CHAPTER X

PLATYHELMINTHES; NEMATHELMINTHES; TROCHELMINTHES; ECHINODERMATA

PHYLUM — PLATYHELMINTHES

Triploblastic Metazoa. A characteristic feature of the Metazoa, as the gastrula stage develops further, is the appearance of a *third* embryonic layer between the ectoderm and endoderm. This new tissue or *germ layer* is called *mesoderm*. Platyhelminthes or *flat-worms* are called *triploblastic* animals because they exhibit these three germ layers. All the remaining phyla of animals are triploblastic.

Germ Layers. Each of the three *germ layers* forms particular tissues as development proceeds. Ectoderm forms the skin or outer surface tissues and the nervous system; mesoderm forms connective tissues, muscles, reproductive, excretory organs and blood systems, while endoderm forms the lining of the digestive tract and its glands.

Body Form. Other important relations are established by the developing gastrula. The body acquires a definite head and tail end; a definite upper and lower surface and bilateral symmetry. An imaginary vertical plane passing through the longitudinal axis from the mid-dorsal to the mid-ventral line from head to tail divides the animal into a right half which is a duplicate of the left half, or in other words, one half is the "mirror image" of the other half. The relation of these characteristics to forward-moving locomotion is obvious.

Although we noted a certain degree of cell and tissue differentiation in Coelenterates, we find a greater specialization in the flat-worms. This becomes evident in the study of a typical example.

Classification. There are three classes of Platyhelminthes, namely: I. Turbellaria; II. Trematoda; III. Cestoda.

Class I. Turbellaria

Morphology and Physiology. These are free-living forms. Planaria (Fig. 145) is a little fresh-water *flat-worm*, about a centimeter long with a blunt anterior and pointed posterior end. The surface layer of ectoderm cells forming the *epidermis* is ciliated. The mouth opens into the pharynx, located on the ventral side just back of the middle region. The pharynx can be protruded like a proboscis. It leads into the intestine proper, which has three main branches each provided with lateral sacs or tubes. Some portion of the intestine is near almost every part of the body. Food is digested in all of its branches and is absorbed through the endoderm cells which line them. It is transferred to the mesodermal organs near by and to the adjacent ectodermal structures. There is no special circulatory or respiratory system. Oxygen is absorbed by the epidermis and probably by the cells lining the intestine and CO_2 is discharged from them. In the mesoderm is a well-defined excretory system developed from mesoderm. It consists of two long urinary ducts which open to the outside on the dorsal surface toward the rear of the animal. To each of these ducts, a series of side branches is connected. All these tubes are composed of layers of flat cells, while each branch ends peripherally in a *flame cell* (Fig. 146), which has irregular branches extending farther out into the mesoderm. The flame cell possesses a hollow cavity which connects with the end of a urinary tube. At the blind outer end of the cell cavity is a mass of cilia or flagella and, in the body of the cell, vacuoles appear. These resemble the

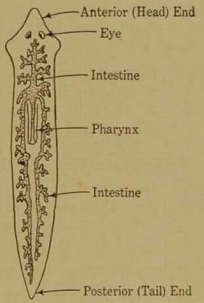

FIG. 145. — Planaria maculata. (After W. C. Curtis.)

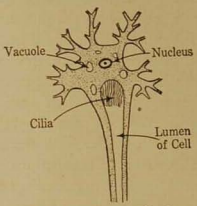

FIG. 146. — Flame cell. From Thomson, *Outlines of Zoology*, D. Appleton & Co., reprinted by permission.

contractile vacuoles of the Protozoa. Evidently wastes are absorbed from the fluids in the mesodermal spaces. These wastes collect in vacuoles in the body of the flame cells and are then discharged into the hollow cavity of these cells. The flame-cell apparatus is one of the simplest of metazoan excretory organs. The vibrating cilia drive the waste fluids into the excretory channels and so to the outside. Probably the contractions of the worm's body assist in the expulsion.

Just underneath the ectoderm is a layer of circularly arranged muscle cells, and under this layer, occur layers of longitudinal and oblique, or vertical muscles which extend from the upper to the lower body wall. There is also *loose* mesodermal tissue present between the intestine and body wall, thus forming tissue spaces filled with body fluid. Contraction of the muscle tissues, aided by ectodermal cilia, accomplish the movements of the worm. Each worm possesses male and female organs (Fig. 147) developed from mesoderm. The *ovaries* are located in the mesoderm in the front portion of the body. Two long *oviducts* extend from the ovaries to the *genital cloaca* or chamber. *Yolk glands* connected with the oviducts secrete yolk about the eggs as the latter pass from the ovaries to the genital chamber. There are a number of *testes* from which the sperm pass into ducts which connect with a pair of long sperm ducts or *vasa deferentia*, which also open by means of a proboscis-like organ, the *penis*, into the genital chamber. Copulation takes place. Sperm from one worm are introduced into the genital chamber of a second worm, whose eggs are thereby fertilized.

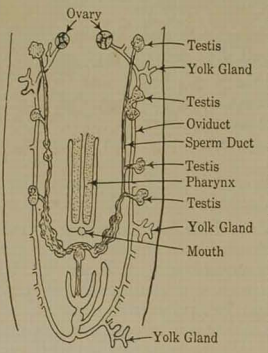

FIG. 147. — Male and female reproductive organs of Planaria simplissima. After W. C. Curtis.

There are two long nerve cords in the lateral regions of the body. Transverse branches from these two strands form a net-

work of nerves. A special concentration of these nerves occurs at the head end. This is regarded as the beginning of the evolution of a brain. Two masses of pigment toward the dorsal surface at the head end and connected by nerves with the "brain" are especially sensitive to light and form rudimentary "eyes." The surface of the body consists of a thin layer of ciliated cells derived from ectoderm. Some of these cells secrete mucus and so are single-celled glands.

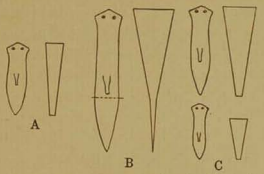

FIG. 148. — Regeneration in Planaria. In A; B and C, the figures at the right indicate variation in metabolic rates. Modified from Newman — *Outlines of General Zoology*, copyright 1924, The Macmillan Co., reprinted by permission.

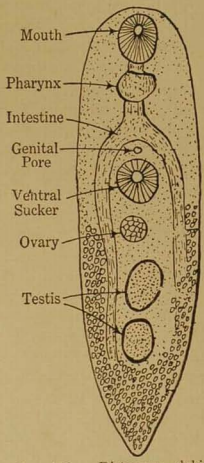

FIG. 149. — Distomum globiporus, a trematode found in the intestine of the winter flounder. After Linton, Bull. U. S. B. F. 1899.

Regeneration. Planarians possess great powers of *regeneration*. If cut into pieces longitudinally, each part regenerates into a complete whole; if cut in two transversely, both pieces regenerate new worms, the front piece regenerating a new tail, and the hind piece, a new head. Small pieces will regenerate into complete but small worms. The smaller worms have fewer cells than those of normal size. If they are further subdivided, the pieces regenerate into still smaller worms with still fewer cells. A lower limit is determined by the reduction of cells to the point where they are not numerous enough to produce a complete animal.

Asexual Reproduction and Axial Gradients. Large and old planarians divide spontaneously into two pieces transversely, somewhat posterior to the pharynx. C. M. Child has proposed the theory of *axial gradients* to explain this. By careful chemical tests

he determined that metabolic activities are greatest at the head end and that they decrease along the longitudinal axis of the body toward the posterior end (Fig. 148). When the animal is young and small, the high rate of metabolic activity can easily dominate the entire body. But as the animal increases in length and bulk, the rate of metabolism of the entire organism decreases. Furthermore, a point is developed toward the posterior end, where the physiological dominance of the apical end disappears and at this point transverse fission occurs. After the division, a higher rate of metabolism is at once established in the smaller anterior piece and moreover a new center of metabolic dominance is established at the apical end of the hinder piece. Each piece develops into a complete worm. Fission thus appears to bring about rejuvenescence. The work of C. M. Child is important for it attacks *directly* a problem in which all men are vitally interested; namely, the nature and causes of growing old. As stated, Child maintains that senescence is brought about by the gradual decrease in basal metabolism. As long as chemical reactions are reversible, life continues. When protoplasm 'sets,' *i.e.*, when reactions become irreversible, death has arrived. After maturity, the tendency toward this condition of irreversibility increases. The reasons why the decrease in basal metabolism increases with old age must be ascertained.

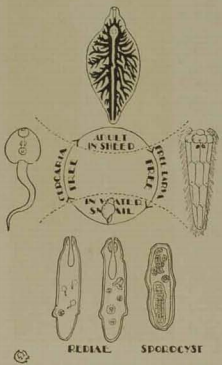

FIG. 150. — Life cycle of liver fluke. From Thomson, *Outlines of Zoology*. D. Appleton & Co., reprinted by permission.

Class II. Trematoda (Fig. 149). They are *parasitic* in many animals. *Fasciola hepatica*, the liver fluke, occurs as a parasite in the liver of the sheep or other domestic animals and causes " rotten liver " and the death of the host. About 3,000,000 sheep were killed in 1879–80 in an epidemic of *sheep rot* in Great Britain. *It has a complicated life history* (Fig. 150). The animal is flat, leaf-like in form, an inch in length by a half inch in width. A

single liver may harbor 200 parasites. Each fluke may produce thousands of eggs, which after passing into the sheep's intestine are discharged with feces. The eggs develop into free-swimming embryos and fresh-water snails act as necessary intermediate hosts before infestation of other sheep can occur. Eight species of liver flukes may infest man. The Chinese liver fluke, *Chlonorchis sinensis*, is common in man, dogs, cats and pigs, in China and Japan. The liver may become enlarged, jaundice result and also gastro-intestinal disturbances. The parasite is transmitted through eating raw or imperfectly cooked fish in which the immature stages occur. Other species which infest the intestinal tract are common in man, in India and China. One species lives in the lungs of man and is the cause of pulmonary hemorrhages. It is common in Japan and neighboring islands. Transmission is brought about by eating imperfectly cooked crabs and crayfish, in which one of the stages in the life history of the parasite is passed. Infestation by drinking water containing cysts discharged from crayfish is also possible.

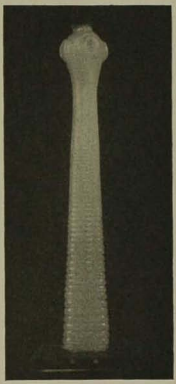

FIG. 151. — Head end of tapeworm, Taenia solium. Photo of model. Courtesy of American Museum of Natural History.

Class III. Cestoda (Fig. 151). **Tapeworms.** There are many species of Cestoda or tapeworms inhabiting the intestine of many kinds of animals. *Taenia solium* is a type which sometimes inhabits the human intestine. The body of the worm is tape-like in appearance, consisting of many segments or *proglottids*. It is bilaterally symmetrical and has a permanent 'head' end or *scolex* with hooks and suckers. New flat proglottids are constantly being formed behind the head, and old 'ripe' proglottids are constantly being dislodged from the hinder end. There is no special vascular, respiratory or digestive system present. Oxygen and digested food are absorbed through the proglottid walls from the contents of the host's intestine. There are well-defined nervous and excretory systems. Each proglottid (Fig. 152) has ovaries and testes and each can produce a great many fertilized eggs. After

fertilization *inside the proglottid*, the latter becomes swollen with developing embryos. These proglottids are detached and pass out of the intestine with the feces, thus liberating the embryos. In this stage they may possibly be eaten by a *pig*. In this intermediate host, the embryos (Fig. 153), which possess hooks at the anterior end, bore their way through the intestine into the blood vessels and are carried by the blood stream to various organs. Usually most of them are found in the connective tissue of the muscles and encyst there. The hooks disappear, the embryo in-

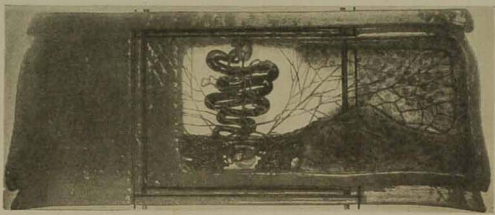

FIG. 152. — Structure of tapeworm proglottid. Photo of model. Courtesy of American Museum of Natural History.

creases in size and from one side there develops a bud which grows into the cavity of the bladder-like form of the embryo. On account of this form, these asexual passive stages are called *bladder worms* or *cysticerci*. The ingrowing bud develops into a head or *proscolex* and a neck. Later proscolex and neck are everted. If man eats infested meat, the bladder worm is released from the "bladder" and the head, with its crown of hooks and four suckers, becomes attached to the wall of the intestine and there the tapeworm continues to grow as long as the head or scolex remains. In 1851, Kuckenmeister first discovered the hog or pork tapeworm, *Taenia solium*, also called the "armed" tapeworm on account of the 20 to 30 sharp hooks around the scolex. The adult stage is limited to man. The larval stage nearly always occurs in the hog but may be found in the dog. The hog tapeworm is rare in the United States but common in Mexico, Africa and Asia. In the United States the beef tapeworm, *Taenia saginata*, is more often found in man. It may be from 4 to 10 meters in length with as many as 2000 proglottids. Its scolex is about 1 to 2 mm. in

diameter but differs from *T. solium* in that it has no hooks. The *adult stage* is found in man in the upper part of the small intestine, and the *larval stage* occurs in cattle. This parasite is found in every country. In Abyssinia, almost every adult harbors one of these unwelcome guests. "Measly" beef, containing cysts of *T. saginata*, has a mottled appearance.

Another tapeworm is common in dogs and cats and the intermediate hosts are fleas and lice. Yet another type is called the fish tapeworm. It is found in fish, and the intermediate stage occurs in small crustacea on which fish feed. It is a common tapeworm found in man in Europe. Sometimes it causes serious anemia, greatly reducing the number of red blood cells.

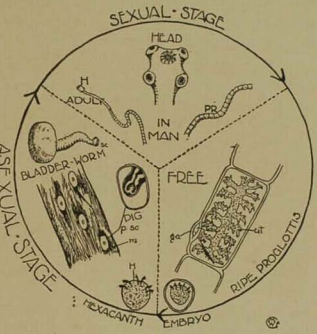

FIG. 153. — Life cycle of Taenia solium. From Thomson, *Outlines of Zoology*, D. Appleton & Co., reprinted by permission.

In the case of both liver flukes and tapeworms, the best protection is to eat *thoroughly cooked meat* and to drink *thoroughly boiled water*.

Summary of Platyhelminthes. They are Metazoans in which the body has further differentiated into the triploblastic condition characterized by ectoderm, mesoderm and endoderm. They possess bilateral symmetry. The digestive tract has but one opening which serves as a mouth and an anus. There is no special respiratory or circulatory system. The independent Planarian group exhibits characters nearer the line of evolution of higher types. Trematodes and Cestodes, on the other hand, are considered to be degenerate (specialized) offshoots of an original planarian-like ancestor. Degeneration is greater in Cestodes than in Trematodes and parasitism has correspondingly increased. The mesoderm in Platyhelminthes is a more or less dense tissue

between ectoderm and endoderm. There is no body cavity, *i.e.*, *coelome* in it. But from the mesoderm has developed specialized systems of excretion and reproduction and also effective muscle tissue. From the ectoderm has developed a special nervous system at the head end of which is the beginning of a brain. The flame cell of the excretory system is a unique organ of excretion. Most flat-worms are monoecious. Although the flat-worms are comparatively simple, yet they are more highly organized than the Coelenterates.

PHYLUM — NEMATHELMINTHES

The Nematodes (Fig. 154) or 'thread-worms' or 'round-worms,' as they are sometimes called, are triploblastic, bilaterally symmetrical Metazoa, long, slender and cylindrical in form and worm-like in appearance. They exhibit *further specialization* over the flat-worms. The intestinal tract extends from the mouth throughout the length of the body and terminates in an *anus* at the posterior end. Thus the general body plan is a tube within a tube with a space or *cavity* between the intestinal tract and the body wall. In higher Metazoa the same general plan is found but the *body cavity* is brought about by the development of a space *within the mesoderm*, part of which is associated with ectoderm to form the body wall, while other mesoderm is associated with the endoderm to form the wall of the digestive tract. Such a *body cavity* is known as a *coelome*. In Nemathelminthes, a body cavity is present, but the mesoderm is associated with the ectoderm only, the digestive tract being composed only of endoderm. On that account the *body cavity* of round worms is *not* recognized as a *true coelome*. The ectoderm, mesoderm and endoderm develop into specialized cells, tissues and organs. The mesoderm, for example, develops longitudinal muscles just within the external ectodermal epidermis. The outer epidermis forms a cuticle of considerable thickness which may molt. The nervous system, formed from ectoderm, consists of a *nerve ring* around the diges-

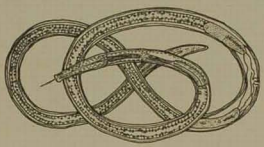

FIG. 154. — Xiphinema, the dagger Nematode. Injurious to plants, being able to thrust the *spear* into living tissues of roots. After Cobb — U. S. Dept. Agriculture.

tive tract near the anterior end, and from the nerve ring, nerves extend forwards and backwards. In the body cavity are well-developed excretory and reproductive systems. The animals are dioecious. There are no special circulatory or respiratory systems. The body cavity contains a fluid. Oxygen probably absorbed chiefly by the epidermal cells is taken up by this fluid and so distributed to other tissues bathed by it. Similarly food absorbed by the cells of the intestinal tract finds its way into the body-cavity fluid and it also bathes all internal organs, making possible the nutrition of all cells of the body. The intestinal tract is divided into regions indicating some degree of specialization. Nematodes are specialized forms occupying a place to one side of the evolutionary road to higher forms.

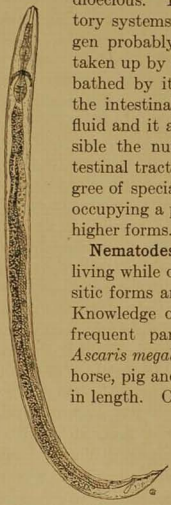

FIG. 155.—Rhabditis hominus (Kobayashi), from J. H. Sandground, *Journal of Parasitology*, 1911. Although found in feces, the author concludes that it is after all not a parasite in the human digestive tract but a free living coprophagous species.

Nematodes and Disease. Some Nematodes are free living while others are parasitic (Fig. 155). Some parasitic forms are free living during part of the life cycle. Knowledge of Nematodes is important because of their frequent parasitism in man and vertebrate animals. *Ascaris megalocephala*, often found in the intestine of the horse, pig and man, is a large type from six to ten inches in length. Other species of Ascaris sometimes infest the intestine of children, and are probably taken in with food or from playing around in dirt.

Trichinosis is a disease due to a parasitic Nematode, *Trichinella spiralis* (Fig. 156). Man is infested through eating raw or only partially cooked diseased pork. It is probable that the old Hebraic laws, prohibiting the eating of hogs which were regarded as 'unclean,' resulted from the observation that this practice caused *trichinosis*, and also tapeworm disease, *taeniasis*. Encysted larvae of Trichinae were first observed by Tiedemann in 1828. Rosenau states that probably from 1% to 2% of the hogs in this country are trichinous. Chandler found that infested sausage was the cause of one epidemic. It was later estimated that one pound of this sausage contained over 2,000,000 larvae of Tri-

china. In a piece of human muscle, from a man dying of trichinosis, a relatively greater number of worms was found. When man eats pork containing encysted larvae, the latter are released in the human intestine where the digestive juices break down the cyst walls. The larvae attain maturity in a few days. Copulation, between male and female worms, occurs in the intestine. The males die but the females containing fertilized eggs burrow into the walls of the intestine. In about a week, the eggs are embryos. They make their way into the intestinal lymphatics, thence to the heart, from which they are circulated about the body, lodging for further encystment in various tissues.

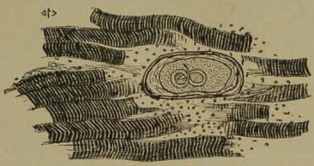

Fig. 156. — Trichina in muscle.

Should a sufficient number invade the muscles of respiration, death may result from paralysis of these muscles. Most of them lodge in the skeletal muscles near the tendons connecting the muscles to the bones. Muscular pains resembling rheumatism often result and 30% or more of the cases result in death. Rats and mice about slaughter houses are almost all infested. Trichinosis occurs in about 1% of the population of modern states. Possible parasitism is prevented by thoroughly cooking meat.

There are many species of the genus Filaria, a thread-like roundworm causing disease. *Filaria bancrofti* is the cause of nine human diseases. One of these is *elephantiasis*, in which parts of the body, usually the limbs, swell to an enormous size, in some cases a number of feet in circumference. In some tropical countries as many as 50% of the inhabitants are affected. The intermediate host is a mosquito. The worms migrate to the blood vessels of the skin at night, and so may be drawn into the stomach of a rapacious mosquito and, by this same animal, later injected into the blood system of some other person. Therefore the infested person is as dangerous to the community as is the mosquito.

Dranunculus medinensis is the 'guinea worm,' frequently causing disease in man in tropical Africa and Asia. The female locates

in the subcutaneous tissue of persons who work in or about water. The worms can be felt under the skin. A skin ulcer develops so that the female worm can protrude her uterus to the outside to discharge a multitude of embryos whenever cold water comes in contact with the skin. The explanation of this peculiar reaction is that usually the embryos are thus discharged into water where a small crustacean, the water flea, *Cyclops*, is present in great numbers. The embryo worms enter the body of these crustacea to continue their life history and perchance are later taken into the intestinal tract of some person who drinks this water. Hypodermic injections of specific compounds such as chloroform in the tissue near the worm kills the latter, which is gradually absorbed and thus removed.

A nematode disease which still causes great economic loss in this country is the result of infestation with the American Hookworm, *Necator americanus*. Cases are found in numbers from Virginia to southern Brazil. Dr. Stiles states that 2,000,000 people in the southern part of the United States suffer from this disease. It was probably introduced here by negro slaves from Africa. Soil pollution is the great factor responsible for its continuance. Hookworms infest the intestinal tract. The eggs, liberated by the female worms into the intestinal tract, are voided with the feces. The eggs hatch and in a few days have developed into active larvae which feed on the fecal matter and soon become mature and able to infest persons properly exposed to them. Larvae live in warm, moist, filthy soil. A survey made between 1910 and 1915 revealed the fact that over a hundred thousand homes in the southeastern part of the United States had no facilities at all for the disposal of human excreta. This is the reason that the earth around these homes became polluted, and why the hookworm larvae remained alive. Persons walking barefooted (and this includes adults of both sexes as well as children) become infested by the larva entering through the skin. From the skin of the foot it gets into the blood stream, is carried to the heart, thence to the lungs, breaks through the lung tissue into the air passages, thence to the mouth. It is then swallowed and passes into the intestine to the wall of which it fastens itself, feeding on blood and causing digestive disturbances. The loss of blood results, not only in lowering resistance to disease, but also causes a great loss in efficiency. Injuries to the lungs render the victim

liable to tuberculosis and to typhoid and other intestinal diseases due to lesions in the intestinal wall.

Waite says that "Wherever hookworm disease prevails, it creates one of the greatest menaces to physical, mental and economic progress." Only patient, continued and constant spread of the gospel of sanitation in infested districts can succeed in removing this form of human degeneracy, probably introduced here by the earlier institution of human slavery.

N. A. Cobb estimates that one acre of alluvial soil contains three billion Nematodes. He calls attention to the fact that "in countries where the wealth consists largely in stock, as in the western part of this country, in Australia and in the Argentine Republic, the monetary loss caused by nematodes is always considerable, and sometimes very great." "A list of more or less serious human nematode diseases and ailments might be increased until practically half a hundred had been enumerated." "The common gallworm has been found infesting the roots of several hundred different species of plants, among them most of our cultivated crops, and causes an annual loss amounting to millions of dollars. There is another nematode that has at times completely checked the growing of sugar beets in certain regions." "It may be estimated that more than 80,000 nematode species infest the forty-odd thousand species of vertebrates." "Numerous as the parasitic species are, it is certain the number of species of nematodes living free in soil and in water far outnumber them." "There must be hundreds of thousands of species."

FIG. 157. — Rotifer or Wheel Animalcule. Photo of model. Courtesy American Museum of Natural History.

PHYLUM — TROCHELMINTHES OR ROTIFERS

This is a small group of microscopic forms found chiefly in fresh water. As an example (Fig. 157) we shall refer briefly to the Rotifer often seen by students when examining fresh-water cultures. The body has three portions, namely: (*a*) the head, which possesses a double row of circularly

arranged cilia. The peculiar motion of the cilia gives the appearance of a rapidly rotating disc, on account of which these forms are often called "wheel animalcules." (*b*) The body is somewhat barrel-shaped and is often protected by a shell-like tube. (*c*) The tail is forked and has a gland which secretes a substance by which the animal is attached to objects. The digestive tract has a mouth, pharynx, stomach and intestine. An excretory system with flame cells is present. The nervous system is quite simple. The animal is dioecious. Some rotifers can survive long periods of desiccation and some can live in the Arctic regions, where, although frozen for the greater part of the year, they become animated during the brief "summer" periods. Rotifers have a cavity between the digestive tract and the outer body wall, but many authorities claim that this is not a true body cavity, as we have already defined it.

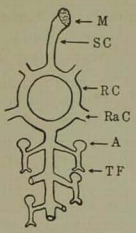

FIG. 158. — Water vascular system of starfish. M, Madreporite; SC, Stone canal; RC, Ring canal; RaC, Radial canal; A, Ampulla; TF, Tube foot.

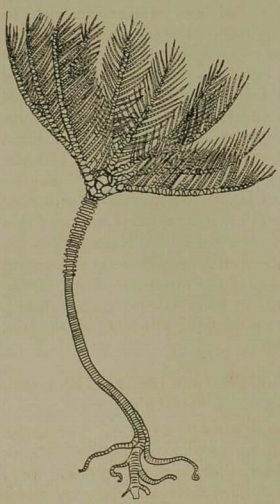

FIG. 159. — Pentacrinus — Sea-lily.

The food consists of minute organisms which are swept into the mouth by the rotating oral cilia.

The body plan of some rotifers is surprisingly like that of the *trochophore larva* of more highly specialized phyla. (See page 184.)

Trochelminthes are Metazoa that have a complete digestive tract with a mouth and anus. They are triploblastic, but as with the

round-worms, the possession of a true body cavity or coelome is problematical.

PHYLUM — ECHINODERMATA [1]

General Morphology. These are triploblastic Metazoa with mouth, and digestive tract terminating in an anus and a *true body cavity*. The dividing egg (Fig. 303) forms in succession a morula (Fig. 303), blastula (Fig. 305) and gastrula (Fig. 305). Bilateral symmetry is established in early embryonic stages succeeding the gastrula, but *this soon becomes modified* so that the adult develops with a pronounced *radial* (*secondary*) *symmetry* adapted to more sedentary life, and slow locomotion is the characteristic result. Echinoderms are regarded as a specialized *offshoot* from the main line of evolution of the higher forms. They are marine forms with a five-rayed body, which, as a rule, has a calcareous exoskeleton in which are spines or plates. There is present also a special water-vascular system (Fig. 158) consisting of tubes containing fluid, and special organs, called tube feet, concerned in locomotion.

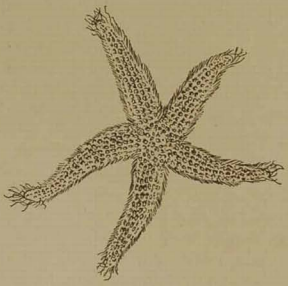

FIG. 160. — Asterias — starfish.

Classification

The phylum is divided into five classes and is made up of about 4000 species.

Class I. Crinoidea (Fig. 159) are feather stars which are attached (for part of the life period, at least) by a stalk to the sea bottom. The mouth surface and mouth opening are directed upward.

Class II. Asteroidea (Fig. 160) are the starfishes, so-called because the arms are prolonged like a five-rayed star. The oral surface is toward the substratum and the anus is above. The body axis is vertical and short. Starfishes are probably the most commonly observed Echinoderms. They move about slowly by

[1] From Greek, "spiny skin."

means of their tube feet. Starfish appear in numbers on oyster beds, where they feed on the oysters.

They have great powers of regeneration. If an arm is lost, it is replaced by a regenerated new one. In fact, at times, a new starfish will regenerate from a single arm. This power of regeneration is shared by all the Echinoderms. Oyster farmers cannot rid the beds of starfishes by cutting them in two and throwing the pieces back into the sea.

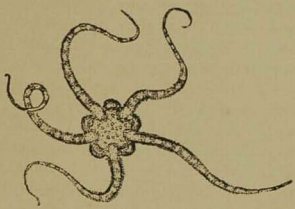

FIG. 161. — Ophiopholis.

Class III. Ophiuroidea (Fig. 161) or brittle stars resemble the Asteroidea, but the five rays are slender, elongated projections from a central disc. The animal progresses by the snake-like movements of its arms. They are the most numerous of the Echinoderms in number of species, and they feed on small animals or seaweeds.

Class IV. The Echinoidea (Fig. 162) have no arms. The body is globular, as in the sea-urchins, or disc-like, as in the sand dollar. The body is covered with spines, the basal end of each being attached to the body surface by a ball-and-socket joint. In some sea-urchins the body is covered with a thick investment of slender spines, while in others there are but a few thick and longer ones. In some, the tips of the spines are poisonous. Sea-urchins are widely distributed in salt waters near the shore. The gonads are used as food by some maritime people.

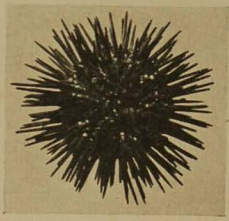

FIG. 162. — Sea-urchin. (Am. Mus. Nat. Hist.)

Class V. Holothuroidea (Fig. 163) or Sea-cucumbers are Echinoderms in which the body wall is soft. There are no spines or tube feet. The body axis may be elongated, giving to the animal a worm-like appearance. The animal rests upon its side with the mouth and anal ends raised somewhat above the main body mass.

The mouth end is provided with tentacles. Radial symmetry is still present. Internal organs are homologous with those of other Echinoderms. The body wall is very muscular. Under certain conditions a sea-cucumber will evert its internal organs. Some have the power of secreting a substance which is discharged as a mass of threads in which enemies are entangled and made helpless. Although the animal may lose its internal organs, it possesses the power to regenerate new ones. In the Far East Holothurians are dried and used for food. This is the " trepang " of the Chinese. Aristotle originated the name Holothurian.

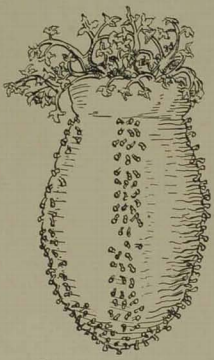

FIG. 163. — Pentacta.

Summary of Echinoderms. They are very old forms, having been well established in the Cambrian Period. They have, apart from the general characteristics noted at the beginning of this chapter, *little in common with other groups of animals.* It has been suggested that their ancestors were worm-like forms with bilateral symmetry and that they later developed *secondary* radial symmetry adapted to a life on the bottom with restricted powers of locomotion. All the groups of Echinoderms have a free-swimming, bilateral larval form. The intestinal tract of the larva has a mouth, oesophagus, stomach, intestine and anus. From the digestive canal two pouches are evaginated to develop into the water-vascular system and the coelome. A larva somewhat similar to this is present during the life history of Balanoglossus, a Chordate. On this account, some zoologists regard Echinoderms as ancient relatives of the Chordata.

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