CHAPTER I

THE ANIMAL KINGDOM

THE doctrine of descent with modification teaches us that just as the numerous varieties of any of our domestic animals have certainly been derived from one or perhaps a few wild ancestral species, so the various forms of wild animals now existing are the modified descendants of pre-existing forms, which, if we could follow them back into the uttermost recesses of the past, would exhibit less and less diversity of structure. Finally we would arrive at comparatively few and generalized types from which have sprung all the endless forms of animal life in past and present times.

Although in imagination we can retrace this evolution of animal life to its very simplest origins, yet when we come to replace our imaginary scheme by a series of animal types which are known to exist or to have existed in past times, it is found that there are very serious gaps in our knowledge, and that so far from being able to reconstruct the complete ancestral history of the animal kingdom in an

objective manner we are forced to accept a great deal of it on trust. The greatest triumphs in this attempt to piece together the actual history of animal change have been won within the last fifty years from the study of vertebrate animals, especially of the most modern and dominant group of them, the Mammalia, and it is no exaggeration to say that we can now trace the history of all the principal kinds of living placental Mammalia through a series of almost continuous gradations back to their common origin in Eocene times. But the Mammalia, geologically speaking, are modern animals, their evolutionary history has been accomplished with comparative rapidity, and their durable fossilized remains have been deposited in strata which in many cases have not been excessively disturbed by subsequent events. We might dwell upon other achievements won by the application of the evolutionary theory to the study of living and extinct animals, but our present object is rather to pass the animal kingdom hurriedly in review[1] and indicate the serious gaps in the evolutionary scheme which there seems little prospect of ever filling in, except by unverifiable conjectures.

The simplest animals known are those whose

[1] In Appendices A and B (pp. 150, 152) a summarized classification of the animal kingdom and a table of the chief geological periods may be found useful for reference.

bodies consist of a single nucleated cell, the *Protozoa*, and these are contrasted to all other animals whose bodies are built up of numerous cells, arranged in definite tissues, the *Metazoa*. Now it is true that certain intermediate forms are known, so-called colonial Protozoa, whose bodies are formed of small colonies of cells, e.g. *Volvox*, but these organisms do not show any affinity to any known Metazoa, their relationship being indeed rather with the more lowly forms of multicellular plants.

The most simply organized of the Metazoa are the *Coelenterata*, including the Jelly-fish, Fresh-water and Marine Polyps, Sea Anemones and Corals, in which the body consists of essentially two cell-layers forming a double cylinder, the one enclosing the other, the outer one, the *ectoderm* being protective in function, the inner, the *endoderm*, enclosing a central cavity and exercising the functions of digestion and absorption (Fig. 1). Between the two layers is a structureless membrane, the *mesoglaea*; this membrane may be greatly swollen, as in the jelly-fishes, and cellular elements from the ectoderm may invade this jelly and give rise to muscular, nervous, or skeletogenous tissue, but the tissue so formed cannot be regarded as constituting a true cell-layer, as it is a subsequent derivation from the ectoderm and is very frequently absent. The reproductive cells (ova and spermatozoa) may arise in

these animals either from the ectodermal or the endodermal cell-layers.

In animals of the Coelenterate type the symmetry of the body is radiate; we cannot ordinarily distinguish a dorsal or ventral surface, a right or a left side of the body. The Coelenterates pass their life either fixed to some object from which they stretch out their tentacles in all directions in search of food, or else, as in the case of the jelly-fishes, they float or propel themselves in the water very much at random, being unable to direct their course for any prolonged period in a straight line. The organs of sense and locomotion in these animals are disposed radially, hence the absence of direction in their movements.

When we pass to the next lowest group of animals, the *Platyhelmia* or Flat-worms, we meet with an entirely different type of symmetry, which is functionally correlated with a more advanced and purposive mode of locomotion. The body has ordinarily a flat ventral surface upon which the animal creeps and on which the mouth opens; the opposite surface is the back or dorsal surface, and the animal is bilaterally symmetrical about its long axis. We can distinguish an anterior and a posterior end; at the anterior end the brain is situated and usually, in association with the brain, special sense organs such as eyes are present. The achievement of this bilateral symmetry was evidently a fundamental

one for the Metazoa, since it is adhered to with extraordinary uniformity in all the subsequent developments of the animal kingdom, and where it has been lost, as in the Echinoderms or Star-fishes,

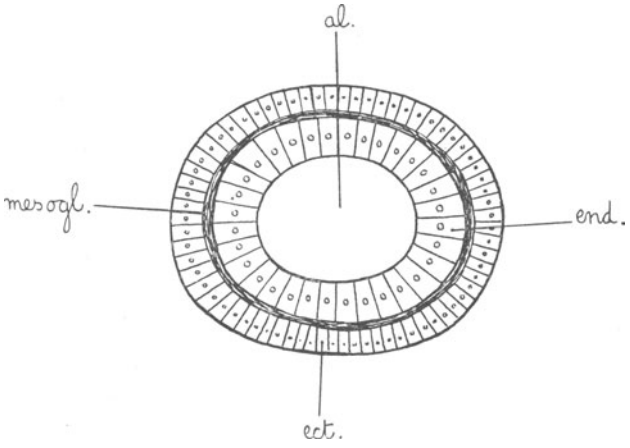

Fig. 1. Transverse section through a Coelenterate. *al.* alimentary canal or gastro-vascular cavity. *end.* endoderm. *ect.* ectoderm. *mesogl.* mesoglaea.

which possess a radial symmetry, the loss is evidently secondary, these animals, as their development shows, being derived from bilaterally symmetrical ancestors. The bilateral symmetry of the Metazoa, from the Platyhelmia upwards, has exercised a profound influence on their evolution. Acquired originally as

a necessary condition for movement directed in a straight line it has led to the concentration of sense organs with their nerve-centres in a forwardly directed head, and to the disposition of all the important organs in pairs on either side of the median axis along which the animal moves. In practically all free-living and active animals the bilateral symmetry is retained, and wherever it has been lost, as in many parasitic and fixed forms, we can always perceive that the loss is a result of the lack of necessity of movement.

The Platyhelmia differ from the Coelenterata not only in their type of symmetry, but in possessing a definite cell-layer, the mesoderm, interposed between the outer ectoderm and the inner digestive endoderm. Within this middle layer, from which the muscular and supporting structures are formed, the reproductive cells are always developed as hollow sacs lined with a fairly regular epithelium or investment of cells (Fig. 2).

We do not know by what steps the bilaterally symmetrical Metazoan with three germ-layers and saccular reproductive organs in the mesoderm was derived from the Coelenterate type, though certain Coelenterates have taken to a creeping habit and have developed a bilateral symmetry. These animals are, however, probably highly specialized Coelenterates, and do not represent real intermediate forms,

so that we must admit that the transition from the Coelenterate to the Platyhelminth type, if it ever took place, is unrepresented by any living or fossil animal.

We are equally at a loss in trying to trace the origin of the *Nemathelminthes* or Round-worm Phylum[1]. These are three-layered, bilaterally symmetrical, unsegmented round worms, many of them

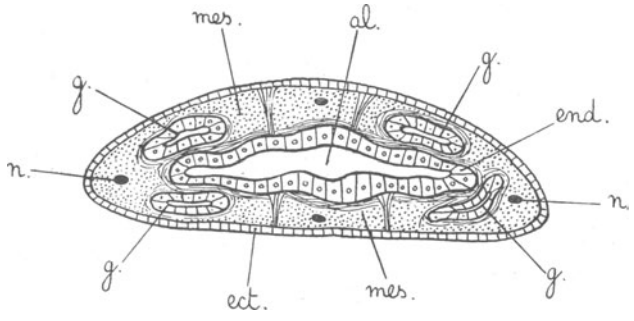

Fig. 2. Transverse section through a Platyhelminth. *al.* alimentary canal. *end.* endoderm. *ect.* ectoderm. *mes.* parenchymatous mesoderm. *g.* reproductive sacs or gonads representing coelom. *n.* nerve-cords.

living in decaying vegetation, others as intestinal parasites in man and Vertebrates (*Ascaris*). They are triploblastic animals like the Platyhelminths, i.e. their tissues are developed from three germ-layers in the embryo, but their internal organs, intestines and

[1] The term Phylum denotes one of the great branches of the animal kingdom (see Appendix A).

reproductive organs, instead of lying in a packing-tissue of mesoderm, are contained in a cavity full of fluid. This cavity represents a blood-system but it is not divided into regular vessels, and no true circulatory system exists as in higher forms.

The Phylum *Nemertea*, containing the Nemertine worms, may perhaps be regarded as affording a link between the Platyhelminth type and the next phylum, the Appendiculata. The Nemertines are round worms which live for the most part a free life in the sea, though a few are found in fresh-waters, a few live on land in damp situations, while a few are parasitic. The Nemertea agree with the Platyhelminths in having a packing-tissue of mesoderm surrounding their internal organs, but in this packing-tissue a definite circulatory system with a heart is differentiated. The body in general is unsegmented as in Platyhelminths, but the reproductive organs consist of laterally paired hollow pouches arranged in linear series along the body. This gives the appearance of metameric segmentation, and it is possible that this represents the beginning of the condition of true metameric segmentation found in the next phylum, the Appendiculata. It must be noted, however, that there is a wide gap between the Nemertea and Appendiculata in the matter of metameric segmentation, for whereas in the Nemertea only the reproductive pouches are involved in the

segmentation, in the Appendiculata the muscles and nervous system have become incorporated in the segmentally repeated sacs which give rise to the reproductive organs, and are themselves metamerically segmented. The nervous system of the Nemertea is also totally different from that of the Appendiculata, being built on the Platyhelminth plan, with lateral dorsal and ventral longitudinal cords, whereas in the Appendiculata there is invariably the double ventral cord with segmental ganglia upon it.

The institution and vindication of the Phylum *Appendiculata*, including a vast quantity of such various organisms as Annelids or segmented worms, Centipedes, Scorpions, Spiders, Mites, Crustacea and Insects, the demonstration that all these widely different organisms can be proved to exhibit an essentially similar plan of organization owing to their having descended from a common ancestor in the remote past, is one of the most noteworthy achievements of zoology in recent times, since it depends entirely on the results of comparative anatomy and embryology, without the assistance of any fossilized remains. The key to the situation was given by the discovery and investigation of a most interesting animal, *Peripatus*, a true link with the remote past, which helped to bridge over the gulf between the segmented Annelid type and the

Arthropod. This question will be considered in more detail in a future chapter.

Now, although the discovery that all these various organisms could be shown to be parts of one intricate evolutionary process from a common type was a satisfactory achievement, yet the origin of the Appendiculate phylum, as indeed of every other phylum, remains shrouded in mystery, save for the possible glimpse of light thrown upon it by the organization of the Nemertea. The great and characteristic acquirements of the Appendiculate phylum, by which it shows an advance of organization over all the lower phyla, are as follows, though we must bear in mind that most of them may be lost in particular cases as the result of degeneration. Firstly, as the name implies, the Appendiculata possess limbs, muscular processes of the body which may become jointed and complicated in structure. Secondly, their bodies are built up of a head and a tail and an intervening region of a varying number of similar rings or segments following one another in linear series. Each one of these segments may carry a complete set of organs, a pair of limbs, a nerve-ganglion, a pair of excretory organs and so forth, so that, discounting the head and the tail, the organism may be said to be built up by the serial repetition of a number of homologous and similar parts. Such an organism, e.g. an Earthworm, is said to be *metamerically*