascends skywards, it sings in jubilant notes.

FIFTH FAMILY: WARBLERS (*Sylviidæ*).

This family is represented in India by many small birds of awl-shaped beaks with which they pick up worms and soft-skinned insects. The **Tailor Bird** (*Orthotomus*) is well known from its habit of sewing two leaves together with a piece of grass as a receptacle for its nest. The European **Nightingale** (*Erithacus luscinia*), the charming little **Robin** or **Red-breast** (*E. rubéculus*), and the **Wren** (*Troglodytes troglodytes*) do not dwell in India.

TENTH FAMILY: ORIOLES (*Oriolidae*).

The Orioles are represented in India by the handsome **Indian Oriole** (*Oriolus Kundoo*) and the **Black-headed Oriole** (*O. melanocēphalus*), both about the size of a maina. The plumage of the cock is golden yellow with some black on the tail and in the large wing-feathers and also in the head in the black-headed species. Its bill is pink and the eyes red. In the hen the yellow of the back is tinged with green. The bird is shy and hides itself in the



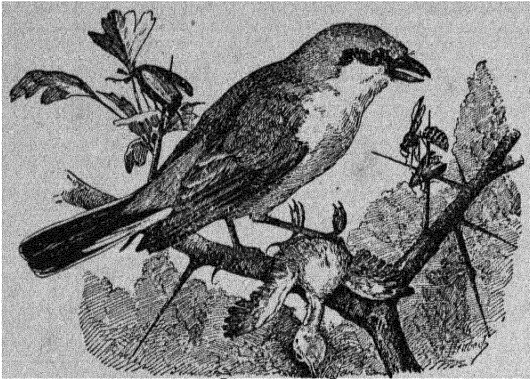
The Oriole and its nest.

foliage of trees, where it looks for its food which consists chiefly of soft-skinned insects and of berries. The beak, accordingly, is weak and awl-shaped. Its song is a clear, mellow whistle sounding somewhat like *peeho, peeho*, or *lorio, lorio*, from which, perhaps, the name was derived. The nest is built in the fork of a tree, and forms a beautiful hanging cradle, most artistically woven and plaited together.

ELEVENTH FAMILY: SHRIKES (*Laniidae*).

The **Shrike** (*Lanius collurio*) is a real “wolf in sheep’s clothing”: by its shape and voice classed among the song-birds, it is a bird of prey in its mode of life. Insects and small vertebrates form its food, which it catches with its strong beak, the upper half of which is bent over at the tip and provided with a tooth-like weapon on each side. Many shrikes—though not all—are said to impale their victims upon thorns and then pull them to pieces, bit by bit. Hence their common name “butcher

bird". Other song-birds seem to mistake the shrike for one of their own number, not only on account of its shape and plumage,



The Shrike (*Lanius collurio*).

but also on account of its ability to mimic the calls of other birds ("mocking bird").

The **Bay-backed Shrike** (*Lan. vittatus*) frequents our gardens. It is of the size of a bulbul with a gray head, broad black eye-brow and white breast.

TWELFTH FAMILY: DRONGOS (*Dicrúridæ*).

The **King-crow** (*Dicrúrus macrocércus*) is black from head to tail, latter of which is forked. You may see the bird often sitting on a bare branch of a tree or on a telegraph wire from which it surveys its surroundings watching and waiting for any insect that may move or rise. It then sallies forth catching it in the air. The king-crow is an excellent flier and its forked tail a perfect steering apparatus. Like mainas and crows it is often found near cattle, from the back and ears of which it picks out ticks.

Crows are the arch-enemy of the Drongo, and it suffices for the latter to see a crow in or about the tree where its own untidy nest is built, for attacking the mischievous enemy. In most cases the crow is severely punished for his intrusion.

THIRTEENTH FAMILY: BULBUL-LIKE BIRDS (*Crateropódidæ*).

The Buleuls belong not only to our commonest, but also to our most handsome and most active birds. The species most seen in Southern India are the **Indian Bulbul** (*Molpastes indicus*) and the **Red-whiskered Bulbul** (*Otocompsa emeria*) both being distinguished by a black crest and a crimson patch under the tail. The red-whiskered bulbul has, as the name

says, red whiskers and also white cheeks, whereas *Molpastes* has the head quite black.

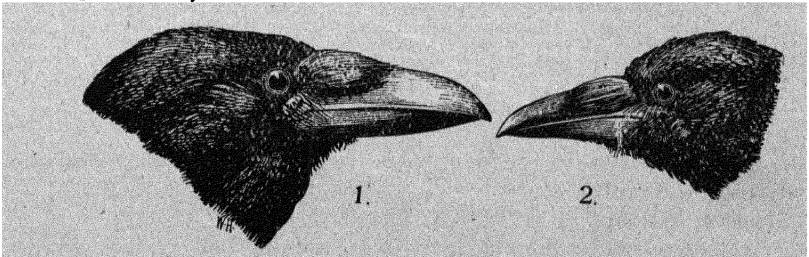
The continuous energy of these birds calls for much food, which consists of all kinds of insects and berries. The bulbul's legs are short and strong and provided with strongly-curved claws, thus being excellently adapted for climbing and perching. The habits are exclusively arboreous. The nests are built anywhere without much attempt at concealment, often in bushes, preferably under a protecting roof. Though the birds are not tuneful songsters, they give forth cheery notes.

The "**Seven Sisters**" or **Jungle Babblers** (*Crateropus canorus*) belong also to this group. They have strong legs, small wings, a heavy body and a long tail. Accordingly they keep to bushes or to the ground, where they delight in turning over each fallen leaf and looking for any insect hidden underneath. The uniformly gray colour of their plumage harmonizes well with their surroundings. This would serve to keep them unobserved from a distance, if they did not betray their presence by their never-ceasing noisy chattering.

The **Common Iora** or **Green Bulbul** (*Ægithina tiphia*) is another pretty bird of this family. Its call is very familiar to early risers and sounds like *didididididiyu!*

FOURTEENTH FAMILY: CROWS (*Córvidae*).

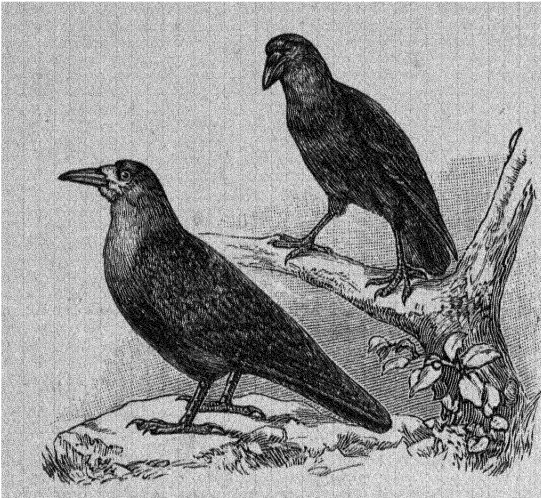
The commonest crow in India is the **Gray-necked Crow** (*Corvus splendens*). "Most birds and beasts are clothed so as



Head of the Raven (*Corvus corax*) (1), and the Crow (2).

to be inconspicuous in their natural haunts. Not so the crow. He, whether flying or at rest, is probably as conspicuous as he could well be. The reason of this is that the crow has no enemies to fear. Not a bird or beast will touch him dead or alive!"

It is as ubiquitous, as its diet is variable: carrion may probably have been its original food. Offal of all description



Crows.

and the remnants of man's food are eagerly sought for and devoured by the crow, thus associating itself invariably with human settlements. Insects, such as ants and locusts, are not despised; and ticks are picked up from the skin of cattle on the back of which the crow perches. Even on small birds

and their eggs the crow sets its greedy eyes; whilst mangoes and other fruits are of equal relish.

The large, sharp-edged beak is a strong weapon and a good implement for the divers ways in which it obtains its food.

The legs are powerful and provided with blunt claws, and equally well adapted for walking or hopping, or for holding on to branches.

Other crows are the **Large Raven** (*C. corax*), the **Magpie** (*Pica rústica*), the **Indian Tree-pie** (*Dendrocitta rufa*) and the **Jay** (*Garrulus*).

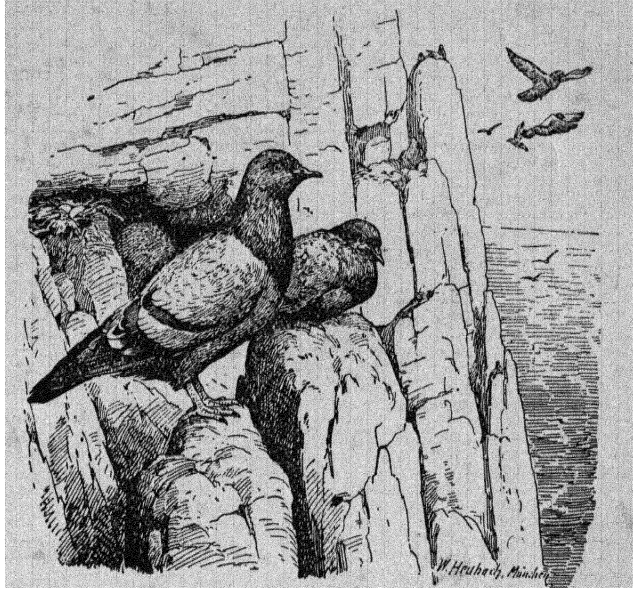
VII. Order:— PIGEONS (*Colúmbidæ*).

Beak at the tip provided with a horny covering; soft at the base; the nostrils covered with cartilaginous scales; edges of beak not overlapping. All toes articulated in the same plane. Young helpless.

The **Domestic Pigeon** (*Colúmba livia*) has been domesticated from times immemorial. It is the descendant of the **Rock Pigeon**, breeding on rocks or buildings, or in the sides of wells.

The Pigeon is a grain-eating bird. During a great part of the day it roves over the fields in search of food. The elongated shape of its body and the long, pointed wings reaching as far

as the end of the tail, enable the bird to fly rapidly (*e. g. Carrier pigeons*). The pigeon has large and keen eyes, and can see a grain of corn, pea, etc., at a long distance. Its strong legs enable it to walk along the ground, when seeking food, for a considerable length of time. Its beak being weak, and provided only with a horny tip, the pigeon can pick up grain, but cannot crush it.



Rock Pigeons (*Columba livia*).

The dividing up of the

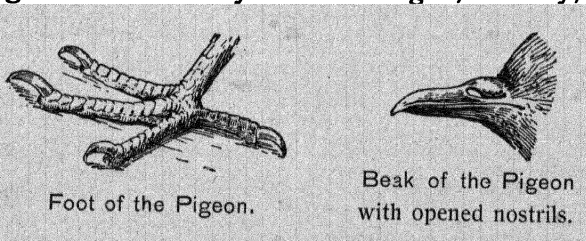
grains is done by another organ, namely, by the gizzard, a

stomach with walls consisting of very thick muscles. Because of the contraction and subsequent dilatation

of these muscles, the food is gradually crushed up into finer and finer particles, pebbles of quartz which the bird occasionally swallows assisting these efforts.

Before the grains are thus ground in the gizzard, they are soaked in the crop. And for this purpose the bird requires a good deal of water. When drinking the bird immerses the whole beak in water, the slit-like nostrils being then closed by hard scales.

The young of the pigeon are at their birth blind and helpless. As they leave the egg completely naked, they must be warmed by the parent birds. The hard food of the parents, too,



Foot of the Pigeon.

Beak of the Pigeon with opened nostrils.

cannot be digested by the young. Hence they are fed in their earlier days on a substance formed in the crop of the parents. Afterwards they obtain grains previously softened in the crop of the parents. The young are thus reared with great difficulty. This accounts for the pigeon's laying only two eggs at a time, for it would not be able to rear more than two young birds.

Allies of the domestic pigeon are found in our forests. There is the **Green Pigeon** (*Crocopus*), the **Stock Dove** and **Wood Pigeon** (*Palumbus*), the **Turtle Dove** (*Turtur*), and others, the commonest of the latter being the **Spotted Dove** (*T. suratensis*), the **Indian Ring Dove** (*T. risorius*), and the **little Brown Dove** (*T. cambayensis*).

VIII. Order: — FOWL-LIKE OR GALLINACEOUS BIRDS (*Gallinæ*).

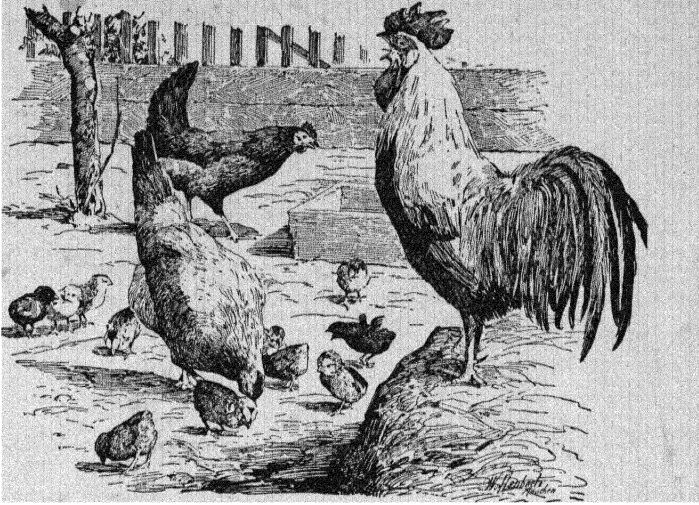
FIRST FAMILY: PHEASANTS (*Phasiânidæ*).

The **Domestic Fowl** (*Gallus domesticus*) was kept as a domestic bird in India and China as early as 1000 years B. C. However different the various breeds of the fowl may be, they are all distinguished by the possession of a red, jagged, fleshy comb on the top of the head and two flaps on the lower beak. The cock always surpasses the hen in brilliancy of plumage, and in the size of the comb; it, moreover, possesses some sickle-shaped tail-feathers overhanging the curved tail.

The fowl is a ground bird. Its flight is slow and awkward; for, the wings are short and saucer-shaped and the body is heavy. But it possesses robust legs, which enable it to run fast, and with endurance. The muscles of the thigh are well developed and the toes strong. The claws are blunt and slightly bent.

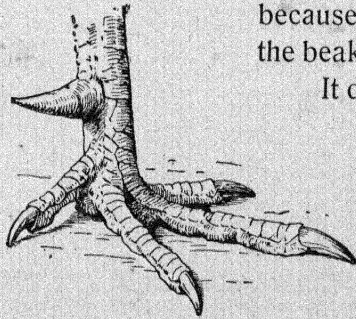
Almost the whole day is spent on the ground in search of food. With the claws of its big front toes it scratches in the loose soil or on the dunghill, looking for all kinds of worms, larvæ, and seeds. By means of its sharp eyes it can detect the smallest fragments in the dark soil. (It is, however, not satisfied with what it thus picks up. It requires to be fed by man.) Small pieces are swallowed, larger ones are chopped with the strong beak. With the aid of the latter it also tears up

leaves, the sharp edges of the upper beak overlapping the lower one in the manner of shears. Like the pigeon, the fowl pos-



The Domestic Fowl.

sesses a crop and a gizzard, in which the hard grains are softened and crushed. But the fowl does not drink in the same way as the pigeon, because the nostrils on the beak cannot be closed.

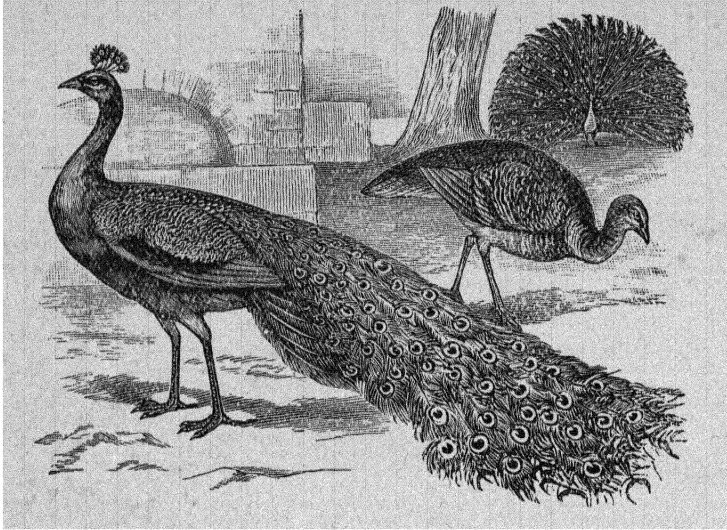


Beak and foot of the Cock.

It drinks by scooping up water in the cavity of the lower bill, and then raising the head, thus making the water to run down its throat.

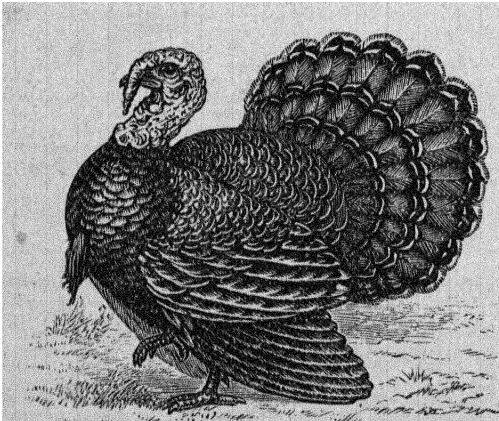
A good hen can lay 150 eggs a year. Only about a dozen eggs, however, are given to the "clucking hen" to be incubated at one time. After about three weeks, the young chickens emerge from the eggs—little creatures clothed in yellow down—following the mother from the moment of their birth, and picking up their own food. This accounts for the hen being able to hatch a larger number of eggs at one and the same time. (Contrast

with doves.) The cocks are not in the least concerned in the bringing up of their progeny. They engage in fierce fights for



The Peacock.

the possession of the hens, attacking each other furiously with their beaks and spurs.



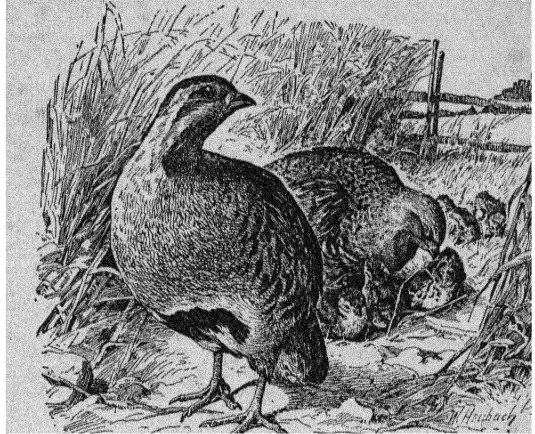
The Turkey.

The domestic fowl is derived from the **Jungle Fowl** (*G. ferruginéus*), whose home is South-eastern Asia. The **Common Peacock** (*Pavo cristátus*), the **Turkey** (*Meleágris gallopáva*), the **Guinea Fowl** (*Númidá meleágris*) are generally kept in poultry yards in the West. Of true pheasants the **Gold** and **Silver Pheasants**

(*Chrysólophus pictus*, *Gennæus nycthémerus*) are seen in most zoological gardens.

SECOND FAMILY: PARTRIDGES AND QUAILS (*Perdiciidæ*).

Another group of the gallinaceous birds is formed by the **Partridge** (*Perdix*) and the **Quail** (*Coturnix*). Both of them nest on the ground between the haulms of grass. They are bad fliers, but rapid runners, like the fowl. The plumage agrees well with the surroundings, being of an ordinary earthy colour. The **Black-breasted** or **Rain Quail** (*Coturnix coromandélica*) is a resident species, the **Common** or **Gray Quail** (*Coturnix communis*) being only a winter visitor to India. Of partridges various genera are met with in India.



Partridges with their young.

IX. Order:—CURSORIAL BIRDS (*Cursóres*).

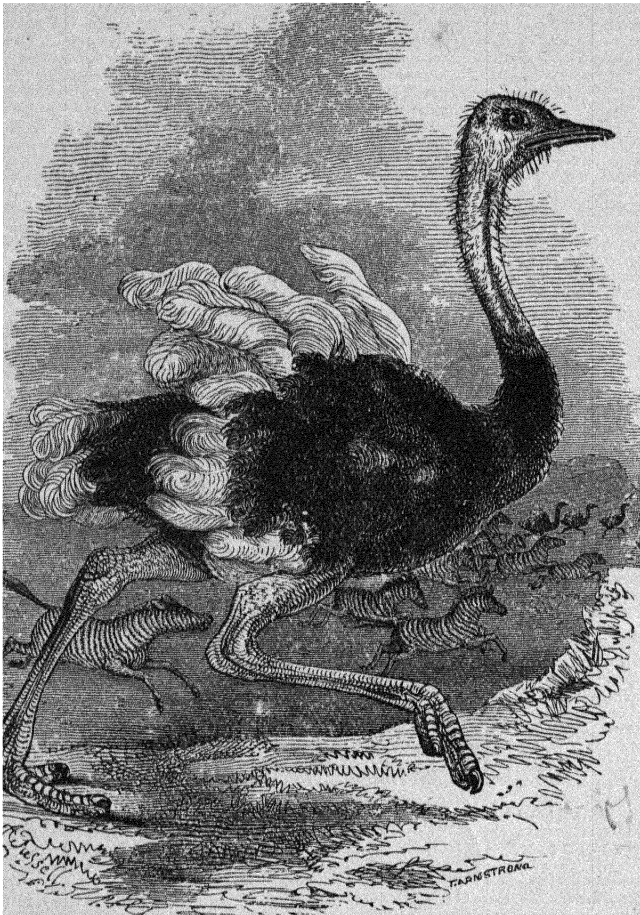
THE AFRICAN OSTRICH (*Strúthio camélus*).

The Ostrich inhabits the deserts and steppes of Africa and Western Asia. From the earliest times it has been incessantly pursued by man for its beautiful feathers. As there was the danger of its being exterminated, it became necessary to domesticate it in ostrich farms. A cock and a number of hens constitute a family, which have a common nest—a hollow in the ground—in which up to thirty eggs are laid. The weight of each egg is equal to that of about twenty-four fowl's eggs.

Like the camel, the ostrich is a true denizen of the desert.

a) Its food consists of desert plants and their seeds, also of insects and other small creatures. But the places where it lives are usually poor in food stuffs. The bird, in order to obtain sufficient nourishment, is therefore obliged to rove over great stretches of country. And if these become destitute, or if the

spring dries up, the bird is compelled to take long journeys. Flight is denied to the ostrich, for its wings lack the flight-feathers,



The African Ostrich.

as well as the tail lacks the steering feathers. The big wing and tail-feathers have soft and flexible shafts, while the barbs are not connected, but are loose and separate. In the cock these feathers are pure white, the body being deep black. The hen has a brownish-gray plumage.

b) The incapacity for flight is

counterbalanced by enormous **running powers**: the naked legs are very tall, so that the bird can take long strides (two to three yards). The thighs are very muscular, and, as is the case in fast-running mammals, the toes are few in number, *viz.*, two. The larger inner toe is provided with a big sole, preventing the bird from sinking into the sand. The upper surface of the legs is protected against the hot and irritating sand of the desert by a thick and hard cover of horny plates.

c) As in the camel, there is a horny **callosity** on the breast which is of good service to the bird when it rests.

d) Corresponding with the height of the legs, its **neck** is very long, for the purpose of reaching the ground. It is also naked, or only scantily covered with bristles.

e) A further use of the great length of both legs and neck is the height to which this bird's far-seeing **eye** is raised, enabling it to catch sight of an enemy when he is still at a great distance.

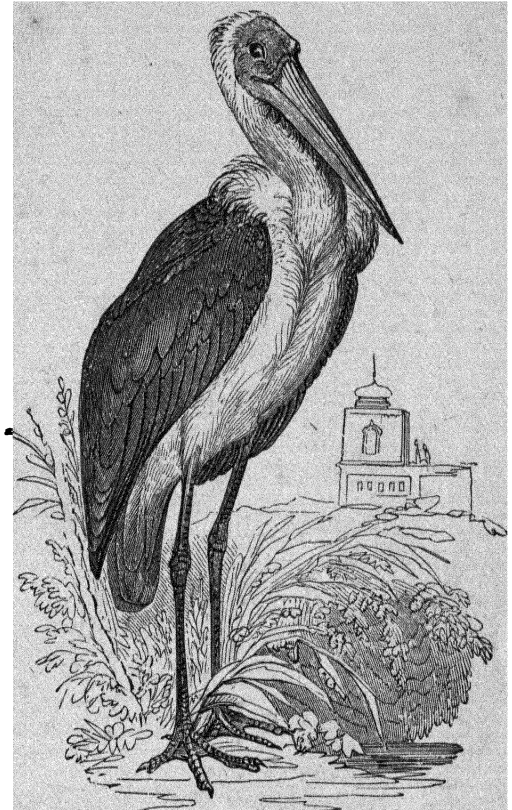
X. Order:
WADING BIRD
(*Grallatōres*).

Legs long. Toes free or united by a short membrane (*rarely webbed*). Beak and neck generally long. Young either helpless, or leaving the nest from birth.

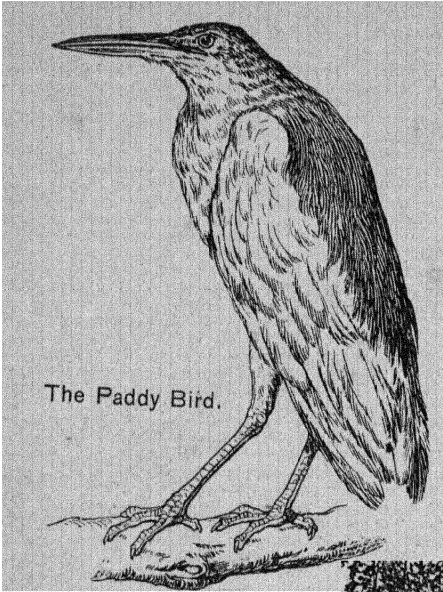
1. Among **Storks** (*Ciconiidae*) the **White Stork** (*Ciconia alba*) is a winter visitor to Northern India. A resident of Northern India is the **Adjutant**

Stork (*Leptoptilus dubius*), of weird appearance; a stork which has acquired the habits of the vulture. Its figure agrees well with its habits, if we note the great beak, and the bald head and neck, as well as its long, naked legs.

2. The **Heron Family** (*Ardéidae*) is represented by the **Paddy Bird** (*Ardéola gráyi*). It is dull grayish-brown when sitting, but makes a startling display of its white body and wings when it flies away. It lives principally on fish, and is an expert in the art of catching them. It takes up its abode in and near paddy-fields where it can always find fish enough. When engaged in fishing, the bird may be seen standing motionless, like a statue, in the shallow water of a paddy-field



The Adjutant Stork.

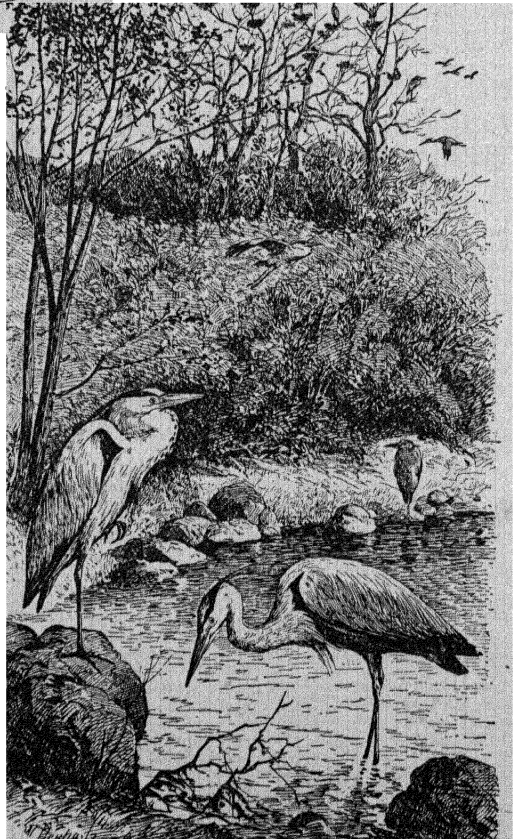


Its gray plumage renders it not easily distinguishable, either for the fish below it, or for birds of prey circling above it. On espying a fish, the long recurved neck is suddenly stretched and the long beak darts forward with lightning-like rapidity. The sharp-edged beak is sure of seizing the fish, however slippery it may be.

Its naked long legs enable the bird to stride with ease over soft marshy soil without wetting

its plumage; and the short webs, connecting the three broad anterior toes, enlarge the surface of support.

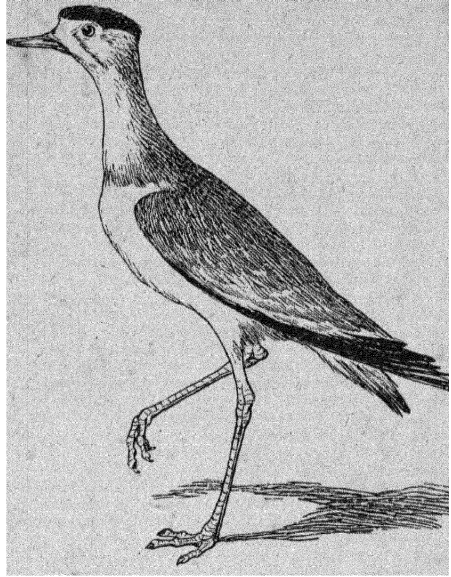
The Heron is not a bad flier. Its long wings equip it for distant voyages (migratory habit). The short tail is of little use as a rudder (compare the swallow); this deficiency is, however, compensated for by the long legs, which are extended backwards during flight, and serve as rudder to this feathered air-ship. The long neck is drawn up against the body during flight.



The Crested Heron.

Other common birds of this group are the **Common Heron** (*Ardea cinéra*), considerably larger than the paddy bird, and the **Cattle Egret** (*Bubúlcus coromándus*) which is white in winter, but becomes buff-coloured in summer.

3. **Snipes** (*Scolopácidæ*) are much sought after on account of their delicate flesh. They are all true waders, distinguished by long thin legs, which enable them to wade in shallow water, and by long and thin beaks for catching water-animals in the water, or in the mud. **Sandpipers** (*Tótanus*) and **Red-shanks** are allied to this group.



The Yellow-wattled Lapwing.

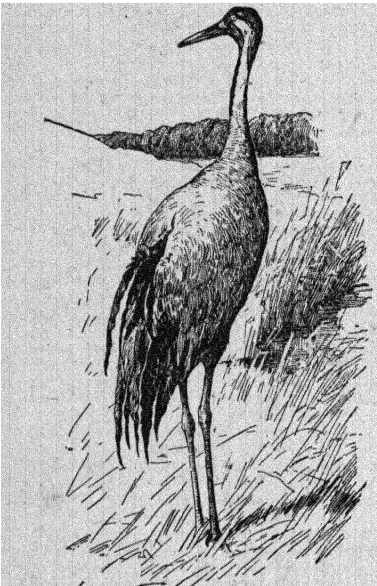
4. Other waders are the **Plovers** (*Charadriidæ*) of which the **Red-wattled Lapwing** (*Sarcogrammus*) and the **Yellow-**



The Peewit or Lapwing (*Vanéllus cristátus*).

wattled Lapwing (*Sarciophorus*) are common types with us. The cry of the former sounds somewhat like “Did-you-do-it” or “Pity-to-do-it”, by which it tries to put those off the track who are seeking its eggs. These, four in number, are laid in a shallow cavity of the ground and are protectively coloured. Being laid in the open and not hidden away in a nest, it is important that they should not be conspicuous; otherwise they would soon be seen and devoured by some egg-eating creature.

The **Pewit** or **Lapwing** (*Vanellus vulgaris*) is a winter visitor to North-western India.



The Common Crane.

5. Of the **Cranes** (*Gruidæ*) the **Common Crane** (*Grus communis*) is seen in winter in Northern India. When these birds migrate to another country, which they do in large flocks like most other migratory birds, they arrange themselves in the form of a wedge, one of the stronger birds taking the lead at the apex of the wedge.

6. **Rails** (*Rallidæ*). The **Common Coot** (*Fulica atra*) and the **Common Moorhen** (*Gallinula chloropus*) are widely distributed in India, and are met with in ponds and rivers between the reeds and rushes near their banks. The coot is black, and there is a white horny plate on the forehead, the beak being of the same colour. They can swim, and the long toes, fringed with notched membranous lobes, make excellent oars. On the approach of danger they dive under water.

XI. Order:—SWIMMING BIRDS (*Natatóres*).

Aquatic birds with webbed feet. Beak and wings variously formed in the different groups. Young precocious.

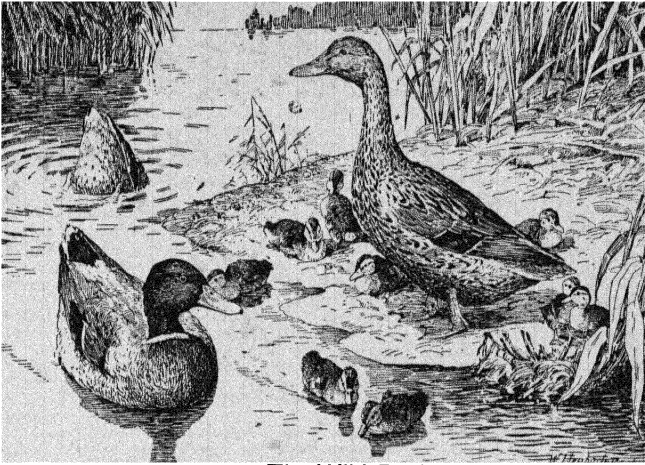
1. DUCKS (*Lamelliróstres*).

THE DOMESTIC DUCK (*Anas domestica*).

Man has been domesticating the duck for thousands of years for the sake of its flesh, its eggs, its fat, and its down.

It is a descendant of the wild duck, a species of which is found throughout the whole northern hemisphere. Like the wild duck, the domesticated duck is a truly aquatic bird.

1. IT DEFIES THE COLD OF THE WATER. a) The **down** covering the breast and abdomen is thick and well covered by stiff and



The Wild Duck.

To the left a Drake, to the right a Duck with its young.

arched contour-feathers (compare, on the other hand, the owl). By this arrangement a large number of air-spaces are formed by the feathers, which diminish the loss of heat from the

body. On the other hand, the cold water is thus prevented from reaching the skin.

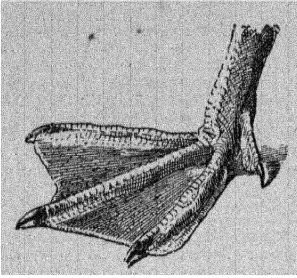
b) This is further achieved by carefully **oiling** or preening the contour-feathers. The duck does this by squeezing an oily fluid from a gland near the tail with its beak and then drawing each feather through the oily beak.

c) A further means of protection against cold is the presence of a thick **layer of fat** below the skin (compare with whale).

2. THE DUCK PLOUGHS ITS WAY ALONG THE SURFACE OF THE WATER with the utmost ease.

a) The **shape** of the body is that of a boat. It is broad and flat and hence the body is better supported than if the body were cylindrical.

b) The **oars** and **rudders** of this boat are the legs, which are worked by strong muscles. The front toes and the web that extends between them form broad oars. When the feet are



The foot of a Duck.

moved forward, they are involuntarily folded. As only the feet project from the body and the legs are short, these oars can execute strong strokes against the water.

The anterior edge of the leg, moreover, cuts the water with ease. Skilful though the bird may be in the water, its movement on land is awkward; for the legs are joined to the body, not in its middle, but far back. The webs of the feet, too, impede walking.

3. THE FOOD of the duck is chiefly OBTAINED IN THE WATER. It consists of small aquatic animals. The bird visits also plains and meadows, and consumes seeds, grains, and grass; the domestic duck is, moreover, fed by its keeper.

a) Its long **neck** enables the duck to immerse its beak deep into the water and to grope along the muddy bottom.

b) The **beak** is broad and flat and provided with numerous leaf-like horny plates or lamellæ, which, when the beak is closed, interlock with each other. After taking up a mouthful



The head of the Wild Duck.

of water with the shovel-like lower mandible, it will close the beak allowing the water to run out at the sides, but retaining the worms, insects and grubs, that have been taken up in the mud and are caught within these fringes as in a strainer. The soft skin covering the upper mandible renders the beak a very sensitive apparatus of touch, by the aid of which the duck is enabled to find food even in turbid water. The hooked tip of the beak is horny like the edges, and adapted for cutting off aquatic plants, and for holding fast slippery animals such as fish and frogs.

c) The duck possesses a **gizzard**, like the dove and the fowl, and takes in sand and pebbles with its food.

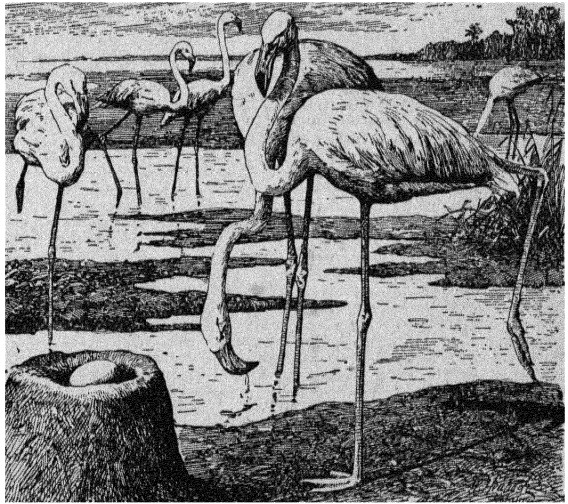
4. ENEMIES AND YOUNG—At the approach of danger the wild duck seeks protection in the reeds growing on the banks of the water; when surprised by a bird of prey, it tries to

escape by diving. The wild duck is, moreover, protectively coloured. The duck is, like the fowl, a very prolific bird laying from ten to sixteen eggs from time to time, with short intervals. Its young are precocious and follow their mother into the water immediately after leaving the egg.

Other swimming birds of the duck-type are the **Mute Swan** (*Cygnus olor*), and the **Goose** (*Anser domesticus*). The former is often kept as a tame bird in ponds, whereas the latter is a domesticated bird kept for its flesh, eggs, fat, and down.

2. FLAMINGOES (*Phænicópteri*).

The **Flamingo** (*Phænicópterus róseus*) is a distant relative of the duck, found in the North-west of India. It is a weird-looking bird, on account of its long wading legs and feet, its long thin neck, and the big lamellate beak, which is curved downwards from the middle. Standing in shallow water, the bird stirs up the mud with its feet, and then gropes about in it after the manner of the duck. When it has seized



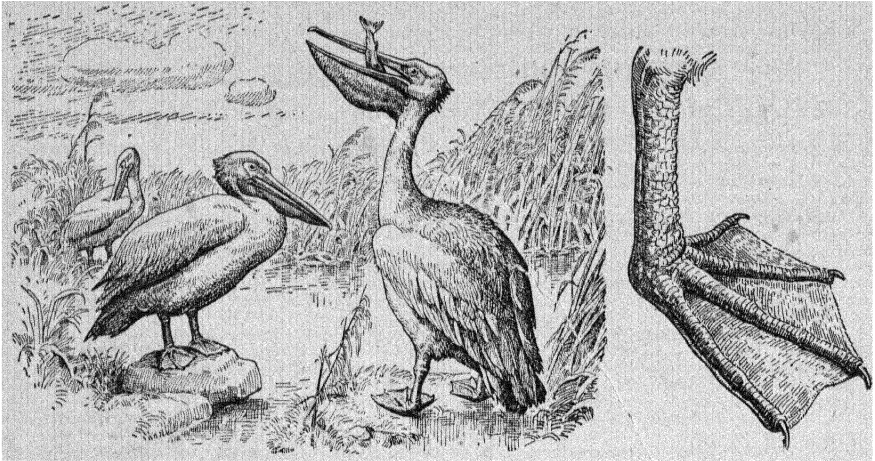
Flamingoes. N. Nest.

its prey, it raises its head out of the water, but bends the neck in such a way that the spoon-shaped upper beak comes to lie downward. Its nest is built of mud, and the bird sits on it with its long legs doubled up under its body. The plumage is of rosy colour, with the exception of the flying feathers which are black.

3. PELICANS (*Steganópodes*).

The **Pelican** (*Pelecánus onocrótalus*) is in shape and habit swimming bird somewhat like a large goose. It differs, however, from the structure of the latter in its feet in which

all toes are united by webs, the hind toe being directed inwardly, and in the beak, which is not only of quite an unusual size, but



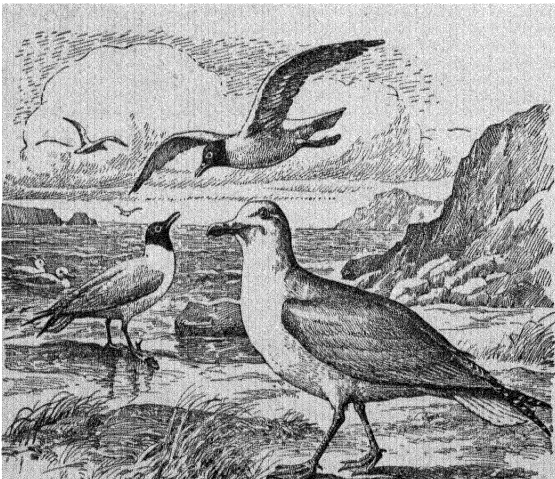
Pelicans.

A foot of the Pelican.

also provided with an extensible skin between the two halves of the lower mandible. When the bird has scooped a fish out of the water by means of this natural fishing net, it presses the mandible firmly against the upper beak, the water runs off, and then the fish is swallowed.

The **Frigate Birds** and **Cormorants** are birds belonging to this group.

4. GULLS (*Láridæ*).



Herring and Black-headed Gulls.

The Gulls are denizens of sea-coasts. Their food consists of fish. By their long, pointed wings they are enabled to fly rapidly and dexterously. Having captured a fish, the gull swoops down into the water as an arrow. Its strong beak upper half of w

ends in a sharp hook, it seizes the prey securely. When tired, the gull rests, floating on the waves. Gulls build their nests in colonies of thousands on steep cliffs or sand-dunes. Their eggs are much sought after by man.

The **Laughing Gull** (*Larus ridibundus*) and the **Yellow-legged Herring Gull** (*L. cachinnans*) are species found in India.

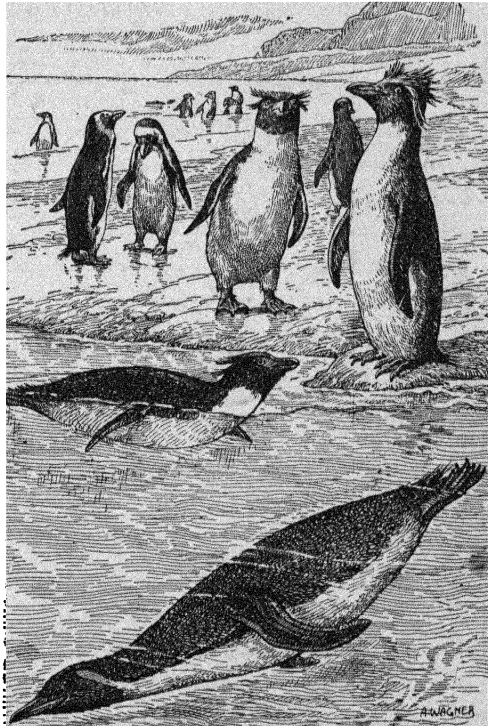
5. DIVERS (*Impennes*).

Of the Divers the **Crested Grebe** (*Colymbus cristatus*) visits Northern India. These birds are even more typically denizens of the waters than the preceding groups. They never leave the water, unless actually compelled to do so, and even sleep on the surface of water. Their eggs, too, are hatched in a nest which floats on the water, and is attached to rushes.

6. THE AUKS (*Alcidæ*) are diving birds similar to the above. They inhabit the North Atlantic Ocean.

7. THE PENGUINS (*Spheniscidæ*)

which are found in the seas round the South Pole, are “the fish among birds”. They are not capable of flying, the wings taking the shape of fins. Thick layers of fat protect the body against the icy cold of the water, and the feathers are well soaked in oil.



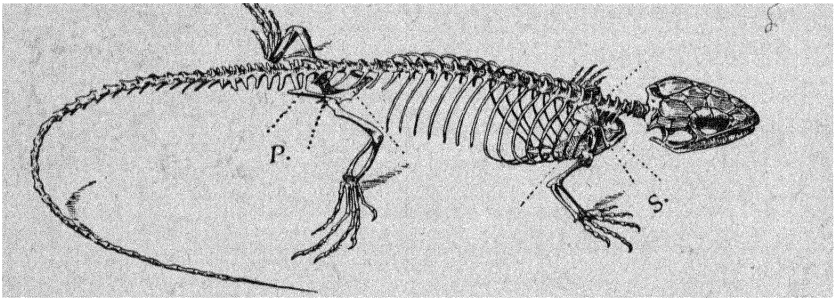
Penguins.¹

Third Class: REPTILES

(*Reptilia*).

Reptiles are animals whose blood temperature changes according to that of the medium (air or water) in which they live. They are covered with horny or bony scales. They breathe by lungs, and are mostly born from eggs.

1. LIMBS.—Most reptiles have four limbs, the hind limbs being nearly equal to the forelimbs; but most of the snakes, which also belong to this order, have lost all traces of the limbs. In proportion as the legs are reduced, the body becomes more elongated and either aids the degenerated legs, or entirely takes over the function of locomotion.



Skeleton of the Sand Lizard.

S. The Shoulder-girdle. P. The Pelvic girdle.

2. SKELETON.—The **backbone** stretches through the whole length of the body from head to tail, the vertebræ, or the joints, varying in number according to the length of the body. In the tortoises the vertebræ are stiffly joined to the carapace of the back. Ribs are present in varying number, and in the snake help its locomotion.

The **skull**, in its general structure, is similar to that of birds. The lower mandible is not directly connected with the skull, but joined on each side by a special bone, the quadrate bone.

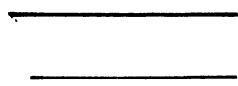
3. TEMPERATURE OF THE BODY.

a) The reptiles, like the mammals and the birds, breathe by **lungs**. But the process of respiration in reptiles is very

omotion (*e. g.* snakes). When the exsiccating influence
her in hot countries becomes so great that the
he body does not suffice as a protection, they
y themselves in the ground, and indulge in a

in, or derma, is thickened in various ways
epidermis. If these thickened portions are
e termed 'grains', when they are larger
, and when each is overlapping the
called 'scales'. The derma in
le) has bony plates in it. The
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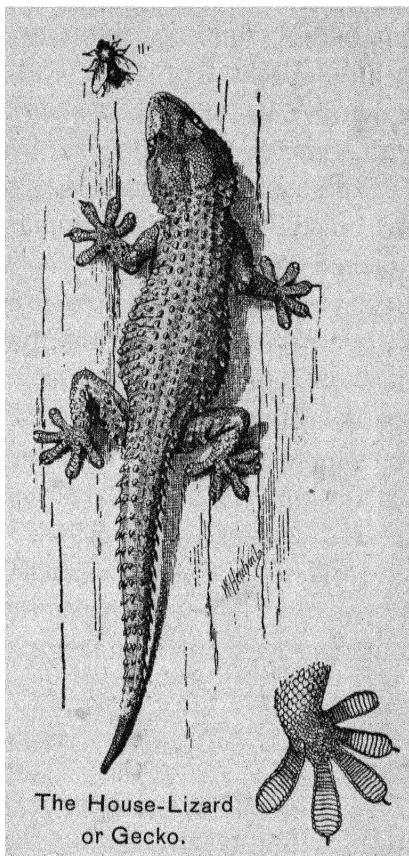


of short
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daytime, it darts forward to catch a fly or some other insect that comes near its hiding place. But it retreats again as soon as it has seized its victim.

2. **FOOD.**—Like most of the preying animals its activity begins as darkness sets in. Then we can see it move briskly from one end of the wall to the other in pursuit of a moth, the buzzing noise of which it catches easily with its keen **ears**. There is no external ear, and the tympanum is freely exposed and visible at the back of the head in the form of a small dark spot. With its enormous goggle **eyes**, prominently set in the head, it keeps a sharp look-out for a straying moth or beetle. It takes notice of **moving** objects only. Suddenly it sallies forth, and seizes an insect with its wide **mouth**, the edges of which are sharp. Slowly the victim, often larger than the gecko's own head, disappears, gulp by gulp, down the greedy throat.



The House-Lizard
or Gecko.

Below, a foot seen from the lower side.

3. **MOVEMENTS.**—The Lizard runs rapidly along the ground in jerks. Its four legs are short and directed away from the body. By their aid alone the lizard could not move so briskly. The action of the four legs is supported by **undulating movements** of the **whole body and tail**, the lower surface of which touches the ground. The scales of these parts, and especially those of the tail, are **propped** against the unequalities of the ground, and thus the **front** part of the body is propelled. This explains also why the **limbs** of lizards are so long and flexible. The more the limbs of a reptile are stunted, the longer becomes the body.

By accident, the **tail** of the lizard is easily detached from the rest of the body and this enables it often to escape an enemy. The

round branches aids in maintaining the balance of the body in moving from branch to branch. The ball-shaped eyes, which are covered with single lids, can be moved quite independently of each other, and insects which form its food are caught with its worm-like gummy tongue, which is capable of being quickly protruded at great length.

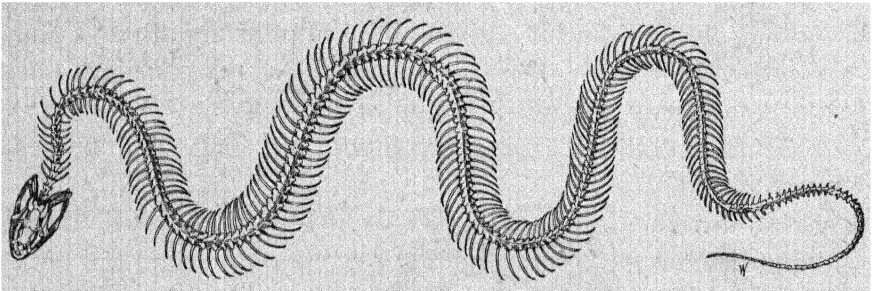
II. Order:—SNAKES (*Ophidia*).

Body worm-shaped, covered with scales or scutes. Limbs absent. Bones of the face mostly movable. Teeth not lodged in sockets. Eyelids absent.

I. NON-VENOMOUS SNAKES

—THE RAT-SNAKE (*Zamenis mucosus*). •

1. LOCOMOTION AND STRUCTURE.—The Snake, like the lizard, moves by undulating sinuous movements of the whole body including the tail. Its legless, **cylindrical body** is very much **elongated** often measuring between six and seven feet in



The Skeleton of a Snake.

length. For this kind of locomotion an extremely flexible body is required. This flexibility is attained by a great number of bones in the **vertebral column**, which are jointed together by a projecting knob, like a round ball, moving in a cup-like hollow or socket. The absence of limbs is compensated for by the presence of a great number of **ribs**, which do not pass all round the body, but have free tapering ends. It is on these ends of the ribs that the snake glides along as upon so many legs. For this purpose the ribs are jointed to the vertebræ by ball and socket joints, and are thus enabled to move forwards and backwards. Each rib corresponds to a scale on the abdomen, and is connected with it by a muscle. When a pair of ribs

is moved forward, the corresponding abdominal scale is erected and wedged against some projection of the ground, which affords it a point of support, the ribs are drawn more closely together, on alternate sides, thereby producing alternate bends of the body. In this way the whole body is drawn forward with a gliding creeping. On smooth surfaces snakes can progress only with difficulty.

The skeleton is thus all backbone and ribs, and there is no sign of a limb-bone.

2. HABIT OF FEEDING AND STRUCTURE.---Like all other snakes, the Rat-snake is a predaceous animal. It lives on small mammals, lizards, and frogs. It has very keen **sight**. The eye is covered by a transparent membrane, formed by the two eyelids that have grown together. The narrow, worm-like black and forked **tongue** can be protruded a long way, and is the seat of the sense of touch. It is often exerted with a rapid motion, sometimes with the object of feeling some object, sometimes under the influence of anger or fear. Being limbless the snake cannot hold its prey and bite off pieces. It must **swallow it whole**, and generally does not wait till its victim is actually dead. But how does the snake manage to devour a frog or rat which is larger than its own slender head?

a) The **mouth** is **deeply cleft**, and b) the **upper** and **lower jaws** are **movable**, the bones of both jaws are but loosely connected with the skull, joined by ball-and-socket joints and held together by elastic muscular bands, so that in the act of swallowing, these bones can be widely separated from each other.

c) Both jaws, and the palate as well, are thickly set with **teeth** sharp like needles, by which the snake seizes its victim. As they are all bent backwards, there is no escape. Next, the framework of the jaws is elevated on one side and moved a little forwards. The same movement is next performed by the other side. In this way the prey is slowly but surely drawn down the throat.

d) When swallowing the process is rendered easier by a copious secretion of **saliva** which makes the huge morsel smooth and slippery.

3. The **colour** of its **scaly coat** corresponds to the nature of its habitat, an uniform brown like that of dry foliage. This serves to hide the animal from its enemies, among which the kite is prominent.

The snake **casts its skin** several times a year, pulling it over its body in one piece while winding about among bushes and stones. The rat-snake propagates its kind by laying white-shelled eggs.

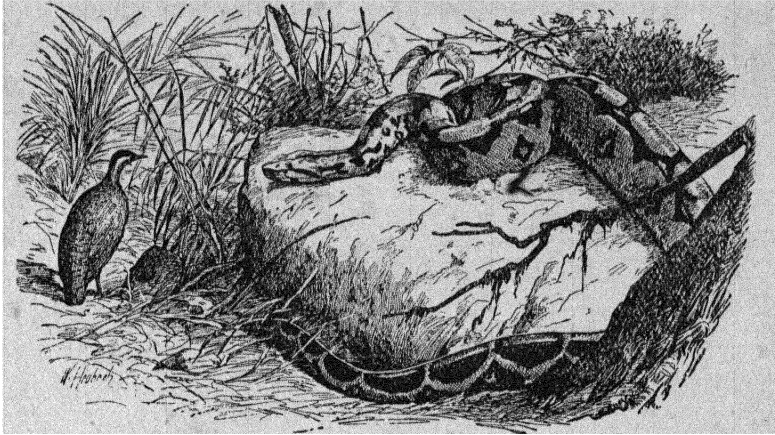
OTHER NON-VENOMOUS SNAKES

1. The **Green Tree-Snake** or, as it is also called, the **Whip-Snake** (*Dryophis mycterizans*). The habits of this snake are truly arboreal and the body is elongated to an astonishing length. The long tail, which is one-third of the total length, tapers to a long, thin point like a whip. This snake is a very nimble climber. Noiselessly it glides along the branches from one tree to another. But, if you happen to brush through the leaves of a thicket, it will not stir and betray its presence, but remains perfectly quiet in its position, for its protective colour makes it quite inconspicuous in the foliage. The Whip-snake is not dangerous to human life, but it possesses in the posterior part of the mouth some grooved teeth, by means of which it can stupefy the victim while it is in the act of swallowing. In some of this genus the elongate form of the head is still more exaggerated by a pointed, flexible, leaf-like appendage of the snout.

2. The **Egg-eater** (*Elachiston sp.*), a snake scarcely twenty inches in length and with a body not thicker than a man's finger, is able to swallow a hen's egg, a feat which seems quite impossible. As the egg passes finally through the alarmingly distended neck, the snake makes some slight contortions and the swelling collapses, the shell having been filed through by a tooth in the throat.

3. The **Indian Python** or Rock-Snake (*Python molurus*) grows to a length of twelve feet and more. The colours of its coat resemble those of the tiger's skin. The python is not venomous, but coiled round a man the tremendous power of its muscles can crush him to death. Closely allied to the python is the

Boa-constrictor of South America, a giant snake, said to be able to kill and devour animals of the size of a deer.



The Python.

4. **Eryx Johnii** has a very blunt tail, and snake-charmers commonly carry it about and “exhibit it as a two-headed snake, the tail being occasionally manipulated and furnished with glass eyes to assist in the delusion” (*Blanford*). .

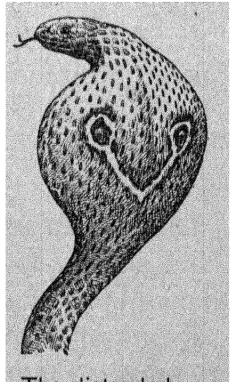
5. **The Common Water-Snake** (*Tropidonotus piscátor*) is frequently met with in or near water.

II. VENOMOUS SNAKES

THE COMMON COBRA (*Najas tripúdtians*).

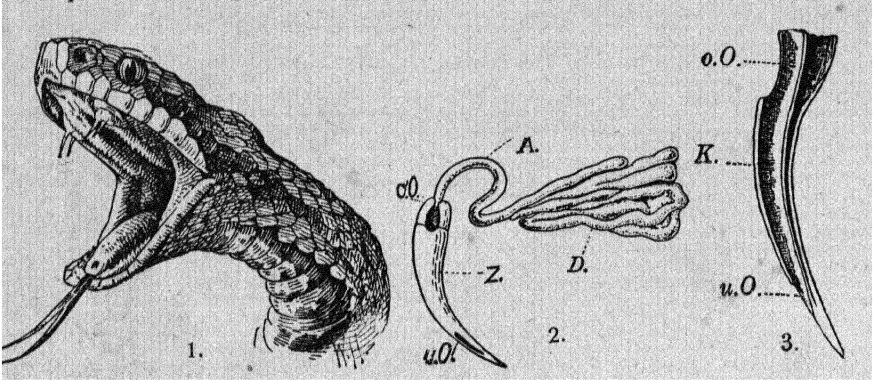
The Common Cobra is easily recognised by the spectacle-shaped markings on the back of the neck. Protected by its yellowish brown colour, it lazily pursues its prey, which consists of small vertebrates, in stone heaps, old walls, and similar places. When alarmed, it assumes a menacing attitude, raising the anterior portion of its body, and distending the “hood” by extending the anterior ribs. The peculiar marks on the hood are drawn widely apart and shew up distinctly, which is always a sign that the cobra is ready to strike.

The **poisonous teeth** or **fangs** are in front of the upper jaw. They are very long and hollow, and their bases are connected with glands, secreting the deadly poison. The



The distended hood of the Common Cobra.

opening through which the poison pours into the wound is not at the tip of the fang, but on the anterior surface close to the tip.



The Viper: 1. Head and anterior portion. 2. Poison fang with glands.
3. Longitudinal section of fang.

D. Poisonous glands. A. Poison duct. Z. Poison fang. o. O. and u. O.
Upper and lower opening of the poison channel K.

OTHER VENOMOUS SNAKES

1. The **Karait** (*Bungarus candidus*) which grows to a length of four and a half feet; it is dark-brown above and, therefore, easily mistaken for the rat-snake, which is similarly coloured, but grows to a larger size.

2. The **Great Cobra** (*Najas bungarus*) as well as the **King Cobra** (*Bungarus fasciatus*) live on other snakes.

3. The **Lachesis viridis** (India), met with in hill-forests, has the upper surface of the head covered with very small shields or scales.

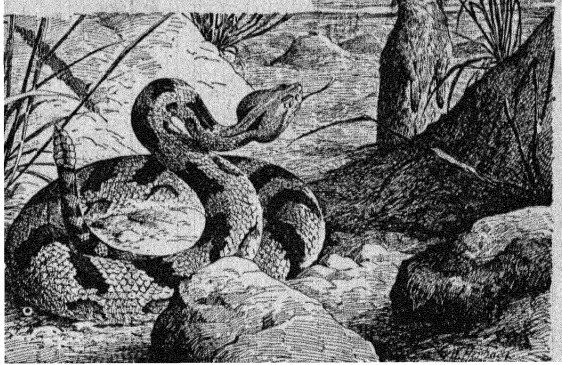
4. The **Sea-Snake** (*Pelomis bicolor*) belongs to the most poisonous of the whole order. The head is very small compared to the extremely slender and prolonged anterior part of the body. It sheds the skin frequently. Its movements in the water are very rapid.

5. **Russell's Viper** (*Vipera Russellii*) is another important and dangerous snake. It has a broad flat head with large hollow fangs in the upper jaw, characteristic of the viperine snakes.

6. The most notorious snake of America is the **Rattle-Snake** (*Crótalus*). At the extremity of its body is "the rattle" which consists of a variable number of dry, hard, horny, cap-shaped joints, each of which loosely grasps a portion of the

preceding, and all of which are capable of being shaken against each other. The snake does not shake its tail when in quest of prey, but only when alarmed, which shows that it is a means of inspiring fear in its enemies. At first, they

try to slink away; when overtaken or cornered, they use every means of frightening the foe by swelling up, puffing, rattling and by threatening attitudes; it is, as a rule, not until they are touched, or provoked by a rapid



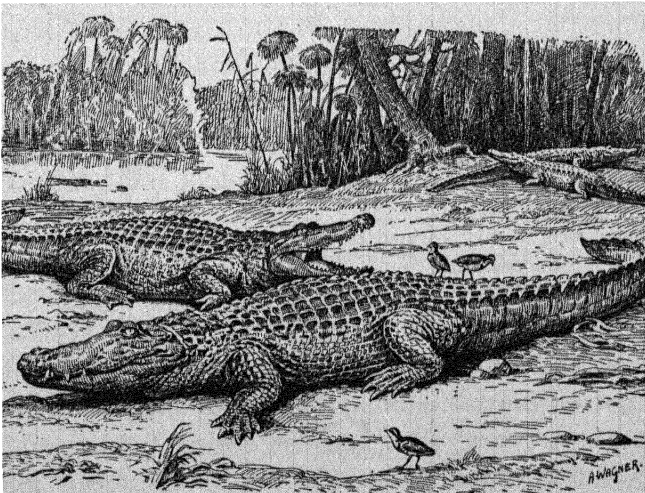
The Rattle-Snake.

movement, that they retaliate, but then they strike with fury.

III. Order: — CROCODILES (*Crocodylina*).

Body lizard-shaped. Tail laterally compressed. Bony dermal scutes developed on the back. Teeth lodged in sockets. Four legs.

The **Common Crocodile** (*Crocodylus niloticus*) has the shape of a gigantic lizard (twenty feet long), and inhabits the rivers



Nile-Crocodiles.

and lakes of nearly the whole of Africa. In the lower course of the Nile it has almost been exterminated by the rifle of the sportsman. It has a heavy **armour**, con-

sisting of horny scutes, supported by strong bony plates in the subjacent derma, but this is not able to prevent a bullet penetrating it. During the hours of sunshine the animal lies asleep on a sand-bank or in the mud, having all the appearance of some weathered old tree trunk. In the evening it begins to be active. The big **tail** is laterally compressed and acts like a propeller when the animal swims. The webbed toes assist further in swimming. The huge **jaws** are furnished with large conical hollow teeth devoid of roots, each becoming replaced when worn out. The jaws, in fact, form two powerful toothed shear-blades; and by shutting them with a snap the monster can easily sever the leg or head of any of the larger mammals that come to the shore to drink. Crocodiles have been known to attack and overpower men. Their food, however, mainly consists of fish. When the waters of the river dry up in the hot season, the animal buries itself in the mud for a “**summer sleep**”. The female lays a great number of eggs, which are hatched by the heat of the sun.

Crocodiles are also commonly found in India, both in fresh-water rivers and lakes (*C. palustris*), and in backwaters and in estuaries of rivers (*C. porosus*). The latter may measure more than thirty feet, whereas the former seldom exceeds twelve feet.

The **Gavial** (*Gavialis gangeticus*) is found in the Ganges, Indus and Brahmaputra. It is distinguished by having an elongated snout.

The **Alligator** or **Caiman** (*Alligator mississippiensis*) is abundant in the southern part of North America.

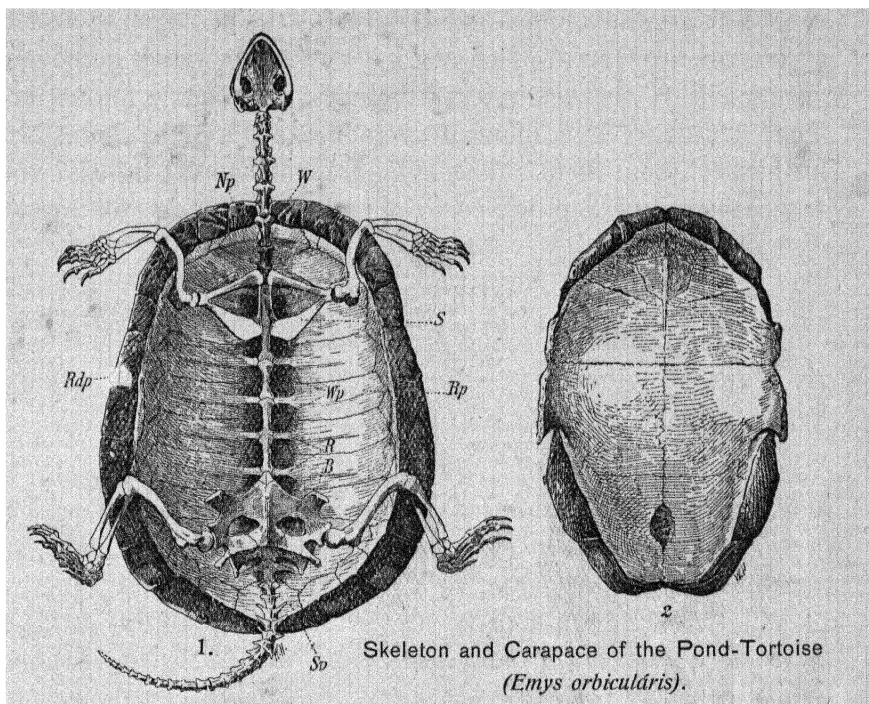
IV. Order:—TORTOISES (*Chelonia*).

Body broad, enclosed in a shell formed of a dorsal (carapace) and a ventral (plastron) shield. Jaws toothless, and covered with horny sheaths. Two pairs of limbs.

THE RIVER-TURTLE (*Trionyx sp*)

1. **BODY-ARMOUR**.—The animal is enclosed in a double shell, the lower one (plastron) being flattened and the upper (carapace) arched. They are joined at the edges, but left open in front and behind to allow of the passage of the head and the limbs. On the approach of danger the tortoise will retract

head, legs and tail under the covering armour, and even shut the shell in front and behind.



1. Skeleton and dorsal shield (carapace), 2. Ventral shield (plastron); both seen from within. *W*. Vertebral column. *R*. Ribs. *S*. Shoulder-girdle. *B*. Pelvic girdle. In the dorsal shield the following are to be distinguished. *Wp*. Vertebral plates. *Rp*. Rib-plates. *Rdp*. Rand-plates. *Np*. Neck-plates. *Sp*. Tail-plates.

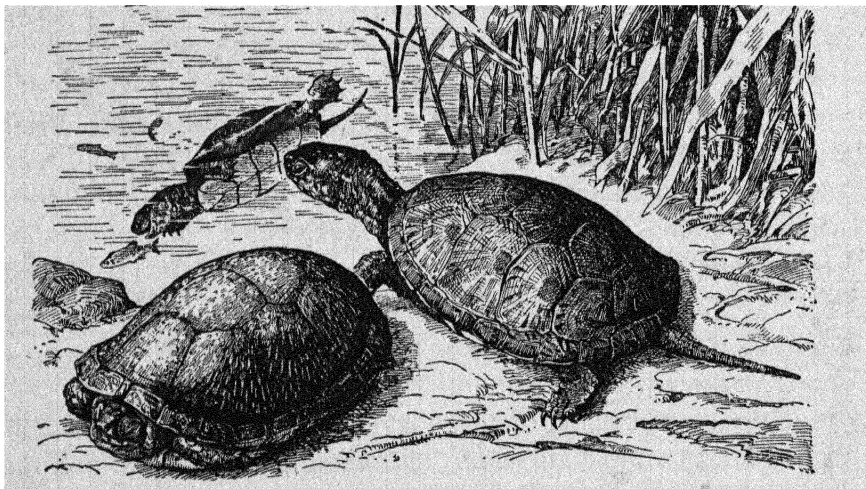
The shells consist of the bony skeleton of the animal, the bones of which are flattened. The expanded vertebræ and the ribs can be recognised when the shell is examined from the inner side. Above this bony armour is, a more or less, cornified skin, which is in several tortoises divided symmetrically into a number of horny plates, which do not coincide with the subjacent bony plates, but cover the sutures of the latter. The case is so strong that great weights can be placed on it without breaking it. The river-turtle before us, however, has a soft epidermis. The whole grows together into a hard, solid shell.

2. **FOOD AND HABITS.**—The river-turtle obtains its food in the water, where it lives on worms, insects, frogs and especially fish. It is a good swimmer possessing in its webbed feet efficient oars. Teeth are absent, their place being supplied

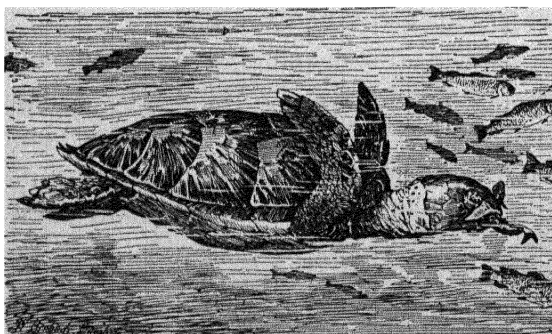
by sharp-edged, horny sheaths covering the jaws. The snout is elongated and bears at its tip two dot-like nostrils, so that in breathing the animal need only raise the latter above the surface of the water. The respiratory needs of the animal are very small, it can remain a considerable time below the surface. They lay their eggs in sand or mud, and trouble themselves no further about them. The eggs are hatched by the sun, and when the young reptiles come out, they are quite able to take care of themselves.

OTHER TURTLES

Of land-tortoises found in India the commonest is **Testudo elegans** with prettily marked shells showing radiating yellow streaks on a black ground.



Pond-Tortoises.



The Hawk's-bill Turtle hunting fish.

In the seas around India are found the **Green Turtle** (*Chelone mydas*) which is edible, and the **Hawk's-bill Turtle** (*Chelone imbricata*). The latter furnishes the best

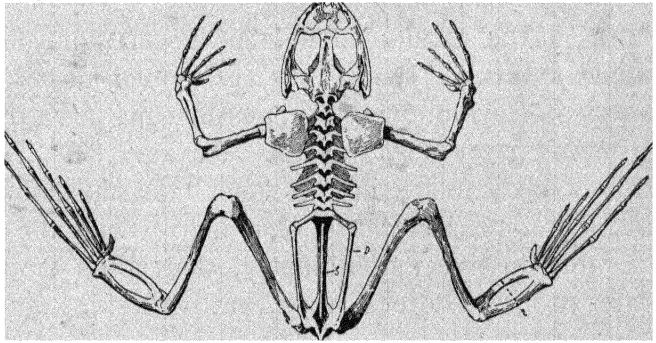
tortoise-shell of commerce and is, consequently, much sought after. The horny plates of its carapace overlap each other like roof-tiles, and are of a brown ground colour variegated with yellow. In boiling water they can be welded into any shape, which they retain after cooling. This predaeous animal attains to a length of over three feet, and inhabits principally the seas between the two tropics.

Fourth Class: BATRACHIANS

(*Amphibia*).

1. FORM OF BODY AND LIMBS.—In regard to the shape of the body, Batrachians are divided into three groups: (1) those that have a broad, flat body without tail, but with well-developed legs adapted for leaping, swimming or climb-

ing (the Frogs and Toads); (2) those that have but small legs and long tails, the body being lizard-like (the Newts and Salamanders); (3) those that



The Skeleton of a Frog.

have no legs at all, the body being vermiform (the Cæcilians).

2. COVERING.—*a*) Batrachians, like reptiles, are animals of **varying body-temperature**. They are, therefore, without any special provision for the preservation heat.

b) The **skin** of the batrachians being perfectly naked and only protected against excessive evaporation by a slimy mucus, dry heat proves injurious to these animals. If a frog is kept in a dry room, it will dry up and die in a short time. But if, on the other hand, such a frog, nearly parched up, is wrapped in wet cloth leaving only the head free, it will quickly increase

in weight, which shows that the skin absorbs water. Hence, numerous batrachians are aquatic animals, and those that live on land are exclusively nocturnal in their habits, getting the benefit of dew and the damp night-air. In the hot and dry season many frogs bury themselves up in the mud, as they cannot then live in the dry air. When the rains begin, they emerge from the places of their summer sleep and become active again.

3. RESPIRATION is effected, as a rule, by gills in the larval stage, and by lungs in the fully developed animals. But many amphibians, breathing solely by their lungs, are able to remain a considerable time below the water. They are, in fact, capable of breathing through their skin, an exchange between carbonic acid gas and oxygen being effected through it.

4. THE HEART consists of two auricles and one ventricle.

5. REPRODUCTION.—Batrachians lay **eggs**. As these are usually deposited in water, they are destitute of a solid protective covering and look like little dark balls within globes of liquid crystal. The young, as they come out of the globes, have a form differing greatly from that of the parents. They represent the mature animal, as it were, only in disguise, in a **mask** or **larva**. Hence they are termed larvæ. It is only after a series of evolutionary changes that the larva develops into the perfect frog, or newt, as the case may be. The development usually takes place in the water, and the habits of the larvæ are, therefore, like those of a fish. Only the mature animals are able to live amphibiously, that is on land as well as in water (from the Greek *amphi*, on both sides, and *bios*, life).

6. SYNOPSIS OF THE BATRACHIANS.

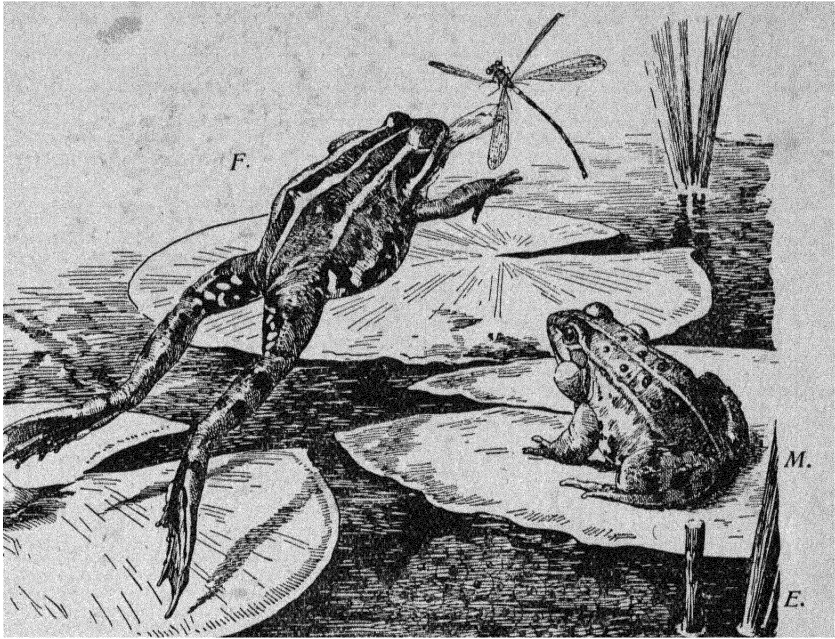
| Orders | Examples |
|-------------------------|--|
| 1. Tailless Batrachians | Common Frog, Bull-Frog, Tree-Frog, Toad. |
| 2. Tailed Batrachians | Newt, Salamander. |
| 3. Legless Batrachians | Blind worm. |

1. Order:—TAILLESS BATRACHIANS (*Anúra*).

THE COMMON FROG (*Rana esculénta*).

1. HABITAT AND COLOUR.—The favourite abode of the frog is in damp places, such as banks of rivers covered with

grass and bushes. Amid such surroundings the animal's colour is its chief protection from its numerous **enemies**, such as the



The Common Frog.

M. Male croaking. *F.* Female catching a dragon-fly. *E.* Eggs.

paddy-bird, the crow, the duck, the marsh-harrier and, above all, the rat-snake, its arch-enemy; for the grass-green surface variegated with dark spots renders the animal quite inconspicuous among the plants.

2. **FOOD AND STRUCTURE.**—The frog feeds, principally, on insects, spiders, worms and snails.

a) It will take its prey only on the move. With its large **eyes** it constantly surveys its surroundings. The sense of **hearing** seems to be acute; for at the slightest noise it leaps into the water for protection. The tympanic membrane is visible behind the eyes. The nostrils are closed by flaps when the animal is in the water.

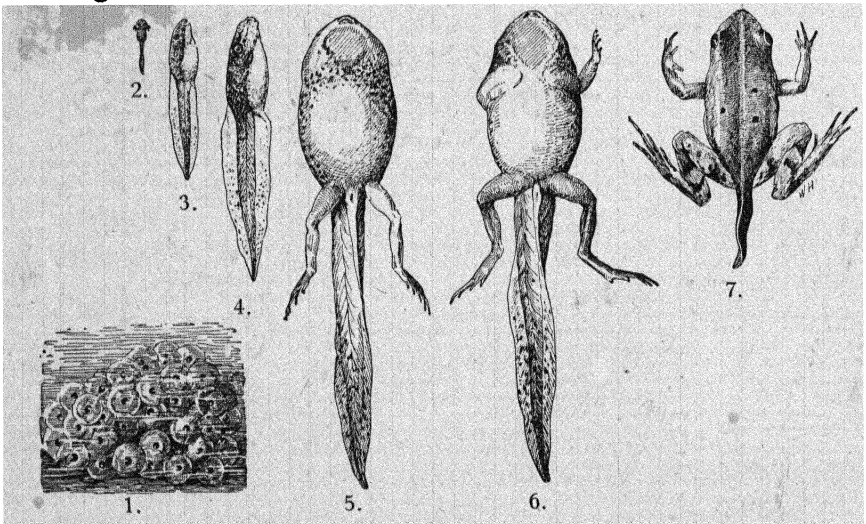
b) The frog has very strong and muscular **hind legs** with which it propels itself in swimming, and on land it does not walk, but hops along after its prey. The five-toed hind foot is webbed. The **forelegs** are weak and serve only to support

the body in falling. In swimming the forelegs are not brought into action at all. They are much shorter and weaker than the hind legs, and their four toes are not webbed.

The hind legs of the frog are, in certain countries, considered a delicacy.

c) The prey is seized by means of the **tongue** which is fixed to the mouth by its front part and can be protruded very long.

3. REPRODUCTION.—a) Frogs are active during the rains. In the dry months they pass their time in a state of torpor, either buried in the mud or in damp holes and corners into which they wedge themselves. But when the rain drips from the roof, and the rice-fields are flooded, they come out into the open, and fill the air with their rancous **croakings**. The sound of the voice is strengthened by two vocal sacs, situated near the angles of the mouth.



The development of the Frog.

1. Spawn. 2– 6. Tadpoles in various stages. 7. Young frog with a rudimentary tail.

b) After a few weeks the female frog spawns, *i. e.*, deposits its **eggs**, which have the appearance of a sago-pudding, each egg consisting of a dark-brown central part, the yolk, which is surrounded by a large amount of gelatinous matter. This jelly protects the eggs from injury and constitutes the

earliest nutriment of the larvæ. The number of these eggs is very large, though not excessive when we consider the numerous enemies to which the frog and its young are exposed, and the fact that the parents concern themselves neither about the eggs nor about their young.

c) Of great interest is the development of the frog. Whereas in most animals the development of the young takes place within the egg; in the frog it can be watched as it takes place outside the egg.

After about four days, the **tadpoles** are hatched out by the heat of the sun. As they live in water, they have in all respects the structure of an aquatic animal, they are in shape like fish, have a long laterally compressed tail fringed by a soft fin and serving them as rudder, and they breathe by means of gills. These, at first, protrude from the neck on both sides in the form of tufts. At a later time, these external gills disappear, being replaced by others formed internally. The mouth is a small opening with horny teeth, with which the tadpoles crop the water-weeds for their food.

After some weeks, the **hind limbs** and subsequently the **forelimbs** are developed, the **tail disappears** and the animal gradually becomes a land-animal. The mouth is now broader, the horny sheaths of the jaws are lost, the tongue is developed, and instead of the gills the animal obtains lungs. In short, the fish-like tadpole is metamorphosed and has become a frog.

d) The **lungs** of the frog are still very imperfect, being simple sacs. There are no respiratory movements of the chest, the air is swallowed in gulp after gulp. Breathing is, to a great extent, effected also through the skin. For this purpose the skin must be damp; consequently frogs are never found far from water.

Other frogs are the large **Bull-frog** (*R. tigrina*), and the small frogs that skim the surface of ponds and hop about in marshes. The **Tree-frog** (*Ixalus*) bears a coat strikingly protective in colour. It possesses sucking disks on the ends of the toes, by means of which it adheres even to smooth surfaces. It has a peculiar loud and clear metallic call.

The **Toad** (*Bufo melano-stictus*) visits the water only for the purpose of depositing its spawn, which is not in lumps, but in necklace-like strings. It is nocturnal in its habits.

II. Order:—TAIL BATRACHIANS (*Urodéla*).

To these belong salamanders and newts, of which there are hardly any representatives in India. They have a lizard-like body with a long tail and four short limbs.

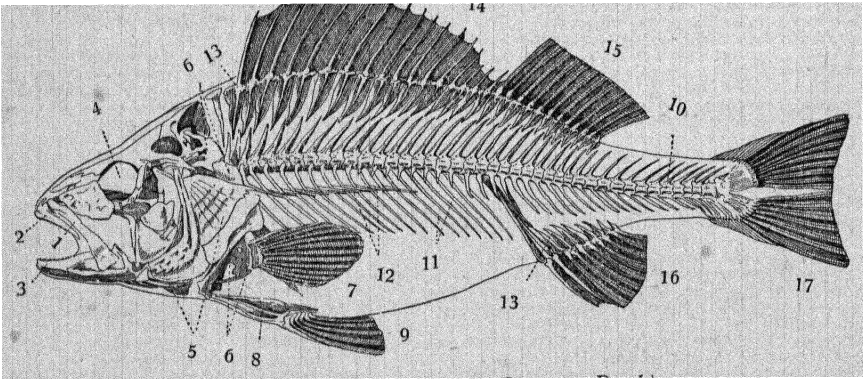
III. Order:—LEGLESS BATRACHIANS (*Apoda*).

These are worm-like, footless animals of underground habits. They have minute eyes entirely covered by the skin. Their larvæ have three pairs of external gills, which shows that these peculiar animals, in fact, belong to the Batrachians.

Fifth Class: FISHES

(*Pisces*).

1. FORM OF BODY.—Fishes are denizens of the deep. As water is denser than air and hence more difficult to be

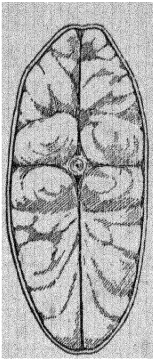


The Skeleton of a Fish (*the Common Perch*).

1. Upper jaw. 2. Intermaxillary bone. 3. Lower jaw. 4. Orbit. 5. Parts of the gill-cover. 6. Bones of the shoulder-girdle. 7. Pectoral fin. 8. Bones of the pelvis. 9. Ventral fin. 10. Vertebral column. 11. Ribs. 12. Intermuscular spinous processes of the ribs. 13. Interspinous bones. 14. First and 15. Second dorsal fin with spinous rays. 16. Anal fin. 17. Caudal fin.

traversed, it is of great advantage to the fish that its body is torpedo-shaped, *i. e.*, both head and tail taper to a point, and are immovably joined to the main body.

2. MOTION AND LOCOMOTIVE ORGANS.— *a)* The rudder and the oars of a boat have broad surfaces. The limbs of

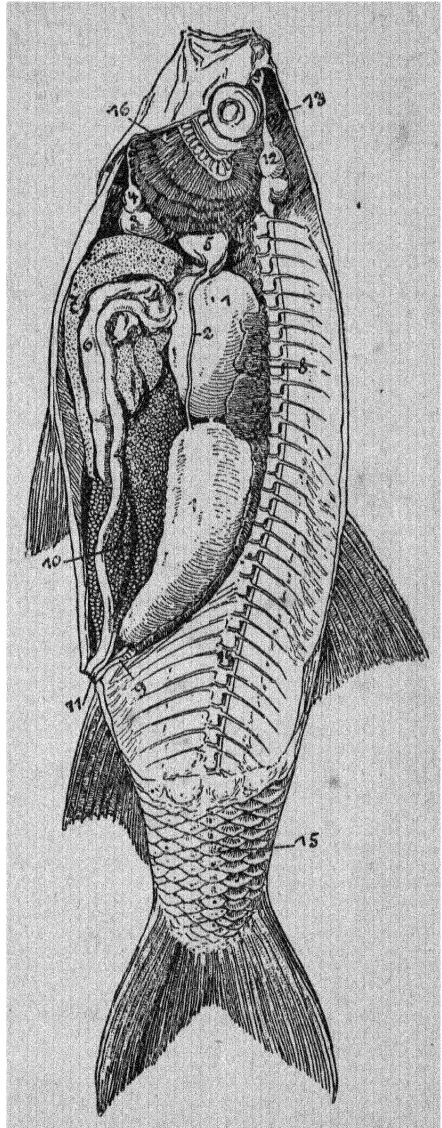


Cross-section of the tail of a fish, showing the four large strands of muscles grouped round the vertebral column.

fishes are constructed on the same plan and present large flat surfaces to exert a strong pressure against the water. They are termed pectoral (breast) and ventral (belly) fins, and correspond to the fore- and hind limbs of other vertebrates. In addition to these paired fins there are also others, developed along the vertical

median line of the body, the dorsal, caudal, and anal fins. Fins are expansions of the skin supported by bony or cartilaginous rays and connected with muscles by which they can be expanded or folded, laid down or erected.

b) A fish is capable of floating at rest at any height or depth in the water. We infer from this fact that the weight of its body must be exactly the same as that of the bulk of water displaced by it. The fish being thus supported by water, its limbs do not require to be strong. They serve chiefly as



Inner structure of a Fish (*Rudd*).

1. Air-bladder. 2. Air-duct. 3. Heart.
4. Swelling of the artery. 5. Throat.
6. Intestine. 7. Liver. 8. Kidney.
9. Urinal duct. 10. Ovary. 11. Ovi-duct. 12. Brain.
13. Olfactory nerve. 14. Vertebral column. 15. Lateral line. 16. Gills.

steering instruments by which the direction of the locomotion can be changed. The dorsal and anal fin (as well as the tail fin) help to balance the fish in the water, just as a ship's keel does. They increase the vertical surface of the body and thus prevent it from rolling over on its side.

c) The most important organ of locomotion is the tail with its large fin. For if one watches a fish swimming rapidly along, one can see that the locomotion is effected by alternate right and left strokes of the tail. In the same way, a boatman sometimes propels his boat by sculling with a single oar at the stern. As the caudal fin thus is the chief instrument of locomotion, it must be large and powerful. The tail consists of four large strands of muscles grouped round the spinal column extending as far as the head.

3. AIR-BLADDER — The air-bladder also is an important part in fish-locomotion. This is a membranous sac, placed beneath the spinal column. It is inflated with air and, hence, reduces the specific weight of the fish considerably, thus enabling it to float passively at a certain depth. The pressure of water increasing with the depth, the air-bladder is compressed or dilated according to the varying level to which the fish descends or rises.

4. The SKELETON is bony in the larger number of fishes. In others it is cartilaginous throughout life.

5. RESPIRATION AND CIRCULATION.— a) If spring water be allowed to stand in a glass for a considerable time, small bubbles of air will be observed to cover the sides of the glass, showing that the water contains air. The fish requires this dissolved air in water for respiration. Its organs of respiration are the gills. They are placed at both sides of the head, and consist of bony arches each carrying two rows of very fine plates, the branchial laminae. The inner margin of the branchial arches is mostly beset with horny teeth or spines, forming the so-called gill-rakers. The function of these rakers is to keep off any solid substances that might have been taken in with the water of respiration. In most fishes the branchial laminae are outwardly protected from injury by bony gill-covers. The posterior edge of the cover is free, and leaves a large slit, the gill-opening.

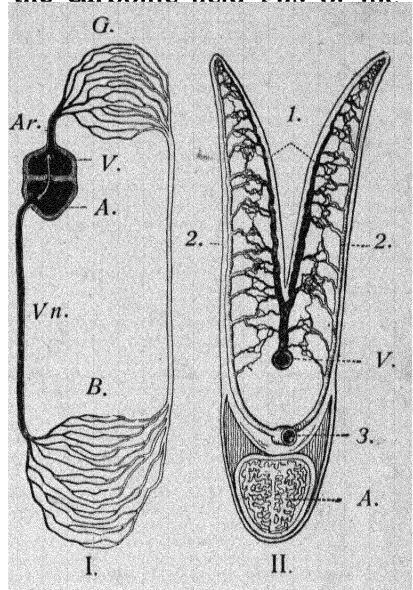
b) Immediately behind the gills there is the heart which consists of a ventricle and an auricle. It pumps the blood

into the gills. These being exceedingly thin membranes, respiration can take place in them: the carbonic acid gas of the blood passes through the membrane out into the water, whereas the oxygen of the air dissolved in the water passes in a reverse direction from the water into the blood.

c) The water that bathes the gills must be constantly renewed. It is taken into the mouth and passed backwards over the gills and let out again through the slits at the sides. This is repeated over and over again, and so we see the fish constantly opening and shutting its mouth as if it were drinking.

If we drive all the air out of a quantity of water by boiling and put a fish into it (after letting it cool), it would die at once for want of air. On the other hand, fish die also out of the water, although they have a large quantity of oxygen. This is because the branchial leaflets dry up, and stick together, so that respiration is arrested and the animals die of suffocation.

d) The quantity of oxygen taken in by the gills in breathing is so little, that it is not sufficient to warm their blood or bodies. Besides, the water that bathes the gills withdraws so much heat from the blood, that a large quantity of heat would be required to keep the temperature of the blood above that of the surrounding water. They are, therefore, cold-blooded animals. And, for this reason, they have no need of a heat-retaining covering.



Circulation of the Blood in a Fish.

I. *Diagrammatic sketch of the Circulation.*

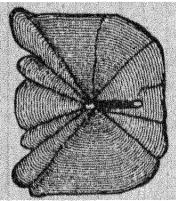
V. Ventricle. A. Auricle. Ar. Artery. Vn. Vein. G. Capillaries of the Gills. B. Capillaries of the Body.

II. *Circulation of Blood through two Gill-leaflets.*

A. Gill-arch (cross-section). V. The Blood-vessel that conducts the blood into the Gill. 1. Branchlets of this vessel, dividing into fine Capillaries in which the blood is purified and then collected in other vessels, 2. which end in the vessel, 3. from which the blood is conducted into the body.

e) **BODY-COVERING.**—A coat of fur, wool, or feathers would also, for another reason, be no good covering for a fish, inasmuch as it would interfere with the movements of the fish in water. The body must be smooth, and, in fact, it has a slimy, slippery feel. The silvery-looking coat consists of a multitude of little, round scales, which overlap one another, and are firmly fixed in the skin in front. When the fish swims about, the water itself presses the scaly coat closer and closer to the body.

6. **ORGANS OF SENSE.**—In the water, even at the depth of a few fathoms, semi-darkness prevails. As the eye of the fish is, as a rule, very large and the pupil very wide, a sufficient amount of light-rays can enter it. Eyelids, which are ordinarily a means of protection against dust, are absent. Neither external ear, nor tympanum are present. The nose is not, as in air-breathing animals, connected with the organs of respiration. It consists merely of two pits placed at the front end of the head, for the water to flow freely in and out. The sense of touch has its seat in the lips, which in some fishes are provided with long tactile filaments or barbels.



Scale of the
Lateral Line
with the tube.

In many fishes a peculiar dark line may be observed running along the middle on the body from head to tail. This is the so-called **lateral line**. Each of the scales in this line is perforated by a small tube and leading down to what is believed to be the organ of a sixth sense, unknown and absent in ourselves. Possibly this sense renders the fish capable of recognising certain conditions of the water, such as the pressure or the relative percentage of salt.

7. **REPRODUCTION.**—Fishes are produced from eggs, and the number of them deposited by a single fish is enormous. The parents take no interest in the fate of their eggs. These form the favourite food of many water-animals, and even the tiny fishes, that come from the spawn, feed on the eggs laid by others. Moreover, the small young fishes, the young fry themselves, form the chief food of all others that are large enough to prey on them. We can now understand why one single fish is made to lay such a multitude of eggs.

8. SYNOPSIS OF FISHES.

| Subclasses | Orders | Examples |
|-------------------------|---------------------|--|
| a) Cartilaginous fishes | 1. Sharks: | Blue Shark, Hammer-headed Shark, Saw-fish. |
| b) Bony fishes | 2. Rays: | Sting-ray. |
| | 3. Physostomi: | Eel, Carp, Herring, Cat-fish. |
| | 4. Acanthopterygii: | Mackerel, Madras Whiting, Mugil. |
| | 5. Anacanthini: | Flat-fish. |
| | 6. Lophobranchii: | Sea-horse. |
| | 7. Plectognathi: | Globe-fish. |

I. SUBCLASS: CARTILAGINOUS FISHES (*Chondropterygii*).

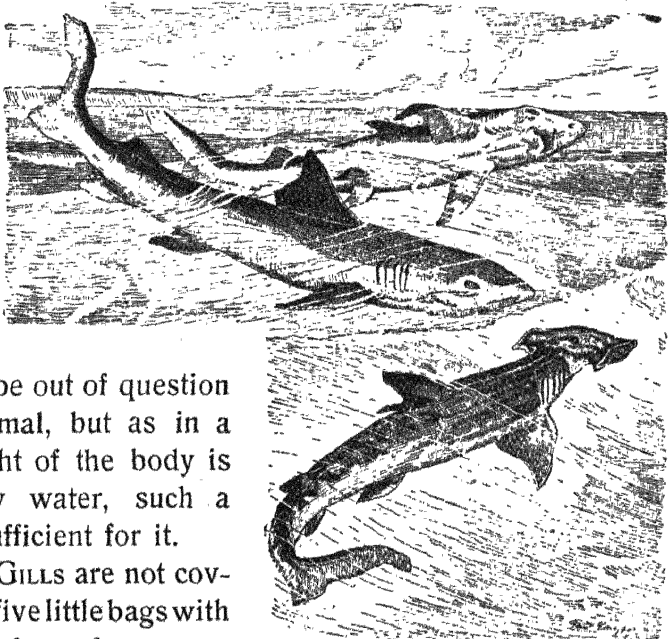
Skeleton not bony, cartilaginous. Gill-covers absent.

I. Order:— SHARKS (*Carchariidæ*).

The Shark (*Carcharias gangeticus*) is a denizen of tropical seas, ascending also the larger rivers as far as, or even beyond, the limits of the tide.

1. Its SKELETON is cartilaginous and remains thus throughout life. A skeleton of this nature would be out of question in a land-animal, but as in a fish the weight of the body is supported by water, such a skeleton is sufficient for it.

2. The GILLS are not covered, but lie in five little bags with openings, which can be seen as five clefts on each side of the neck.



Two Blue Sharks and a Hammer-headed Shark.

3. The shark is a terrible and voracious **pirate**. It is fond of following ships in order to pick up the offal that is thrown overboard.

4. On account of its large **size** (up to fourteen feet) and **strength** it becomes formidable to the largest fishes of the sea. It has been known to attack men also. But its dangerous offensive character is often exaggerated.

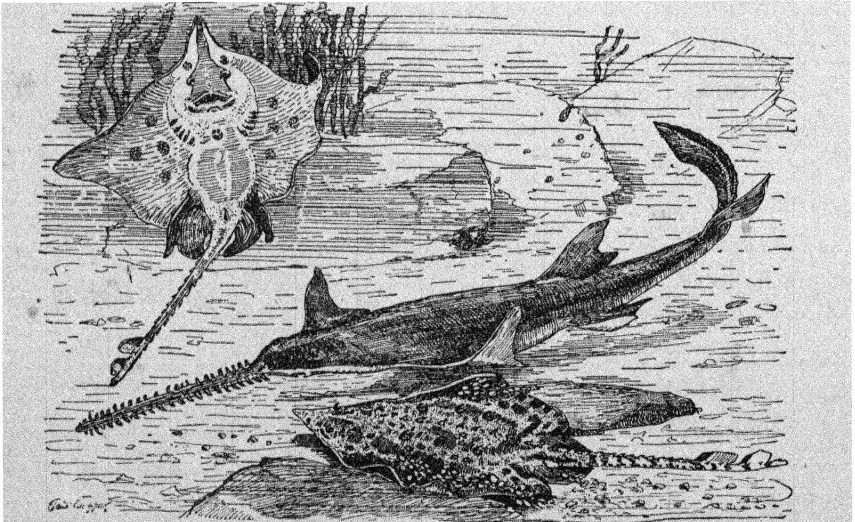
5. The elongated shape of the body and the powerful **tail** which is provided with an asymmetrical **fin** render the shark a very good swimmer, though it possesses no air-bladder.

6. The skull projects far beyond the wide **mouth**, which bristles with several rows of large, double-edged teeth.

7. The **Blue Shark** brings forth living **young**. The majority of sharks, however, reproduce themselves by **eggs**, which they attach to the tendril-like ends of sea-weeds.

OTHER SHARKS

The **Hammer-headed Shark** (*Zygæna*) has obtained its name from its extraordinary T-shaped head, and is greatly dreaded.



Rays and Saw-fish.

The **Saw-fish** (*Pristis*) has its snout produced into a long flat plate armed with strong teeth on each side.

II. Order:— RAYS (*Trygonidæ*).

The **Rays** (*Trygon*) resemble the flat fishes in their mode of life. Their head and abdomen are compressed into a broad plate, which is laterally fringed by the fan-shaped pectoral fins. Their thin whip-like tail, often armed above with spines like the middle line of the back, is distinctly marked off from the disk-shaped anterior portion of the body.

The flesh of some species of sharks and rays is eaten by the poorer classes. They are often dried and exported into the interior of the country as well as to other countries, *e. g.* China.

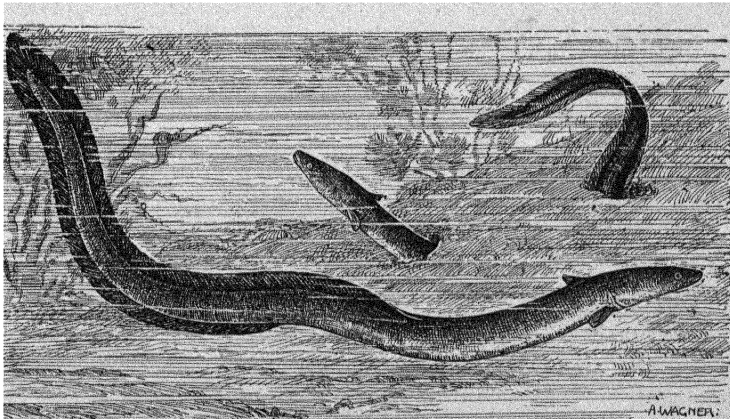
II. SUBCLASS: BONY FISHES (*Teleostei*).

Skeleton bony. Gills covered. Skin ordinarily provided with scales.

I. Order:— PHYSOSTOMI

Air-bladders provided with an air-duct. Fin-rays articulated and not spinose. Ventral fins situated behind the pectoral fins. Most of the Indian fresh-water fishes belong to this group.

I. The **Murænas** and **Eels** (*Murænidæ*) have an elongated snake-like body and a flattened tail, bordered by a fin-band.



Eels.

The animals progress by undulating movements of their body and tail.

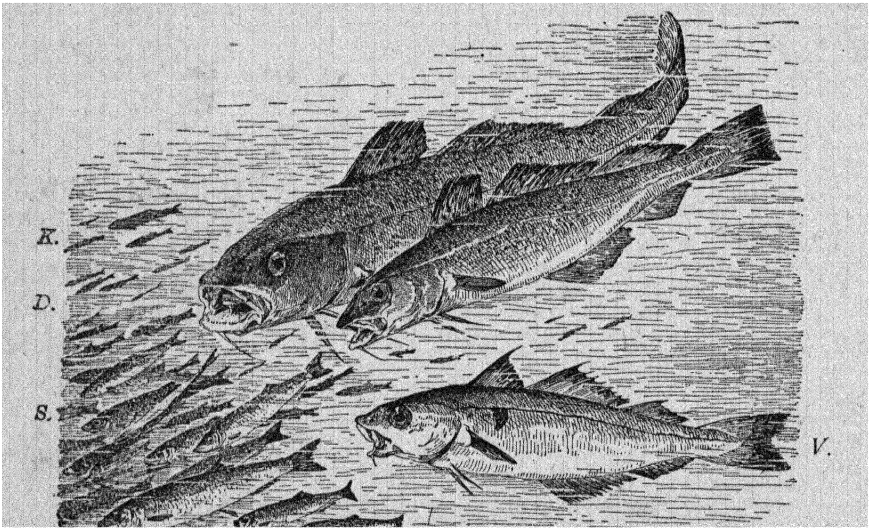
II. The **Carps** (*Cyprinidæ*) are covered with scales and have a toothless mouth. They are all fresh-water fishes, and

most of them are edible. Common Indian Carps are the Rohi (*Labeo-rohita*), the Catla (*Catla Buchanani*), and the Mahseer (*Barbus tor*).

III. The **Herring family** (*Clupeidæ*) is represented by the Indian Sardine (*Clúpea longiceps*) which is largely used in the production of fish-oil. The Common Herring (*C. haréngus*) is a denizen of Northern seas.

THE INDIAN OIL-SARDINE (*Clúpea longiceps*).

1. **HAUNTS AND BODY-COLOURING.**—The Sardine haunts the upper layers of water in the ocean. Like other fishes which



Herrings (S.)

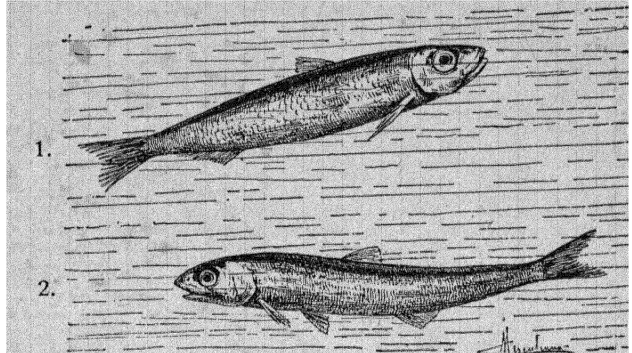
pursued by two Cod's (K. D.) and a Haddock (V.)

similarly live in the surface-layers of the water, their entire body is clad in a brightness of silver, passing into a blue or greenish glimmer in the back.

2. **NOURISHMENT.**—The sardines live on various small animals that move freely in those upper layers. As a large quantity of such animalcules is required to feed a fish of the size of a sardine, small though it be, it is necessary to catch a great lot of them. This is managed by a kind of bony net in its mouth, through which the water passes when it is taken up and sent to the gills for the supply of the required air to

breathe. The little animals are caught in the meshes of that net, and then swallowed.

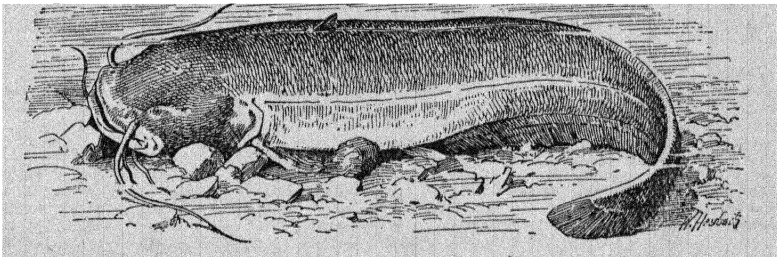
3. **REPRODUCTION AND FISHING.**—The eggs of the sardines being heavier than water and not able to float, the fish does not



1. Sardine, and 2. Anchovy.

spawn in the deep sea, but comes to the shore in search of hard ground and shallow water. Thus the fish is found at certain places near the coast in large shoals every year during the spawning time. And it is at this time that man goes to catch the fish. What enormous masses of these sparkling fishes are caught annually can hardly be estimated: it may be many millions of them.

USE.—The sardines are excellent to eat. They are either eaten fresh or are preserved in tins. As they contain much fat, they are also used for producing fish-oil. A large part of them remains as surplus for use as manure.



The Sheat-fish (*Silurus*).

IV. The **Cat-fishes** (*Siluridae*) are scaleless and have generally large heads furnished with feelers or barbels.

V. The **Half-beak** (*Hemirhamphus*) has an elongated lower jaw.

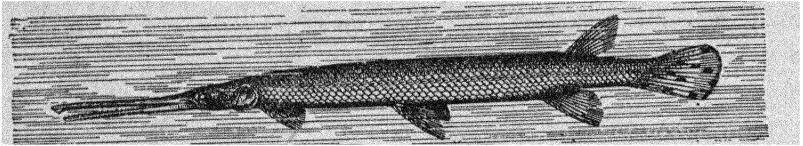
VI. The **Flying-fish** (*Excoetus*) has the shape of a herring, but possesses very large wing-like pectoral fins. If it is pursued

by an enemy, it jerks out of the water and glides through the air above the waves to a distance of about 200 yards, using its broad fins as a parachute.

II. Order:—ACANTHOPTERYGII

Air-bladder closed. Part of the dorsal, anal, and ventral fins are spiny and not articulated.

The vast majority of this order are marine fishes. It contains the **Perches** (*Percidæ*), the **Sea-brems** (*Sparidæ*),



The Bill-fish (*Lepidosteus*).

An enamel-scaled fish in the rivers of North America.

with the **Black Rock Cod** (*Chrysophrys*), the *Sciænidæ* with the **Otolithus** (*Tulu: Kallur*), the **Horse-mackerels** (*Carangidæ*), the **Pomfrets** (*Stromateidæ*), the true **Mackerels** (*Scombridæ*) with the **Mackerel** (*Scomber*) and the **Tunny** (*Thyunus*), the **Madras Whiting** (*Sillago sihama*), the **Spiny Eel** (*Rhynchobdella*) and the **Gray Mulletts** (*Mugilidæ*). Many of these fishes are highly esteemed as food.

The Mackerels are, like the sardines, found in such numbers that a large surplus remains for use as manure.

One family, the **Murrels** (*Ophiocephalidæ*), are fresh-water fishes inhabiting both ponds and rivers. They can live for a long time out of water or buried in the mud; for they breathe by means of bronchiæ. They can also travel some distance over the ground, especially when it is moist, and this they achieve by serpentine movements of their body aided by their pectoral and caudal fins.

III. Order:—ANACANTHINI

Air-bladder closed. Fin-rays articulated and not spinose.

This order contains several important edible fishes of the North Atlantic, such as the **Cod** (Cod-liver oil) and **Haddock**, and is represented in Indian seas only by some **Flat-fishes** (Plaice, Flounder, Sole and Turbot).

The **Flat-fishes** (*Pleuronectidæ*) are remarkable for their asymmetrical body. They live near the bottom of the sea, and their habits agree well with their peculiar shape. The young are bisymmetrical animals like other fishes; they swim in the same

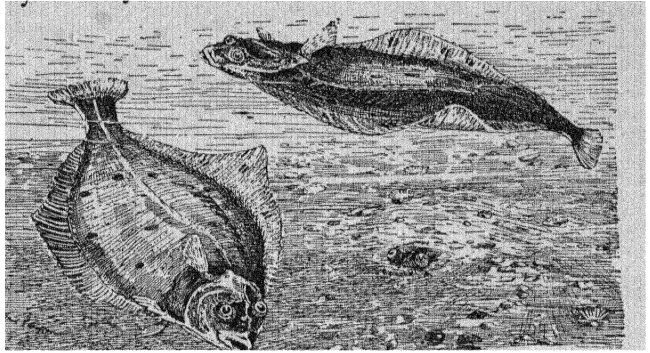
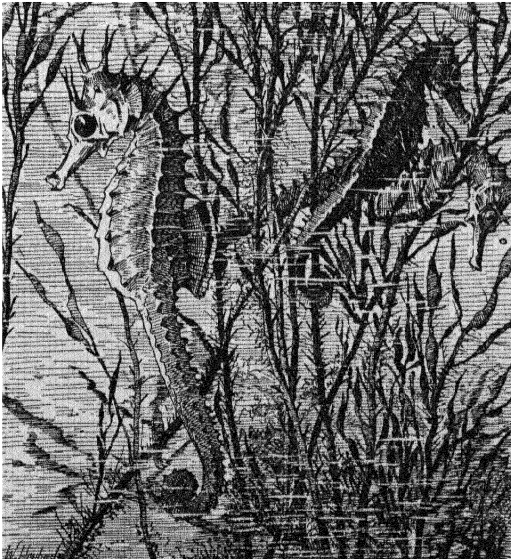


Plate.

manner, and have both sides of the body of the same colour; but when they grow larger, their body becomes gradually flatter, and in swimming they take a horizontal position. At the same time they seek the bottom of the sea, to which they turn the left side of their body. But in this position the left eye would be useless for sight. Consequently the eye is shifted to the right side and the colour of the under or “blind” side disappears, whereas the upper side assumes a striking resemblance to the colour of the sea-bottom.



The Sea-horse.

IV. Order: LOPHOBRANCHII

These are very unlike ordinary fishes. Their body is encased in a dermal skeleton, and their gills are not laminated, but composed of rounded tufts. The **Sea-horse** (*Hippocampus anti-quorum*) has its habitat in the midst of sea-weed to which it attaches itself with its prehensile tail. Its

coloration and the tubercles of spines on the head and body closely resemble their surroundings, and constitute the means by which these defenceless creatures escape detection by their enemies.

V. Order:— PLECTOGNATHI

The **Sea-hedgehog** (*Diodon*) is a representative of this order, characterized by the more or less globose form of its body. It is covered with a thick skin, without scales, but provided with variously formed spines. It has the power of blowing itself out into a ball. The spines are then erected and the body will float, belly upwards, on the surface of the water like a spiny ball.

Second Division—Articulated Animals (*Arthrópoda*).

1. SKELETON.—There is no bony or cartilaginous skeleton in the body of an insect, or a crab. These animals are, therefore, boneless or invertebrate animals. They have, instead, a horny or leathery outside case, which gives them their shape, and is aptly described as a cuticular skeleton. It provides protection against external injury and desiccation as well, and is composed of a horny substance called chitin.

These animals, then, are cased in armour, as the knights of old! And this armour consists of separate pieces, admitting of great freedom of movement. The numerous segments are jointed to one another by a soft, elastic skin.

The limbs, a pair of which may be attached to each segment of the body, are similarly encased in that hard chitinous skin; to enable the insect to move, the limbs are also divided into several segments and jointed.

2. The NERVOUS SYSTEM is situated on the ventral side of the body. It is formed of a series of ganglia, corresponding to the number of the body-segments and connected with one another by two nerve-cords. From the ganglia nerve-fibres pass off to the several organs of the body.

3. CIRCULATION.—The heart which drives the blood through the body has the form of a tube situated under the back. As the blood circulates very slowly and as the arterial and venous blood is mixed, the resulting heat is low. The arthropoda are, therefore, cold-blooded animals. The blood, besides, is colourless. The breathing is done either by holes in the side, or by gills in water-animals.

4. REPRODUCTION.—The young, as a rule, differ in shape from the parent. They are larvæ, and only attain to the shape of the parent animals after a metamorphosis. The chitinous case being incapable of enlargement, it follows that the skin is repeatedly cast during the growth and metamorphoses of the animal.

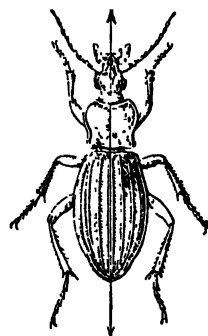
5. SYNOPSIS OF THE ARTICULATED ANIMALS.

| Classes | Examples |
|--------------------------|---|
| I. Insects | Butterfly, Rhinoceros-beetle, Bee, Fly, Locust. |
| II. Centipedes | Scolopender, Millipede. |
| III. Spider-like Animals | Geometrical spider, Scorpion, Itch-mite. |
| IV. Crabs | Lobster, Sand-crab, Acorn-shell. |

First Class: INSECTS

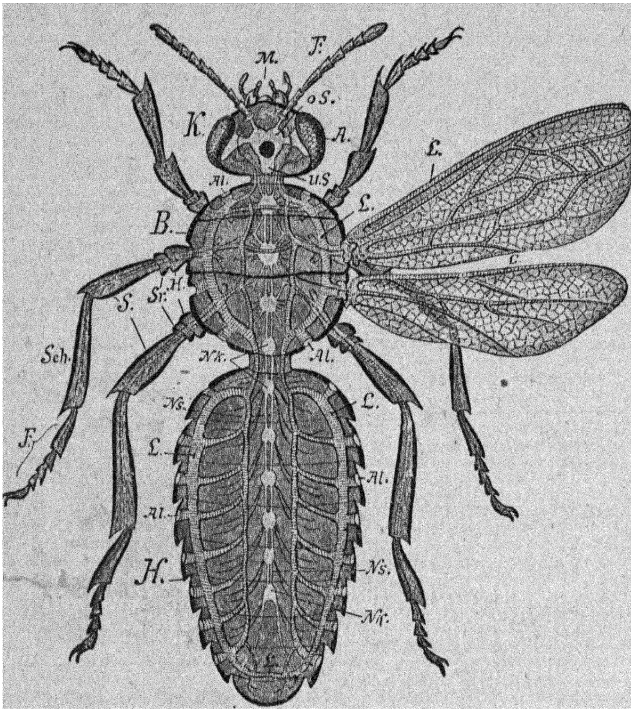
(*Insecta*).

1. DIVISIONS OF THE BODY --In the forepart of the body is the mouth, surrounded by three pairs of mouth-parts, which in order to perform their work effectually require firm supports. These are provided for by the coalescence of several segments into a firm capsule, the **head**. The three succeeding segments carry the legs and the wings. The same conditions apply to the organs of locomotion as to those of the mouth, and, accordingly, these three segments likewise, wholly or partially, coalesce into a single division, the **thorax**. In the last division of the body, the **abdomen**, the several rings are quite distinct from each other, neither legs nor wings are developed here.



A bisymmetrical Animal.

2. ORGANS OF LOCOMOTION.—*a*) There are always three pairs of legs, and these are attached to the lower surface of



Divisions of the body of an Insect, with respiratory and nervous systems.

1. DIVISIONS OF THE BODY:

- K.* Head with eyes *A.*, feelers *F.*, and mouth-parts *M.*
B. Thorax with the three pairs of legs and two pairs of wings. *H.* and *Sr.* the first two short joints; *S.* the thigh; *Sch.* the leg; *F.* the foot with several joints and two terminal claws.
H The Abdomen.

2. RESPIRATORY SYSTEM:—

L. Tracheæ; *Al.* Stigmata.

3. NERVOUS SYSTEM:

Nk. Nervous ganglia; *Ns.* Nerve-cords; *u. S.* Lower and *o. S.* Upper throat ganglion, from which nerves pass off to the eyes and feelers.

the thoracic division. In the adult insects they consist, as a rule, of five divisions, the first short division connects the leg to the body skeleton, and, in conjunction with the second joint, considerably increases the mobility of the leg; the third division, the thigh, is the stoutest, and contains the muscles which move the two following joints, viz., the elongated leg and the foot, which itself consists of several joints.

Few things are more wonderful than the way in which the legs and feet of different insects

are fitted to suit the particular mode of living of each kind, viz., jumping, or burrowing, or leaping (see Grasshoppers, Cocoanut-beetle, Cockroach).

b) The second and third divisions of the thorax generally carry on their dorsal side each a pair of wings. These are

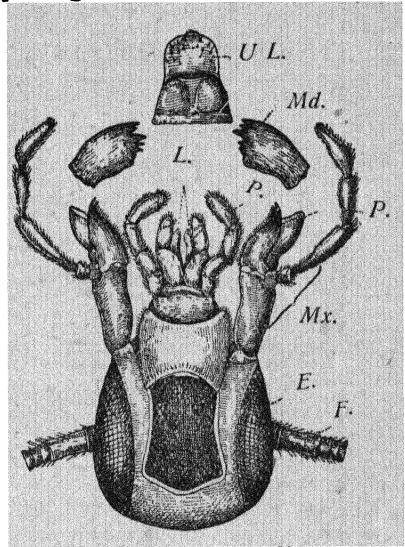
skinny structures which are expanded and supported by firm tubes, known as nervures.

The systematical division of the insects into several orders is based on the structure of the wings.

3. DIGESTION.—*a)* Three pairs of the limbs, namely those of the three segments composing the head, serve the nutritive function. The first pair form the undivided biting jaws or mandibles. They are situated below the upper lip which is formed by a projecting plate of the chitinous capsule of the head. It is to be noted that, whereas in most animals it is only the lower jaw that moves up and down, in insects both jaws move and always from side to side. The second pair of limbs are transformed into the maxillæ, each provided with a feeler-like process, the maxillary palp. The third pair, equally furnished with a pair of palps, forms the lower lip, or labium, generally in one part.

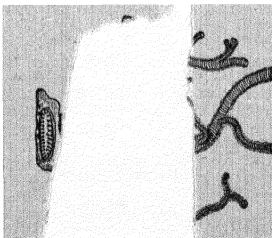
All these parts vary considerably according to the nature of the food and the manner of taking it.

b) The intestine consists of several separate parts. Two large salivary glands always open into the mouth. Kidneys are represented by tubular vessels.



(cockroach) seen from below.

U. L. Upper Lip. *Md.* Mandibles (upper jaw). *Mx.* Maxillæ (lower jaw) with feeler-like processes *P.*
L. Lower Lip with feeler-like processes *P.*
E. Eye. *F.* Feeler.



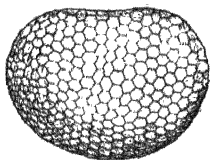
of the
le.

4. RESPIRATION — *a)* The organs of respirations are fine tubes, which are called air-tubes or **tracheæ**. As a rule, they form two main canals running through the whole length of the body and sending off smaller and smaller branches in every direction and penetrating even into the feelers, legs and wings, and surrounding all the inner organs as with a net. The

process of respiration, *i. e.*, discharge of carbonic acid and absorption of oxygen, takes place in the finest terminations of these tubes. The outer ends of these air-tubes are small openings of the skeleton, known as **stigmas**.

b) The manner in which insects breathe may be observed in any larger insect, especially in a cocoon-beetle when it is preparing to fly away. The abdomen is then seen to expand and contract alternately. The contraction of the body exercises a pressure on the tracheal tubes by which the air contained in them is driven out. The tubes, however, are lined with elastic coiled springs, opening the tubes again immediately after the pressure ceases and thus sucking in fresh air.

5. ORGANS OF SENSE.—a) **Eyes**. If the eye of a larger insect is examined by means of a lens, it will be seen that its surface is composed of a great many small six-sided areas or facets. Each facet represents an eye, and thus the two globules standing out well from each side of the head are made up of an immense number of small eyes massed together.



The compound eye
of a Cockchafer.

In addition to these compound eyes, the bees and some other insects have a number of small single eyes in front of the head. As a rule, larvæ have only such single eyes.

b) The **feelers** are the organs of feeling, smelling, and hearing. Many insects, however, seem to be completely dumb.

6. METAMORPHOSIS.—The larvæ and the perfect insect differ from each other in structure and habits. In some the larvæ pass through the pupa stage, a stage of rest, in which the animal is motionless and does not take food, before it changes into the perfect insect. In others no pupa stage is interposed in the course of development. The metamorphosis is called complete in the first case, but incomplete in the second. The larvæ that crawl about, and have a long body with six legs and a number of fleshy feet, are called grubs. They are the young of butterflies and moths. The larvæ with a head and only six legs and a thick, footless posterior part of the body, are called grubs. The perfect insects, after they have passed through the pupa stage, are called beetles.

larvæ with no legs at all nor any discernible head are maggots, the larvæ of flies.

7. SYNOPSIS OF THE INSECTS.

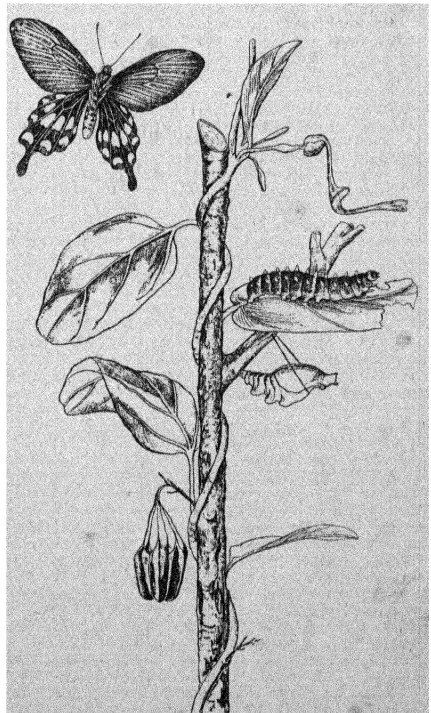
| Orders | Examples |
|-----------------------------------|---|
| 1. Scale-Wings (Butterflies). | Swallow-Tail, Silk-Moth, Death's-Head Moth, Clear-wing, Clothes-Moth. |
| 2. Sheath-Wings (Beetles). | Rhinoceros-Beetle, Water-Beetle, Glow-Worm, Weevil, Bark-Beetle, Longicorn-Beetle, Lady-Bird. |
| 3. Hook-Wings (Bees and Ants). | Honey-Bee, Red Ant. |
| 4. Two-Wings. | House-Fly, Mosquito, Flea. |
| 5. Net-Wings. | Ant-Lion, Caddis-Fly. |
| 6. Long-Beaks. | Bed-Bug, Cicada, Plant-Louse, Head-Louse. |
| 7. Straight-Wings. | Grasshopper, Cricket, Mantis, Cockroach. |
| 8. False Net-Wings. | Dragon-Fly, Termite. |
| 9. No-Wings. | Paper-Fish. |

I. Order:—SCALE-WINGS (*Lepidóptera*).

1. THE BIRTHWORT SWALLOW-TAIL (*Papilio Aristolóchiæ*).

A. THE EGG.—The female Swallow-Tail deposits her eggs in large numbers on the under-side of the leaves of the Indian Birthwort (*Aristolochia indica*). The leaves of this plant form the food of larvæ when hatched. The lower side of the leaves is selected as a safe place for the small eggs, affording protection against rain and the scorching heat of the sun as well as to hide them from the eyes of their enemies.

B. THE LARVA of the swallow-tail is a caterpillar, a worm-like creature with four rows of bristles extending from head to tail, and of blackish-



purple colour with a white belt about the middle of the body. Leaves being a food stuff of little nourishing value, the caterpillar must consume a large quantity of it. It grows rapidly and casts its skin several times. Besides, it lays up within its body a store of reserve material on which the life of the pupa may be sustained.

1. As the larva need not go in pursuit of its food, it may be a lazy creature with short legs, of which there are three pairs as in the perfect insect.

2. The body of the caterpillar is, however, so elongated, that the three pairs of thoracic legs would not support it. This is made possible only by means of the abdominal legs which are attached in pairs to the third, fourth, fifth, sixth and last of the abdominal segments, there being a gap between the last pair (the claspers) and the one before.

3. Since the larva lives on solid food, it possesses organs for biting and chewing. The mandibles form strong pincers.

4. Like most of the animals living above ground, the caterpillar possesses eyes, six of these are situated on each side of the head, and they are of the shape of 'simple eyes'.

C. THE PUPA.—1. By the time the caterpillar has attained to its full size, it leaves the food plant and creeps up the tree on which the Birthwort was climbing, to search for a suitable place for undergoing its transformation.

2. It fastens itself to a twig by a web, the material of which is secreted from two glands in the head. With these glands it spins a strong belt or band across its body. This done, the skin splits at the neck and is stripped off by twistings of the body, leaving the pupa in a suspended condition.

3. This is a brownish object with numerous projections and edges, so that it is not easily noticed. Parts of the future butterfly may be distinguishable on the case of the pupa. The pupa thus remains in an apparently lifeless state for some time. But in its interior great changes take place and the sluggish plant-feeding caterpillar is converted into the swift-winged, honey-sucking butterfly.

D. THE BUTTERFLY.—On a warm sunny day, during or after the rainy season, the now fully-matured butterfly bursts through its pupal shroud and soars aloft to enjoy sunshine and

air. This gentle creature lives, however, only a short time. On account of the short duration of its life it is able to subsist upon a food which is not very nourishing, *i. e.*, upon sweet vegetable juices.

1. Being like the bee, an animal that sucks the honey of flowers it must be winged. There are two pairs of wings.

a) If one of the wings is rubbed gently with the finger, it will be found to consist of a colourless membrane, which is on both sides covered with a kind of dust. Examined under a lens or microscope, this dust will be found to be composed of small scales, arranged in rows and overlapping each other like roof-tiles.

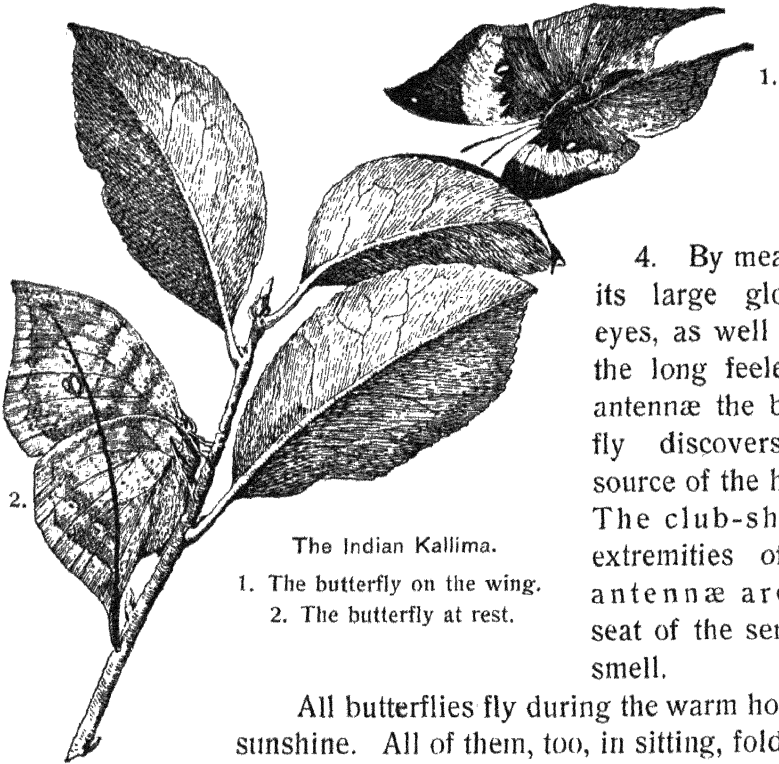
b) The scales are coloured and thus give the butterfly its gay dress. The central part of both fore and hind wings is deep black, the peripheral parts of the forewings being gray marked with black streaks along the venures, and the peripheral parts of the hind wings being beautifully dotted with a series of five white triangular or quadrangular spots and another series of five scarlet crescent-shaped marks. In addition the hind wings are each distinguished by a long tail-like projection from which the swallow-tail derives its name. When the swallow-tail is at rest, it folds the wings vertically over its back. The under-side of the wings is similarly coloured.

c) The flight is of a reeling, unsteady and, therefore, incalculable character, by which the butterfly can escape the persecution of its enemies.

2. The legs are very weak. In this way the weight of the body is lightened. The legs are not used for walking or moving, but only for holding on to objects.

3. In order to suck up its liquid food, the butterfly is provided with a long proboscis, which is formed by the coalescence of the two maxillæ. The remaining mouth-parts, as found in other insects, are stunted. The proboscis is spirally coiled up when not active.

Next to the bees, the butterflies are the most important fertilizers of flowers. By means of their long proboscis they can take the nectar out of very long and narrow flower-tubes, which other insects with a short proboscis are unable to probe.



The Indian Kallima.

- 1. The butterfly on the wing.
- 2. The butterfly at rest.

4. By means of its large globular eyes, as well as by the long feelers or antennæ the butterfly discovers the source of the honey. The club-shaped extremities of the antennæ are the seat of the sense of smell.

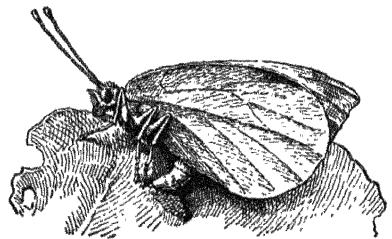
All butterflies fly during the warm hours of sunshine. All of them, too, in sitting, fold their wings vertically. In some the upper side is gaily coloured, whereas the lower side is of a colour which presents little contrast to the surroundings, thus hiding the insect from its enemies. This may, for instance, be looked for in the **Kallima** butterfly (*Kallima philarchus*), the folded wings of which are like the leaves of the tree. A similar mimicry may be observed in the larvæ of certain moths, resembling dry twigs.

The illustrations given below of the

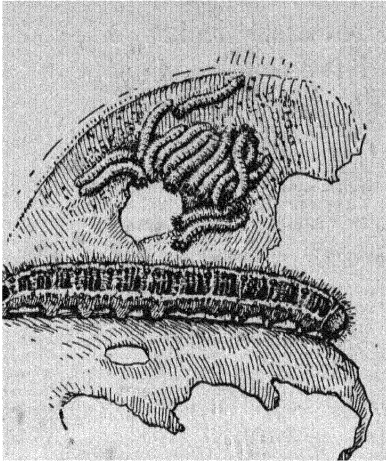
White Cabbage-Butterfly (*Pieris brassicæ*) are explained in the description of the **Swallow-tail**.



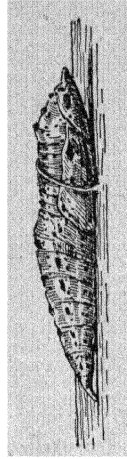
Caterpillars of Looper-moths, resembling dry twigs.



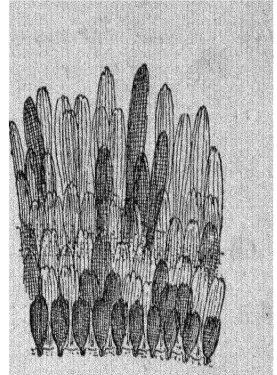
The White Cabbage-Butterfly, in the act of depositing eggs.



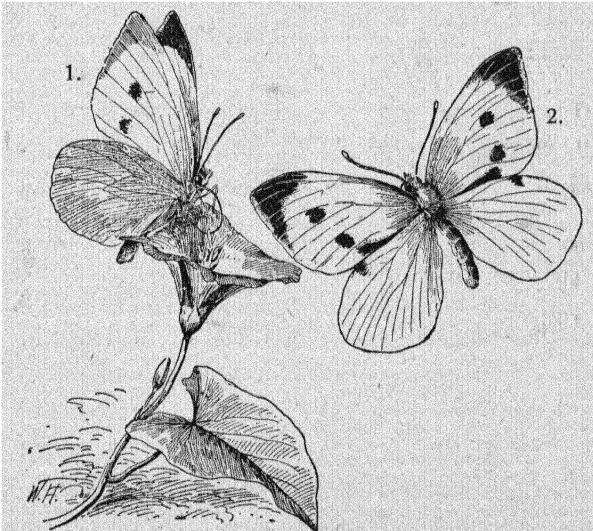
Young caterpillars and one full-grown caterpillar, of the White Cabbage-Butterfly.



Pupa of the White Cabbage-Butterfly.

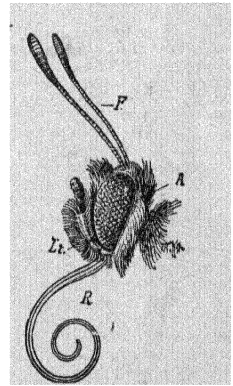


A piece of the wing of a White Cabbage-Butterfly, with white and black scales (*magnified*).



White Cabbage-Butterflies.

1. Male. 2. Female.



Head of the Cabbage-Butterfly (*magnified*).

F. Feelers. A. Eye.
R. Proboscis. Lt. Labial palpi.

Other common Indian butterflies are *Euplæa core*, *Danaïis limniace*, *D. plexippus*, *Papilio demoleus*, *Delias encharis*.

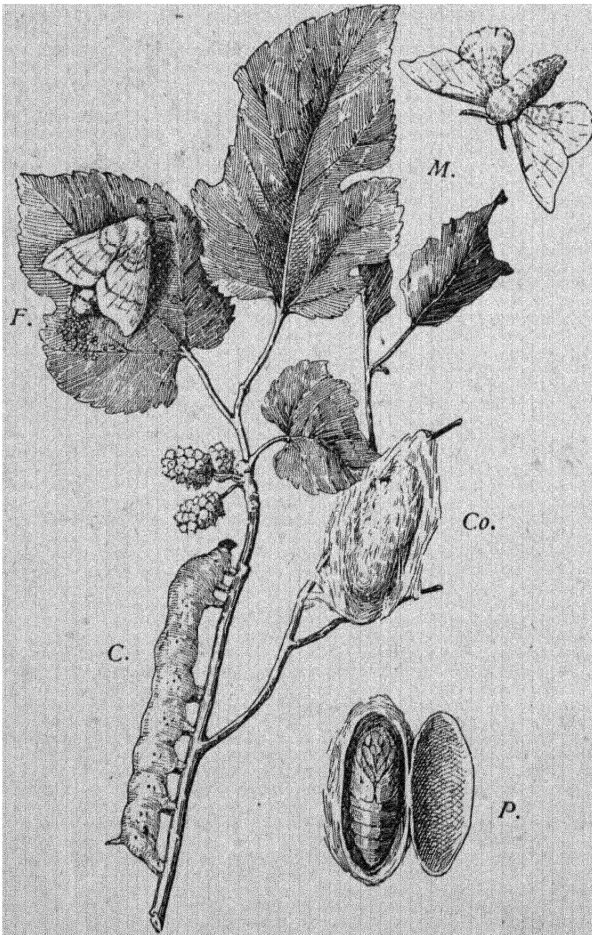
2. THE ERI-SILK MOTH (*Attacus Ricini*).

The home of this insect is Assam, where the *Ricinus* plant on which the larva feeds is called Eri.

The Silk-Moth, like most nocturnal lepidoptera, is an insignificant-looking insect of a dull colour. While at rest the wings are so kept that the hind wings are covered by the larger forewings, which slope away from the body like a roof. A short time after the moth has left the pupal state, the female begins to lay its eggs, which may amount to 400 in number. After this, both the female and the male moths die without having taken any food.

After seven to twenty days the eggs are hatched. The young caterpillars, like all members of the same family, are greedy creatures. They are of grayish-white colour and possess a horn on the last but one abdominal segment. In the structure of

the head, and of their three pairs of pectoral legs and the five pairs of abdominal legs the caterpillars do not differ from those of the diurnal butterflies. They grow quickly and after shedding their skin about four times they begin to spin a web around themselves. From the mouth there emerges a very thin silky thread, which is glued from twig to twig, until a loose network is formed. The insect next twines the threads round itself and thus forms a dense woof, called the cocoon, in which the insect,



M. Male. *F.* Female. *C.* Caterpillar. *Co.* Cocoon.
P. Pupa.

as pupa, passes its stage of rest. After about ten days the perfect moth breaks the pupal case open and leaves it.

It is this cocoon that provides us with silk thread to be spun together into strong threads and then woven into silk cloth.

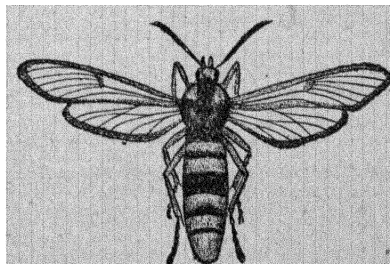
Other silk-moths which similarly pass their pupal stage in a silk-cocoon, are the **Atlas Moth** (*Attacus Atlas*), the **Tasar Silk-moth** (*Antheræa paphia*), and the **Mulberry Silk-moth** (*Bombyx mori*).

3. THE DEATH'S-HEAD MOTH (*Acherontia lachesis*).

has a mark on the thorax somewhat resembling a human skull. Its habits are nocturnal, and during daytime it lies hidden from sight on the ground among dry fallen leaves. The colour of the forewings is remarkably protective. The hind wings, on the other hand, are conspicuously coloured, but as they lie hidden under the forewings, this in no way affects the safety of the moth. With approaching dusk it is roused to activity. Its strong muscular body and the long narrow forewings make it a rapid flier. With tremulous wings it soars in front of the flowers which, by their white colour and powerful perfume, invite it as a welcome guest, and with its long proboscis it sucks up nectar out of the deep flower-tubes. This moth's eyes shine in the dark like those of a cat.

Other nocturnal moths are the **Castor Tiger Moth** (*Arctia ricini*), whose larva is covered with very long hairs, and **Nyctipao-macrops** with beautiful 'eyes' on the forewings.

4. The **Burnets** (*Zygænidæ*) and the **Clear-wings** (*Sesiina*) are diurnal. The larvæ of the latter live in wood. The wings of the **Hornet Clear-wing**, which in shape and coloration resembles a hornet, are transparent like glass, being devoid of scales.



Hornet Clear-wing.

5. A host of small moths forms the group of the Microlepidoptera, of which the **Clothes-moth** (*Tinea pellionella*) is well known. Its larva lives on hairs and wool, out of which it forms a protecting envelope. The caterpillar of another small moth (*Tinea*) makes a flat case of lime, and creeps along whitewashed walls.

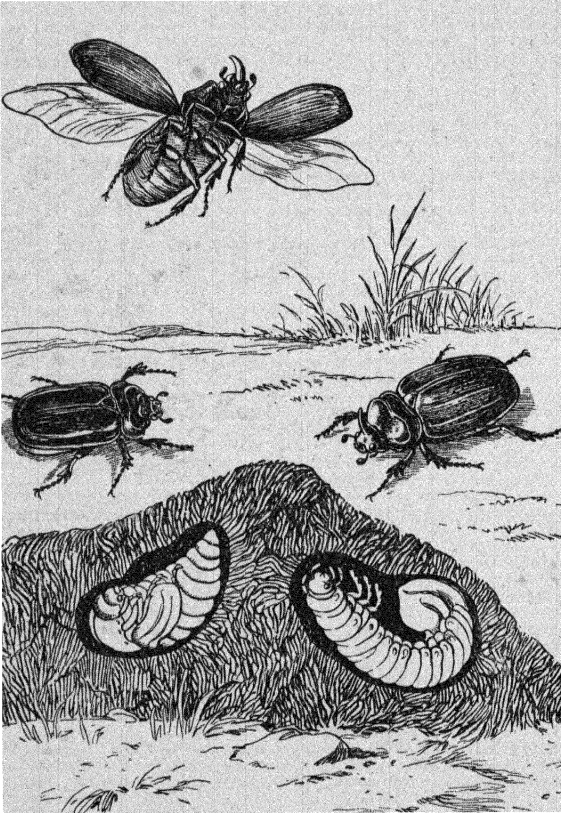
II. Order:—SHEATH-WINGS (*Coleóptera*).

1. THE RHINOCEROS-BEETLE (*Oryctes nasicórnis*).

A. THE FULLY DEVELOPED BEETLE.

1. By the time the Rhinoceros-Beetle reaches the surface it has already got through a good deal of difficult ground.

a) With its head well forward, which in the male is provided with a strong shield and a horn on it, it burrows its way through the ground, using the horn like a pick-axe to loosen the soil.



The Rhinoceros-Beetle.

b) The broad tibiae of the first pair of legs are employed as shovels.

c) The middle and posterior pair of legs serve to support the animal from behind and to shove the body forward.

2. But how is the heavy body adapted for flight?

a) As is the case in all beetles only the hind wings are used

as organs for flight. The forewings represent brown horny plates which protect the delicate hind wings against injury. They are, therefore, described as wing-covers or sheaths. But as the hind wings are longer than the forewings, they must be folded in order to be completely covered by the covers. When preparing for flight, the beetle raises the wing-sheaths a little

and begins to breathe vigorously. The air-holes or stigmata by which the insect breathes, are situated in the loose elastic skin between the upper and lower parts of the segments.

b) The dorsal surface of the abdomen thus covered by the wing-sheaths is soft, whereas all the other parts of the body are strongly armoured.

c) Being a stout and heavy insect, the rhinoceros-beetle is an awkward and slow flier.

3. FOOD.—Its food consists of leaf and flower-buds of the cocoanut and other trees.

a) Its eyes, and especially the feelers, show to the animal where its food is to be found. The last three joints of the feeler are widened into large plates or lamellæ.

b) By means of the sharp claws of the last joints of its toes the beetle holds fast to its support.

c) The pincer-shaped mandibles cut off small pieces of the food, which are then masticated and swallowed. The mouth-parts are, therefore, masticatory.

B. THE LARVA OF THE RHINOCEROS-BEETLE.

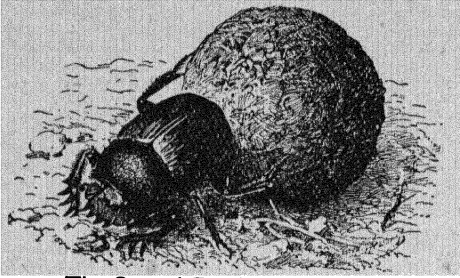
The larvæ of the rhinoceros-beetle are found beneath the ground where they feed on dung and other decaying matter. The structure of the body is, therefore, entirely different from that of the winged insect.

It has a worm-like shape, somewhat like the caterpillar of the butterfly from which it, however, differs in having no abdominal legs. Living in the soil, which supports it on all sides, the larva does, indeed, not require legs for locomotion. The only limbs present are three pairs of long and weak legs behind the head, which are of no use for burrowing or scraping. For these purposes the larva employs the strong pincer-like mandibles, which are also useful instruments for gnawing. The head is also furnished with a hard covering, but the remaining part of the body is soft. Like most animals living beneath the soil or in the dark, the grub is devoid of eyes and white in colour. The egg and the pupa are also white.

ALLIED BEETLES.

Like the rhinoceros-beetle several other common beetles have their larvæ living in the soil on decaying matter or dung.

Such are the handsome **Stag-Beetle** (*Lucanus cervus*), several

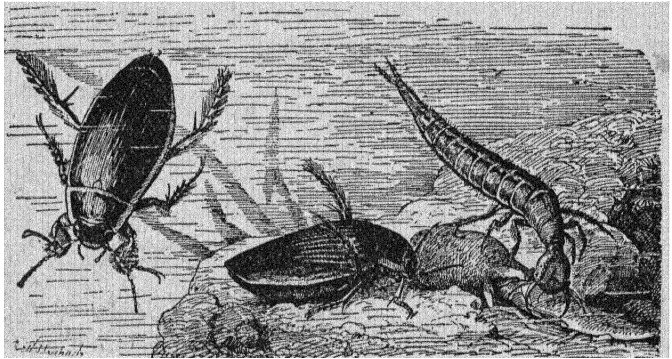


The Sacred Beetle of the Egyptians.

kinds of **Cockchafers**, and the **Sacred Beetle of the Egyptians** (*Scarabæus sacer*). The old Egyptians held this insect as sacred and made images of it in stone and clay.

2. The **Water-Beetle** (*Hydróphilus piceus*) and

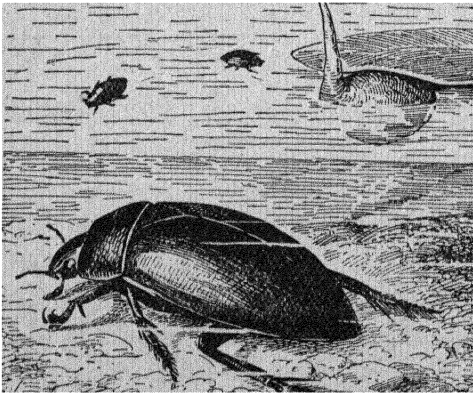
the **Whirligig-Beetle** (*Gyrinus natator*) are both swimmers, their legs being adapted for the purpose.



The Common Water-Beetle.

3. The **Sexton or Burying**

The Male taking in fresh air. Female and Larva eating a dead tadpole.

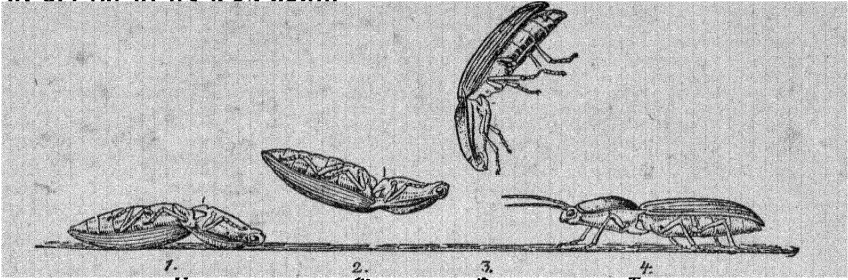


Whirligig-Beetles (*Gyrinus natator*) and the Great Water-Beetle (*Hydróphilus piceus*).

Beetle (*Necróphorus, Silpha*) has the habit of burying the carcass of animals, on which the beetles as well as their larvæ depend for food.

4. The **Skip-Jack** or **Click-Beetle** (*Elatéridæ*), like many other insects, on the approach of danger allows itself to drop to the ground and pretends to be dead. If it happens to fall on its back, it skips upwards

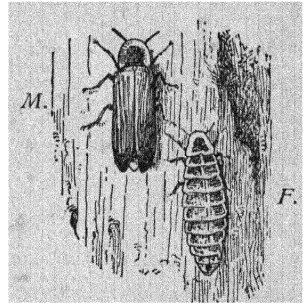
after a short while, turns over while skipping and so manages to get on to its legs again



The Skip-Jack

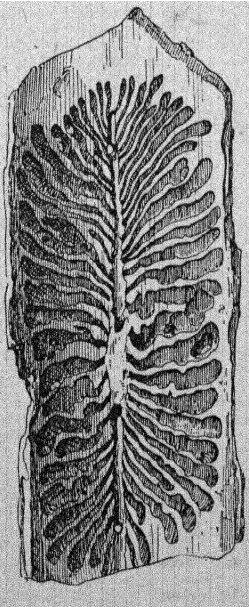
1. Lying on its back,
2. and 3. Skipping,
4. On its legs again.

5. The **Glow-worm** (*Lampyris*) is capable of shining in the dark, and is the cause of those beautiful illuminations of trees and shrubs on warm summer nights. The male insect is winged, whereas the female is without wings. The luminous organ is on the under-side of the body.

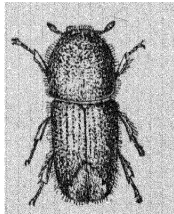


The Glow-worm,

M. Male. F. Female.



Piece of bark showing the bores of the larvæ.

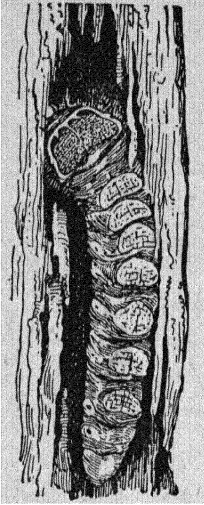


The Bark-Beetle.

7. The **Bark-Beetle** (*Ips typographus*) deposits its eggs in rows under the bark of trees. The larvæ eat their way into the bast, and form parallel passages which widen as the grubs grow. At last, the larva enters the pupa condition, and the perfect beetle bores a vertical opening through the bark, by which it leaves the tree.

8. The larvæ of the

Longicorn-Beetles (*Cerambycidae*) live also under the bark of trees, or in their wood, and are provided with powerful mandibles. The mature beetles are distinguished by handsome long feelers which they carry in long curves over the back. When touched they emit a squeaking noise.



Larva of the
Longicorn-Beetle.

9. The **Lady-Birds** (*Coccinellidæ*) are usually conspicuously coloured. Their food as well as that of their larvæ consists of plant-lice.

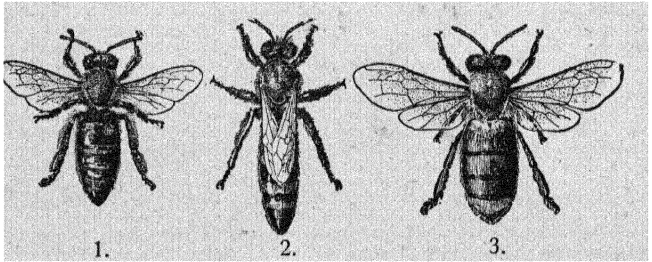
III. Order:—HOOK-WINGS (*Hymenóptera*).

1. THE HONEY-BEE (*Apis mellífica*).

A. THE BEE DOMESTICATED:—The honey-bee has been domesticated from time immemorial. The bee-keeper provides a house (hive) for the bees, and, as a reward for his troubles, he takes a large portion of the honey which his pets have stored in the cells of the combs of wax.

B. THE BEE-COMMUNITY.

1. *Members of the Community.*—A hive is inhabited by from 10,000 to 50,000 individuals. The males, or drones, appear in comparatively small numbers. They are larger in size than the other bees and have big eyes. The females constitute the greater part of the community. But among them only a single one is capable of laying eggs. It is much bigger than the others, and is designated as the “queen”. The small females, that cannot lay eggs, perform all the various labours required for the maintenance of the commonwealth, and are called “workers”.

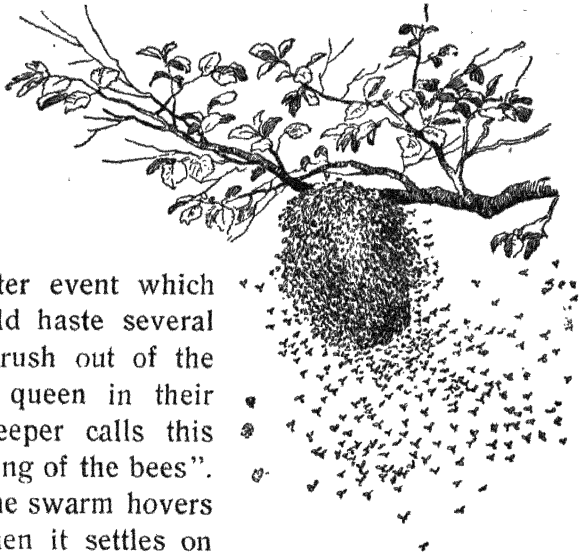


The members of the Bee-community.

1. Worker. 2. Queen. 3. Drone.

2. *Foundation of the Hive.*—When the population of a hive has largely increased, a young queen is also forthcoming. But, since two queens can never live together in one hive, there must either be a struggle for life and death between the two, or the old queen must quit the

hive. It is the latter event which takes place. In wild haste several thousands of bees rush out of the hive with the old queen in their midst! The bee-keeper calls this exodus the “swarming of the bees”. For some minutes the swarm hovers about in the air, then it settles on the branch of a tree. One bee clings with its legs to the other, until a large cluster, like a big bunch of black grapes, is formed. The bee-keeper now appears, shakes the branch and causes the swarm to fall into a basket. Towards evening he sweeps the lot into an empty hive which will henceforth be the dwelling place of the newly formed kingdom.

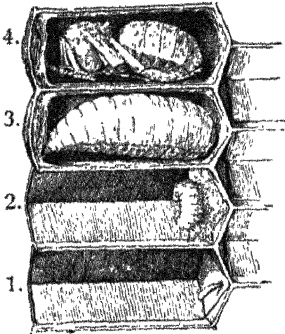


A Swarm of Bees.

3. *Work in the Bee-community.*—As soon as the bees have taken possession of their new home, they set to work in right earnest. Between the segments of the under-side of the abdomen there protrude little plates of wax. From this substance the workers build up their honeycombs, which hang vertically from the roof of the hive, and consist of numerous horizontal cells placed back to back in two layers. The cells are all of the same size and hexagonal in section.

Even before the first cells are completed, the queen deposits an egg in each. A few days after the eggs are laid, a white eyeless larva—a maggot—creeps out of the egg. But as it possesses no legs, it cannot leave its birth-place, and would die of starvation if the workers did not supply it with food. This is served so abundantly that the maggots are full grown

in a short time. The entrance of the cell is then closed with a lid of wax, and the imprisoned insect enters upon its pupal stage, from which the fully developed bee soon issues.



Cells of a Honey-comb with larvæ in their various stages:

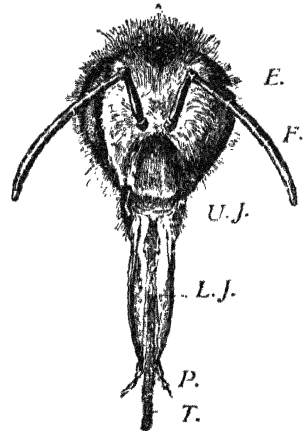
1. Egg.
2. Larva lying on food.
3. Larva full-grown in closed cell, spinning its cocoon.
4. Pupa.

At a certain time the workers construct some bigger cells in which drones are produced, and a very few large cells, in which, by very careful nurture, the young queens are reared.

C. STRUCTURAL EQUIPMENT FOR THE VARIOUS ACTIVITIES OF THE BEE.

1. The bee possesses two large eyes, one on each side of the head, as well as three small simple ones on the forehead. In spite of this equipment the bee is not able to see distinctly from a great distance. It is the sense of smell—the organs of which probably are the feelers—by which the bee is guided to the places where its food is found, and also back again to its hive.

2. The bee's food consists of nectar and pollen. These substances are present in flowers, but only in small quantities. It is therefore of great importance to the bee that it has wings, by means of which it can easily move from flower to flower and collect the necessary quantity. Being a rapid and agile flier, it collects so much of it that it can also provide the helpless larvæ and those members of the community which do not leave the hive, with food. The wings are four in number and are all used as flight-organs. The rapid motion of the wings during flight causes the humming sound.



Head of Honey-Bee.

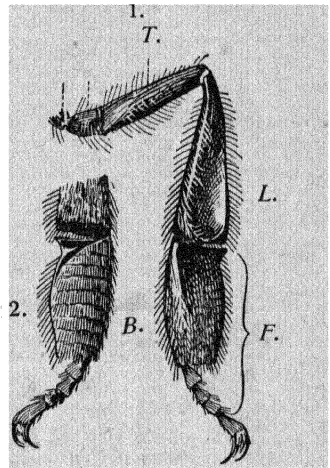
- E* Eye. *F* Feeler.
U.J. Mandible (upper jaw).
L.J. Maxilla (lower jaw).
P. Labial Palpi. *T.* Tongue.

3. By means of the claws of the last tarsal joints the bee holds fast to the flower on which it has alighted.

4. As soon as the bee has settled, its mouth-parts begin to be active. Some of them are so folded up that they form a tube, in which the tongue moves up and down. When sucking, the tongue is protruded and dipped into the juicy nectar of the flower. On retracting it, the liquid adhering is brought into the tube and sucked up. By means of its powerful mandibles the bee loosens and consumes the pollen dust, kneads the wax, and carries the refuse out of the hives.

5. The flower-juices which the bee drinks are partly stored in the gullet, and, after arrival in the hive, brought up and given to the larvæ, or poured into storage cells, which, when filled, are sealed with waxen lids.

6. The receptacle in which the pollen is carried to the hive is a small depression on the outer side of the fourth segment of the hind legs. It is aptly termed the 'basket'. The fifth segment is lined with several short hairs and forms a brush with which the pollen dust is brushed from the hairy coat of its body into the 'baskets', which, after a time, get quite filled with pollen balls.



Left hind Leg of a worker.

D. THE BEE IN ITS RELATION TO OTHER ORGANISMS:—

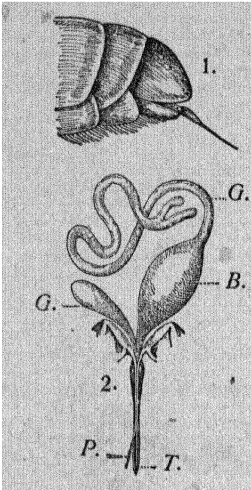
1. As is the case with most insects that visit flowers in search of food, the bee renders the plants a most valuable service in return: for, by carrying the pollen from one flower to another, it effects the pollination and fertilization of the flowers.

2. With the exception of the bee-eater, and some other birds, birds are careful not to attack the bee; for a sting of the bee is very painful. The chief enemies of the bee, however, belong to its own tribe. They are the hornets and wasps.

The sting of the bee, which is in its abdominal part, consists of a finely pointed tube, provided with two barbed pricks, gliding forward and backward in it. This instrument is connected with a bag of venom. On stinging a man or animal, a drop of

- 1. Leg, seen from the outer side. *T.* Thigh. *L.* Leg (tibia) with the 'basket'. *F.* Foot with the terminal claws.
- 2. Foot seen from the inner side. *B.* Brush.

poison is injected into the wound, where it produces inflammation, or in the case of small animals, even death. But as the sting cannot be pulled out of the skin of the stung animal, it is detached from the body of the bee, together with some of its inner organs, when the bee leaves the assailed animal. This soon causes the death of the bee also. This is, however, not the case when the bee stings another bee, in the body of which the sting does not stick fast.



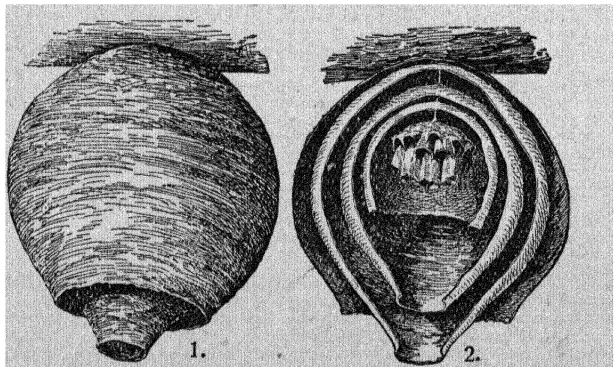
The Sting of the Honey-bee.

1. Last rings of the abdomen with the sting exerted.
 2. Structure of the venomous apparatus.
- G. Venomous glands.
B. Venomous Bag.
T. Tube. P. Prick.

2. OTHER BEES, WASPS

The **Humble Bees** (*Bombus*) construct their dwellings generally under the ground. They are mostly flower-visitors. The black bee, frequently seen about beans, is the **Carpenter Bee** (*Xylocopa*), gnawing at wood and building its nest therein. The **Indian Bee** (*Apis dorsata*) is much smaller than the domesticated honey-bee. It has its nest in the jungles under branches of trees or under overhanging rocks. The honey is taken by the people, but it is not nearly so

rich as that of the honey-bee. The **Wasps** (*Vespa*) display considerable workmanship in the structure of their dwellings. They are **carnivorous**. Another common bee is the **Mason Bee** (*Osmia*),



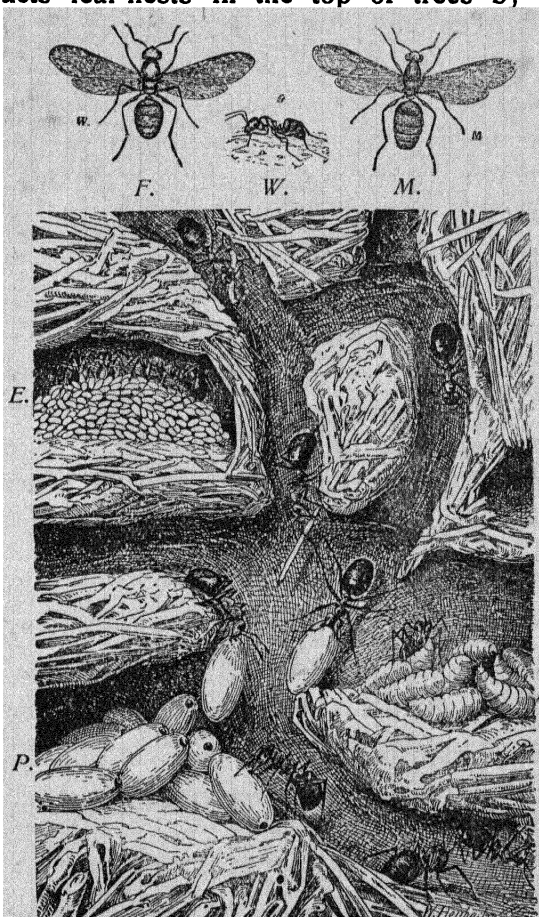
1. Viewed from the outside. 2. Opened.

which builds small cells of clay kneaded with its saliva, and then puts a worm in it, after depositing an egg in the victim, which is to be the future food of the larva developing from the egg.

3. ANTS (*Formicæ*).

One of the commonest ants is the **Red Ant** (*Cecophylla smaragdina*). It constructs leaf-nests in the top of trees by

drawing the edges of leaves together and securing them with strong cords of silk. In these nests is found the insect in its various stages, namely, minute eggs, white legless larvæ (maggots), the pupæ enclosed in a cocoon (erroneously, sometimes called ants' eggs), and the full-grown fierce red ant. Most of the members of the ant-community are labourers. For their untiring labours they use their pincer-shaped mandibles, which are also used as weapons against their enemies. The mandibles being strong and large, the head that carries them with the muscles required to move these



The Ant.

F. Winged female. *W.* Wingless female (worker).
M. Winged male. Below: part of a nest, in which workers are engaged in the care of the eggs (*E.*), the larvæ (*L.*), and the pupæ (*P.*).

organs, must also be considerably large. Another section of the ant-community, the soldiers, have still larger heads and more powerful jaws. The second division of the body of these labourers, the thorax, is very weak, as they are wingless. The winged males and females have bigger breasts and long abdomens. Soon after their nuptial flight they drop their wings, the

males die, and the females (queens), of which there are several in a nest, become the mothers of new colonies.

Ants are fast runners. Their long and strong legs facilitate walking, and their sharply-clawed feet enable them to climb up trees and to walk head downwards. Their industriousness has become proverbial. On approaching their nest you may see them engaged in their various activities. Here some may be seen dragging a caterpillar along; there others fiercely gnawing away at the body of some dead animal till nothing but the skeleton is left; a number of them may be seen climbing up to their "milch cows", the plant-lice or aphides, in order to lick up their sweet excretions; and if you come very near their haunts, quite a number of them will take up a defensive position in order to inflict painful bites on you, if possible.

There are many kinds of ants, too well known to everybody as unwelcome pilferers of all sorts of sweet delicacies in our houses. On the other hand, these industrious creatures are useful to man as scavengers and destroyers of many noxious insects.

4. THE ICHNEUMON-FLIES (*Ichneumonidæ*)

deposit their eggs in the body of living caterpillars, in which their larvæ live as parasites.

5. GALL-FLIES (*Cynipidæ*)

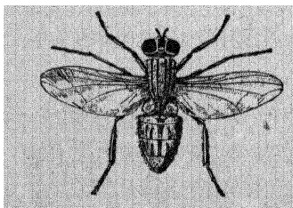
oviposit in leaves and buds of plants, and thereby cause a proliferous growth in them, known as galls.

IV. Order:—TWO-WINGS (*Diptera*).

Mouth-parts piercing and sucking. All the thoracic segments coalescent. Forewings membranous. Hind wings changed into club-shaped "balancers". Metamorphosis complete

1. FLIES (*Brachycera*).

THE HOUSE-FLY (*Musca domestica*).



The common House-Fly.

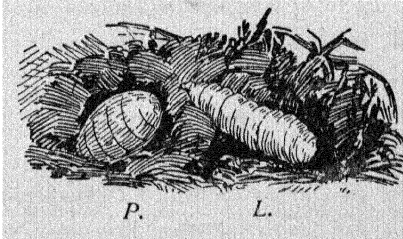
The House-Fly is an unwelcome inmate of our houses. Its colour is dirty gray. Its membranous wings easily carry it to any place it likes. The hind pair of the wings is reduced to two minute structures which are described as balancers or poisers. The long and movable legs enable the fly

to run quickly. It is also able to sit on and run up smooth window-panes or on the ceiling. This is due to the presence of two finely-haired, ever-wet pads between the two claws of the last tarsal joint.

As soon as our meals are served, these flies appear. Whether they discover the presence of food by means of their large eyes or their minute feelers, we do not know. The fly sucks up fluids by means of its pestle-shaped proboscis. It consumes also solid substances, but only after first liquefying them. For this purpose saliva is poured forth from the proboscis.

The fly oviposits on all sorts of decaying sub-

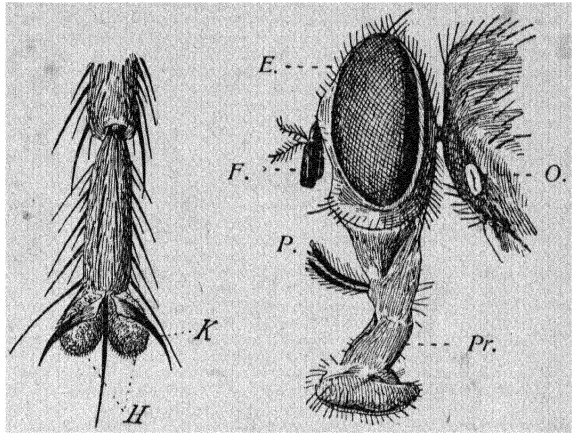
stances. Only twelve hours later larvæ creep out from the eggs, and bore their way into the nauseous mass to eat it. They are devoid of eyes and legs. After a fortnight the skin of the maggot shrinks, hardens and forms the envelope of the pupa.



Larva or Maggot (*L.*) and Pupa (*P.*) of the House-Fly.

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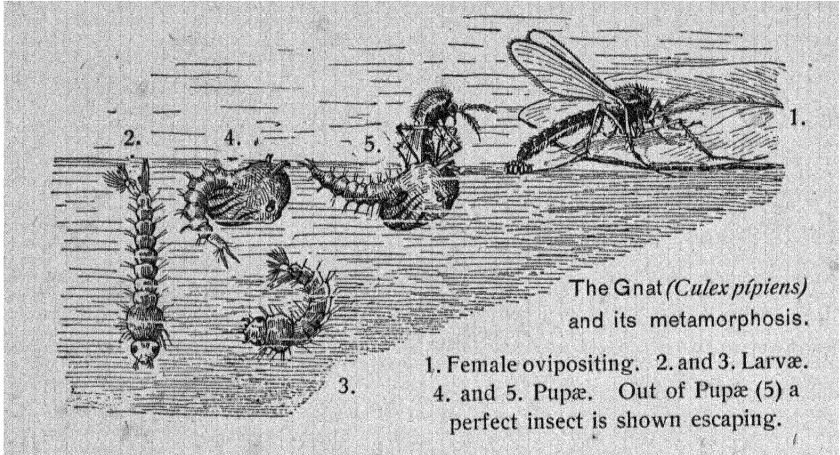
The **Stinging Fly** is provided with a proboscis fitted for stinging. A still more formidable blood-sucker is the **Gad-Fly**



Foot and Head of the House-Fly.

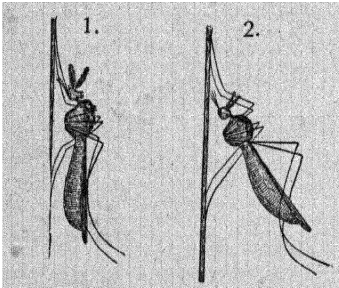
K. Claw. *H.* Adhesive balls.
E. Eye. *O.* An opening of the respiratory organ.
F. Feeler. *P.* Maxillary Palpi. *Pr.* Proboscis.

(*Tabanus*), and the **Tsetse-Fly** (*Glossina*), which makes cattle breeding an impossibility in places where it exists and infects men with the germs of sleeping-sickness. The **Ox-Warble Fly** (*Hypodérma bovis*), and **Horse-Bot Fly** (*Gastróphilus equi*), have their larvæ in the bodies of cattle and horses



2. MOSQUITOES (*Nematócera*).

Apart from its feather-like feelers, the **Mosquito** or **Gnat** closely resembles the house-fly. The female is a bloodthirsty creature. By means of its dagger-like mandibles it bores a hole



A Gnat (1) and an Anopheles (2) each sitting on a vertical wall.

in the skin of its victim and sucks up the blood through its proboscis. Gnats are found most numerous in well-watered districts, their young living in stagnant water. The larvæ can be seen hanging, as it were, from the surface of the water, extending from the end of their body a rosette of fine hairs. In the middle of this rosette is the opening of the respiratory organ, which is capable of being closed. The pupæ

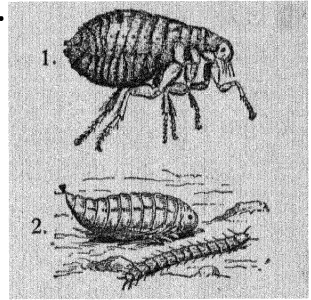
also live in the water, and are capable of moving or swimming in the water, which they effect by the help of their long, movable abdomen, which is sharply marked off from the thick anterior part of the body.

The kind of mosquitoes called **Anópheles** is the bearer of the malaria germ, which by the sting of this mosquito is transferred

to the blood of man and causes malaria fever, to which many thousands of people succumb. By the position which these animals take at rest, they can be distinguished from the gnat which does not carry malaria germs.

3. FLEAS (*Aphaníptera*).

The best-known example of these insects is the **Human Flea** (*Pulex irritans*). It is wingless, but possesses in its strong hind legs powerful jumping organs. These fleas are blood-sucking, and live a parasitical life on other animals. The eggs are deposited in the corners and chinks of the floor. The larvæ live on decaying vegetable matter. As the bearer of the plague germs which it carries from infected rats to man, the flea is one of the most dangerous insects we know.



The Human Flea.

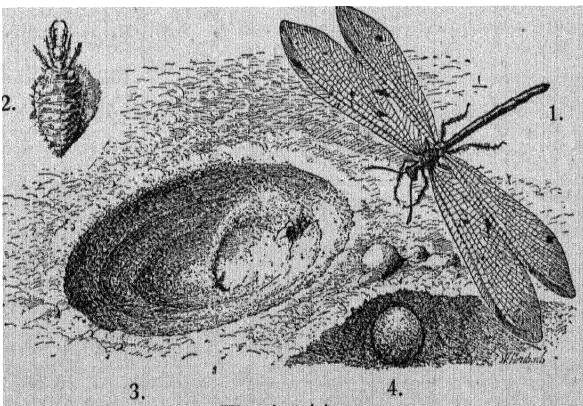
1. The perfect insect.
2. Larva and Pupa.

V. Order:— NET-WINGS (*Neuróptera*).

Mouth-parts biting. First thoracic segment usually free. Wings all equal, transparent, with net-like venation. Metamorphosis complete.

THE ANT-LION (*Myrméleon formicárius*).

On sandy soil one can often see pretty funnel-shaped depressions, at the bottom of which is found a small stout larva



The Ant-Lion.

1. The perfect insect.
2. Larva.
3. Funnel of the larva which bombards an ant.
4. Cocoon of the pupa.

which goes by the name of ant-lion. This little animal catches ants and other small insects in these traps. When such a small insect comes to the edge of the trap, the loose sand glides

away under its feet, and the unhappy insect sinks down the slope of the trap, when the robber, lurking in ambush, begins to bombard the falling victim with showers of sand till at last the latter gets into the grip of the strong mandibles of the “ant-lion”.

The larva when entering the pupa stage, buries itself deep in the sand and spins a cocoon of web and sand. The fully developed insect resembles the dragon-fly, having four large, transparent wings with a network of nerves, but it possesses club-shaped feelers, and the wings, when at rest, are laid on the body as in the hawk-moths so that they slope away from the body like a roof.

ALLIES

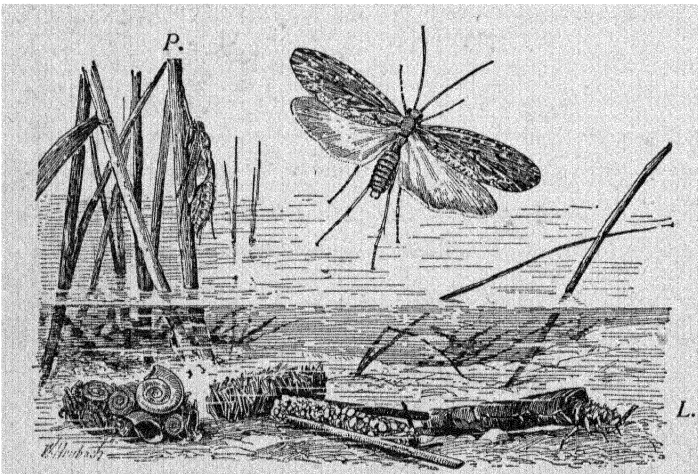
Frequently upon leaves there may be seen white threads ending in a small knob. These are stalked insect-eggs, from which

green larvæ are produced which make great havoc among plant-life. The adult insect has green gauze-like wings and golden coloured eyes.

This is the **Aphis-Lion** (*Chrysopa*).

The wings of the **Cad-**

dis-Flies (*Trichoptera*) are covered with hairs. The larvæ live in the water where they form cases of little particles of rubbish for the protection of their soft abdomen.



A Caddis-Fly and its metamorphosis.

L. Larva. P. Pupa that has deserted its case and climbed a reed.

VI. Order:—LONG-BEAKS (*Rhynchôta*).

Mouth-parts piercing and sucking, forming a beak. First thoracic segment usually free. The two pairs of wings similar or dissimilar. Metamorphosis incomplete.

1. BUGS (*Heteróptera*).

THE BED-BUG (*Cimex lectuláritus*).

1. The Bed-Bug is one of the most disagreeable of human parasites. In the daytime it lies hidden in chinks and crevices, which it easily enters, the body being thin and flat. At night it emerges from its hiding-place in order to suck the blood of sleepers. Its mouth-parts form a proboscis or beak enclosing four stinging bristles by the help of which the skin is pierced and the blood sucked. The disagreeable smell emitted by this animal as well as by other bug species, serves them as a means of protection against enemies. The bed-bug having only rudiments of wings is unable to fly.

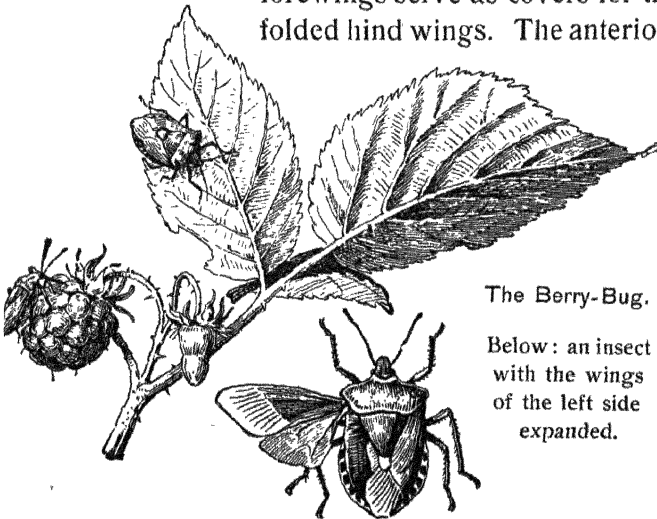


The Bed-Bug.

ALLIES

A large number of bug species live in the open air. All feed on plant or animal juices. Only a few are entirely without wings. The forewings serve as covers for the membranous, folded hind wings. The anterior part of the fore-

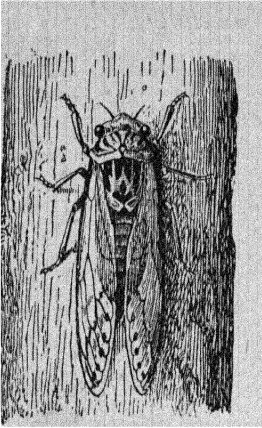
wings is hard. Some of them are beautifully coloured. Others mimic thorns and other parts of plants. There are also some species living in water, of which we mention the



The Berry-Bug.

Below: an insect with the wings of the left side expanded.

Water-Measurer (*Belostoma indecium*), which with its widely extended legs glides along the surface of water with great agility.



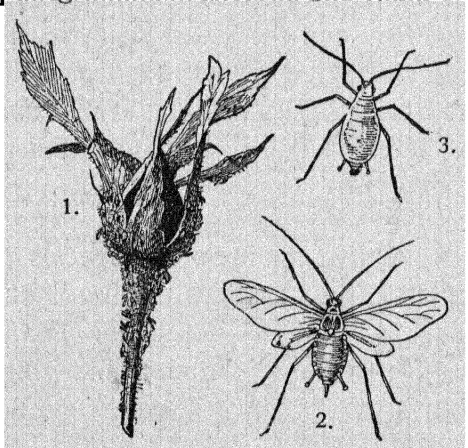
The Manna Cicada.

2. CICADAS (*Homóptera*).

These have large broad heads and forewings of the same structure. The larvæ of some species live on young shoots of plants covered under white froth, looking like saliva. The froth is an exudation from the body of the larvæ which feed on the juices of those plants. The males of some species emit a loud screaming sound, frequently heard in the months of May and June.

3. PLANT-LICE (*Phytophthires*).

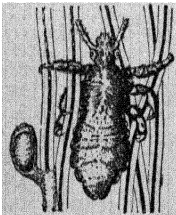
Plant-lice are often seen in large numbers covering the young leaves and shoots of plants. They deprive the plants of their nutritive juices to such an extent that the parts affected are crippled, and often the entire plant is destroyed. The juices pass rapidly through the bodies of the insects and are again secreted in a semi-digested condition in the form of small drops very rich in sugar.



Plant-Lice.

1. Rose bud with numerous Plant-lice.
2. Wingless female. 3. Winged male.

The **Lac-Insect** (*Coccus lacca*) punctures fig-trees (*Ficus religiosa*, *F. bengalensis*) which produces the flow of a resinous juice from which shellac is obtained.



The Head-Louse.

On the left side an egg glued to a hair.

4. LICE (*Aptera*).

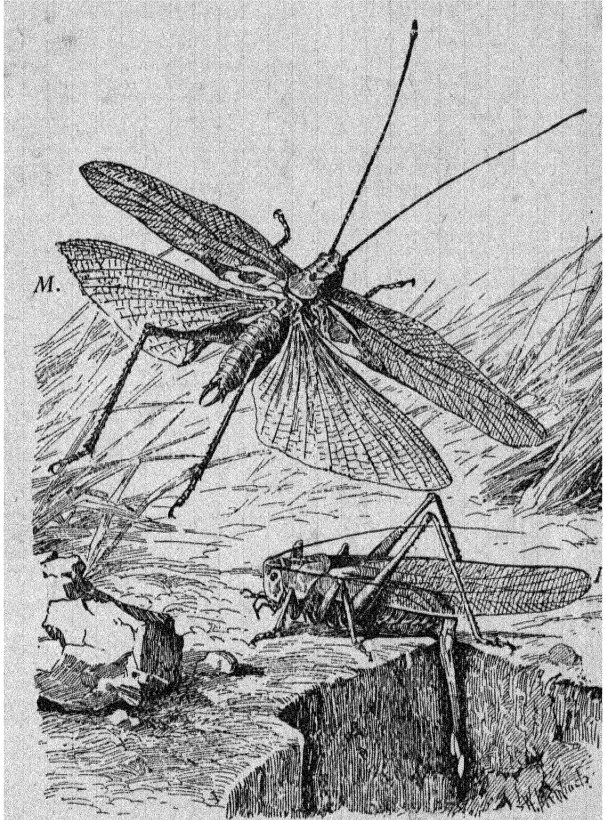
These insects are wingless parasites. The **Head-Louse** (*Pediculus capitis*) lives on the head of people of unclean habits, gluing its eggs on to their hair. The **Clothes-Louse** (*P. vestiment*) deposits its eggs between the seams of garments.

VII. Order:—STRAIGHT-WINGS (*Orthoptera*).

Mouth-parts biting. First thoracic segment free. Forewings form wing-cases. Hind wings membranous, folded like a fan. Metamorphosis incomplete.

1. LEAPING ORTHOPTERA (*Saltatoria*).

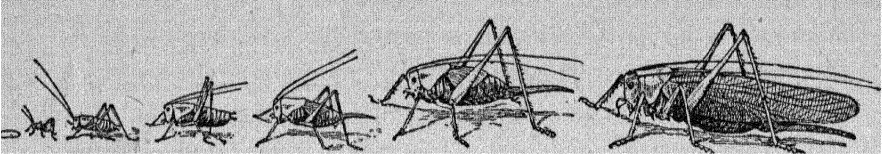
The **Grasshopper** (*Locusta viridissima*) has a protective colouring. In the field, it is hardly discernible on account of its grass-green colour. By means of its long and very strong hind legs the grasshopper can jump a great distance. For longer journeys it makes use of its wings. The narrow forewings serve, as in the case of beetles, as wing-covers, under which, at rest, the hind wings are folded up like a folding fan. The nourishment of the grasshoppers consists not only of leaves, but also of insects (flies, caterpillars, etc.).



The great Green Grasshopper.

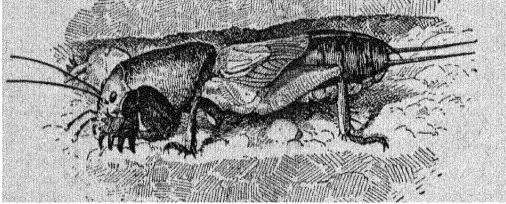
M. Male. F. Female depositing eggs in the earth.

Their mouth-parts are, therefore, adapted for biting, as in beetles. The female grasshopper possesses a dagger-like instrument at the end of its body, by means of which it deposits its eggs in the earth. The larvæ leave the soil as soon as they escape from the eggs. They resemble their parents in structure and mode of life. The wings and the ovipositor alone are absent in the early stages. With increasing growth and after several moultings these organs also appear. Thus



Incomplete metamorphosis of a female Grasshopper.

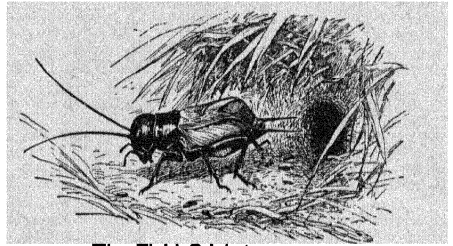
the larva by degrees passes into the complete insect, there being no pupal stage in the middle.



The Mole-Cricket.

Field-Cricket (*Gryllus campestris*) do damage to the plants by gnawing at their roots and stems.

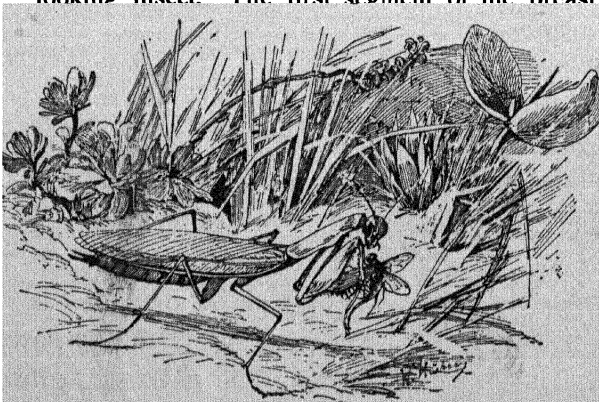
The **House-Cricket** (*G. domesticus*) is found in houses. The well-known chirping of the crickets is produced not by their legs, but by their wings, which may be seen vibrating.



The Field-Cricket.

2. GRESSORIAL ORTHOPTERA (*Gressória*).

The **Praying Mantis** (*Mantis religiosa*) is a fantastic-looking insect. The first segment of the breast is very long



The Praying Mantis with a captured fly.

and could pass for a neck. The first pair of legs is transformed into a catching apparatus. The middle and hind pairs are re-

markably long and enable the insect to take large strides. Motionless, the green insect sits in the green grass, raising the forelegs, apparently as in prayer, but in reality poised suddenly to seize its victim. The sickle-shaped tibia can be turned in into a double row of spines on the upper leg.

The **Walking Leaf** (*Phyllium pulchrifolium*) and the **Stick-Insect** (*Menexenus*, *Phanocles*, etc.) mimic leaves and sticks and



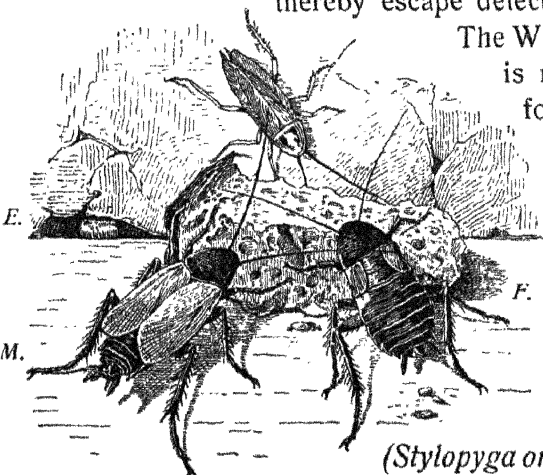
The Walking Leaf (*Phyllium pulchrifolium*).



Two Stick-Insects.

thereby escape detection from their enemies.

The Walking Leaf, for instance, is not only green like the foliage which form its surroundings, but also resembles a leaf in its structure, or becomes brown like a fallen leaf.



Cockroaches.

M. Male. F. Female. E. An egg-case in the middle of the wall-crevice.

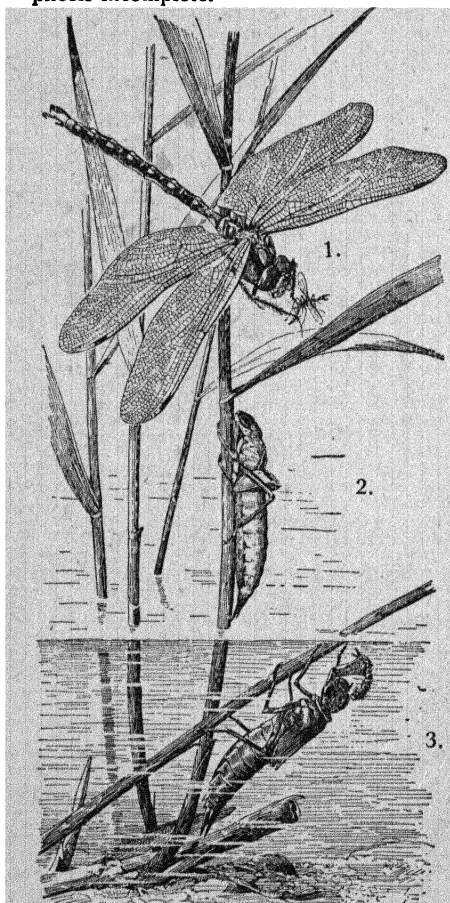
3. CURSORIAL ORTHOPTERA (*Cursória*).

The **Cockroaches** (*Stylopyga orientalis*) have long wing-

cases one overlapping the other. The females have only rudiments of wings and are therefore incapable of flight. They are of nocturnal habits, hiding during the daytime in holes and crevices. At night they come out of their hiding-places and gnaw and scrape at anything that is eatable. The cockroaches do not deposit their eggs singly, but packed together in cases.

VIII. Order:— FALSE NET-WINGS (*Archiptera*).

Mouth-parts biting. First thoracic segment free. Fore and hind wings similar, but net-like venation, generally incapable of being folded up. Metamorphosis incomplete.



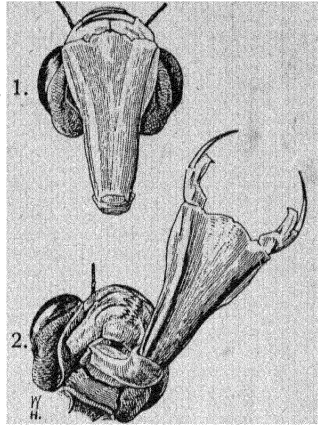
The Dragon-Fly.

1. Male with a captured gnat.
2. Empty skin of larva.
3. Larva with extended mask with which it has seized the larva of a gnat.

1. The **Dragon-Flies** (*Libellulidæ*) form a large family of insects with biting mouth-parts, and four large transparent wings traversed by a close network of nerves filling the membrane in every part. These wings, as well as the very slender body, render the insect a very rapid flier. With its large goggle eyes it spies its victim, and seizes it by means of its underlip which is transformed into a catching apparatus.

The dragon-flies are usually seen in the vicinity of water because there are the haunts of flies, gnats and such other insects which form its food. They also drop their eggs into the water as they hover over it. The larvæ enter on a life of rapine as soon as they are hatched. They sit motionless at the bottom of the water and, like the complete insect, seize the

victim with the under lip. The latter is composed of three distinct portions somewhat like the human arm, and the parts are folded on each other over the mouth so that the mouth looks as if covered by a mask. The real organ of prehension is formed by the third part, which represents a pair of pincers or a two-fingered hand. When the larva sheds its skin for the last time, it shows wings on its sides, it is now a pupa. But this pupa, unlike those of the beetle, butterfly, the bee and the ant-lion, does not lose any of its activity. The metamorphosis is therefore said to be incomplete. After a few days the pupa climbs out of the water on to a plant or rock, where it clings till the full-blown dragon-fly emerges from the torn skin of its former stage.

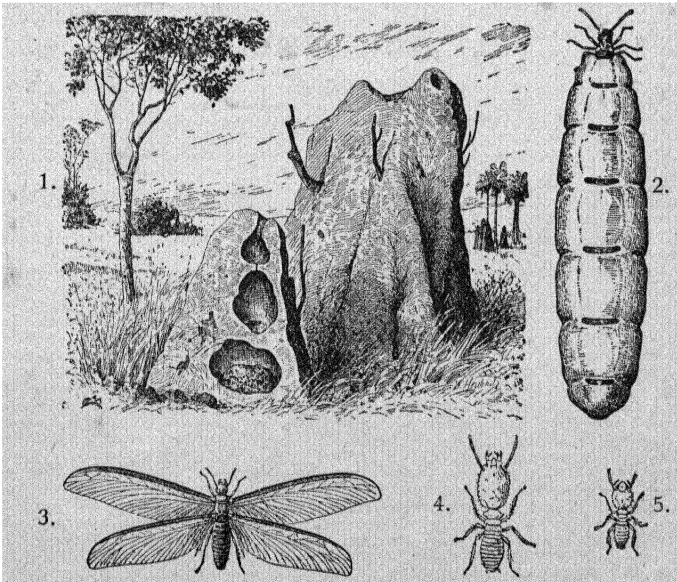


Head of a larva of the Dragon-Fly viewed from below.

1. Mask folded up.
2. Mask extended.

Besides the mask, the hemispherical eyes and the short feelers are visible.

2. The **Termites** (*Termitidæ*), or "White-Ants", as they are commonly called, live in well-organised



societies like ants, building for themselves underground cities, the upper parts of which we know as "white-ant hills". The walls of these buildings are very solid. If we break through them, small yellow termites with large heads

1. White-Ant hills, one of which is opened.
2. Female or Queen.
3. Winged male.
4. Soldier.
5. Worker.

and strong mandibles will at once appear, and defend the endangered city. These are the "soldiers". Between the soldiers, we may see ordinary termites with smaller heads and less formidable weapons. These are the "workers". They deserve their name. For every one of them will be seen to carry a small bit of earth which it wets and glues to the breach. Hundreds of these workers hurry to the scene, and by their energy and labour the hole, which we made, is soon closed up again.

The interior of the building contains large cavities as large as a man's fist, which are filled with a curious gray mass, looking at first sight like a sponge. On close examination, we find that it consists of a woody substance. Termites eat wood and excrete it in a semi-digested form; the excrements are put together to form a scaffolding for rearing a certain fungus which with its root-work pervades the whole woody structure, but at the surface forms small white globular heads. It is these heads which the termites crop and use as food for themselves and for their larvæ. Those soft gray masses in the holes are nothing but fungus-gardens, cultivated by these insects. The workers and soldiers are wingless; and have no sexual organs. It is, as in the bee, the queen that is to lay eggs and so propagate its kind. At the bottom of the ant-hill there is the cell of the queen with specially strong walls. The queen has a large abdomen as big as the thumb, compared with which her head and thorax with the legs look like minute appendages. Her big white abdomen is filled with eggs, which are constantly deposited, and at once carried to the fungus-plantations by the workers. Near by is the king, much smaller in size.

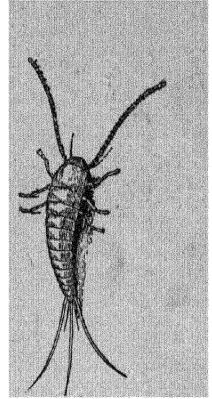
From the building there extend many ways by which the workers bring the particles of wood, which they so much require for their cultivations. At times winged males and females issue from the larvæ in uncountable numbers. These leave the city and fly off, a few to found new colonies, the majority to perish. For the swarming of the white-ants constitutes a veritable harvest for birds, bats, lizards, spiders, toads, etc.

IX. Order:— NO-WINGS
(*Apterygota*).

Mouth-parts biting. Wings absent. No metamorphosis.

The **Paper-Fish** or **Sugar-Mite** (*Lepisma saccharina*) is a wingless little insect covered with silvery scales like a fish. The abdomen ends in three long bristles.

It feeds on paper, wool, sugar and similar substances, and is an inmate of our houses.

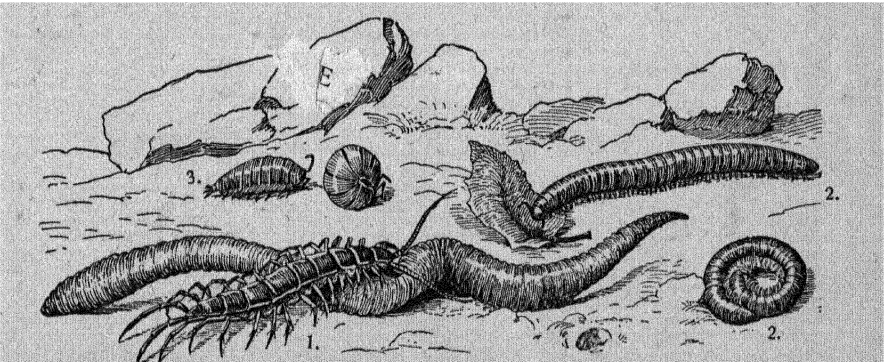


The Paper-Fish.

Second Class: CENTIPEDES

(*Myriápoda*).

Centipedes have, as a rule, a long body, which requires a large number of legs for its support. Each somite has one or two pairs of legs. The body is not divided into three parts

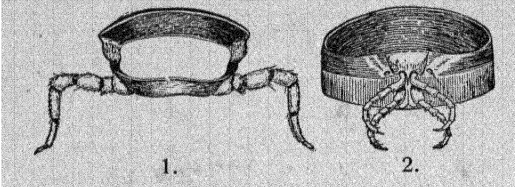


Centipedes.

1. *Scolopender* that has attacked a rainworm.
2. *Common Millipedes*,
3. *Pill-millipedes*, one stretched and one rolled up.

viz., head, thorax, and abdomen, but the head can be distinguished from the rest of the body, the trunk. The strong head supports the mouth-parts (which are biting) as well as the feelers (*antennæ*) and the eyes.

The **Scolopender** (*Scolopendra subspinipes*) has one pair of legs on each somite. It can inflict bites which may prove dangerous even to man.



Somite of a Scolopender (1) and a Millipede (2).

The **Millipedes** (*Julus*) are harmless, living on decaying vegetable matter. Their body is cylindrical and each somite carries two pairs of short legs, on which the animal

creeps along slowly. On the approach of danger they roll themselves up into a flat spiral and simulate death.

Third Class: SPIDER-LIKE ANIMALS

(*Arachnoidea.*)

Air-breathing, wingless, jointed animals. Head and chest (thorax) usually merging into one structure, which carries two pairs of jaws and four pairs of legs. Abdomen never develops legs.

SYNOPSIS OF THE SPIDER-LIKE ANIMALS.

| Order | Examples |
|---------------------|-----------------------------------|
| 1. True Spiders | Geometrical Spider, House-Spider. |
| 2. Shepherd-Spiders | Daddy-long-legs. |
| 3. Scorpions | Black Scorpion. |
| 4. Mites | Itch-Mite. |

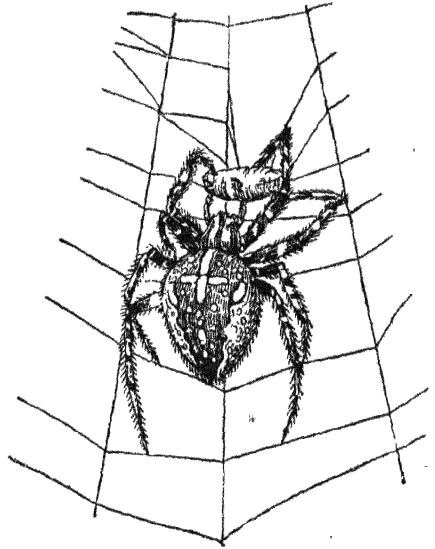
I. Order:—TRUE SPIDERS (*Araneina*).

THE GEOMETRICAL SPIDER

The body of the Geometrical Spider consists of two parts. The chief features of the front part are the mouth-parts, the eyes and four pairs of long legs. This part, therefore, corresponds with the head and the chest of the insects. The larger hinder part is the soft almost globular abdomen.

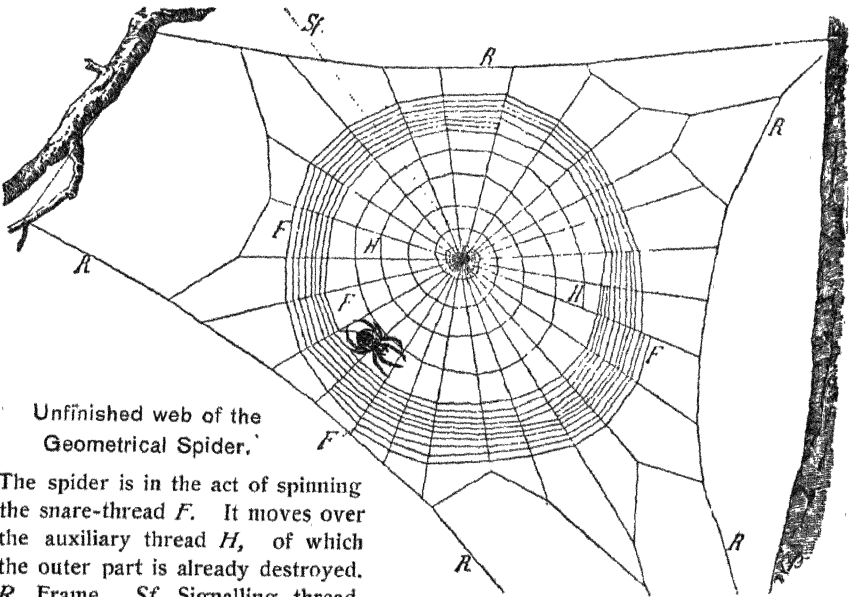
The spider feeds chiefly on flies and midges. Being wingless, it is unable to catch these animals in the air. It, therefore, puts up a net which is spread more or less vertically between trees or walls. Let us see how the spider constructs its web.

a) First, one thread is spun out which, swaying in the wind, eventually touches some object to which it is instantly attached, thus forming the first link across the space where the spider intends spinning its web. Similar lines thrown out in other directions produce an irregular polygon and the framework of the net. Across this polygon a thread is spun next, and from its middle point threads are made to radiate in all directions



The Geometrical Spider.

The captured fly is spun round; the web is torn.

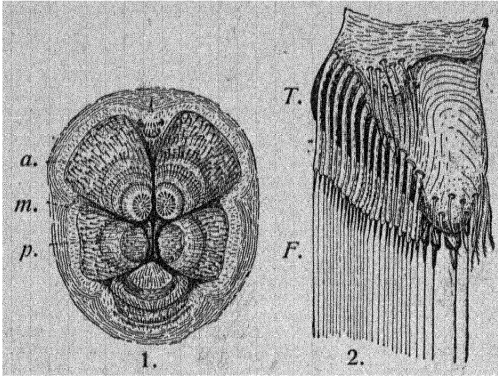


Unfinished web of the Geometrical Spider.

The spider is in the act of spinning the snare-thread *F*. It moves over the auxiliary thread *H*, of which the outer part is already destroyed. *R*. Frame. *Sf.* Signalling thread.

like the spokes of a wheel. Then beginning at the centre, the spider goes round and round in widening the circles, pulling

a line after it and fastening it to each spoke in turn. This done, the creature begins to draw another thread in a narrow spiral form outside towards the centre of the web. This is the real



Spinners of the Spider.

1. Lower side of abdomen with spinners. *a.* anterior, *m.* middle, and *p.* posterior spinners.

2. One of the middle spinners. *T.* Fine spinning tubes. *F.* Fibres of silk emitted from the tubes.

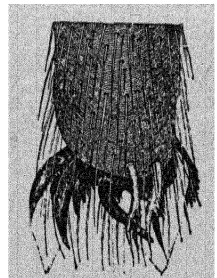
snare-thread studded with a viscid substance. The first spiral, which served only as a ladder between the spokes, will now be destroyed. And thus the web is complete.

b) The material for this ingenious structure is furnished by glands near the end of the body. This accounts for the strikingly large size of the abdomen.

c) The material of the web is a thick gummy fluid, which hardens when exposed to the air. When the spider presses its body on to an object, a tiny drop of this gummy fluid is forced out from the glands and sticks to that object. When the spider moves away, more fluid will be drawn out through a thousand little holes from the glands. The fluid hardens instantly, and thus a thread of great firmness is composed.

d) It is very remarkable that the spider never gets entangled in the meshes of its web, like the flies and midges that fall victims to it. This is due to the fact that the animal possesses comb-like claws at its feet, which are hooked into the thread with ease.

When the web is finished, the spider settles itself in the centre, or hides itself in a convenient recess, which, however, is connected with the web by means of signal-thread. As soon as a victim gets into the meshes of the net, the spider pounces upon it with lightning-speed. If, however, the net is shaken by the wind only, the spider does not stir. This shows that it has a fine sense of touch.



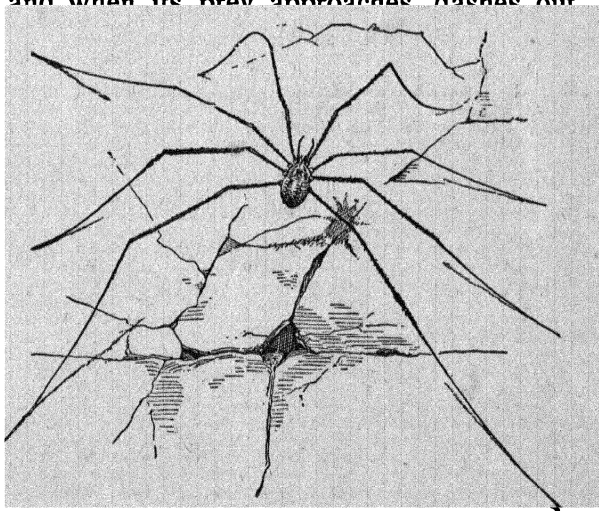
Claws of the Spider.

The sight of the spider seems to be very weak in spite of its possessing eight eyes in the front of the head.

The victim is almost instantaneously killed by the poisonous bite of the spider. After fastening the captured and killed victim by a few threads wound round its body, the spider either sucks up its sap or stores it to be eaten at leisure.

The female spider is much bigger in size than the male, and is known to possess the cruel habit of eating its male consort. The eggs are wrapped up in a dense web, and then suspended in some concealed place. The young spiders are just like the parent animals, and do not undergo a metamorphosis like other insects.

Another common spider is the great **Indian House-Spider** which does not build a web, but chases and runs down its prey, which mainly consist of cockroaches. There is also another kind which does not spin a web, but lies in ambush in some hidden place and when its prey approaches dashes out to seize it. Others, again, build irregular webs, about the corners of rooms, or funnel-shaped ones, leading into some hole which provides a lurking place.



Daddy-long-legs.

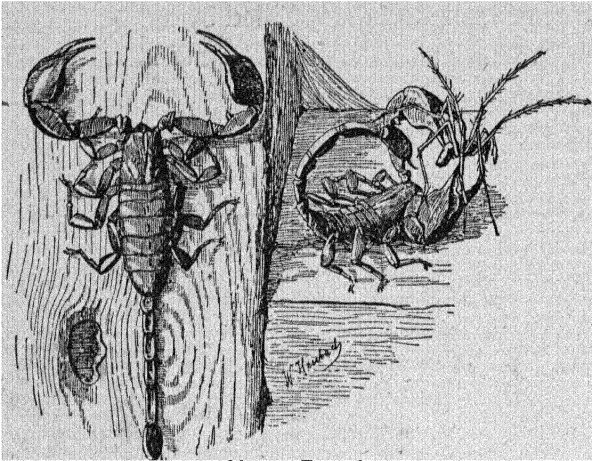
II. Order:—
**SHEPHERD-
SPIDERS**
(*Phalangina*).

During the day the **Daddy-long-legs** (*Phalangium*) sits lazily on a wall or under stones, but at night it runs after small insects and spiders for which purpose its long legs are advantageous. It does not construct a net.

III. Order:—**SCORPIONS** (*Scorpionina*).

The Scorpions seemingly bear a greater resemblance to the cray-fish than to a spider, on account of their large

pincers and their hard skin. Yet they belong to this class of animals. The head and chest form one part, the abdomen has



House-Scorpion.

The insect on the right hand is about to kill a captured spider with its sting.

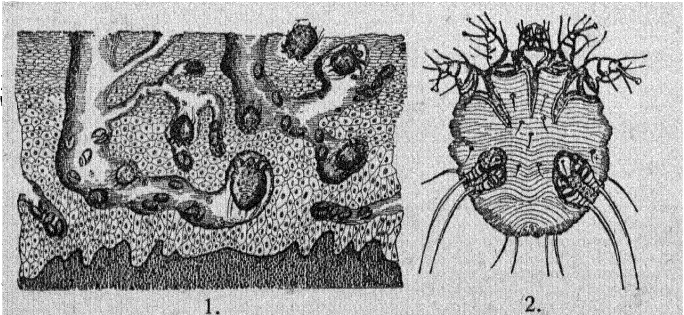
two divisions, of which the first is thick and cylindrical consisting of seven segments, and the hinder part thin and tail-like consisting of six segments, the last having a sting. Having seized its prey by the help of its powerful pincers, the scorpion holds it up

in order to inflict its poisonous sting. It is an animal of nocturnal habits and is, therefore, in the daytime found hidden in holes or under stones. The sting of the larger species can become fatal even to man.

IV. Order:—TICKS and MITES (*Acarina*).

The Ticks and Mites are other spider-like animals. Ticks bore into the skin of mammals to suck blood. The Itch-Mite

(*Sarcoptes scabiei*) bores its way under the human skin, and there forms long thin tunnels causing the disgusting disease known as the



The Itch-Mite.

1. Piece of human skin, undermined by the Mite. In the bores larger and smaller insects and eggs. 2. A single Mite.

itch. A little scarlet animal, *Trombidium*, appearing on the surface of the soil after the first rains, also belongs to this order.

Fourth Class: CRUSTACEANS

(*Crustáceæ*).

Jointed animals, living almost exclusively in water and breathing by gills. Usually possessing two pairs of feelers and a pair of legs on every segment of the body.

SYNOPSIS OF THE CRUSTACEANS.

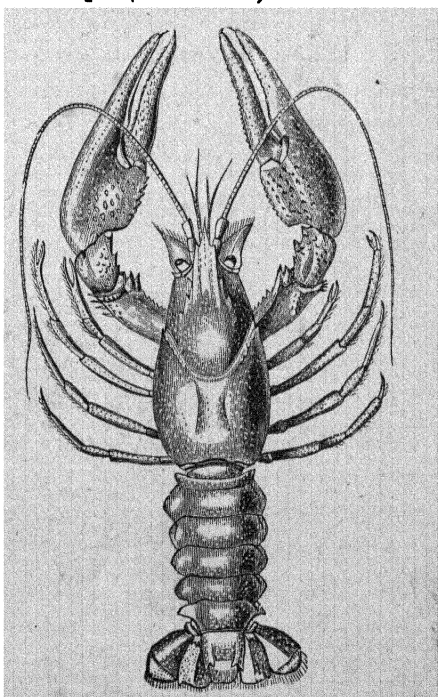
| Orders | Examples |
|------------------------------------|-----------------------------------|
| 1. Crusty Crabs (Thoracostraca) | Lobster, Hermit-Crab, Shore-Crab. |
| 2. Lower Crabs (Entomostraca) | Barnacles, Balanides. |

I. Order:—CRUSTY CRABS (*Thoracóstraca*).

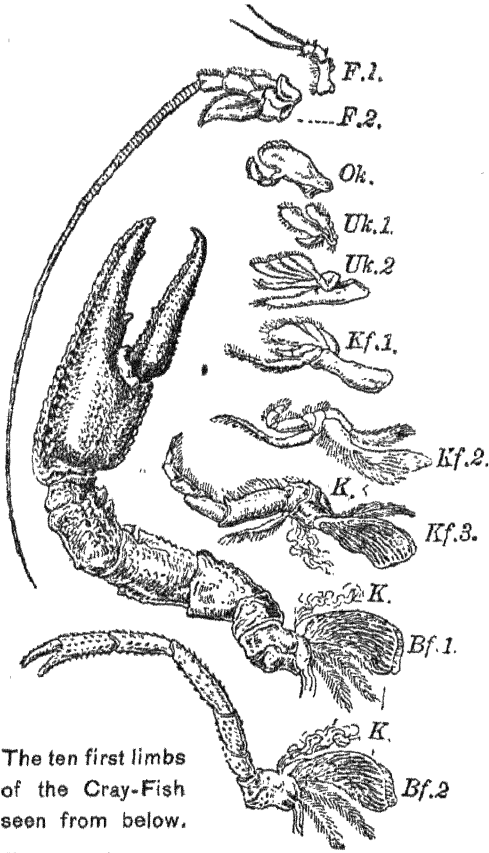
The **Cray-Fish** (*Astacus*) is a fresh-water animal, whereas the **Lobster** (*Homarus*), **Shrimp** (*Palæmon*) and the **Hermit-Crab** (*Paguris*) are marine.

They all have two divisions in their body, one which comprises head and chest, and the other which is the abdomen. The anterior division carries two pairs of long feelers, stalked eyes, movable in all directions, as well as a great number of limbs, varying considerably in structure and size according to the functions assigned to them. The abdomen, too, has several legs, which are, however, weaker than those of the chest.

All parts of the body are encased in a strong armour, which serves as an important means of protection to the animal. As the armour does not increase in size, the crab, while growing,



The Cray-Fish.



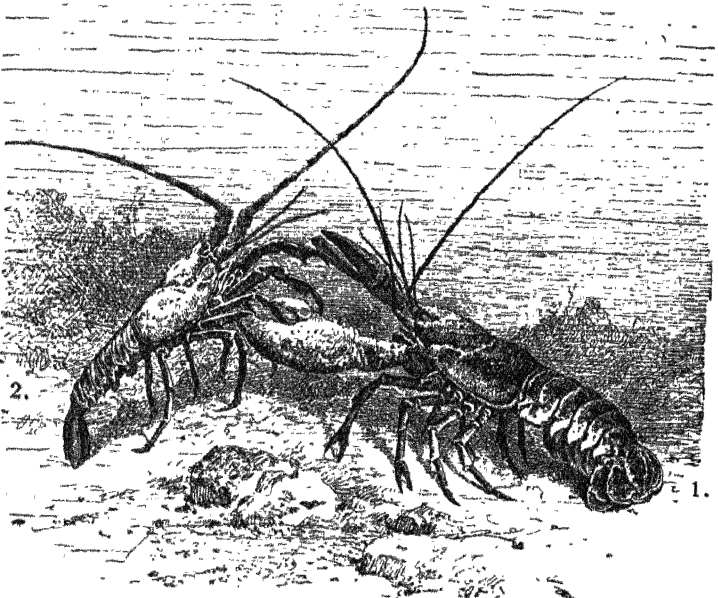
The ten first limbs of the Cray-Fish seen from below.

F. 1. and *2.* Feelers.
Ok. Upper jaw. *Uk. 1.* and *2.* Lower jaw.
Kf. 1. 2. 3. first, second and third maxillary feet.
Bf. 1. and *2.* first and second thoracic feet.
K. Gills.

is obliged to cast its shell periodically in order to form a more capacious one.

Of the very numerous limbs some are used as feelers, some as organs of mastication, some for seizing the food (the pincers) and some for moving (the legs).

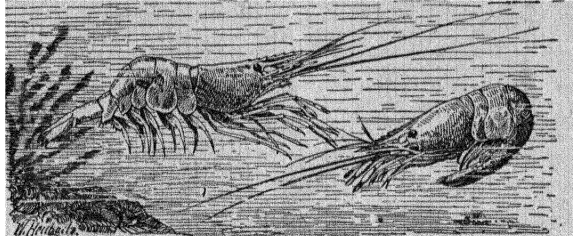
Except the feet, the abdomen of the long-tailed crabs forms a very useful organ of locomotion. By repeatedly bending the abdomen downward and forward in sudden jerks the Lobster can move backward. Strong muscles are present in the abdomen to enable



Common Lobster (1) and Spiny Lobster (2) fighting.

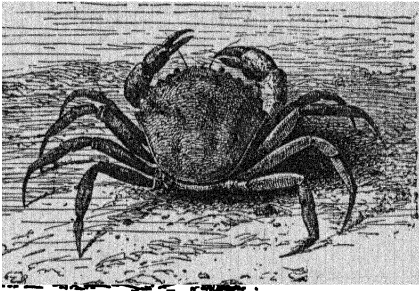
the animal to do this work. The tail consisting of five plates is broadened, and the strokes are thus made more effective.

The **Hermit-Crabs** (*Pagúridæ*) have a very soft abdomen, unfit for swimming. They seek the shell of snails for their protection and thus become



Shrimps.

“Hermits”. When a hermit-crab grows too big for that shell, it seeks a more capacious one and occupies it. On the approach of danger it withdraws as far as possible into its fortress, and bars the entrance with the hard shelled portion of its body, and especially by the powerful pincers, of which one is often larger than the other.

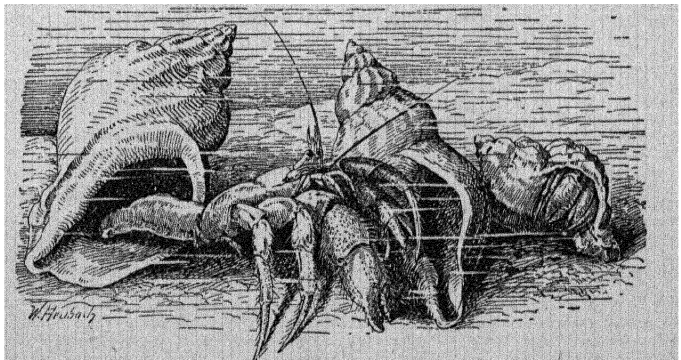


Shore-Crab.

Crusty Crabs in which the abdomen is rudimentary, the **Short-tailed Crabs**

(*Brachyura*).

Among these the best known are the **Sand-Crabs** and the **Shore-Crabs**, all swift runners by virtue of their long legs.

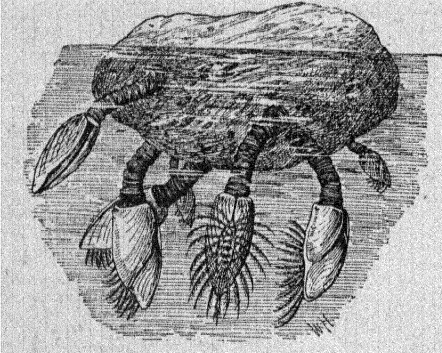


Hermit-Crabs.

The animal has left the shell (in the middle of the picture) which has become too small, in order to occupy the larger one. On the right hand a hermit-crab, withdrawn inside a shell.

II. Order:— LOWER CRABS (*Entomóstraca*).

If a fine gauze net be drawn through the water of a pond or pool, and then washed in a bowl of water, we shall find that we have captured a quantity of minute creatures, of which a great many are crustaceans. These never settle on the ground or on any object, they float in the water, and are known by the Greek term *Plankton*. The crustaceans are very small,



Barnacles

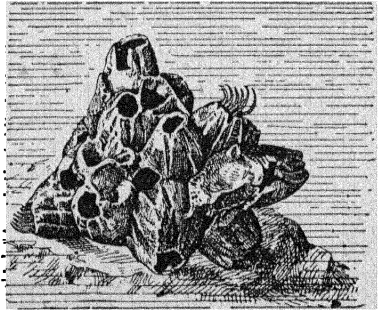
fixed to a floating piece of pumice stone.

Tendril-like legs protrude from a cleft in the shell, and by their movements they produce a current of water which carries their food towards them.

Other little crabs that fix themselves to some support, as a rock or the shell of a snail, but not by means of a stalk, are the **Balanides** or **Acorn-Shells** (*Balanidæ*). They look like small warts and may be seen at low tide on the shore.

but many, by reason of the great numbers in which they breed, are of much importance in the household of Nature, as forming the food of many larger animals.

The **Barnacles** (*Lepas*, are somewhat larger crabs. borne upon movable stalks and fixed to objects moving on the sea. They are enclosed within hard shells like mussels



Acorn-Shells (*Balanus*)

fixed to a rock.



Third Division—Molluscs (*Mollusca*).

Bilaterally symmetrical animals with a soft body. Limos not jointed. Locomotive organ a ventrally placed foot. Above the foot a cutaneous fold (mantle) which covers the respiratory organs, (branchiæ, or lungs), and which, as a rule, secretes a calcareous shell.

SYNOPSIS OF THE MOLLUSCS.

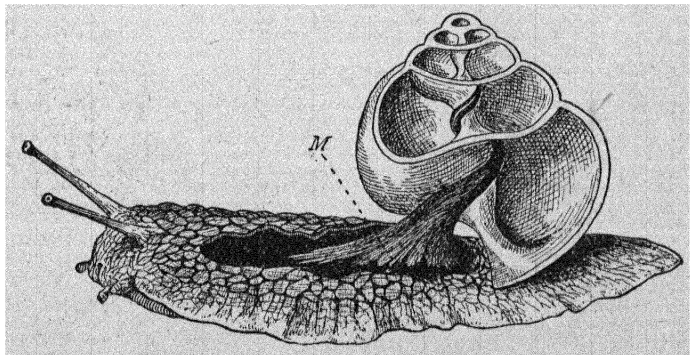
| Classes | Examples |
|--|---|
| Gastropods Headless Molluscs Cephalopods | Slug, Snail, Conch, Cowrie. Oyster, Cockle, Pearl-Oyster. Cuttle-Fish, Nautilus, Ammonites. |

First Class: SNAILS AND SLUGS

(*Gastrópoda*).

1. THE SHELL.—The snails, as a rule, have a shell of one piece consisting of a central column running through to the top of the shell and a long tube coiling round it corkscrew-like. The outer side of the shell is often beautifully coloured, whilst the inner part

has a mother-of-pearl appearance. If the shell is placed in hydrochloric acid, it is almost entirely dissolved, carbonic acid being liberated at the same time. This shows that it consists for the most part of calcium carbonate. The shell grows with the size of the



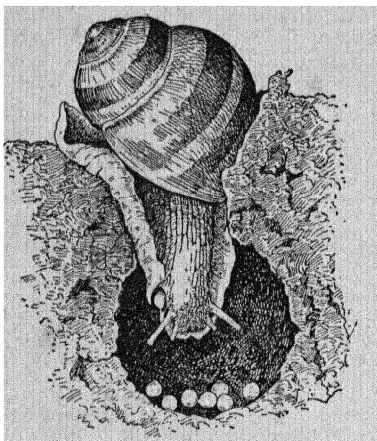
Roman Snail.

Shell opened. *M.* Muscle by means of which the snail withdraws itself into its shell.

same time. This shows that it consists for the most part of calcium carbonate. The shell grows with the size of the

animal itself, and at times a thin newly formed ring of lime is found at the margin of the shell, which gradually becomes hard. The striation of the shell shows how it has grown gradually.

2. HEAD AND FOOT.—The animal uses the shell as a safe hiding place for its soft body. Head and foot are stretched out of it when it moves. The head has two pairs of feelers, of which the upper and longer pair carries the eyes, visible in the form of two black dots. At the slightest touch these tentacles are retracted into the head. The mouth-parts are well developed, the chief organ being a tongue covered with thousands of tiny teeth all pointed backward, and thus resembling a minute rasp or file,

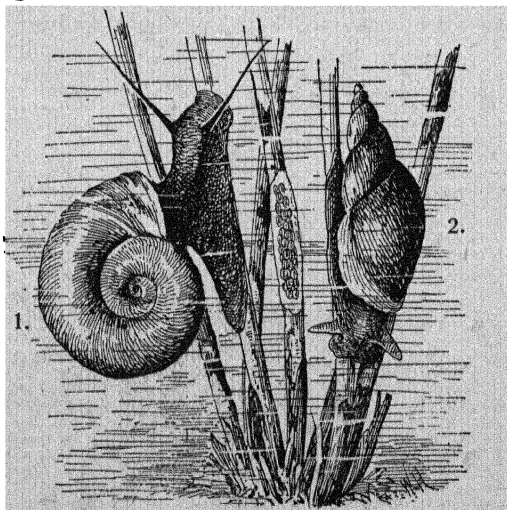


A Roman Snail ovipositing.

with which the vegetable food on which the animal feeds is ground.

The organ of locomotion is a muscular foot with a broad sole, on which the animal glides slowly along without lifting its sole from the surface of support. Wherever it goes, it leaves a trail of slime behind. With this slime it smoothes its path.

3. THE MANTLE.—On the back of the animal there is a peculiar structure, very distinct, especially in the naked slugs. This is the “mantle” which, like a shield, covers the respiratory organ beneath. A round opening is seen on the right side. This is the respiratory aperture.



Planorbis (1) and Pond-Snail (2).

Snails and slugs are, by reason of their naked soft body, conditioned for an aquatic life. The home of most of them is

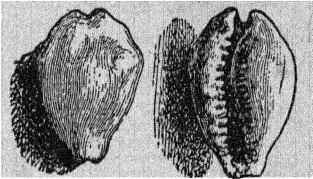
the water. Land-snails are protected against loss of moisture by a viscid slime which is secreted by the mantle.

The best-known sea-snails are the gigantic **Conch** (*Tritonium*) the shell of which is used by man like a trumpet; the

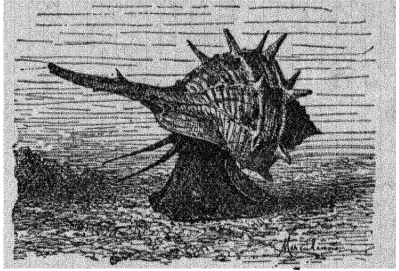
Cowrie (*Cypræa monéta*), the small cream-coloured shell of which

is used as money in some countries; and the **Purple-Fish** (*Murex*), of

the slime of which the inhabitants of the Mediterranean Coast prepared purple in ancient times.



Shell of Cowrie.



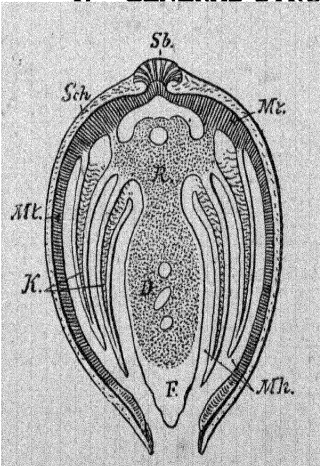
The Purple-Fish (*Murex*).

Second Class: MUSSELS

(*Lamellibránchia*).

1. GENERAL STRUCTURE.—The Mussel may be compared

to a book. The two valves of the shell, which are joined on one side by a hinge, correspond to the cardboard covers. The first and last leaves are represented by the skinny mantle lobes, which lie closely adjacent to the valves of the shell. The second and the third leaves from each end of the book are represented by the leafy gills, and all the remaining leaves of the book taken together represent the body and foot of the mussel.

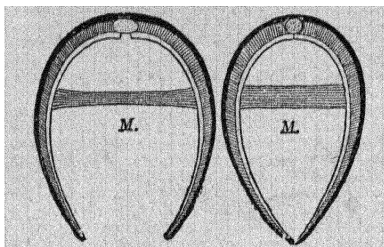


Transverse section of a Mussel (*diagrammatic*).

F. Foot. R. Body.
D. Sections of intestines.
Mt. Mantle. Mh. Mantle cavity. Sch. Shell.
Sb. Hinge. K. Gills.

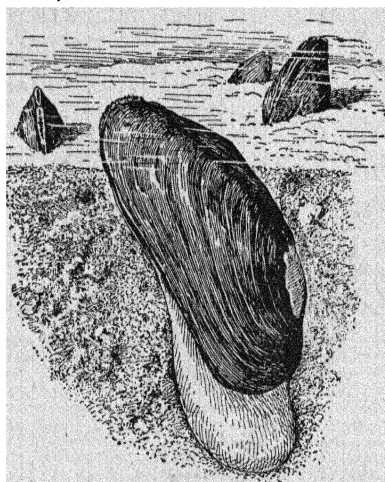
2. THE SHELL.—Its soft body is protected by a strong shell, which consists of two valves joined together by an elastic band on the back, and moving in a hinge, which is formed by several ridge-like elevations of one

valve fitting into corresponding depressions of the other. The closure of the shell is effected by one or two muscles, which pass across the body from one valve to the other, to each of which they are firmly attached. Their places of attachment can be distinctly seen in empty shells. The shells are formed, as in the snails, by secretion from the mantle.



Opened and closed Mussel (diagrammatic). M. Muscle.

3. LOCOMOTION.—Like the snails, the mussels have a foot which they can protrude from their shell. The foot is either used for attaching the animal to some support, as in the Painter's Mussel, or for slowly crawling on the bottom of the water as in most sea-mussels, or even for boring a hole into wood or into soft rock as in the Boring Shells (*Pholas*). Some shells, e. g. the Common Oyster (*Ostrea*) are sessile, one of the shells becoming cemented to the supporting surface.



Painter's Mussels stuck in marshy soil.

4. NUTRITION AND RESPIRATION.—The animal has

The animal in the front is laid open, to show its foot.

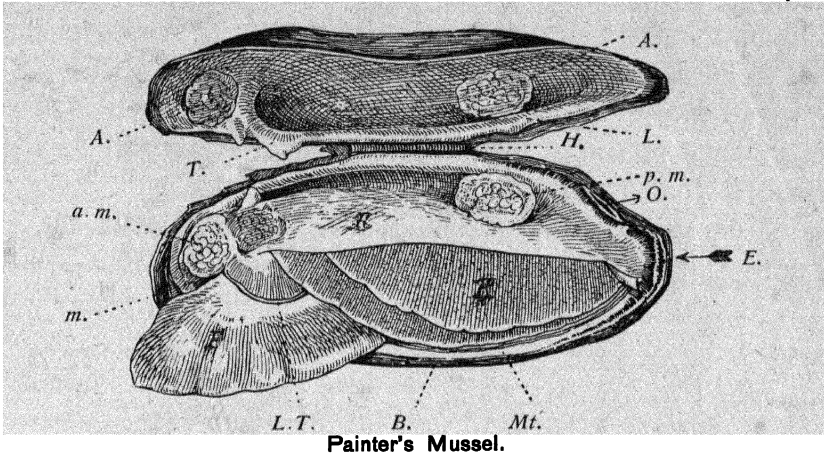


Skull of the Pearl-Oyster (inside).

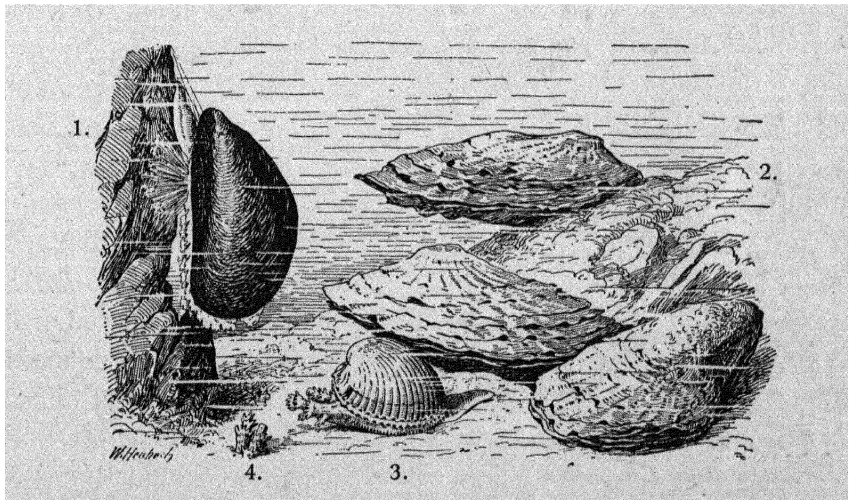
no head, and many mussels have neither feelers nor eyes. Their food consists of minute animals and plants, and they have, therefore, no organs for dividing the food, but simply an opening, by which the food is taken in. Respiration is effected through the gills through which a constant current of water is made to pass.

All mussels are water-animals, most of them living in the sea. The **Common Oyster** (*Ostrea*) is edible. The **Pearl-**

Oyster (*Avicula*) produces the valuable pearl. When foreign substances, such as grains of sand or parasitical worms, happen to get into the body or between the mantle and the shell of



H. Hinge. *T.* and *L.* Teeth and ridges of the hinge. *B.* Border of shell. *Mt.* Mantle. *F.* Foot protruded. *L. T.* Labial tentacles near the mouth (*m.*) *K.* Gills. *R.* Body. *a. m.* and *p. m.* Anterior and posterior contractor. *A.* Place of attachment of the contractor to the shell. *E.* Opening by which water and food is taken in. *O.* Opening by which waste products are thrown out.



1. The Sea-mussel with foot protruded. 2. Three Oysters. 3. The Cockle with foot protruded and fringed siphons for the in-flowing and out-flowing water. At 4, the two siphons of a cockle, which is buried in the sand, can be seen.

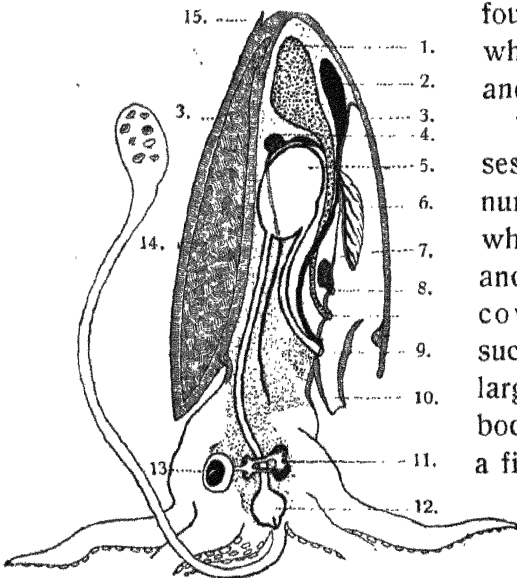
this animal, they cause irritation, and are enclosed by layers of a white brilliant matter, which also forms the interior of the shell and is secreted by the animal itself. The shells of the **Cockle** (*Cárdium*) have a heart-like shape. They are found abundantly on the coasts of India, and are burnt to make lime. The **Boring Shells** (*Pholas*), the front edges of which are rough like a file, burrow deep into wood or even rock and are, in consequence of their continued growth, unable to leave their self-created prison, but they are thereby well protected against enemies. They maintain communication with the free water by means of siphons.

Third Class: CUTTLE-FISHES

(*Cephalópoda*).

The **Cuttle-Fish** (*Sépia*) is an inhabitant of the sea. It is found abundantly everywhere on the coasts of India and of other countries.

1. STRUCTURE.—It possesses a large head with a number of so-called “arms”, which surround the mouth, and are on their inner side covered with numerous suckers. The head bears a large eye on each side. The body is flattened and carries a fin on each side. On the dorsal side the mantle encloses a flat, porous shell, the cuttle-bone, often found lying on the seashore. On the ventral side, the mantle forms a cavity, from which the funnel-



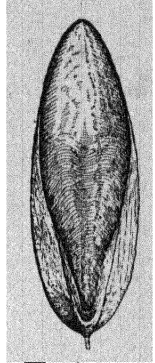
Structure of the Cuttle-Fish (*diagrammatic*).

1. Ovary. 2. Ink-bag. 3. Mantle. 4. Heart. 5. Stomach. 6. Gills. 7. Mantle-cavity. 8. Opening of the kidneys. 9. Anus. 10. Funnel. 11. Chief part of the nervous system. 12. Mouth-cavity. 13. Eye. 14. Cuttle-bone. 15. A portion of the fin.

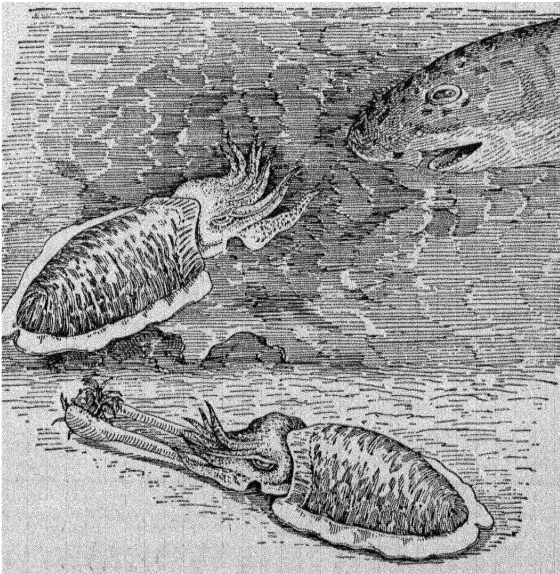
shaped foot protrudes. The mantle-cavity contains also the gills.

2. HABITS.—The arms with their suckers are formidable weapons for offense and defence. The animal is enabled to adapt the colour of its body to the colour of its surroundings. When pursued by an enemy, it discharges a blackish-brown ink (*Sepia*) which darkens the water around it and enables it to escape from its enemies. This colouring matter is produced from a gland, and stored up in the so-called ink-bag. An important painter's colour, *viz.*, sepia, is made from that ink.

The mouth, which lies between the arms, is provided with powerful jaws, which divide the food consisting of fishes and crabs. The tentacles are used both for capturing the prey and for moving. A rapid backward locomotion is effected by forcibly driving out the water of the mantle cavity through the funnel.



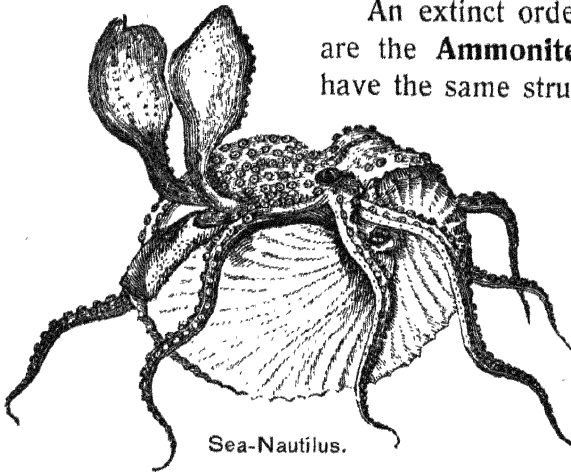
The bone of the Cuttle Fish.



The upper animal is threatened by a shark and discharges ink.

Some of the cuttle-fishes have eight arms, some ten. The **Pearly Nautilus** (*Nautilus*), which is an inhabitant of the Indian Ocean, constructs a shell coiled into a spiral, like that of a snail. This shell, however, is by transverse partitions divided into several chambers, the outer foremost of which is occupied by the animal, whereas the rest are filled with air.

An extinct order of the cephalopods are the **Ammonites**, which essentially have the same structure as the nautilus.



These, as well as fossil mussels and snails, are of great importance in geology, as certain geological periods are characterized by certain fossils of these classes.

Fourth Division—Worms (*Vermes*).

Bilaterally-symmetrical animals, without jointed limbs; body invested by a tubular and muscular skin.

SYNOPSIS OF THE WORMS.

| Classes | Examples |
|-----------------|---------------------|
| Segmented worms | Earth-worm, Leech. |
| Round worms | Maw-worm, Trichina. |
| Flat worm | Tape-worm. |

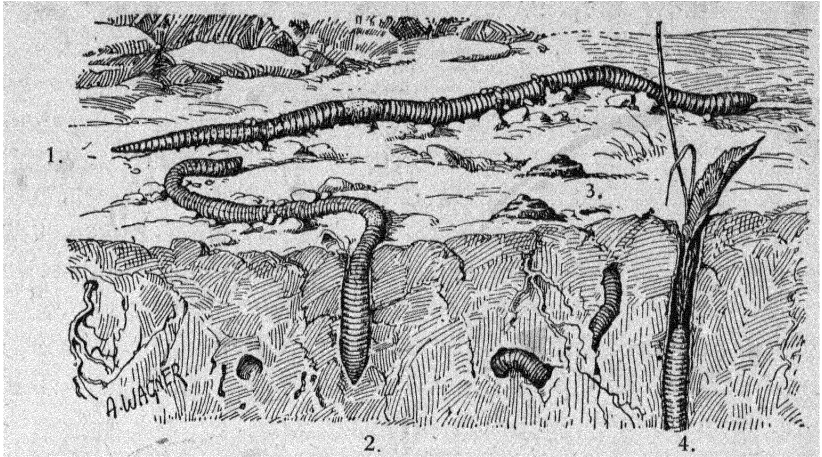
First Class: SEGMENTED WORMS

(*Annelida*).

1. The Earth-Worm (*Lumbricus*).

a) COVERING AND HABITAT. The Earth-Worm has a soft and naked skin. If the body should evaporate water excessively, the

animal would die. The skin is, therefore, always covered with a slimy fluid to check it. Moreover, the earth-worm comes to the surface in the daytime only after a rain, and at night when there is dew. At other times the animal remains in the damp soil. Hence it is never met with in a dry and sandy soil.



The Earth-Worm.

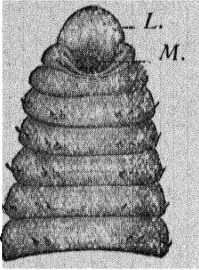
1. The animal creeping.
2. Burrowing in the soil.
3. Worm-castings.
4. A worm drawing vegetable substances into the earth.

b) STRUCTURE AND LOCOMOTION. By means of its elongated tubular body the earth-worm can burrow in the soil with comparative facility.

It progresses by narrowing and stretching the forepart of its body and then shortening and drawing the posterior part of the body up to it, for which work the worm is enabled by a tubular muscle lying below the skin. The great pliancy of the body is enhanced by its division into numerous rings. Locomotion is further facilitated by minute bristles, of which there are four pairs on each ring, all pointing backwards. They can be moved forward and backward like feet.

The burrowing work may be done in two different ways. If the soil is loose, the worm will divide it with its pointed anterior part as with a wedge. If the earth is hard, it simply eats the earth, passes it through the intestine and returns it to the surface in the form of the well-known worm-castings. In that manner the earth-worm carries the lower strata of the soil to the surface, and loosens it, ploughing it like the farmer.

c) **FOOD AND SENSE-ACTIVITIES.** Together with the earth, decayed vegetable and animal substances are taken up by the earth-worm. At night it also drags down into its runs fallen leaves and other half-decayed substances, which, after they have decayed, form a welcome food for it.

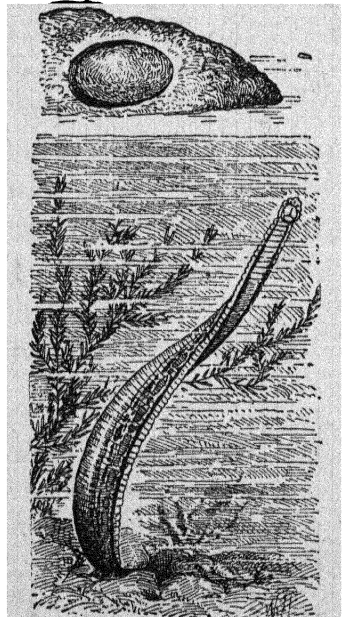


Anterior part of the Earth-Worm (seen from below).

L. Anterior lobe of the first segment.
M. Opened mouth.

If a worm is surprised on a visit to the surface of the soil, even the slightest tremor of the ground will suffice to make it retire into its hole. This shows that it has a fine sense of touch. Although it has no eyes, it is not insensitive to light; for if the light of a lantern is thrown on it, it at once retreats.

2. **The Medicinal Leech (*Hirúdo medicinalis*)** lives at the bottom of lakes and ponds. Its colour is greenish-brown, like that of its surroundings. The leech is a parasite, its food consisting of blood which it sucks from other water-animals. For this purpose it possesses a sucker on either extremity of its body. One of them is the mouth, in which there are three jaws with sharply serrated edges which are used like circular saws. When the skin of the victim is sawn through, the leech begins to suck and to fill its intestines with so much blood that it swells to a size several times larger than before. This supply of food lasts it for several months. It is to this peculiar manner of feeding that the leech owes its application in medicine.



Medicinal Leech.

The leech can swim by undulating its flat body. It creeps by means of the two suckers, in much the same way as the Loooper, alternately drawing up its body into a high arch or loop and again extending it, thus spanning out its way as we should span out a given length with our hand. In the Western Ghats and in

jungles and coffee-plantations a smaller kind of leeches, *Hæmobdella indica*, is very common.

Second Class: ROUND OR THREAD-WORMS

(*Nemathelminthes*).

The **Common Round Worm** or **Maw-Worm** (*Ascaris lumbricoides*) is a parasite which inhabits the intestine of man, especially children.

Another parasite of this class is the **Trichina** (*Trichinella spiralis*), a minute worm that lives in muscles of rats, rabbits, pigs, and men.

Third Class: FLAT WORMS

(*Plathelminthes*).

The **Human Tape-Worm** (*Tænia saginata*), which lives in the small intestine of man, and the **Dog Tape-Worm** (*T. echinococcus*), which lives in the dog, are two representatives of this class.

Fifth Division—Spiny-skinned Animals

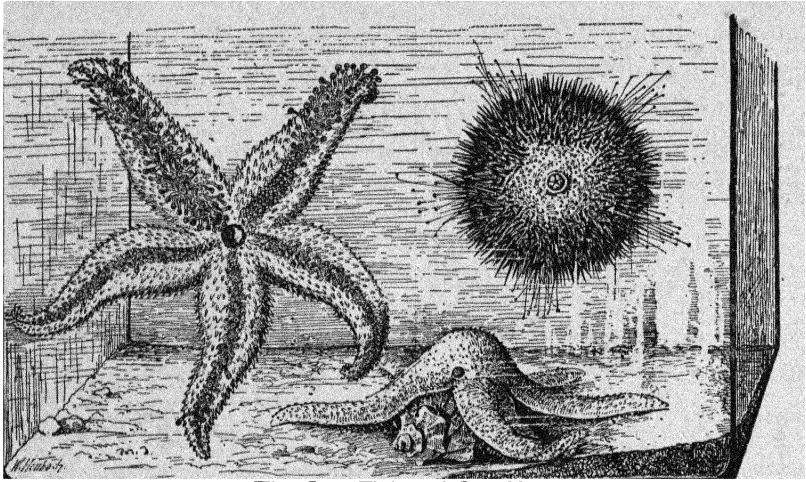
(*Echinodermata*).

Radially symmetrical. Usually five-rayed animals. Chalky deposits in the skin. Skin often spinous.

1. The **Star-Fish** (*Asterias*) is often met with on the coasts of the Indian Ocean. It has the form of a five-rayed star. This defenceless creature is protected by its skin having deposits of numerous chalky or limy plates, which on the outside are produced into numerous spines.

If we watch a star-fish in the act of creeping, *e. g.* on the walls of an aquarium, we notice a number of threads protruding

from the underside all along the five rays or arms, making it appear as if worms were crawling out of its interior. Each thread terminates in a minute sucker, by which the animal fastens itself to its support. Suddenly several threads begin to stir. They extend in length and all move towards one side; next they attach themselves to the support and shorten; thus the body is drawn forward by many little ropes, as it were. These threads are the animal's feet or locomotive organs.



The Star-Fish and Sea-Urchin
in an aquarium, creeping up the glass-side. A Star-fish sucking
out a snail.

The animal's movements being slow, it can possess itself only of sessile or slow-moving animals. Its chief food, therefore, consists of snails and mussels. It seizes its prey with its arms, presses its toothless mouth against the shell-opening of the mollusc and sucks it.

2. The **Sea-Urchin** (*Echinus*) is also pretty common on our shores. The calcareous plates fuse into one shell which is about the size and shape of an orange. The shell bristles all over with movable spines. In the dead animal they drop, and one can then easily find on its surface five double rows of minute holes, the openings through which the animal stretches its sucker-like feet. The mouth of the sea-urchin is on the lower flat surface and is provided with five sharp teeth which project from it.



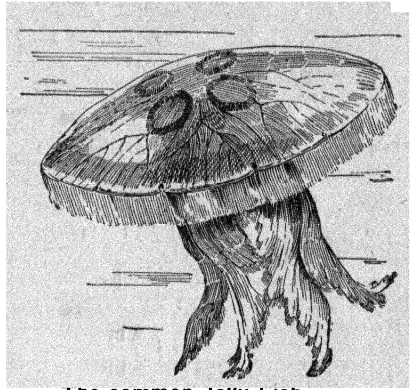
Sixth Division—Cœlenteráta.

Radially symmetrical animals with only one body-cavity.

1. JELLY-FISH (*Aurélia aurita*).

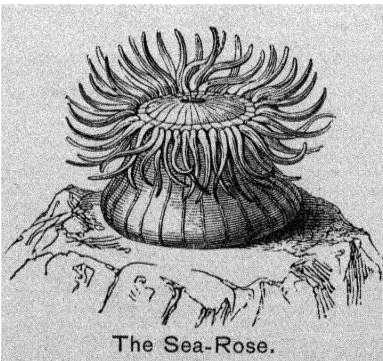
1. HABITAT.—Any one who has seen the sea must have noticed the graceful shape of the Jelly-Fish and its delicate half-transparent blue and red tints. When thrown on shore, the beautiful shape of its body soon disappears, and it becomes a shapeless jelly-like mass. The open sea is, indeed, its element.

2. STRUCTURE.—The jelly-fish bears some resemblance to an opened umbrella: there is a disk-like body at the top, from which something like the handle of the umbrella hangs downwards. This “handle” is drawn out into four fringed lobes, between which there is the mouth of the animal. The mouth leads into the body-cavity, from which numerous canals pass out radially towards the edge of the umbrella. By the forcible contraction of the edges of the umbrella the water contained in the cavity is driven out, and the animal with the convex upper side of its body swims backward. The four arms are provided with stinging organs, and serve to seize the prey which is taken up by the body-cavity and digested.



The common Jelly-Fish.

2. CORALS (*Anthozóá*).

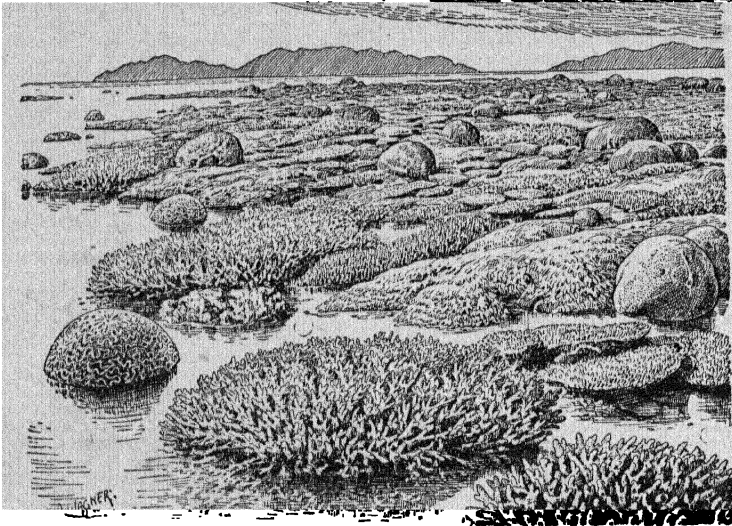


The Sea-Rose.

Some of the corals live single, some in colonies. Of the first kind we mention the **Sea-Rose** (*Actinia*), a delicate, richly coloured creature, with numerous tentacles surrounding the mouth, and thus resembling an animated flower. The tentacles are really stinging darts for the purpose of

killing the prey on which the creatures feed, and the victim when caught in this way is sucked down the mouth into the stomach.

The **Stone-Corals** (*Madreporaria*) resemble the sea-rose,

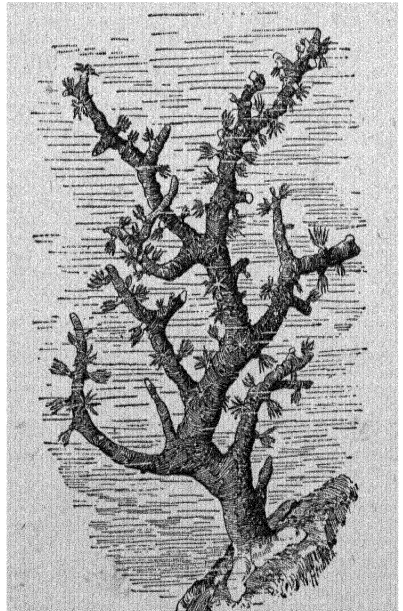


Coral Reef (near the coast of Australia).

but they grow from the parent in the form of a bud, just like buds in a plant; these buds

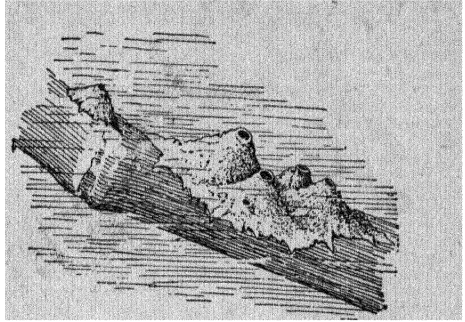
do not detach themselves from the parent but grow with it, budding again themselves and forming at last something like a tree. At the same time they create a strong support, the coral rock, by changing the carbonate of lime which these creatures absorb from the sea-water, into a rocky skeleton, on the top of which the soft animals live. The immense reefs constructed by these animals sometimes form whole islands and mountain chains, and are of great importance geographically and geologically.

The **Precious Red Corals** (*Corallium rubrum*) form small tree-like growths, and are, unlike the stone-corals named above,



The Precious Red Coral.

covered with a soft layer, as a tree by its bark, from which the animals spring like snow-white flowers. The red chalky axis of these animals is hard like marble and can be fabricated into various ornamental articles.



Young Sponge

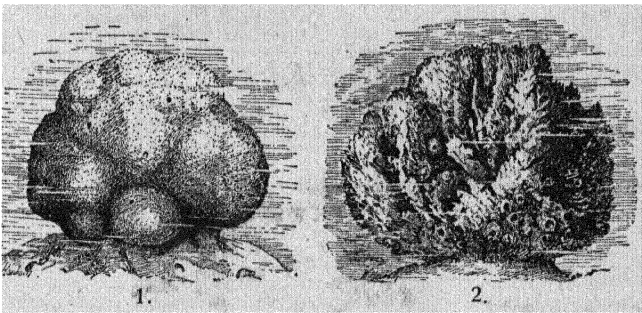
representing an individual animal.

3. SPONGES (*Spongiaria*).

The sea abounds with sponges which are sessile, and have various forms and colours.

They are animal colonies, their soft hollow bodies being supported

by silicious or calcareous needles or by horny fibres. The best-known of this group are the Bath-Sponges with a horny skeleton.



The Bath-Sponge.

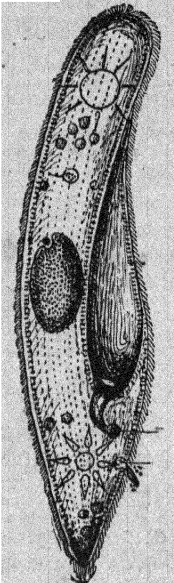
1. Shape of Animal Colony with living individuals. 2. Shape of horny skeleton of the colony, animals decayed.

Seventh Division—Protozoa.

Body composed of a single cell.

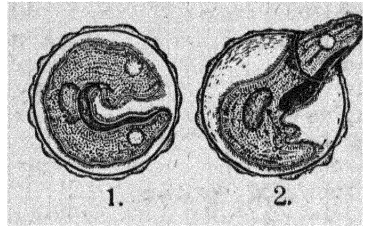
If we steep some hay in water, and examine a drop of the liquid under the microscope, a few days after, we shall find a number of minute animals of various shapes. These animals are known by the name **Infusoria**, because they are obtained by pouring water on any sort of substances.

The commonest species among the infusoria is the **Slipper-Animalcule** (*Paramecium caudatum*), which has its name from its shape. Its body consists of a bit of an albuminous substance. By the help of vibrating cilia, which cover its body, it is enabled to swim in the liquid. The cilia have also to sweep in its food which consists of decaying substances and minute algæ, etc.



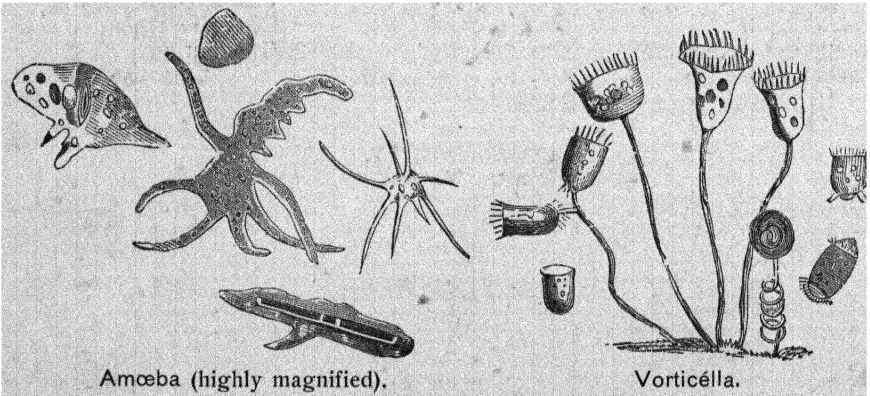
Slipper-Animalcule
(150 times magnified).

If food becomes scarce, or when the water in which they live dries up, the infusoria and all other protozoa enclose themselves in a capsule surrounding their body with a thick membrane. They are carried away with the dust to be re-awakened to life when moistened again. This explains their appearance in the infusions referred to above.



Slipper-Animalcule
enclosed in a capsule.

Like the slipper-animalcule, all other protozoa are extremely minute and delicate creatures consisting of a single cell. They



Amœba (highly magnified).

Vorticella.

live in water and are abundant in all rivers, ponds, lakes and seas. We mention the **Bell-Animalcule** (*Vorticella*) and the **Amœba**, the latter being the cause of dysentery in man.



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