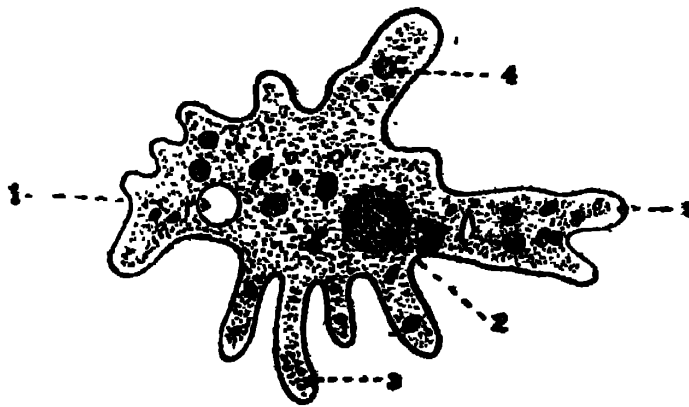


CHAPTER XXVII

DETAILED CONSIDERATION OF SOME TYPICAL ANIMALS.

The Amoeba.

The Amoeba is the smallest animalcule known. It belongs to the phylum Protozoa. The animal is unicellular. The cytoplasm is differentiated into an outer clear **Ectoplasm** and an inner granular **Endoplasm**. There is a **Nucleus** with a **Nucleolus**. There are some round bodies called **food vacuoles** in the cytoplasm. There is another large vacuole called **Contractile**



1—Contractile vacuole, 2—Nucleus, 3—Pseudopodia,
4—Food vacuole in endoplasm.

Vacuole. This single cell performs all the functions of an animal. The animal generally lives in the mud of ponds, tanks and ditches of our country and are often attached to the waterweeds. One species lives as a parasite in human beings and causes ~~Dysentery~~. The size of the animal is about $1/100$ of an inch. It is not seen with the naked eye but is visible with the help of the microscope.

Movements :

The animal moves by sending out protoplasmic-processes called **Pseudopodia**. The animal is ever changing its form by means of pseudopodia. At one moment it has a particular form, the next moment it changes its form by thrusting out other pseudopodia. Firstly the Ectoplasm flows out and then the Endoplasm follows to form the pseudopodium.

The movement is carried out by the protrusion of a pseudopodium and the whole mass of protoplasm flows into it. Next moment another pseudopodium appears and the movement of the animal is thus carried on. The animal is called **Proteus Animalcule** on account of its everchanging form.

Nutrition .

The Animal Amœba feeds on small organisms *viz.*, microscopic plants and animals. The pseudopodia encircle the food and gradually incorporate it in its own protoplasm. As soon as the food comes into the protoplasm, a drop of water is secreted round it and the food is digested. The reaction of the secretion is at first acid and then alkaline. The secretion kills the food (mainly living microscopic organisms) and the wasteproduct after digestion is over, is simply left out when the animal moves away from the particular place. In Amœba digestion takes place within the cell. This is called **Intracellular digestion**. The animal digests the food within the food vacuole. The food consists mainly of proteins and carbohydrates, but not of fat, it is said.

Irritability, Automatism & Conductivity :

The Amœba is irritable, automatic and conductive. The irritability is not situated in the special sense organs but if an electric shock be passed into a drop of water with amœba in it, it will withdraw its pseudopodia and contract. Its conductivity is seen when it is pricked by a fine thread of glass or when it is brought in contact with solutions of salt, sugar or acids. It moves away. The conductivity is proved by the fact that a pseudopodium is formed at a point other than the actual point of stimulus. It moves away from strong light. There are some actions of the amœba which are not referable to any stimulus but takes place from within the animal and are known as Automatic.

Excretion and Respiration :

The whole body of the animal comes in contact with water so the discharge of waste products can take place throughout the body of the animal as also Respiration. It breathes, that is, absorbs oxygen and gives off CO₂ from all over the body. There is a contractile Vacuole in the animal which discharges the water which enters throughout the body of the animal and the water which has accumulated as a result of metabolism is discharged containing the waste products. The Carbon dioxide collects in the contractile vacuole and is passed out by it. Therefore, the contractile vacuole acts both for excretion and for respiration.

Depression :

Sometimes due to unfavourable conditions the animal undergoes depression. The nucleus becomes larger and

all the functions of the body are almost brought to a standstill.

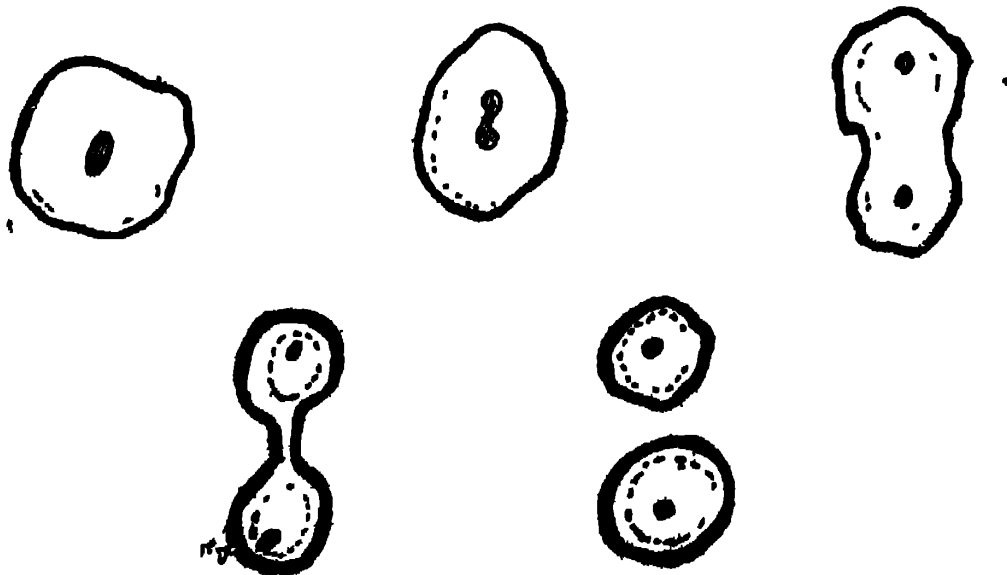
Encystment :

The Amœba sometimes withdraws its pseudopodia and forms and secretes a wall round it called the Cyst. This is called its Encysted condition. This takes place due to unfavourable conditions either the water in the pond dries up or is frozen. The approach of favourable period means the activity of Amœba and the cystwall breaks and normal life is resumed.

Reproduction :

There are two kinds of reproduction in Amœba (1) **Binary fission** and (2) **Multiple fission**.

Binary fission—The animal simply divides into two. First the nucleus divides and then the cytoplasm divides to form the daughter amœbac. Sometimes the nucleus



Binary fission of Amœba.

Nucleus divides into two and the cytoplasm too forming two amœbæ.

divides by Mitosis, the cytoplasm constricts in the middle and forms two individuals. The nucleus always divides before the body of the cell divides.

Multiple Fission :—The amœba becomes encysted and the nucleus automatically divides into a number of nuclei. The nuclei move towards the surface and collect a bit of cytoplasm. The cystwall breaks and the individual escapes as spores with pointed pseudopodia. Each such spore develops into a new amœba.

Thus an amœba while enclosed within the cyst breaks up into a number of rounded structures which are ultimately liberated by the breaking of the cystwall and each one becomes a minute independent amœba. This process is called **Sporulation** and the structures that give rise to new amœba are called spores.

Plastogamy :

Sexual reproduction has not yet been provided in amœba. Sometimes a number of amœbae fuse and thereby form a mass of protoplasm containing many nuclei. This mass is known as plasmodium and the process is known as plastogamy.

Thomson says that **conjugation** has been observed in amœba.

Monocystis :

v. v. Inf.

This animal is also microscopic in size, unicellular in structure and belongs to the group of Protozoa. The Protozoa is sub-divided into a class called Sporozoa which live as parasites inside the bodies of various animals. Parasites are animals that live upon other

animals, rob the host of its nutrition, sometimes even destroy and eat the tissues of the host and ultimately killing it. Monocystis is a parasite which lives in the seminal vesicles of the Earthworm. When an Earthworm is cut open, certain white lobed organs known as sperm-sacs are found at its anterior end. Inside these organs the sperms of the worm undergo development and the Monocystis lives and passes through the various stages of its life-history within the Sperm-mother cells of the worm. Monocystis lives upon the fluid nutrition meant for the Spermatozoa of the Earthworm

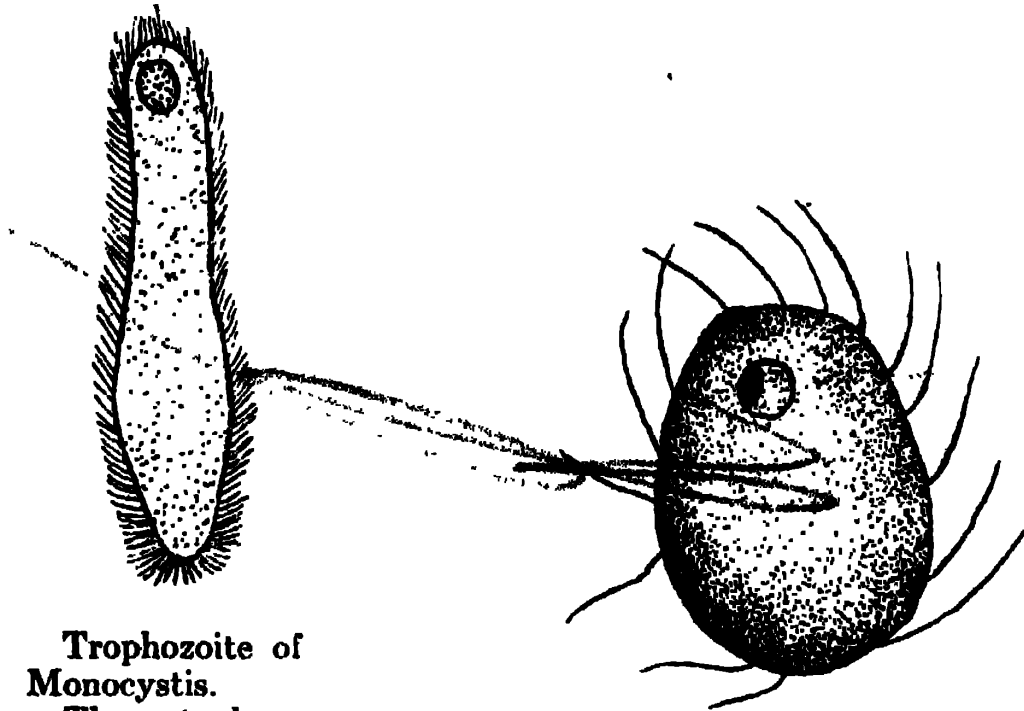
The life-history of the Monocystis is divided into three stages called **Trophozoite**, **Gametocyte** and **Sporozoite**.

The Trophozoite Stage :

The ordinary animal is the **trophozoite**. The full grown adults are visible to the naked eye—flattened worm-like cells; the shape alters during the sluggish movements. Peripherally there is a porous cuticle, a clear cortical zone and a network of myoneme fibrils. Each trophozoite has an elongated body, the outer portion is the Ectoplasm and the inner medullary portion is the Endoplasm. The Endoplasm contains a spherical nucleus with nucleolus. The Ectoplasm has an outer cuticular portion. There are fine fibres in the ectoplasm composed of myonemes which carry out a series of wave-like undulations in the body of the trophozoite. There is no mouth, no contractile vacuole, fluid nutriment being absorbed from the cells of the host, by the whole body of the Monocystis.

The Gametocyte Stage :

Reproduction—Two trophozoites come to meet each other and are covered by a common double cyst wall



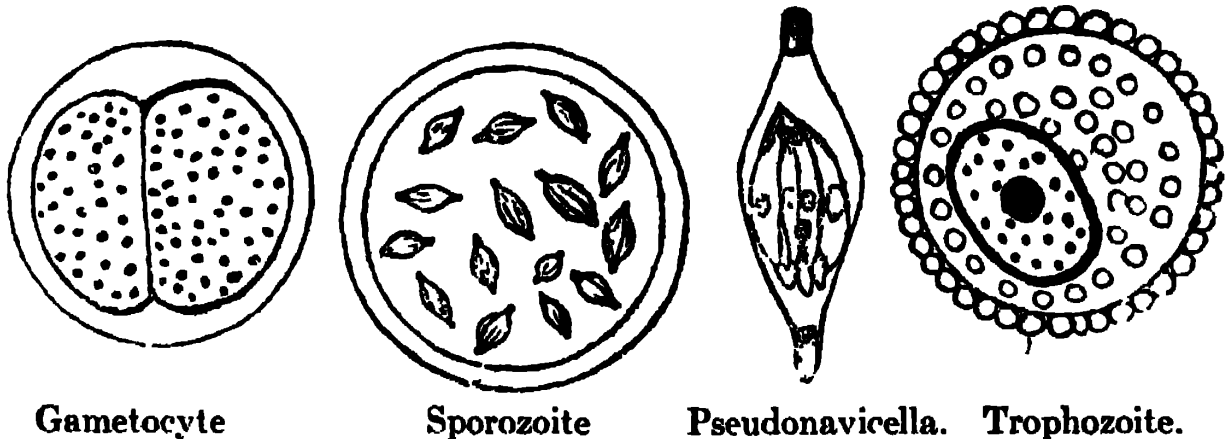
Trophozoite of
Monocystis.

The ectoplasm is covered with the tails of the sperms of earth-worm.

Trophozoite.

which is secreted. Now each is known as a Gametocyte. In the Gametocytes the nucleus of each divides into a number of nuclei. Each nucleus collects some cytoplasm and forms a gamete. So that some gametes are formed in both gametocytes. The partition-wall disappears and the gamete of one unites with the gamete of the other. Therefore gametes are derived from separate parents. This is called Cross Conjugation. As a result of union of two gametes a zygote is formed. This zygote is known as a Sporont. It secretes a boat-shaped horny case and

is known as a **Pseudonavicella**. The cyst at this stage contains a number of such boat-shaped spores.



The Sporozoite Stage :

The nucleus of the zygote undergoes division within the cyst into eight sickle-shaped bodies called Sporozoites. Each sporozoite will enter a fresh host and assume the trophozoite condition. But generally the Earthworm dies when the sporozoite condition is reached. The dead earthworm mixes with the soil and when the soil is eaten up by some fresh Earthworm, it makes its way up into the seminal vesicles and gradually reach the trophozoite condition. There are certain worm-eating birds and if they happen to eat an infected earthworm the cyst remains intact in the alimentary tube of the bird. But the cyst dissolves in the alimentary tube of the fresh living earthworm which has eaten it due to the action of the digestive juices there, and the Sporozoite enters the seminal-vesicle of the animal.

The body of the trophozoite is sometimes covered with cilia, but these tails really belong to the sperms of

the earthworm whose main part has been absorbed by the parasite. The covering of cilia only adheres to the body of the trophozoite, there being no organic connection with it.

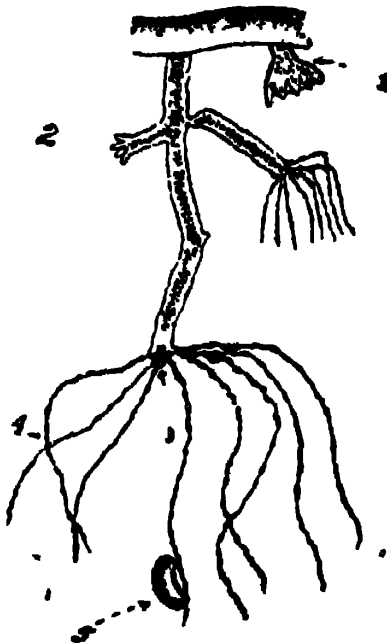
Thus the life-history of the Monocystis is completed in three stages.

Hydra :

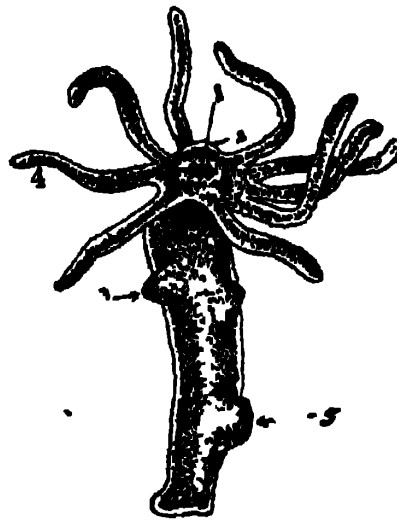
The Hydra or fresh water **Polyp** is composed of numerous cells, so it is a Metazoa in contrast with Protozoa which are composed of single cells. All animals above the Protozoa are known as Metazoa. The Hydra belongs to the group of small animals called **Coelenterata**. The Coelenterata have only one set of spaces within, which all communicate with each other and with the exterior through the mouth. The shape of the animal is that of a minute cylinder. The base or foot is attached to some surface generally weeds whilst the other extremity carries a circle of delicate thread-like appendages called **Tentacles**. The hollow space of the animal is called the **Coelenteron** or **Enteron** lined by **Endoderm Cells**. The body of the Hydra consists of two layers of cells called **Ectoderm** (outside) and **Endoderm** (inside) with a middle structureless lamella between the two layers called **Mesogloea**. Hydra is a member of the group of Coelenterata which have the following peculiarities :—

- (1) The animals are called **Diploblastica** because the body is composed of two layers called **Ectoderm** and **Endoderm**.

- (2) The body of the animals has a single space called Coelenteron. There is a single aperture of the Coelenteron *e.g.*, the mouth.



1—New hydra in the form of bud, 2—Bud, 3—Mouth, 4—Tentacle, 5—Water-flea.



Hydra.
1—Mouth, 2—Hyposome, 3—Bud, 4—Tentacle, 5—Bud.

- (3) There is a lamella between Ectoderm and Endoderm called Mesogloea.
- (4) Nervous system is in the form of cells.
- (5) Reproductive organs are developed either from Ectoderm or from Endoderm.

Functions of the Coelenteron :—

- (a) Digestion is carried on in the Endodermal cells. There are intercellular and intracellular digestion. When digestion takes place outside the cells of the Endoderm (inter) or when digestion takes place within the cells of the Endoderm (intra).

- (b) The residue left after digestion passes out through the mouth.
- (c) Respiration and excretion take place to some extent from the Endoderm cells.

Habitat :

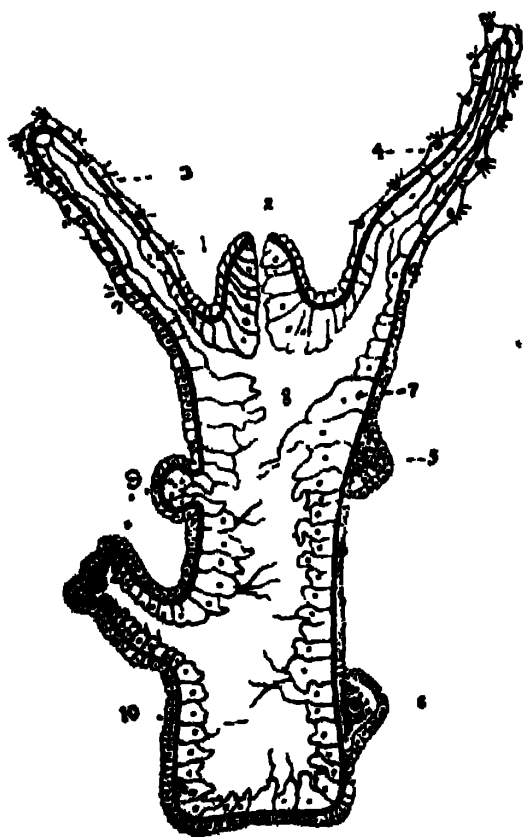
Hydra lives in fresh water attached to some weeds. If some weeds be kept in a glass jar, Hydra aggregate at the base of the jar or they attach themselves to the sides of the vessel. They are brown or white in colour. The species common in Bengal is the Hydra Vulgaris. If the animal be undisturbed it is found to attach itself by the base and the free end shows half-a-dozen threads called tentacles. The animal lives on waterfleas. The water-flea touches the tentacle and is forthwith stunned. The water-flea may be caught by the tentacles and sent to the mouth or the water-flea goes away and recovers from the effects of stunning imposed by the tentacles.

Shape :

The body of the Hydra is like a hollow cylinder with a ring of hollow tentacles surrounding the mouth. The other end is the base of the animal. The mouth is placed on a raised structure called "Hypostome" or Oral cone. The mouth leads into the only space of the body called Coelenteron or Enteron. The hollow space inside the tentacles is continuous with the Enteron. The body of the Hydra is pointed and consists of an outer Ectoderm and an inner Endoderm. There is a structureless lamella between them and is called Mesogloea which is secreted by those cells.

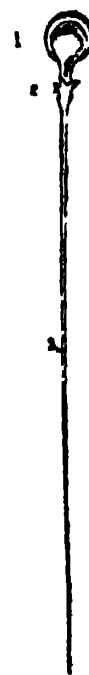
Ectoderm :

The Ectoderm cells are more or less conical in shape. The first type of Ectoderm cells is known as **musculo-epithelial** cells. These cells have their broad ends on the outer side and form a continuous layer of protoplasm. The narrow end of the cells forms a contractile process and runs along the tentacles and the body of the animals. The contractile processes form a



Longitudinal Section of Hydra

- 1—Cnidoblast cell, 2—Mouth,
 3—Tentacle, 4—Nematocyst,
 5—Primary, 6—Ovary,
 7—Endoderm, 8—Coelenteron,
 9—Bud,
 10—Ectoderm.



Cnidoblast cell

- 1—Nematocyst,
 2—Barb,
 3—Wire.

distinct layer on the outer side of the lamella. The cells of the base are filled with granules secreted by the

protoplasm meant for the fixing of the animal upon weed or any other surface. Each cell has a large nucleus.

The second type of cell is the interstitial cell. These cells are round and fill up the intervening spaces of the narrow ends of the epithelio-muscular cells. These cells are kept in reserve and in necessity can give rise to the other cells of the body.

The third type is the **cnidoblast** cell found in the Ectoderm. These cnidoblast cells occur plentifully on the tentacles and are absent from the basal part of the animal. The cnidoblast cells project on the surface. They have a short process called **cnidocil** and a sac within called nematocyst. The narrow outer end of the sac is tacked in and produced into a long hollow thread which lies coiled up in the sac. The space between the thread and the sac is filled with fluid. The cnidocil is a sense organ. The wire when discharged paralyses the prey when any pressure is brought to bear on the outside of the sac, the thread has got three barbs at the base and comes away from the sac like an electric discharge,

The nematocysts are of three kinds :—

- (a) Large kind with a straight thread provided with barbs at the base.
- (b) Small kind with spiral thread.
- (c) Small kind with straight thread and small sac.

The tentacles show some projections due to the presence of some cnidoblast cells both of the large and small variety. The large ones serve both for offence and defence. The sac pours out a fluid which has probably a corrosive action on the tough skin of the water-flea on

which the Hydra lives. The main work of the nematocyst is to catch the prey and not to kill it until it is sent into the mouth. The cnidoblast cells arise from the interstitial cells. Firstly, these cells are found on the tentacular region and anterior region of the animal, but the cells move to other parts and take up their position when necessity arises. The germ cells arise from the interstitial cells. Nerve cells are found near the interstitial cells which are connected with the sense cells reaching the musculo-epithelial cells by fibres. There is no central nervous system. There is only a very rudimentary development of the nerve cells.

Endoderm :

The cells are columnar and tall. The cells contain granules which they secrete. There is a large vacuole containing the nucleus. The free ends of the cells have flagella. There are long narrow cells in the Endoderm which are granular in character and found towards the part near the mouth. They are known as Gland Cells. The secretion of these cells helps digestion. The numerous ordinary cells of the Endoderm are columnar and nutritive in function.

The green Hydras show some round bodies in the Endoderm cells containing green colour. The green colour is due to Chlorophyll which is invariably present in plants. This is due to the association of a degenerate Alga with the Hydra. This sort of association of life is known as symbiosis as neither injures the other but they live a life of mutual help. The Alga is a minute microscopic plant related to Chlamydomonas and the group is known as Zoochlorella. The Zoochlorellae

remove the waste products and CO_2 of Hydra and manufacture organic food with the help of chlorophyll. The Hydra takes away the excess of organic food and utilises it for its own nutrition.

Movements :

The movements are carried on by the muscular processes present in the outer portion of mesogloea though the basal cells can slowly move with the projecting pseudopods. The body of the Hydra contracts and it does not remain stationary even if the prey be absent. The body contracts and sends out the tentacles in a new direction. Sometimes the animals move, the tentacles attach to some new spot and the whole basal disc is removed with them. The movement is comparable to that of the looping caterpillar.

Nutrition :

The food of Hydra consists of small organisms and mainly water-fleas. When the animal has enough food it allows the prey to escape but if it is in a starved condition the touch of food makes the tentacles active. The prey is in contact with one of the tentacles and the other tentacles swing over it until it is sent into the mouth. While inside the enteron, digestive juices are secreted and the soft parts assimilated. The digestion might take place in the enteron *i.e.*, intercellular digestion or the flagella might send the food within the cells where the process is known as intracellular digestion. The undigested residue is eliminated through the mouth by the contraction of the wall. The Ectoderm cells do not take food directly but are nourished entirely

by diffusion from the Endoderm cells. Thus the Ectoderm is protective and sensory while the Endoderm is nutritive.

Respiration and Excretion :

There is no special organ either for respiration or excretion. The two functions are carried out from the surface of Ectoderm and Endoderm cells.

Reproduction : Asexual and Sexual :

There are two kinds of reproduction in the Hydra, *viz.*, Asexual and Sexual. Asexual reproduction takes place by budding. A projection appears from the Ectoderm cells which is multicellular and forms a bud. This bud increases in size and gradually the tentacles appear. It may remain attached to the parent animal or may separate out to form a new individual.

Occasionally Hydra might reproduce by fission either longitudinally or transversely. The separated part grows out into a new Hydra. In fission growth is after separation but in budding growth takes place in the new individual while still attached to the original structure."

Regeneration :

Hydra has the power to build up its lost parts provided it be not too small. The part must have the two layers with mesoglea. If a tentacle or part of the body is lost Hydra can regenerate the lost parts. The higher animals however do not possess this property except in the healing of wounds.

Sexual Reproduction :

Sexual reproduction takes place in spring and summer. The animal is hermaphrodite *i.e.*, both ovary and spermary

occur in the same animal. The sexual organs arise from the Ectoderm when the breeding season comes on. The testes are many in number and occur near the upper part while the ovary is single and found near the base. The organs are developed from the interstitial cells of the Ectoderm. In the case of the ovary the interstitial cells project and there is a covering of the musculoepithelial cells. There is developed an Oocyte which will develop into a single ovum and eat away all other interstitial cells. During fertilization the Ectoderm cells separate so as to expose the ovum and one sperm cell fertilises it.

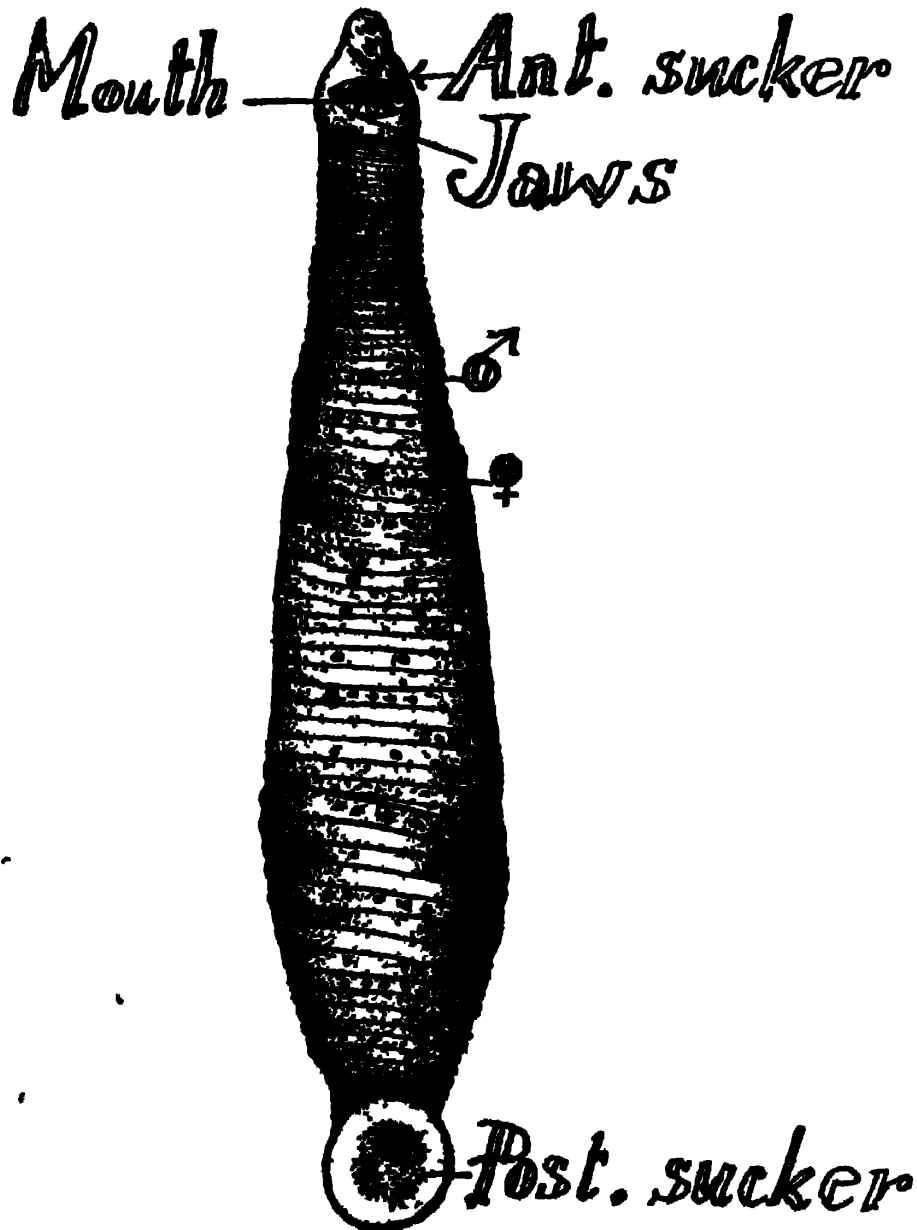
In the case of the spermary, the interstitial cells develop into sperms each having a head and a tail and a covering of Ectoderm. When the sperms are ripe or mature the Ectoderm breaks down and the sperms float in the surrounding water. After fertilisation the ovum becomes oosperm or unicellular embryo. Rapid division takes place of this cell which is known as segmentation. A mass of cells is formed called Morula or Polyplast which builds an outer shell. The animal comes out by the bursting of this shell. The Ectoderm and Endoderm are formed. The mouth develops and gradually the Enteron becomes functional and the tentacles appear as buds. Ultimately adopting the adult form and a fully developed Hydra is formed.

• Leech :

The scientific name of this group of animals is Hirudo, commonly known as Medicinal Leech because formerly it was largely used by medical men in their daily practice for the depletion of blood. The animal has got external markings corresponding to internal divisions. The animal

is therefore called a segmented animal. The phylum to which Leech belongs is known as Annelida.

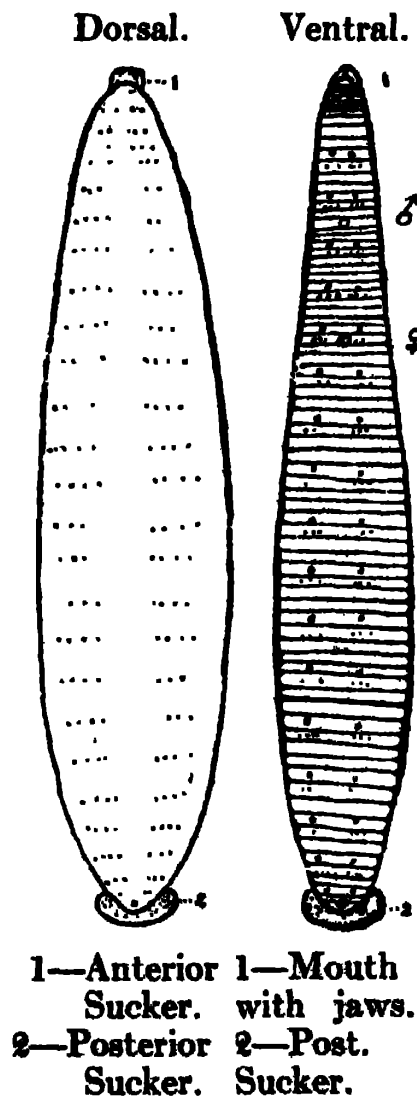
The Hydra has two layers in their body wall *e.g.* Ectoderm and Endoderm with a middle lamella. There-



Leech.

fore it is known as Diploblastica. The Leech has three layers *e.g.* Ectoderm, Mesoderm and Endoderm. Therefore, it is called Triploblastica. All the higher animals

are triploblastica. The Epidermis is formed from the Ectoderm whereas the great mass of tissues *e.g.* skeletal, muscular, excretory and generative organs are formed from the mesoderm. In Hydra the cavity is one but in higher animals two types of bodycavities occur in the mesoderm :—



- (1) The primary body-cavity or haemocoel or open blood vessels and,
- (2) The Secondary body-cavity or true body-cavity or Coelome.

The functions of the coelome are (1) It forms a perivisceral cavity which surrounds the viscera and allows them to move.

(2) The walls give rise to the generative cells.

(3) It is sometimes concerned in Excretion.

The haemocoel on the other hand is a system of spaces of more complex form than Coelome. Its function is to contain the blood and lymph. A blood vascular system is occasioned in the higher animals on account of the great mass of internal tissue.

The Leech is generally found in the fresh water ponds, ditches, slow running streams and marshy places. Formerly it was bred in special ponds in England for the use of the medical practitioners. Normally it lives by sucking the blood of toads, frogs and fishes but in the adult stage it can also live on warm-blooded animals and even on man. To induce the animal to suck the blood of man the skin may be moistened with milk or blood. A small cut acts admirably for the purpose. A Leech can draw 1 to 2 drams of blood only. The length of the animals varies from one to five inches. Each end of the animal is provided with a downward facing sucker. The body of the animal is segmented and recently it has been shown that the segments are always 33 in number. Some of the segments are fused together as for example, the posterior sucker consists of 6 or 7 segments. Each segment is generally divided into 5 annular rings. The mouth is situated in the Anterior sucker while the Anus opens by a small aperture at the base of the posterior sucker. The male and the female organs open by median apertures on the 10th and 11th segments

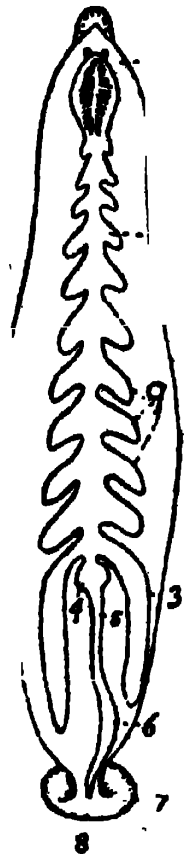
respectively. The Excretory system is in the form of a pair of Nephridia occurring in each segment from the 6th to the 22nd segment. Sensory Papillae occur in the form of a ring in each segment on the first annulus. On the head these papillae form a pair of eyes in each segment. The animal moves by looping movement and swims by the undulations of the body. The animal is covered by a thin cuticle which is shed from time to time. Below the cuticle is the Epidermis. The bloodvessels form capillaries below the Epidermis. The skin in the Leech serves as a respiratory organ because the bloodvessels come in contact with the surrounding water through the skin. Below this, muscle layers run in circular and longitudinal fibres, within which a special tissue occurs called the Botryoidal tissue. The walls of the Botryoidal tissue are full of black pigment and the cavities are full of blood. This tissue functions as a perivisceral cavity and imbeds the alimentary tube.

The Alimentary Canal :

The mouth has three jaws covered by cuticle. This is used in inflicting the characteristic triradiate wound on the prey. The mouth is followed by the muscular pharynx which has unicellular glands. The glands by their secretion prevent the blood from clotting. The blood is sucked and sent to the crop for storage. This secretion often leads to the continued bleeding in animals where a leech was attached. In Physiological experiments extracts of the head of Leeches are used to prevent clotting of blood. The pharynx is followed by a short Oesophagus and then comes the crop. The crop has eleven pairs of caeca which are dilated through the

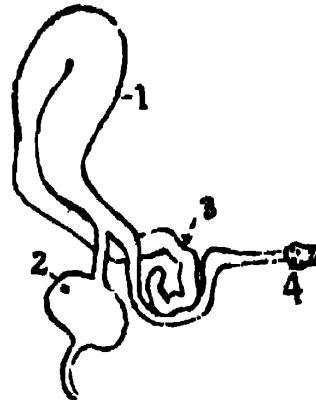
accumulation of blood. The last pair of caeca is the largest and extends its limbs right up to the anus. The crop leads into a small globular stomach is followed by

Alimentary
tube.



- 1—Pharynx, 2—Crop,
3—Large caecum, 4—Stomach,
5—Intestine, 6—Rectum,
7—Anus, 8—Post
Sucker,
9—Caeca.

Nephridium.



- 1—Duct,
2—Bladder,
3—Duct,
4—Lobe of
nephridium.

a short intestine and the ultimate part is the dilated rectum opening by an aperture called Anus. The blood when digested inside the stomach turns green.

It is said that a full meal may last from six months to a year.

Excretory system :

The excretory organs are the 17 pairs of Nephridia. The nephridia are V-shaped rods of cells. The glandular tissue is traversed by a system of intracellular ductules. There is no internal opening but in the testes segments the nephridia have a swollen end in the capsule of the testis.

Blood Vascular system :

There are two systems of tubes containing a fluid like blood—a red plasma with a few colourless corpuscles. One system is the true blood vascular system consisting of two lateral trunks which are joined before and behind and in the middle by capillaries. The lateral vessels can contract but there are no hearts.

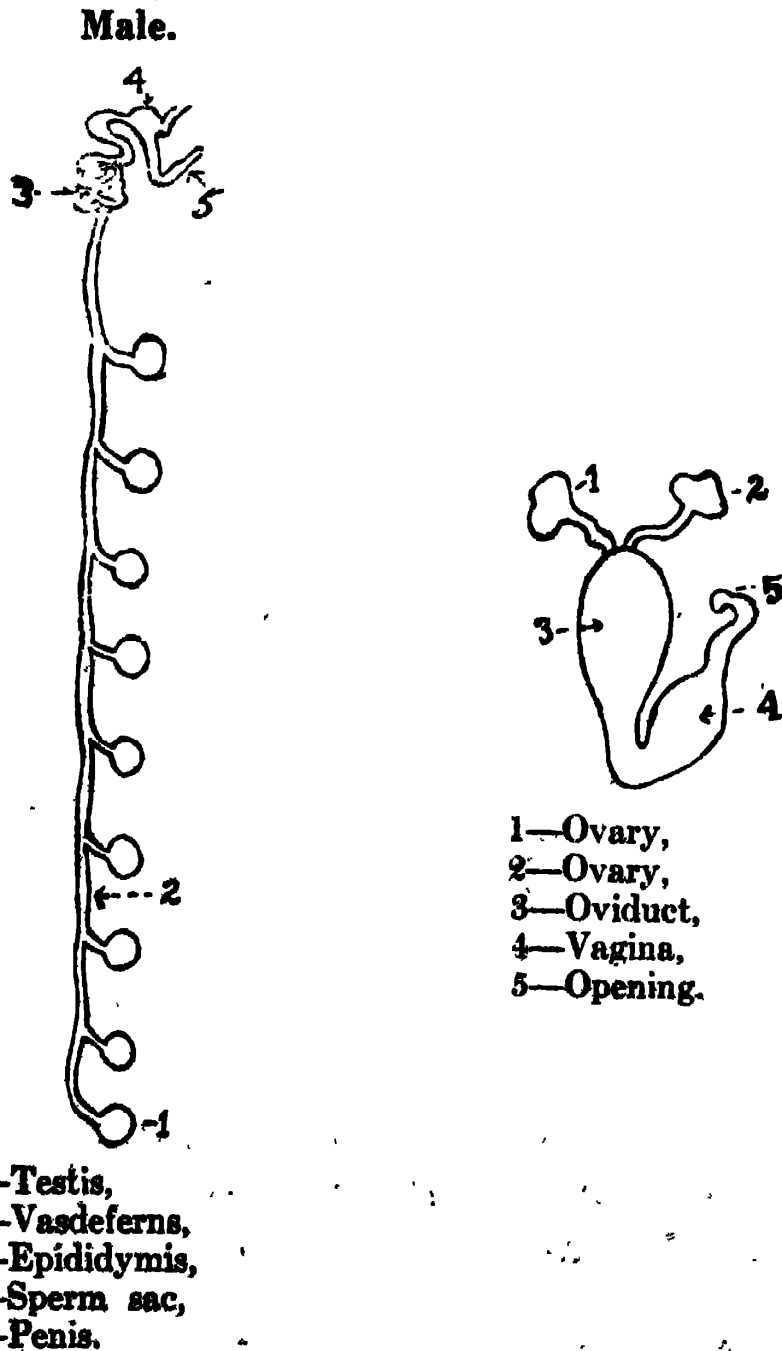
The other system consisting of a dorsal and a ventral longitudinal *sinus*. The walls of this system are thinner than those of the other system. The second system represents the cœlome because it communicates with the capsules of the ovary and testis. The botryoidal tubes communicate with the sinuses.

Nervous system :

The nervous system consists of two cerebral “ganglia” at the head part above the pharynx. There are two circumpharyngeal commissures connected with a double ventral nerve chord. The ventral chord carries about twenty-three pairs of ganglia, almost one for each segment. The subpharyngeal and the last ganglia represent several fused ones. Nerves pass to the body from the cerebral and other ganglia.

Reproductive system :

The animals are hermaphrodite. The testes are ^{eleven} ~~nine~~ pairs of organs from 12th to ~~20th~~ ^{22nd} segments. The testes of each side have a common passage called "Vas



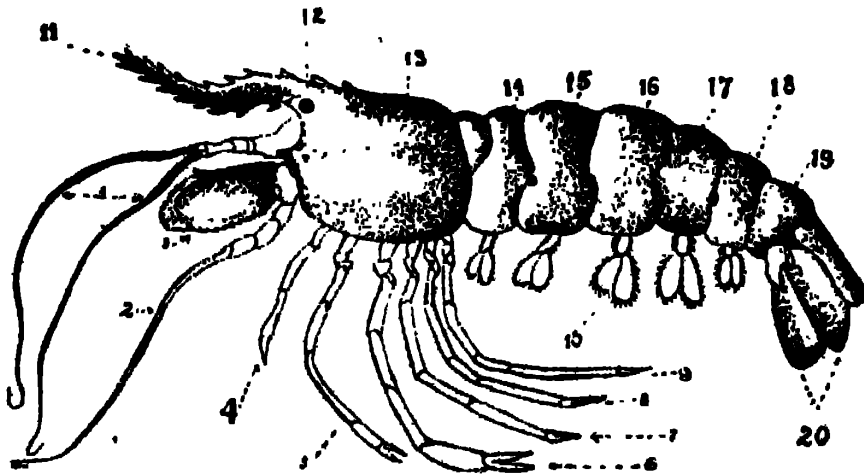
deferens." The two Vasa deferentia join to form a coiled structure called Epididymis in the 10th segment.

and open by a muscular "penis." The "Penis" has a "Prostate" gland at the base.

There occur a single pair of ovaries which have oviducts uniting into a median vagina, and opening by the single aperture in the 11th segment. The Eggs are laid in cocoons secreted by the clitellar glands in the skin of the 10th to 12th segments. The eggs are laid on the holes of the banks; the young resembles the parents and at first feeds on the juice of small water-insects. It takes about three years for the maturation of a young leech. Thus the group of leeches is characterised by:—

(1) Segmentation of the body.

Prawn



1—1st antenna, 2—2nd antenna, 3—exopodite, 4—3rd maxilliped. 5—1st Walking leg, 6—2nd Walk-leg, 7—3rd Walk-leg, 8—4th Walk-leg, 9—5th Walk-leg, 10—Swimmeret, 20—Last pair of Swimmerets with telson on the back, 11—Rostrum, 12—Eye, 13—Cephalothorax. 14 to 19—Abdominal Segments.

(2) Closed blood-vascular system.

(3) Nervous system with cerebral-ganglia and a double ventral nerve-chord.

(4) Presence of coelome.

(5) Paired Nephridia.

(6) Hermaphrodite condition.

The freshwater prawn (palaemon) :

The Prawn belongs to the phylum Arthropoda. The word Arthropoda is derived from "Arthron" meaning joint and podos a foot. The animal has jointed feet. The prawn, the scorpion and the insects, Butterfly, Bees, Ants etc., all belong to this phylum, because they all possess jointed feet. This is the largest phylum in the whole animal kingdom and is comparable in number to all the animals put together of other phyla. The Prawn occurs both in fresh and saltwater. The popular Bengali name of the animal is "Goldachingree," and the scientific name is Palæmon. The Bengal variety is mostly confined to freshwater ponds, canals and rivers. The other variety of "Chingree" known as "Bagda chingree" is found only in saltwater Jheels and is known scientifically as Penæus. The food of Palæmon consists of algæ, moss and other weeds.

The Arthropoda is divided into four classes and the name of the class to which the prawn belongs is called Crustacea.

The Prawn belongs to the order Decapada which owes its name to the fact that its members have their hinder five pairs of thoracic limbs adapted for locomotion typically as walking legs. The order includes the most highly organised crustaceans, such as prawns & shrimps, and the true crabs.

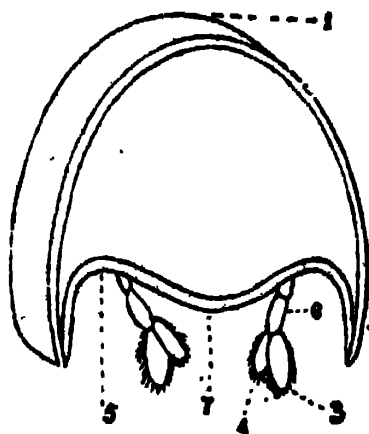
The systematic position of Palæmon is shown in the following scheme :

Phylum : Arthropoda, class : Crustacea, order : Decapoda. Sub-order : Natantia. Family : Palæmonidæ. Sub-family : Palaemoninae, Genus : Plæmon.

External features : prawn :

The body is bilaterally symmetrical. It is segmented like that of the Leech but the number of segments is much less being only 19 in all, some of the segments being fused in front. The whole body is covered by a hard chitinous cuticle. The body is divisible into a fused anterior portion called the **Cephalothorax** and a segmented posterior portion called the **Abdomen**. The body is provided with variously modified appendages *e.g.*, legs, jaws etc. covered by jointed exoskeleton, the

Transverse Section of
abdomen of Prawn.



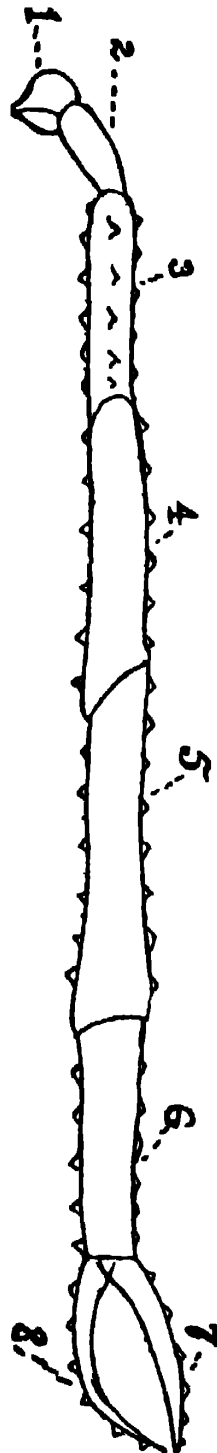
- 1—Tergum, 2—Pleuron,
3—Exopodite, 4—Endo-
podite, 5—Epimeron,
6—Biramous appendage,
7—Sternum.

movable segments are known as podomeres. The Cephalothorax has a shield-like covering called the Carapace. The Carapace bears a saw-like structure,

called the **Rostrum**. The Cephalothorax is formed by the fusion of a number of segments. The presence of several pairs of appendages testify to this fact. A flat piece called **Telson** is found at the end of the abdomen on the undersurface of which the anus opens. The Telson bears no appendages. Each abdominal segment has a dorsal piece at the back called **Tergum** and a narrow piece in the belly part underneath called the **Sternum** with a pair of V-shaped prolongations called **Pleura** joining them at the sides. A continuous ring is formed by the tergum, sternum and pleura of each segment. The limbs are joined to the sternum and the portion between the limb and the pleuron is called **Epimeron**. The terga overlap one another and the tergum of each segment is joined to the next by thin cuticle which allows some movement of the animal. The dorsal plate and carapace are fused to form dorsal shield. There is a chamber in which the gills lie on each side. This chamber is called the Gill-chamber and the covering is known as Gill cover or **Branchiostegite**. The mouth and the sense organs lie in the head region. The mouth lies a little below the front end. Below the rostrum there are two stalked eyes, one on each side and below the eyes are seen two pairs of Antennæ one pair on each side. These antennæ serve as sense organs.

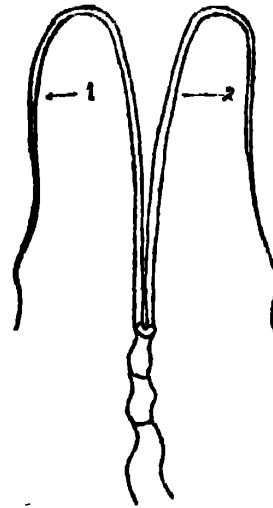
The genus *Palæmon* has carapace less than one-third of the length of the animal: rostrum long and armed above and below with a varying number of teeth. The first pair of legs small, slender and chelate; the second pair of legs also chelate, much larger than the former, the remaining pairs simple and clawed. The third maxilliped pediform. The gills consisting of three

epipodites, one podobranch, two arthrobranches and five pleurobranches.



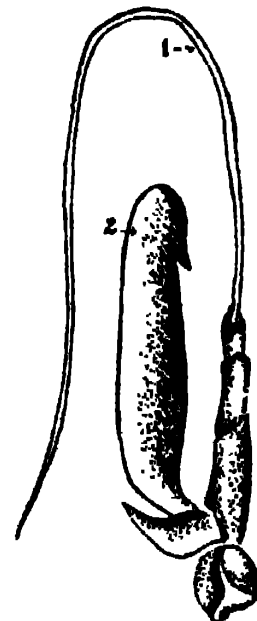
1—Coxopodite, 2—Basipodite,
3—Endopodite & Ischiopodite,
4—Meropodite, 5—Carpopodite,
6—Propodite, 7—Dactylo-
podite, 8—Chela.

1st Antenna
of Prawn.



1 & 2—Flagella.

2nd Antenna
of Prawn.



1—Flagellum,
2—Exopodite.

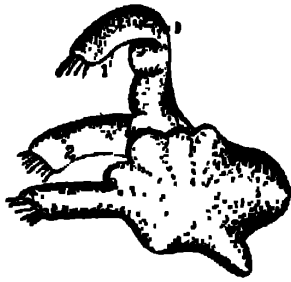
Appendages or limbs of prawn :

There are thirteen pairs of appendages in the Cephalothorax but some authors calculate the number as fourteen counting the stalked eyes as one pair. The abdominal part has six pairs of appendages. The hardened pieces of the exoskeleton are called the sclerites and the thin membrane connecting them at each junction is called arthrodial membrane. The appendages are of **biramous** type *i.e.*, more or less the ultimate portion is divisible into an Exopodite and an Endopodite at least in the larval condition. The total number of appendages is therefore nineteen excluding the stalked eyes and the telson which is not a segment. The first five segments form the head, the next eight thorax and the last six with telson abdomen. The third pair of Maxilliped show all the parts of a complete limb. Each has a basal part called Coxopodite above it, is the basipodite. The Coxopodite and the Basipodite together form the Protopodite. The Coxopodite bears on its outside a flat portion called the Epipodite bearing a fringed structure called the Gill. The base of the Epipodite bears a tufted knob called the Coxopoditic Setæ or Setobranch. The Basipodite bears a slender jointed structure on the outside called Exopodite and a stout five-jointed inner structure called Endopodite. The joints are named from the Basipodite as Ischiopodite, Meropodite, Carpopodite, Propodite, and Dactylopodite. The third maxilliped resembles a leg. The limbs are made on this plan but some part may be absent on account of the particular function it has to perform. The first two pairs of limbs are sensory which are used in search of food. The food consists of either living or dead organic matter. The next

six pairs are used as jaws and are found close to the mouth because they have to bring food to the mouth and also help in chewing. The five pairs of walking legs are used exclusively for walking. The first two pairs end in pincers or Chelæ and are called Chelipeds which are used for grasping or catching the prey. The third and fifth legs bear the openings of the Reproductive organs at their bases. The appendages of the Abdomen are six pairs of short legs used for swimming and hence are known as swimmerets. The Telson is used for making rapid backward strokes.

The first pair of appendages are known as **Antennules**. Here the protopodite is three jointed instead of two. The first joint bears on its upper side a slit edged with bristles, the **Statocyst**. The third joint bears two many-jointed flagellae or feelers. They are often compared to exopodite and Endopodite. The outer flagellum bears on its under side of joints peculiar bristles which are supposed to serve the sense of smell. The second pair of **antennae** bears the opening of the green gland or the Excretory organ at the base of the Coxopodite. The Basipodite is divided into two pieces. The Exopodite is a flat, triangular pointed scale while the Endopodite is a long flagellum. The third appendage is the pair of **mandibles**. The Coxopodite is a strong plate with toothed incisor edge which bites against the fellow on the other side of the body. Above the incisor edge and so hidden from ventral view is a broad irregular ridge called the molar process. In front of the Coxopodite, a three-jointed palp is formed by the Basipodite and an Endopodite. The mouth bears the two mandibles at the two sides. The fourth pair of appendages are the

first pair of maxillae or maxillulae. Each has three thin plates jointed to the basal piece. One plate is an expansion of the Coxopodite the second represents the basipodite and the third the Endopodite. The fifth limb



1st Maxilla.
1 & 2—Protopodite.



1st Maxilliped.
1—Exopodite,
2—Protopodite.



2nd Maxilla.
1—Scaphognathite,
2—Protopodite.

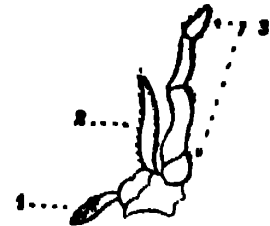
Mandible of Prawn.



1—Teeth,
2—Endopodite,
3—Protopodite.



2nd Maxilliped,
1—Podobranch,
2—Endopodite.
3—Protopodite.
4—Exopodite.



3rd Maxilliped,
3—Endopodite.
2—Exopodite.
1—Gill,

is the second pair of maxillae. It is deeply cut into several parts. The protopodite bears two thin lobes directed towards the middle line of the body and each in turn is divided into two. The Endopodite is a narrow structure directed forwards. The Exopodite is a wide plate directed forwards from the outer side of the limb and is known as Scaphognathite. The second Maxilla is situated in the front end of the Branchiostegite. The

function of the Scaphognathite is to drive the current of water over the gills and thus bathing the gills and driving the current forwards out of the Gill chamber. It serves as an accessory organ of respiration.

The sixth limb or the first pair of Maxillipeds belong to the thorax. It has two broad basal lobes called Coxopodite and basipodite, the Endopodite is small and unjointed and Exopodite is large and looks like the third Maxilliped. The Epipodite is present but does not bear the gill. The second pair of Maxilliped is almost like the third but the Endopodite is small and the

Fifth leg.



- 1—Coxopodite,
- 2—Basi,
- 3—Ischio,
- 4—Mero,
- 5—Carpo,
- 6—Pro,
- 7—Dactylo-
podites.

Exopodite is relatively large. It bears a gill. The third has been already described. Then comes the five pairs of walking legs or Pereipoda.

The first two pairs bear pincers and are called Chelipeds. Each of the legs shows a five jointed Endopodite and the exopodite is wanting. The four pairs of legs bear gills on the Epipodite but the fifth pair do not bear any gill. The leg has the following parts from the base :—

- (1) Coxopodite, (2) Basipodite, (3) Ischiopodite,
- (4) Meropodite, (5) Carpopodite, (6) Propodite and (7) Dactylopodite.

The opening of the female reproductive organ is at the base of the 3rd leg through which the eggs are laid. There is a similar opening at the base of the 5th pair of legs through which the sperms are shed from the male generative organ.

The abdominal appendages are the **pleopods** or **swimmerets**. Each has a short Coxopodite, a long Basipodite and an Endopodite and Exopodite, each having imperfectly separated joints. The Endopodite is larger than the Exopodite and both bear bristles. In the male the first joint of the Endopodite bears a rolled up scroll. The sixth abdominal pair of appendages are very large. The protopodite is short and the exopodites and endopodites are very broad. They form with the telson the tailfin used for hasty jerks in swimming. The base of each leg is attached to the body by arthrodial membrane.

Outer Epidermis and Cuticle of Prawn :

The Epidermis of prawn is a layer of protoplasm with many nuclei but columnar Epithelium generally occurs with syncytium or undifferentiated at places. The Epidermis secretes a cuticle on the outside which becomes hard due to the deposit of lime salts and remains thin at the joints to allow movements of the body. The hard cuticle forms the Exoskeleton of the body. The animal sheds off the cuticle from time to

time and a new one is secreted. This is called Moulting or Ecdysis of Prawn. The basis of cuticle is chitin which is a compound of ammonia. The animal gets rid of nitrogenous waste material through this cuticle. When the animal is leaving the old cuticle a split appears on the back and along the limbs and the animal escapes from this old cuticle. In the meantime the animal has to hide itself because the new cuticle takes several days to harden. The male generally moults twice a year and the female once a year.

Skeletal and Muscular System :

The animal has an outer skeleton of thick and hard cuticle. The thorax portion has an internal skeleton in the form of hard ingrowths of cuticle. This is called Endophragmal skeleton.

The movement of the body is carried on by various striped muscle fibres. There is no continuous muscular layer. There are two sets of muscles for the movement of the abdomen. One is the extensor system beginning from below the carapace and continued along the base of the terga. The contraction of these muscles straighten the abdomen. There is another set of more powerful muscles on the ventral side attached to the sterna and Endophragmal skeleton. These by their contraction bring together the sterna and thus contract the abdomen. By these muscular movements jerks are produced and the animal escapes from its enemies. Its gentle movements are carried out by the walking legs and the padding of the abdominal swimmerets.

Appendages and Segments of Prawn.

Head	1.	First pair of antennules	Sensory limbs.
	2.	Second „ „ antennæ	
	3.	Mandibles	
	4.	First pair of Maxillae	
	5.	Second „ „ „	
Thorax	6.	First pair of Maxillipeds	Jaws.
	7.	Second „ „ „	
	8.	Third „ „ „	
	9.	First pair of legs	Legs.
	10.	Second „ „ „	
	11.	Third „ „ „ — (Female)	
	12.	Fourth „ „ „	
	13.	Fifth „ „ „ — (Male)	
Abdomen	14.	Abdominal limb	Swimmerets.
	15.	„ „	
	16.	„ „	
	17.	„ „	
	18.	„ „	
	19.	Telson & „ Tail fin.	

Body cavity :

The body cavity or the perivisceral cavity of prawn is large and the organs lie in it. This is **haemocoel** because the blood vascular system comes in contact with this cavity. It is not a cœlome.

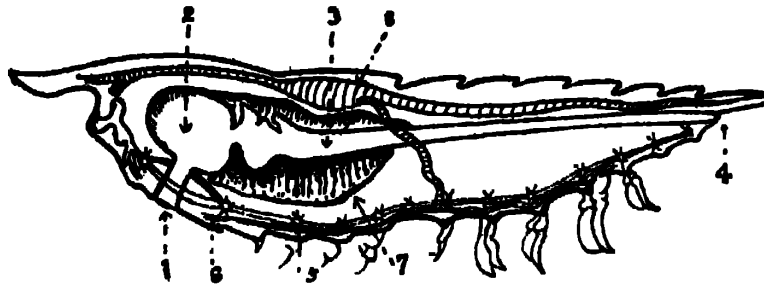
Alimentary system :

The alimentary canal is derived from three regions in the embryo, the stomodaeum, the mesenteron and the proctodaeum. The stomodaeum develops into the foregut consisting of the buccal cavity, the oesophagus and the stomach; the mesenteron forms the adult midgut and the hepato-pancreas while the proctodaeum develops into the hindgut. The foregut and the hindgut have an internal lining of cuticle continuous with the cuticular

covering of the integument but the long midgut has a soft endodermal lining.

The mouth is a wide aperture situated on the ventral side of the Cephalothorax. It is bounded in front by a wide upper lip or Labrum and behind by a pair of lower lips or Metastoma. There is a short œsophagus or gullet which leads into the stomach or Proventriculus. This stomach has two chambers, a large front part or Mill chamber often called the "Cardiac division" of the stomach, and a smaller hind part or "Filter chamber," often called "Pyloric division" of the stomach, separated from the mill chamber by a pit in the roof. (Two large plates are found in the two divisions of the stomach and are known as Cardiac and Pyloric Ossicles. Embedded in the floor of the cardiac stomach lies a large triangular cuticular plate called the **hastate plate** on account of its resemblance to the head of a spear. They are joined in the middle by two smaller pieces called Urocardiac and Prepyloric ossicles. The forked middle tooth projects from the prepyloric ossicle. At each side of the pit the cardiac and pyloric ossicles are connected by two more pieces the Zygo-cardiac ossicle and the Pterocardiac ossicle. The cardiac stomach is generally found filled with semi-solid food. In a living prawn the expansion and contraction of the stomach, allows the food to mix up with the hepatopancreatic secretion and thus the food is digested. There is no gastric mill in cardiac stomach. The filter chamber leads into the short midgut or Mesenteron. The mid-gut is followed by the almost straight hindgut or intestine. The filter-chamber has many ridges covered with bristles which serve to strain out the particles of food so that

only fine food enters the midgut. On each side of the midgut the Liver or Hepatopancreas opens. The Hepatopancreas is a large lobed yellow gland consisting of numerous short tubes which open by ducts on each side of the digestive gland. The food is either raked up by the third maxilliped or torn to pieces by the Chelipeds and then passed into the mouth by the jaws. The mandibles cut the food into small pieces and then send to the proventriculus. Then the food passes to the midgut where with the digestive fluid from the gland



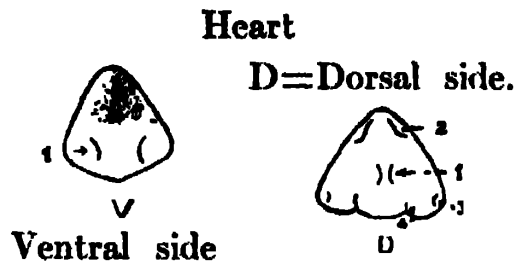
L. S. of prawn

- | | | |
|----------|--------------------|-------------------|
| 1—Mouth, | 2—Stomach, | 3—Intestine, |
| 4—Anus, | 5—Nerve cord, | 6—Ventral vessel, |
| | 7—Digestive gland, | 8—Heart. |

digestion and absorption take place. The filtrate from the food passes backwards into the hepatopancreatic ducts, while the refuse over the filter consisting of larger particles of undigested or indigestible food is pushed upwards into the dorsal chamber of the pyloric stomach, whence it is pressed backwards into the midgut. The hindgut has a swelling near about the anus. The hepatopancreas or the so-called liver is a massive compact organ, orange-red in colour consisting of two lobes. The large bulk lies behind the cardiac stomach but a part of it lies around the floor and sides of the stomach. Dorsally it is covered by reproductive organs and heart. The intestine leads to the anus which opens below the telson,

Vascular system :

The Heart is a triangular (on surface-view) hollow organ on the dorsal side of the animal with muscular walls. It is situated in the thorax within a space called



1=Ostia

Pericardial Sinus. Five pairs of openings called Ostia are found on the heart through which the cavity of the Heart communicates with the pericardium. The ostia are guarded by valves, which allow the blood to enter the Heart from the pericardial sac but not otherwise. The Ostia are situated in the following way :—

- (1) One pair is seen on the ventral side of the heart.
- (2) Second pair is found on the outer sides of the dorsal surface.
- (3) Third pair occurs dorsally close to each other in the middle line.
- (4) Fourth pair is seen dorsally at the posterior border of the heart.
- (5) Fifth pair is at the outer angles of the posterior border.

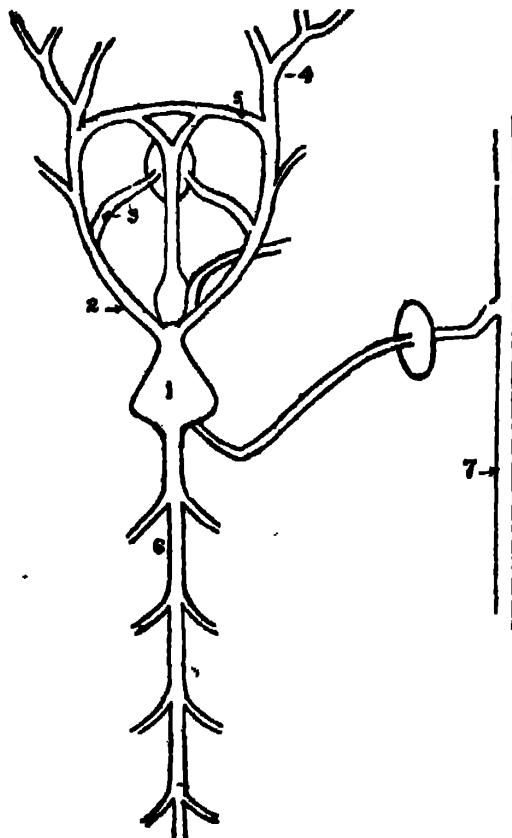
Arteries and veins :

Blood vessels which are sent from the heart to different parts of the body are called Arteries. They

carry pure oxygenated blood to the different parts of the body. Blood vessels which bring blood from various parts of the body to the Heart are called Veins. They carry impure blood.

Blood vessels of prawn :

The heart receives all its blood from the pericardial sinus. When the heart contracts, it pumps out all its blood into the arteries which have strong muscular walls.



- 1—Heart, 2—Antennary, 3—Hepatic,
 4—Antennary, 5—Anastomosis,
 6—Dorsal Abdominal, 7—Ventral Abdominal.

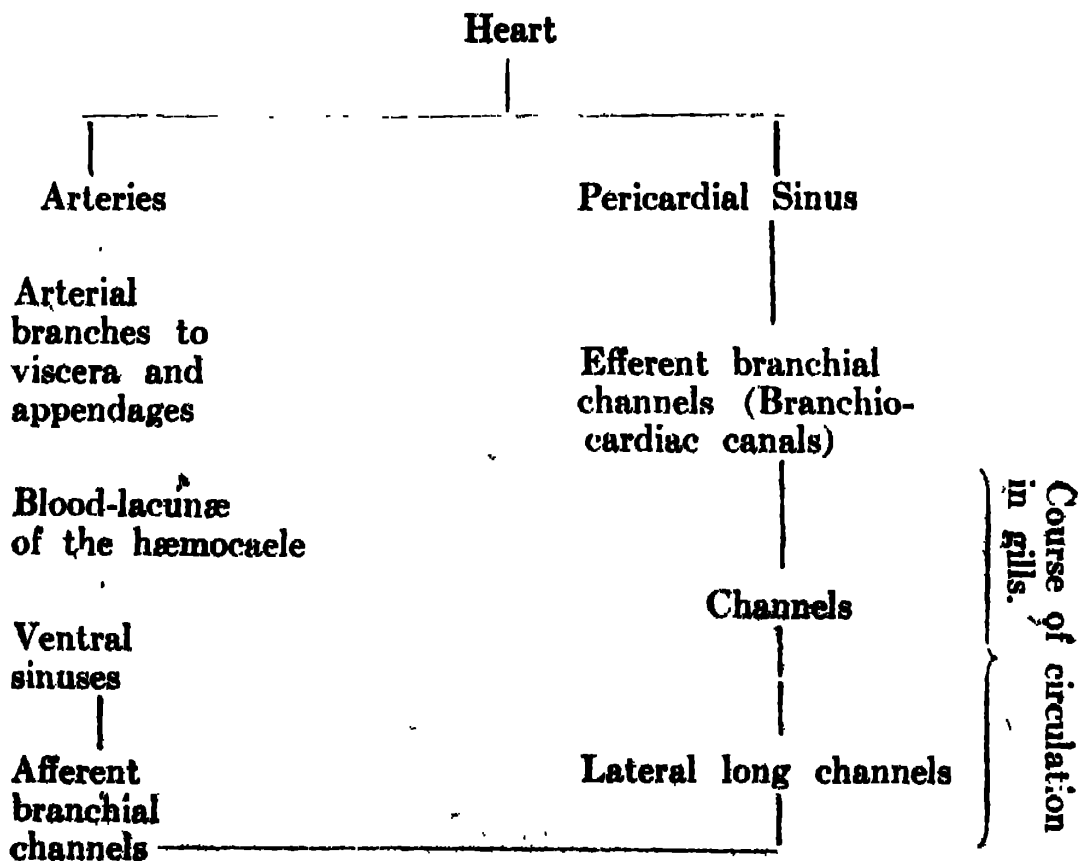
Three blood vessels arise from the front end of the Heart—a median Ophthalmic artery which runs forwards over the stomach and joins the antennary

arteries. Two antennary arteries run forwards on the two sides of the ophthalmic artery. Each antennary artery divides into three branches, (1) a pericardial branch; (2) gastric branch and (3) a mandibular branch supplying blood to the pericardial sinus, the cardiac stomach and the mandibular muscles respectively. After giving off these branches, each antennary artery divides into a dorsal and a ventral branch. The dorsal branch gives an optic artery to the eye and the ventral branch supplies the antennule and the antenna. Below the antennary arteries are given off two Hepatic arteries which supply the Liver. The hinder portion of the Heart gives off a vessel which at once divides into a (1) Supraintestinal artery which runs below and is situated above the intestine and supplies the muscles of the intestine and (2) a sternal artery which goes through an opening in the ventral nerve cord in the ventral part and divides into a Ventral Abdominal and a Ventral Thoracic artery by which the limbs are supplied. The blood vessels branch minutely but there are no capillaries. Ultimately the branches open into Sinuses and thus the Blood vascular system comes in direct contact with the body cavity, for which it is known as Hæmocoel. The largest of these is the Perivisceral Cavity. The blood from the limbs and to a great extent from the perivisceral cavity collects in a sternal sinus which lies in a space formed by the Endophragmal skeleton which contains the ventral Nerve cord and the Ventral blood vessel. The blood is carried from this sinus by afferent branchial sinuses for oxygenation in the Gills. After oxygenation pure blood passes by Efferent branchial sinuses to the pericardial sinus from which it enters the heart and becomes distributed by various

vessels. Part of the blood around the stomach passes by a vessel from the branchio-stegite to the pericardial sinus. The vascular system of the Prawn is said to be open.

The blood of Prawn is a clear fluid which contains white corpuscles and coagulates readily which is an advantage for an animal having open vascular system. Hæmocyanin an organic compound of copper plays the same part as Hæmoglobin of higher animals. It takes up the oxygen in the respiratory organs and gives it off to the tissues. In the oxidised condition it tinges the blood blue but colourless when deoxidised.

The course of circulation of blood in palaemon.



The blood-sinuses and the blood-channels :

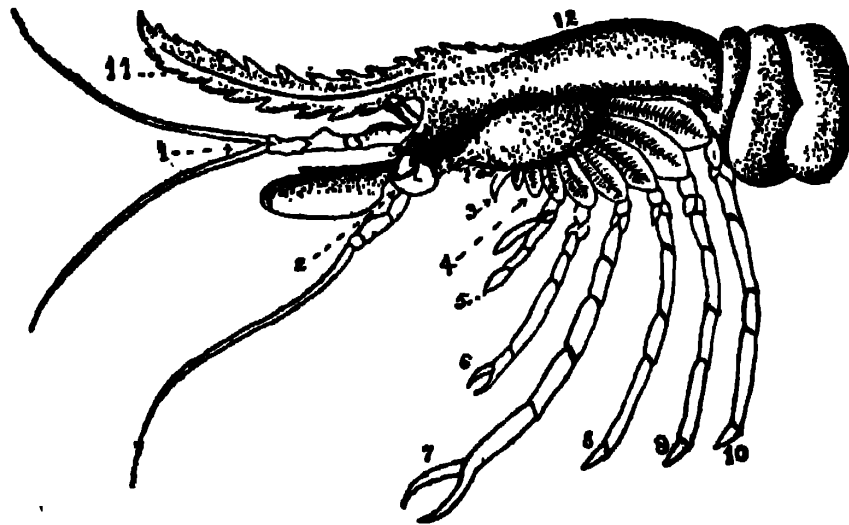
The blood in the various organs of the body flows through a network of hæmocoelic lacunae or sinuses distributed throughout the body and is finally received into a pair of ventral sinuses which are situated below the hepatopancreas and the flexor muscles of the thorax. These two adjacent ventral sinuses communicate with each other. These sinuses are protected ventrally by the sterna and the endophragmal skeleton.

From the ventral sinuses blood is carried to the gills on each side by six definite channels called the **Afferent branchial channels**. These channels are also lacunar in character. Of the branchial channels, the last five send blood to the pleurobranchs while the first channel supplies the two arthrobranchs and possibly to the podobranch. In the gills the blood circulates and is aerated. The aerated or oxygenated blood returns to the pericardial sinus through the six pairs of **efferent branchial channels** (branchio-cardiac canals). It is seen that the afferent and efferent channels pierce the wall of the thorax one above the other and therefore, on removal of a gill, two openings are exposed at the root of each gill.

Respiratory System : 1951

The respiratory organs of the prawn consist of the lining of the carapace, three pairs of epipodites, and eight pairs of gills or branchiae, all of which are situated in the large but compressed gill-chambers, one on each side of the thorax. Each gill-chamber is enclosed between the branchiostegite on the outer side and the wall of the thorax on the inner and is in communication with the exterior along its anterior, ventral and posterior borders but is closed along its dorsal aspect. The thin inner lining of the branchiostegite contains blood-lacunae and is constantly bathed in fresh water, thus forming a respiratory surface.

The respiratory system consists of eight Gills on each side which lie inside the Gill Chamber. The gill chamber is bounded on the out-side by the Branchiostegite and by fused Epimera of the cephalo-thoracic segments on the inside. The chamber is open in front, below and behind. A current is produced by the scaphognathite



1—1st antenna, 2—2nd antenna, 3—Scaphognathite, 4—Gill, 5—3rd maxilliped, 6 to 10—Legs, 11—Rostrum, 12—Carapace.

within the branchial chamber. The gills are of three different names according to their position. When a gill is attached to the basal podomere (coxa) of an appendage, it is known as a **podobranch**; when attached to the arthrodial membrane connecting the appendage to the body, it is called an **arthrobranch**; but when it is attached to the lateral wall of the segment to which the appendage belongs, the gill is called a **pleurobranch**. Starting from the anterior end, we find that the first maxilliped bears no gill but only a bilobed epipodite. The second maxilliped bears both a podobranch and a small epipodite. The third maxilliped bears two arthrobranches and a small epipodite. Gills of the segments of

the five walking legs, are five pleurobranchs. The first gill is a podobranch being attached to the base of the second maxilliped. The second and third gills are arthrobranchs being attached to the arthrodial membrane of the third maxilliped. The remaining five gills are pleurobranchs.

The epipodites are simple leaf-like plates attached to the coxal joints of the three maxillipeds and each outgrowth of the epipodite forms a simple primitive type of gill. The epipodites lie in the anterior part of the gill-chamber below the scaphognathite; of the eight gills, seven are exposed on removal of the gill-cover but the eighth lies hidden beneath the dorsal part of the second gill.

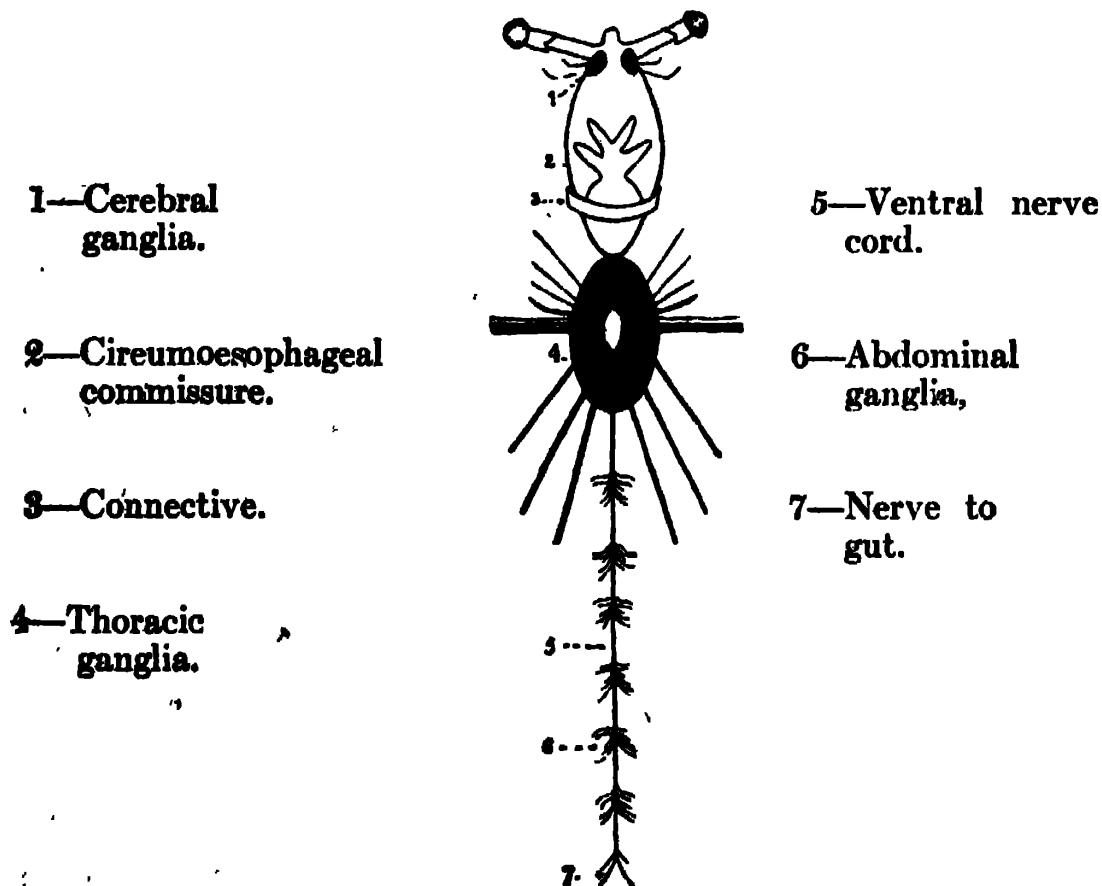
The gills are thin walled and each gill consists of numerous delicate plates arranged like the leaves of a book. The plates have a stout axis. The gill axis is attached to the side of the animal. The axis carries an Afferent vessel and an Efferent vessel. The thin-walled gill exchanges CO_2 and takes up oxygen from the current of water and thus the blood becomes oxygenated. The scaphognathite keeps vibrating incessantly so as to produce a continuous current of water flowing through the gill-chamber. Water enters the gill-chamber along the posterior and ventral margins of the branchiostegite; it then passes over the gills and reaches the antero-dorsal depression of the gill-chamber, wherefrom it is expelled out at the anterior end by the baling action of the scaphognathite. The vibratory movements of the scaphognathite are supplemented by the movements of the whip-like exopodites of the maxillipeds which whisk away from the sides of the animal the water which the scaphog-

nathite has baled out. The gill-chamber containing the epipodites and gills and the lining of the carapace are thus constantly being bathed in a current of fresh water.

Excretory System :

The excretory organs of the crustacea comprise two pairs of glands: (a) the antennary glands opening at the bases of the antennæ and (b) the maxillary glands

Nervous system of prawn.



opening at the bases of the maxillae. Both types of glands do not function at the same time; as a rule, one succeeds

the other. In Decapoda like prawn, the maxillary glands form the larval kidneys while the antennary glands form the functional kidneys of the adult. The kidneys of the adult prawn are a pair of antennary glands.

The Excretory organs are also known as Green glands. The glands are situated in the Head and their ducts open at the base of the second antennæ. Each renal gland consists of a single much coiled tubule with connective tissue. The renal branch of the Antennary artery comes in contact with the Renal tubule. The blood gets rid of the nitrogenous waste products in the cells of the Renal tubule. There is a dorsal Renal sac which lies dorsal to the stomach and below the carapace. The sac contains fluid and is connected with the Reproductive organs. There are two ducts from the Dorsal Renal sac which pass to the ventral side and open into the Renal saccules, one on each side. The saccules are situated on the inner side of the Renal glands. The saccules send two ducts to the excretory apertures of the two sides.

Besides the antennary glands, the integument is believed to be an important organ of excretion.

Nervous System :

The nervous system resembles the nervous system of the Leech. The Brain or cerebral Ganglion or supra-oesophageal Ganglion is situated between the green glands. It gives off nerves to the Eyes and the Antennæ. It sends below two circumoesophageal Commisures to join behind the oesophagus. Below it, is the Thoracic Ganglion supplying the third Maxillipeds. Here the fusion of

ganglia has taken place forming thoracic ganglionic mass. In the circumoesophageal commissures a loop is formed by the fine nerve cords round the œsophagus. This is known as Postoesophageal loop. The Thoracic ganglionic mass is perforated by the sternal artery. It supplies nerves to all the appendages of the cephalothorax. The thoracic ganglionic mass gives rise to a double ventral nerve cord. This cord has six ganglionic swellings corresponding to six segments. Each ganglion gives rise to nerves which supply the muscles. The sixth ganglion supplies the sixth segment and the telson.

The nervous system therefore consists of: (a) a pair of supraoesophageal ganglia or the brain connected by (b) a pair of circumoesophageal commissures with (c) a ventral nerve-chain of paired ganglia lying in the mid-ventral line along the whole length of the body of the prawn and (d) the visceral nervous system consists of a number of small ganglia in connection with the œsophagus and the stomach.

Sense Organs :

The setæ or hairs distributed all over the body may have the function of tactile organs. The sensitiveness of the Antennæ, serves the animal to search for food.

Organs of smell or Olfactory organs :—

The setæ on the outer flagellum of the first antennule may have the function of smell.

Eyes or sense of sight :—

There are two stalked compound Eyes. Each eye is compound i.e. consists of a large number of simple

visual elements called ommatidia or ocelli. Each Eye has a number of elements called Ommatidia. The Eye is black owing to pigments in some of its cells. It is covered with a colourless portion of the cuticle called Cornea which is divided into a number of square facets, each of which corresponds to an ommatidium. Each ommatidium has a complex structure. Each is an elongated body consisting of a number of cells derived from the Epidermis with refractive bodies secreted by them. Beneath the corneal facet lying at the surface of the eye are situated a pair of corneagen cells which secrete a new cornea when the old one is discarded during ecdysis. Beneath the corneagen cells lie tall cells called the cone-cells or vitellae. These cells surround the crystalline cone. Beneath the crystalline cone lies the rhabdome which is surrounded by reticular cells. The rhabdome and the reticular cells together form the receptor or retinal part of the ommatidium. The innermost cells form a group called Retinula whose inner ends are continued into nerve fibres. It is regarded that a mosaic of images is combined in the nervous system to give a single impression of objects seen by the prawn.

Statocyst or Otocyst or organ of Hearing :—

These are a pair of sacs at the base of the first antennules and are connected with nerves. The sac has a lining of hairs which are connected to the nerves. The sacs are filled with sand grains. This organ is a balancing apparatus of the animal. The sand grains move against the hairs and the direction of the body is perceived through them. Formerly the organ was regarded as an organ of hearing but recently experiments carried on with moulting prawn disprove the former idea.

Iron grains were placed inside the sac and a magnet attracted the iron grains which changed the direction of the animal and proved their balancing power. The statocysts have been shown to be organs for perceiving the direction of the force of gravity.

Reproductive System :

The sexes are separate. These organs lie above the gut and below the pericardium. The organs in both sexes have lobes. Two ducts open to the base of the third and fifth thoracic legs (Maxillipeds). The females are smaller than the males of the same age.

Male :

The testes are two in number and the anterior portion is attached to the renal sac in front. The Vasa Deferentia or sperm ducts are much coiled tubes beginning from the testes and ending by a shorter portion at the base of the fifth legs. Each spermatozoon has a cup-like body and a stiff tail. The testes fuse at the anterior part but are free posteriorly. The end of the vas deferens is dilated and forms vesicula seminalis.

Female :

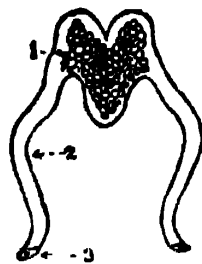
There are two ovaries which lie near the Renal sac. Ova are produced within them. The two ducts from the ovaries are short and open at the base of the third thoracic leg. The ova are large, each with a nucleus and plenty of yolk material.

Development :

Generally pairing takes place in september and October *i.e.* just after the rains. After the ovum is fertilised it is held fast in the swimmerets. Segmentation takes place there and a larva hatches out which is called

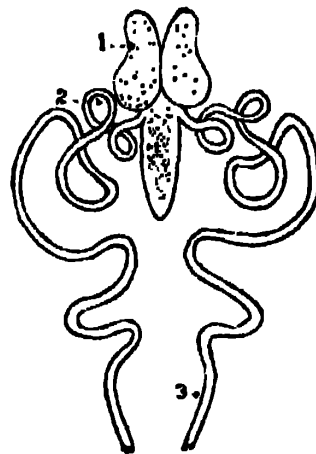
the Zoea larva. The larva moults several times until the adult form is reached. This is called the Metamorphosis of Prawn. The hard covering is shed from time to time to make room for growth taking place in the

Ovary of prawn.



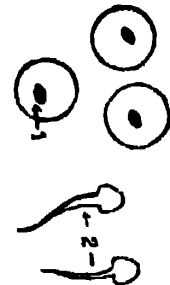
1—Ovary.
2—Oviduct.
3—Opening.

Tests of prawn.



1—Testis.
2—Vasdeferens.
3—Opening and last part.

Sperms and ova of prawn.



1—Ovum.
2—Sperm.

meantime. The Zoea has a cephalo-thorax and a segmented abdomen. The appendages of the cephalo-thorax are all biramous and have two pairs of antennæ, one pair of mandibles, two pairs of maxillæ, three pairs of maxillipeds, three pairs of thoracic legs. The abdomen has no appendage. The carapace has a small rostrum. There is one median Eye called Nauplius Eye in addition to the pair of compound Eyes. After several moults the Zoea becomes a Schizopod or Mysis. It differs from the Zoea in that two or more thoracic appendages appear. The Mysis moults several times and reaches the adult or prawn stage. Several modifications occur in the cephalothoracic appendages, the nauplius Eye is lost and the abdominal appendages appear.

Regeneration :

Prawn can reconstruct a lost limb by regeneration. This is helpful because the animal can escape from its enemy by leaving the limb. This power of regeneration is known as Autotomy. When the leg is separated blood clots the injured part and gradually the limb grows with each moult.

Bhetki :

The fish is scientifically known as *Lates Calcarifer*. The name of each animal or plant in Biology has two parts. The first part refers to the **Genus** and the second part refers to the **Species** to which the animal belongs. This is known as Binomial Nomenclature. The great Biologist Linnaeus first found out the value of such nomenclature and promulgated it.

The animal is a type of Chordata and specially of Vertebrata. The higher animals all have a structure called Notochord which is generally dorsal in position. There are some lower Chordates where the Notochord is either rudimentary or confined to the larval condition before the attainment of the adult structure *e.g.*, *Balanoglossus*, *Ascidian* etc. The "Bhetki" has a vertebral column which is derived from the Notochord. The case of the notochord is replaced by a bony column called the Vertebral column and hence the name Vertebrata. Therefore the presence of vertebral column is a characteristic feature of the vertebrata which is generally dorsal in position. The second characteristic is the presence of openings in the back of the throat called Gill slits. These Gills are richly provided with blood vessels in the Bhetki and help the animal in carrying on

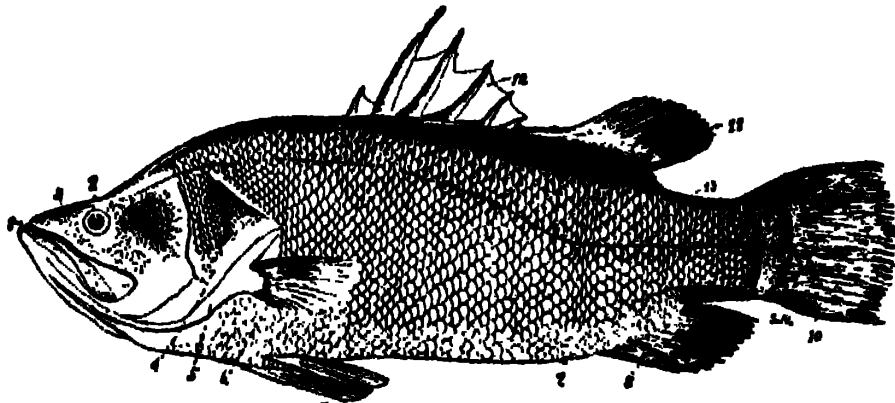
the process of respiration but in the more advanced groups like the Guineaping or man the clefts are only present during the developmental stages of the foetus and are absent in adults. The third characteristic is the presence of the Brain and the spinal cord in the form of a tube. The fourth characteristic is the presence of a Cœlome and a Heart which is ventral in position.

Habitat :

The fish Bhetki occurs in the saline estuaries of Bengal. It is used largely by the inhabitants as an article of food. The size varies from four inches to four feet in length.

External Characters :

The fish has a head, trunk and a tail. There is no neck. There is a distinct line visible on each side of the animal (which is flat from side to side) which is known as the Lateral line provided with



- 1—Mouth, 2—Eye, 3—Nostril, 4—Operculum, 5—Branchio-Stegal membrane, 6—Pectoral fin, 7—Pelvic fin, 8—Anal fin, 9—Anus etc., 10—Caudal fin, 11—Dorsal fin No. 2, 12—D. fin No. 1, 13—Lateral line.

sense organs extending from head to tail. The whole body is covered with scales. The scales are covered by the epidermis which secretes a slimy mucus which,

makes the animal difficult for a catch with hand. There are a pair of nostrils on each side. There are two eyes but they are not provided with an eyelid but a transparent membrane covers each eye which is called **Nictitating membrane**. There is a large mouth inside which palatine teeth are found when the mouth is opened. On the roof of the mouth is a double row of vomerine teeth. There is a large tongue which forms the floor of the mouth. The region from the mouth to the **Operculum** is known as the **Head**. The trunk extends from the **Operculum** to the anus and the region behind the anus is the tail.

Apertures of Bhetki :

(1) The mouth is large and terminal.

(2) Double nostrils on each side *i.e.*, each Olfactory sac has two apertures externally, the anterior one is provided with a flap-like valve.

(3) The gill-chamber has a bony covering called **Operculum** which shelters the gills or respiratory organs of each side. The operculum is continued into a slimy membrane supported by bony rays called respectively **Branchiostegal membrane** and **Branchiostegal rays**.

(4) At the posterior ventral side near the anal fin there is a slight depression of the skin having three apertures called the **Anus** in front, **Genital** in the middle and **Urinary** behind.

Fins :

The appendages of the fish are called the **fins**.

Some are unpaired (single) and median while the others are paired and lateral. They are :—

- (1) **Dorsal fin**, median and unpaired.
- (2) **Posterior Dorsal fin**, median and unpaired.
- (3) **Caudal fin or tail**. It is of the homocercal type *i.e.*, symmetrical in form. It is the chief organ of locomotion.
- (4) **Single Anal fin** behind the Anus.
- (5) **Paired Pectoral fins** just close to the Gill opening.
- (6) **Paired Pelvic fins** on the ventral side of the animal.

Muscles of the Body :

The muscles are known as Myotomes or Myomeres. These are arranged segmentally on the two sides of the body. There are two sets of such muscles one below the other separated by the lateral line. The muscle segments are V-shaped and each segment is connected with the other by connective tissue.

There are some other muscles which are used for controlling the fins. These muscles are voluntary.

Coelome :

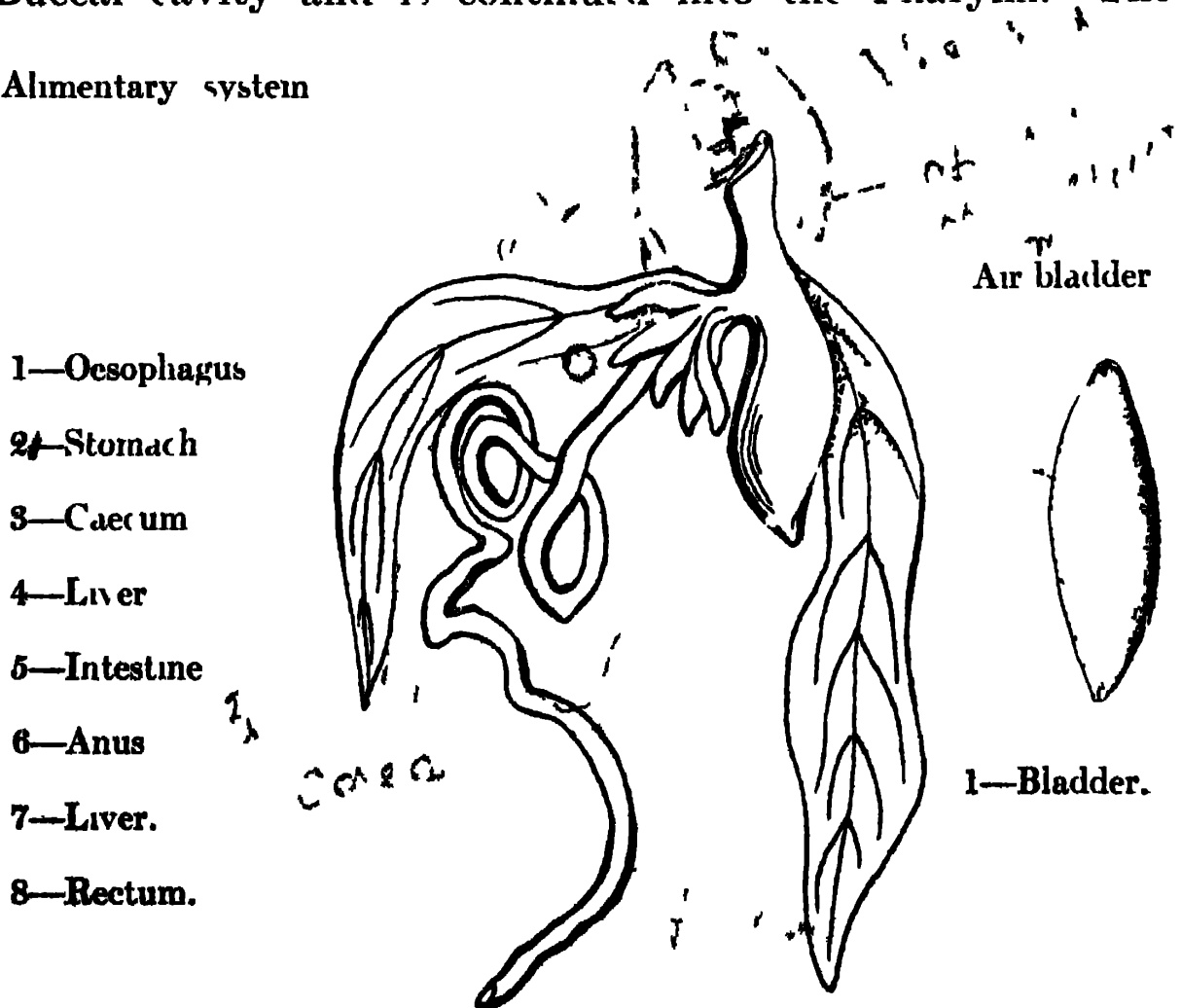
The body cavity is called the Coelome. The largest cavity is the abdominal cavity containing the abdominal organs. There is another cavity called the Pericardial cavity, containing the Heart. The abdominal cavity is lined by a layer of Epithelium called Peritoneum. The layer covering the organ or organs is called the Visceral

layer, while the layer which lines the wall of the body-cavity is called the Parietal layer. The two layers *viz.*, visceral layer and parietal layer form a continuous layer on the dorsal side below the spinal column which is known as the Mesentery. This is used to hold the abdominal organs in position.

Alimentary System :

The mouth is wide and leads into a part called the Buccal cavity and is continued into the Pharynx. The

Alimentary system



Pharynx is perforated on each side by four apertures called Gill-slits. The Pharynx is followed by a short oesophagus which opens into the elongated stomach.

There are both palatine and vomerine teeth. They are mainly used for preventing the food from slipping out of the mouth. They are not implanted in sockets and are not used for cutting or chewing.

The stomach has two ends. The end towards the pharynx is called the cardiac end. The other end from which the intestine begins is called the Pyloric end. The pyloric end has a number (5) of blind pouches called **Pyloric caeca**. The pyloric end is provided with a valve called Pyloric Valve. The pyloric caeca open into the first part of the intestine. The intestine is a much coiled tube which ends in the Rectum. The Rectum opens by an aperture called Anus. There is no distinct Pancreas. The coils of the intestine are richly laden with fat and they are kept in position by the mesentery. (The rectum is not clearly distinguishable).

The Liver has two long lobes and a small and has a gall bladder. The spleen lies on one side of the intestine.

Swim-Bladder :

There is a thin sac just behind the alimentary canal and in front of the Vertebral column. This is called the Air-Bladder or Swim-Bladder. The bladder has two lobes called the anterior and posterior lobes. The air-bladder is a hydrostatic organ *i.e.*, it functions as a float *viz.*, it renders the fish bulk for bulk of the same weight as the water in which it lives that is, it gives buoyancy to the fish according to various depths of water. It arises as a diverticulum of the alimentary canal.

Functions of the Air-bladder :

" (1) The most important function of the air-bladder is hydrostatic *i.e.*, it acts as a float for the fish as already explained.

(2) It acts as an accessory respiratory organ in some fish.

(3) It acts as a sound producing organ by the vibratory movements in the gases contained inside the organ due to the rapid contraction of the muscles associated with the walls of the air-bladder.

(4) It serves as an accessory organ of hearing in some fish.

The gases contained in the air-bladder are oxygen 65%, nitrogen 30% and CO₂ 5 %.

Heart and Vascular System :

The heart of Bhetki consists of a sinus Venosus, an auricle and a ventricle. The heart lies within a sac called Pericardium.

The Sinus Venosus is a thin-walled sac lying posteriorly and receives the impure or venous blood of the body from the Anterior and Posterior veins.

The Auricle is placed ventrally to the sinus venosus. The blood is directed by valves from the sinus venosus to the Auricle and not otherwise. The auricle has thin walls.

The Ventricle is thick-walled. Its contraction forces the blood into the ventral Aorta. The aperture between the auricle and the ventricle is guarded by valves and

Systemic veins bring blood directly to the Heart. Portal veins have to bring the blood through some intermediate structure. The Afferent Branchial Arteries although they have been included under Arteries may be described as real veins as they carry impure blood to the Gills for oxygenation.

There are two principal veins in the anterior part of the animal bringing blood from the head region called Anterior Cardinal Veins. The two veins coming from the lower portion are known as Posterior Cardinal Veins. The Anterior and Posterior Cardinals of each side unite to form a common vessel called Precaval Vein or Ductus Cuvieri before opening into the sinus Venosus. There are two veins also coming from the Liver to the sinus venosus called Hepatic Veins. The right posterior cardinal is a continuous vein from the tail region. The right posterior cardinal lies ventrally to the kidney. These are all systemic veins.

Portal Veins :

There is a Renal portal system. Blood from the region of the tail is collected by the Caudal Vein lying along side the Caudal artery. Before entering the kidney the Caudal vein divides into two Renal portal veins lying on the back portion of the kidney. The right Renal portal vein is continuous with the right posterior Cardinal vein. The left Renal portal vein is broken down into capillaries and then the left posterior cardinal vein is formed by a number of small veins from the substance of the kidney.

Hepatic Portal System :

The hepatic portal system is formed by a number of veins bringing venous blood from stomach, intestine, and rectum, and enters the Liver by a single vein called Hepatic portal vein. There is a system of capillaries in the Liver and ultimately the blood passes to the sinus Venosus by two Hepatic Veins.

Blood :

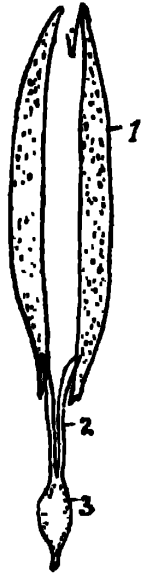
The blood of Bhetki consists of a liquid portion called the Plasma, and two kinds of corpuscles float in it. There are white blood corpuscles and red blood corpuscles. The white ones are nucleated and amœboid. The red cells are oval nucleated and contain a red pigment called Hæmoglobin.

Circulation :

Venous blood of the body enters the Heart through the two precaval veins. From the sinus Venosus, the blood passes to the Auricle, then to the ventricle and by means of the ventral aorta to the Gills for purification. After oxygenation pure blood is supplied by the Cephalic arch and the Dorsal Aorta to the different parts of the body. There is a system of capillaries by which the arterics communicate with the veins. The arterial blood after ramifying in the tissues by fine branches becomes impure and then enters the capillaries and then goes to the veins; thus a continuous channel is established. The contraction of the Heart pumps the blood to different parts of the body. The cycle is repeated all the time the animal is alive.

Excretory System :

There are two elongated kidneys, which begin almost below the Gill arches and extend to the end of the abdominal cavity. They are the second step in the



1—Kidney,
2—Ureter,
3—Bladder.



1—Gill arch,
2—Gill filament.

development of the kidneys and are known as Mesonephros. The surface of the kidney is perforated by fine apertures through which the kidneys have communication with the peritoneal cavity. The two kidneys are almost fused in the middle line. Each kidney has a passage beginning near the middle, passing downwards joins up to form the Urinary Bladder. The urinary bladder opens by an aperture to discharge the waste products of the body. The kidneys lie just on the ventral side of the vertebral column.

Respiratory System :

The respiratory organs of the fish Bhetki are the gills. They lie in a chamber which is covered externally by a

plate of bony structure called Operculum. The operculum consists of four bones called Operculum, Pre-operculum, Inter-operculum and Sub-operculum. The bones are moved by muscles. There is a membrane behind and below the operculum which is called the Branchiostegal membrane which can perfectly close the chamber. This bony mechanism is always opening and closing to drive out the incoming water from the mouth during the whole life time of the animal. The Gills are placed on four Gill arches separated by five Gill clefts. The Gill chamber opens internally into the Pharynx. Each Gill has two book-like folds consisting of a number of Gill filaments. The arches carry the afferent and efferent vessels. The filaments are richly supplied with fine blood vessels called Capillaries.

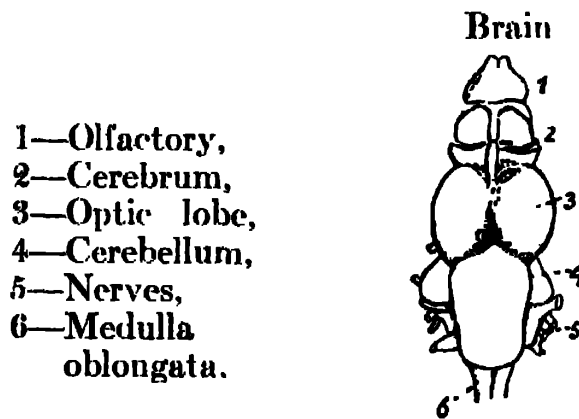
Mechanism of Respiration :

The water enters the mouth of the fish and passes through the Gill clefts to the Gill chamber which drives the water out by lifting the Operculum. The process of respiration consists of two different actions *viz.*, Inspiration or the taking in of water and expiration or driving out of water. During inspiration the water enters the mouth and while passing through the clefts the water washes the gill filaments when oxygen is supplied to the blood inside the capillaries there. This oxygen of course comes dissolved in the water. The waste product in the form of CO_2 is exchanged for it almost simultaneously and the CO_2 passes out dissolved in water. The Hyoid arch is retracted when the mouth is opened in taking food or in inspiration and at the same time the Gill aperture is closed. But the Gill aperture opens when

swallowing food and at the same time the Hyoid arch is brought forward.

Brain and Nervous System :

The Brain consists of two Olfactory lobes in front. The cerebrum lies below them. The cerebrum consists of two hemispheres having a longitudinal fissure between them. The thalamencephalon comes next and is partly covered by the Cerebrum. On the ventral aspect is the Infundibulum to which is attached the Pituitary body. In the dorsal side is the minute Pineal body. On the ventral aspect there is a crossing of the Optic nerves. There are two large optic lobes. Then comes the Cerebellum which is large and median in position. The final part is the Medulla Oblongata continued in the Vertebral column as the Spinal Cord which runs down to the tail.



Cranial Nerves :

There are ten pairs of cranial nerves :—

1. Olfactory supplying the nostril.
2. Optic Nerves supplying the Eyes.
3. Oculomotor Nerves arise from the mid-brain and supply four out of six muscles of the Eye-ball.

4. The Pathetic Nerve arises from the point between mid-brain and medulla oblongata. It supplies the superior oblique muscle of the Eye.
5. Trigeminal Nerve is of great size and wide distribution. It arises from the side of the medulla. It has a ganglion near its origin called the Gasserian Ganglion. It divides into two branches *viz.*, Ophthalmic and Mandibular. The Ophthalmic again divides into deep and superficial branches which supply the skin near the mouth and the orbit. The Mandibular nerves supply the jaws.
6. Abducent is a small nerve arising from the Medulla and supplies the muscle of the Eye.
7. Facial arises from the Medulla also it has two branches, *viz.*, Palatine supplying the mucous membrane of the palate and the Hyomandibular supplying the Lower jaw and the Hyoid arch.
8. Auditory Nerve supplies the organ of hearing.
9. Glossopharyngeal arises from the medulla and supplies the first branchial arch.
10. Vagus or Pneumogastric arises from the side of the Medulla and has a ganglion called Vagus Ganglion. It gives off nerves called Branchial nerves to the Gill-slits. The Vagus also gives off a Cardiac Nerve to supply the Heart and a Gastric branch to the stomach. A nerve arises in fish from the Vagus and is known as the Lateral Nerve which supplies the Lateral line sense organs of fish.

Spinal Cord :

The Spinal Cord is a long continuation of the Brain. Nerves arise from it and are known as Spinal Nerves which supply the various parts of the body except the cranial portion.

Sympathetic System :

There are two cords of Nerves on the two sides of the Vertebral Column. The sympathetic cords are united at the anterior portion with the Vagus. The cords run towards the tail by the sides of the precaudal vertebræ and pass along the hæmal canal by the side of the caudal artery.

Sense Organs :**Tactile Sense Organs :**

These are found in the form of cells of the Epidermis on the surface of the body.

Olfactory organs are represented in the nasal sacs supplied by the Olfactory Nerves.

Taste organs occur as Tastebuds in the Pharynx.

Ear :

There is only Internal Ear.

There are two eyes which are complicated organs.

Reproductive System :

The animals are either male or female. The male organs are the testes in the form of sacculated tubes. The testes are paired organs and extend almost to the whole length of the abdominal cavity. Each testis has a duct which joins with the other duct and open to the

exterior by a single aperture. The ovaries are also sacculated organs and are much wider than the testes. Sometimes the ovaries are filled with numerous ova.

Ovary.

Testis

1—Testis,
2—Duct.

They have ducts which unite to open to the exterior by a single aperture between the Anus and the excretory aperture. The sexual organs are not well-developed in the young fish.

Skeleton :

The skeleton of Bhetki consists of a cranium which contains the Brain. The cranium consists of a number of bones but the detailed study of which is not meant for the Intermediate students.

The bones of the cranium are :—The dorsal part of the skull consists of two bones called Parietals, in front of which are the two frontals. On the side of the parietal bone is the Pterotic bone. The sphenotic lies in front of the Pterotic. Below the Sphenotic lies the Orbital which is seen from the side. The Mesethmoid bone lies in front of the Frontals with two lateral Ethmoids. The Nasal bone lies in front of the Lateral Ethmoid. The Maxilla and Premaxilla lie in front of the Mesethmoid. The Jugal bone is seen from the side articulating with the first orbital. There are five otic

bones on each side of the skull *e.g.*, Epiotic, Opisthotic, Pterotic, Prootic and Sphenotic. At the back of the skull there are four bones *e.g.*, Basi-occipital, two lateral occipitals, called Exo-occipitals and a Supra—cocipital bone. There is a large hole below the Supra-occipital called the Foramen Magnum through which the Brain communicates with the spinal cord.

On the ventral side the Basi-occipital has in front the long Parasphenoid bone. The Vomer lies in front of the Parasphenoid. At the side of the Parasphenoid is the lateral Alæsphenoid one on each side.

On the lateral aspect the Pterotic bone has the Hyomandibular bone on each side. The Hyomandibular has a triangular operculum which covers the Gill-chamber. There is another bone called Symplectic. The Pre-operculum lies below the Hyomandibular. The Sub-operculum lies below the Operculum and another bone called Inter-operculum lies in front of the Sub-operculum.

The lower jaw or Mandible consists of a Dentary in front, Angular below and Articular behind the Dentary. They are all fused bones.

Hyoid Apparatus :

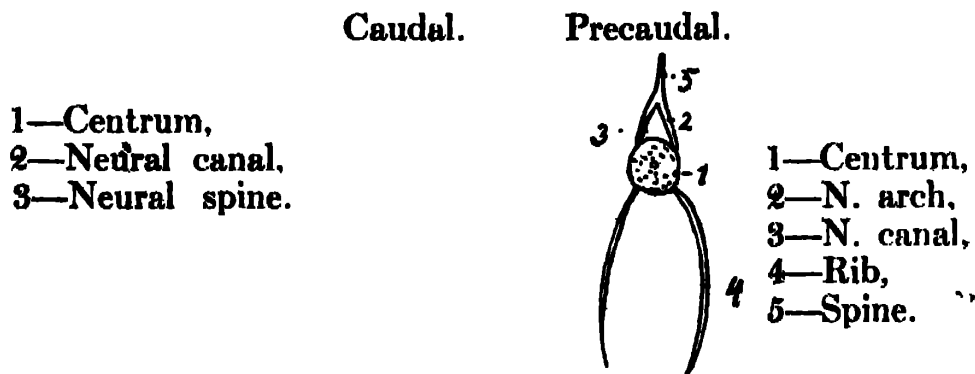
The bone which articulates with the Hyomandibular above is the Epihyal, below are the Ceratohyal and the Hypohyal fused together. They give off curved bones called the Branchiostegals. There is another bone called Basihyal further in front and Glossohyal which supports the tongue. The Urohyal lies backwards, to Basihyals.

There are four Gill arches. The arches are fused with some median bones behind the Glossohyal. The arches bear the Gill filaments from their lower border.

There are two girdles which form the appendicular skeleton *e.g.*, Pectoral Girdle and the Pelvic Girdle. The Pectoral Girdle is well developed but the Pelvic is not so. The Pectoral Girdle consists on each side of a Supra-clavicle, and L-shaped clavicle and the rodshaped Postclavicle. The Scapula lies below the clavicle. The coracoid lies below the clavicle with a large foramen. The fins are supported by small bones called Pterygiophores and some fin-rays.

The Axial Skeleton

The Axial skeleton of Bhetki consists of the Vertebral column. There are two kinds of Vertebrae *e.g.*, Precaudal and Caudal. Each vertebra of the Precaudal region consists of a biconcave solid centrum called Amphicoelous Centrum from which two arches join and is called the

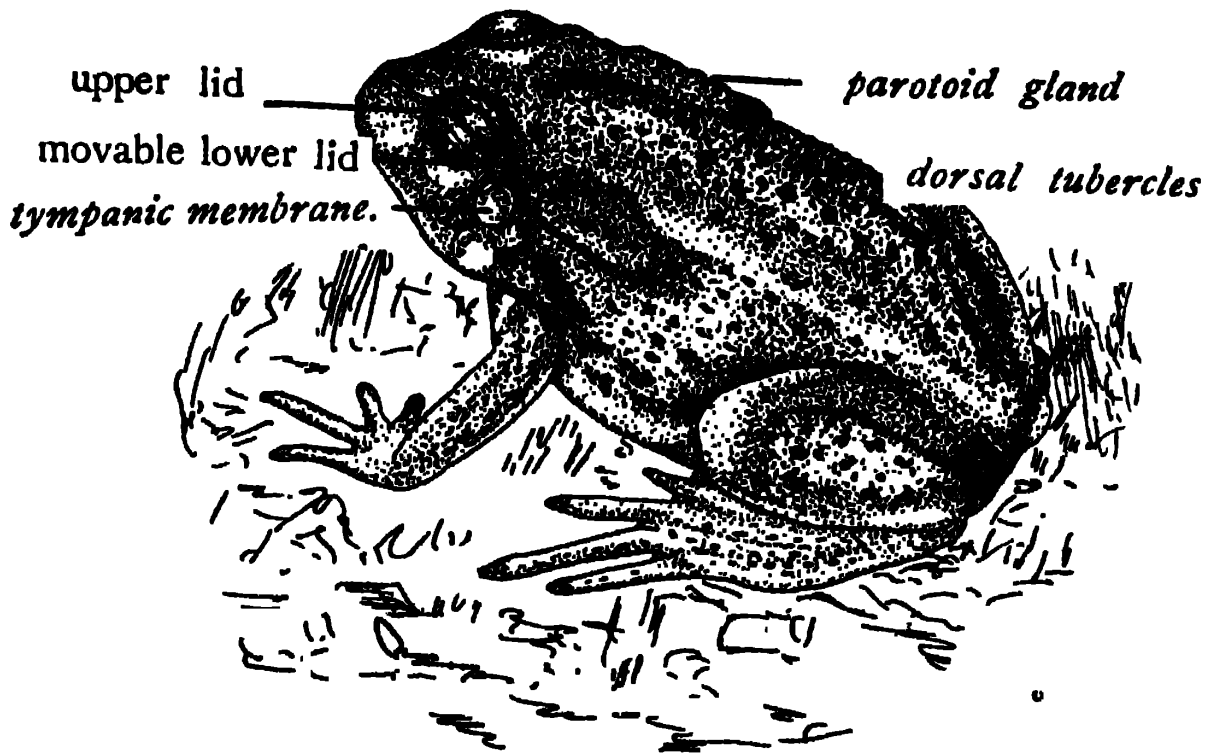


Neural Arch and bears a spine on the dorsal side called Neural Spine and the sides of the arch bear two transverse processes. Ribs come out from the two sides of the Centrum. The Caudal Vertebrae differ from the pre-

caudal in that the transverse processes join up to form a second arch called Haemal Arch in addition to the neural arch. The last bone of the axial skeleton turns upwards and is known as the Urostyle. There are articular processes in each vertebra called Prezygapophysis in front and Postzygapophysis behind which keep the vertebral column in position.

The Toad :

The scientific name of Toad is **Bufo melanostictus**. The animal belongs to the class **Amphibia**. The word



Toad.

Amphibia means double life because the animals have to pass the early stages of their lives in water as **Tadpoles** which are peculiar fish-like larvæ breathing by gills and afterwards become converted into land animals as adult

Toads breathing by lungs. The other familiar member of this class is the frog. The toads are very common in Bengal and the peculiar croaking sound produced by the males is known to all.

Difference between Toads and Frogs :

Toad.	Frog.
1. The skin is dark.	1. The skin is bright yellow with stripes.
2. Short body.	2. Long body.
3. Webs in the digits of the hind limb are short.	3. The webs are longer in the digits of the hind limbs than in toad.
4. Skin is very glandular and warty.	4. Skin is not warty.
5. Omosternum is absent.	5. Omosternum is present.
6. Epicoracoids twisted.	6. Epicoracoids are overlapping.
7. Plentifully distributed in Bengal.	7. Rarely found in Bengal.

External Features :

The animal has a peculiar and characteristic squatting posture. There is a **head**, a **trunk** but no **neck** nor a **tail** in the adult. The skin is rough and warty, with multiple poison glands in the shape of pimples; these glands are more numerous on the dorsal surface than on the ventral. The colour of the Skin is paler on the ventral aspect. The head is triangular in form—the apex representing the snout. At the sides of the head, there are two prominent eyes. Each eye has a movable upper

eyelid, an immovable lower eyelid and a transparent movable nictitating membrane. Behind each eye, there is a circular spot called **tympanum** which represents the external ear. Behind each tympanum, there is a large aggregated gland called the **parotid gland**.

The trunk is provided with two pairs of limbs. Each forelimb has three segments—an **arm** or **brachium**, the middle segment or the **forearm** or **antebrachium** and the distal third segment or the **hand** or **manus**. In the hand may be distinguished a **wrist** or **carpus**, a **palm** or **metacarpus** and fingers or digits of which there are only four, the thumb or pollex being absent. In the males, there is a pad of skin called thumbpad on the inner side of the first digit similarly each hindlimb has three segments. The first or proximal segment is known as the **thigh** or **femur**, the second or middle segment as the **Shank** or **Crus** and the third segment as the **foot** or **Pes**. The foot has an ankle or **tarsus** followed by the **metatarsus** and then comes the webbed toes or digits which are five in number. The lower surface of the foot is called the **plantar** surface and the similar surface of the hand is called the **palmar** surface. The webbed hindlimb is rarely used for Swimming.

• Skin :

The skin of toad is a thin protective covering. It contains the glands of several kinds and some pigment cells. The toad sheds off the skin from time to time. This process is known as **ecdysis**. The change of colour

noticed in frogs and toads is due to the contraction and expansion of the pigment cells of the skin. The skin is devoid of any sweat-gland consequently it has very little excretory function. On the other hand, the skin is richly supplied with blood and has a part in respiration.

Apertures :

There is a large horizontal slit at the end of the snout called the **mouth**. At the posterior end of the trunk, there is a small aperture called the **cloacal aperture**. There are a pair of minute apertures called the **external nares** situated one on either side of the snout just above the slit of the mouth

Body-wall and Body-cavity :

Just below the skin, a series of large spaces are found called subcutaneous lymph-sacs. The flesh below the sacs is bound to the skin by connective tissue. Owing to the presence of sacs the skin is much looser than most other animals. The flesh is composed of muscles. Therefore a body-wall is found composed of skin and muscles. There is a lining membrane of the body-wall known generally as Peritoneum. This wall encloses a large cavity of the body found in the trunk called the **Body-cavity** or **Coelome**, in which lie most of the principal viscera. The term **viscera** denotes the soft internal organs of the body *viz.*, the Stomach, Lungs, Heart, Intestine, Liver etc., and the generative and excretory organs.

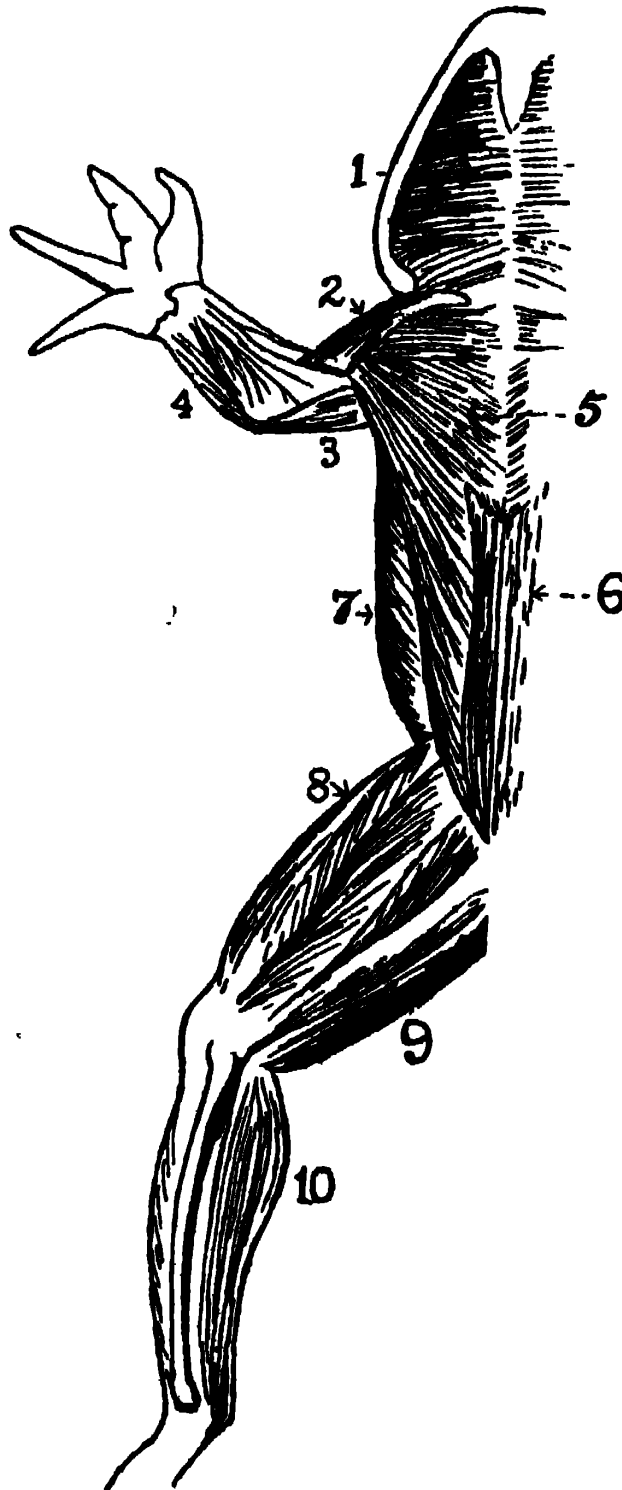
The animal has a backbone on the dorsal part called the **Vertebral column**, composed of a number of vertebrae. The vertebral column has a continuous cavity in which the **spinal cord** is placed. The spinal cord is continued into the skull and ends in the Brain lodged inside the **cranium**.

There are two bony girdles *e.g.*, the **Shoulder girdle** and the **Pelvic girdle**. The girdles together with the vertebrae completely encircle the body. The shoulder girdle gives attachment to the hind limb. The muscles of the limbs are supported by bony structures. The Cœlome is lined by a membrane called **Peritoneum** which also covers the organs lying in the cavity as viscera so that the organs lie within the folds of the Peritoneum and the organs are attached to the body-wall by such membranous folds. The largest fold is known as the **Mesentery** which binds the intestine to the Cœlomic wall. There are two dorsal lymph-sacs between the peritoneum and the dorsal muscles. Each of the two kidneys lies in the dorsal lymph-sac of each side.

Muscular System :

The muscles carry out the movements of the body with the help of the nerves which give them the requisite sensitiveness and action. The muscles of the limb and other parts are of the Voluntary type *i.e.*, they are under the control of the will whereas the muscles found in the Stomach, Heart, Intestine etc. are involuntary *i.e.* they are not under the control of the will. All the muscles are covered by a structure called **Fascia** which is mainly

composed of connective tissue. The details of the muscles are not meant for Intermediate students. (The principal



Muscles.

1—Mylo-hyoid, 2—Deltoid, 3—Latissimusdorsi, 4—Infraspinatus,
5—Pectoralis, 6—Rectusabdominis, 7—Obliquexternus,
8—Vastusinternus, 9—Gracilis, 10—Gastrocnemius.

muscles of the body of the toad are distributed as follows :—

(1) Muscles of the Trunk. Ventral side.

Abdominal Muscles :

- (a) Rectus abdominis—runs along the belly.
- (b) Obliques Externus—a broad sheet at each side of the body.
- (c) Obliques Internus and Transversus lie within the External oblique.

Breast Muscles :

- (a) Pectoralis—large and fan-shaped.
- (b) Coraco-radialis—arising from the coracoid.

Muscles of the Back :

- (a) Muscles of the Lower jaw.
 - (1) Depressor Mandibular arising from the supra-scapula.
- (b) Muscles inserted on to the forelimb.
 - (1) Latissimus Dorsi—triangular. It draws back the arm. It is inserted into the Deltoid ridge.
 - (2) Infraspinatus—raises the arm.
- (c) Muscles inserted into the shoulder girdle.
 - (1) Levator scapular—
 - (2) Serratus—
- (d) Muscles inserted into the hind limb.
 - (1) Gluteus—arising from Ilium.

(e) Muscles inserted into the Hipgirdle.

(1) Coccygeo—iliacus.

Muscles of the Back bone :-

(a) Muscles of the forelimb.

(1) Muscles for the upper arm. Deltoides inserted to the Humerus.

(2) Muscles for the forearm Triceps Brachii arising from the scapula and Humerus, and inserted into the upper end of Ulna.

Muscles of the Hind limb :

(a) Muscles of the thigh.

(1) Adductor Magnus.

(2) Sartorius.

(3) Gracilis.

(4) Triceps Extensor Cruris.

(b) Muscles of the Shank.

(1) Peroneus.

(2) Gastrocnemius.

(3) Tibialis Anterior.

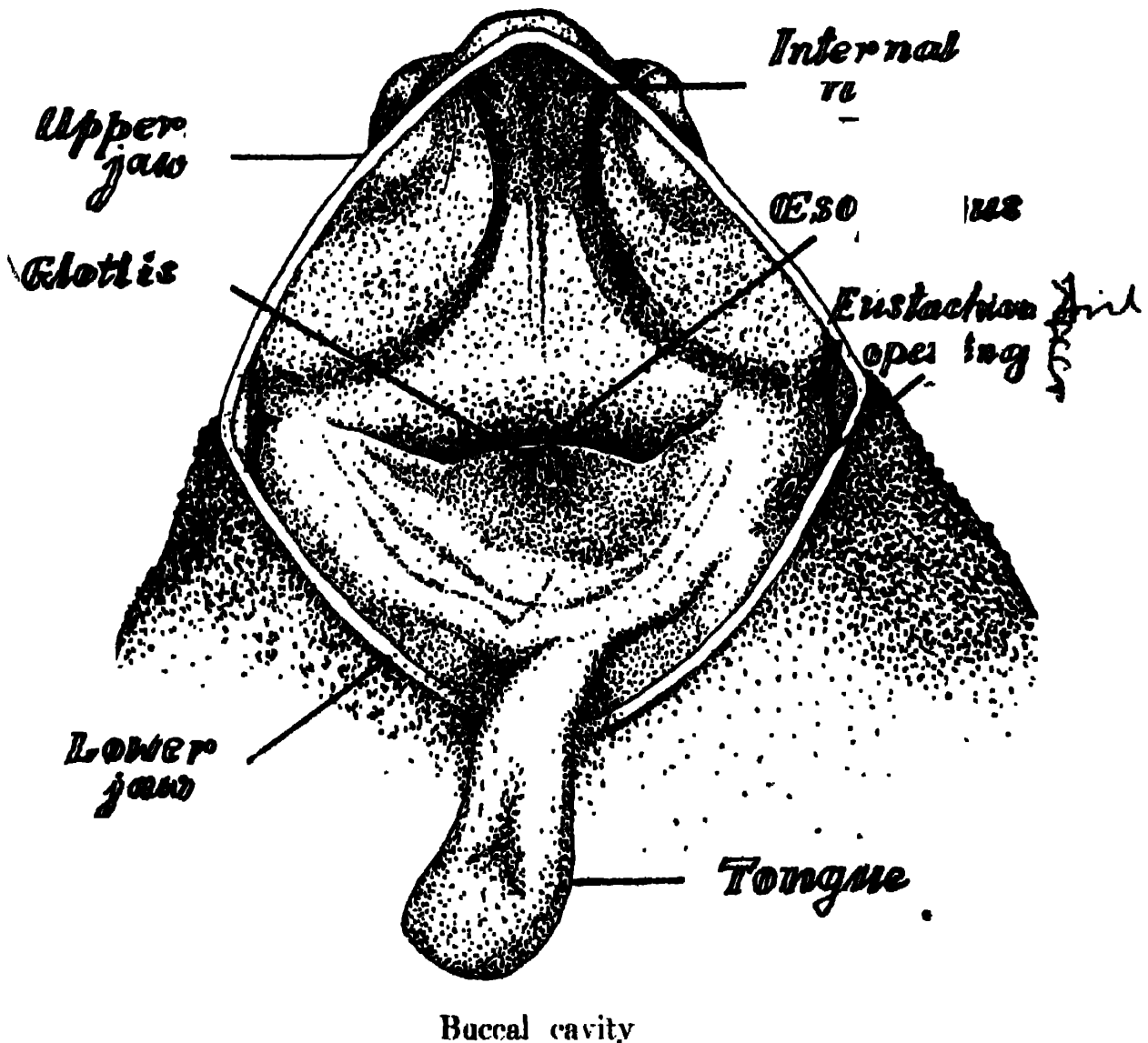
(c) Muscles of the wrist, ankle and toes are numerous small muscles.

Alimentary System :

There is a large mouth with upper and lower jaws. The jaws are toothless but the upper part of the jaws become hard and horny and do not allow the prey to slip away as the toad lives on small insects.

The mouth leads into the Buccal cavity where the tongue is attached in front but free behind. The tongue is rolled out to catch insects and a sticky secretion helps to hold them.

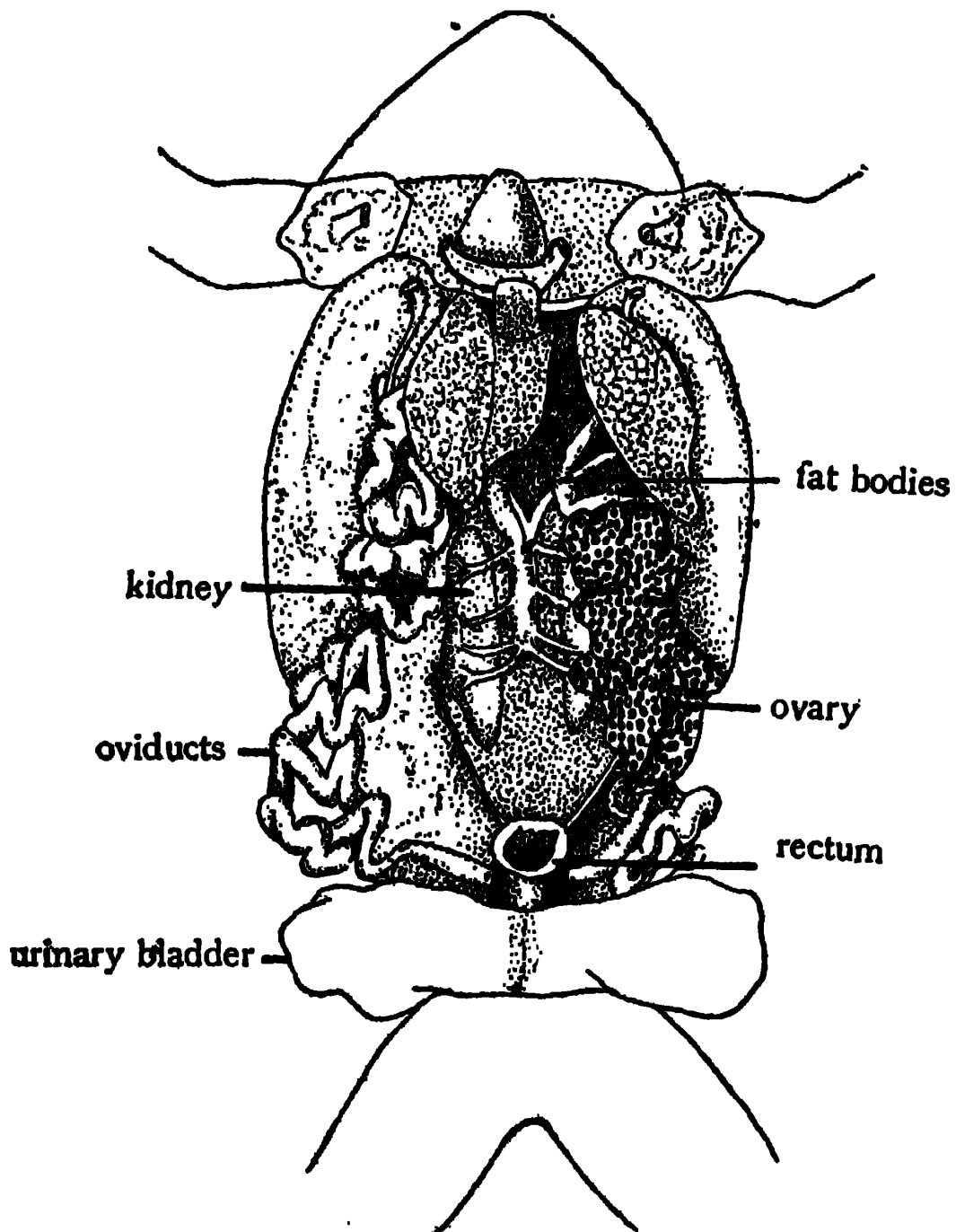
The floor of the mouth specially on the right side shows an aperture. This is the opening of the Vocal-sac found in the male animals only. When the chin is



depressed the vocal-sac is filled with air and when it is raised air escapes and produces the peculiar croaking sound which is heard more frequently in the breeding

season and during the rains by which sound the male trumpets the female.

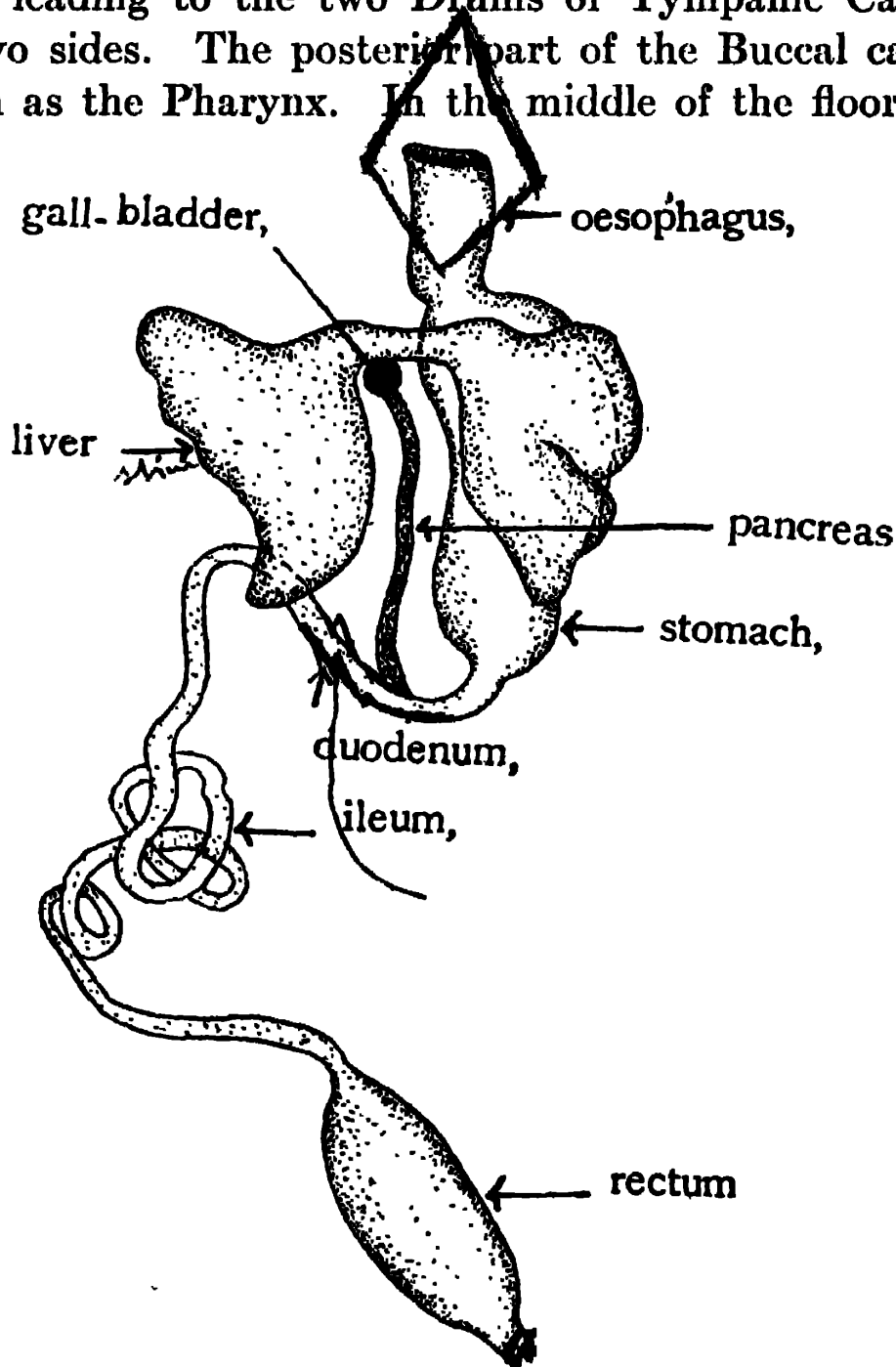
On the roof of the Buccal cavity in the front part there are two apertures of the posterior nares or Inter-



Viscera of toad

nal Nostrils. At the angle of the jaws on the sides of the roof there are two other apertures of the Eustachian

tubes leading to the two Drums or Tympanic Cavity of the two sides. The posterior part of the Buccal cavity is known as the Pharynx. In the middle of the floor of the



Gut of toad with glands

Pharynx is a slit-like opening which leads into the Wind-pipe. From the Pharynx a tube which is called Gullet or Oesophagus leads backwards to the stomach which is spindle like in form. The stomach has two ends. The

end which is anterior and is connected with the Oesophagus is known as the **Cardiac end**. This end is wider than the other end. The other end of stomach is called the **Pyloric end** and is connected with intestine.

The intestine is divided into two main divisions *viz.*, the **small intestine** and the **large Intestine**. The small intestine has further two parts *e.g.* a short straight tube called the **Duodenum** and a much coiled tube called the **Ileum**. The Ileum leads into the dilated and short Large Intestine or **Rectum**. The Rectum opens into a chamber called **Cloaca** by an aperture called the **Anus**. The **Cloaca** in its turn opens externally by the **Cloacal aperture**. The intestine is kept bound to the wall of the abdomen by a fold of Peritoneum called the **Mesentery**.

Digestive Glands :

Besides the digestive fluids secreted by the glandular cells of the Stomach and Intestine there are glands the secretion from which completes the digestion. The glands are the **Liver** and the **Pancreas**. The Liver is a large reddish brown structure in the front part of the stomach. It has two main lobes *viz.*, right and left and a small median lobe unites them. The **Gallbladder** lies between the right and left lobes. The Gallbladder receives the green **bile** secreted by the Liver and passes it by the **Bile Duct** into the Duodenum.

The **Pancreas** is a creamy white structure lying between the stomach and the Duodenum. It is traversed by the **Bile Duct** into which it pours forth its own secretion called the **Pancreatic juice**.