CHAPTER III.

Distinctions between the Animal and Plant series—Difficult nature of the Subject—"Regnum Protisticum"—Comparison of Animal and Plant forms with reference to Form; Motor Power; Chemical Composition; Intimate Structure; Nature and Mode of Assimilation of the Food—Relations of the Animal and Plant worlds.

THE relations which exist between organic and inorganic bodies having been already discussed, we then observed how sharply and definitely things living were separated from things lifeless. The inanimate crystal possessed no relations in common with the animal on the one hand, or with the plant on the other. We now proceed to the consideration of a second set of differences—namely, those which exist between the two great groups or series of living beings, animals and plants.

And to the unscientific observer our present task might appear to be followed by results quite as certain and definite as those which were elicited from a consideration of the differences between the organised and inorganised series. Nay, so patent, so obvious, and so apparently well ascertained are the differences between the animal and plant worlds, and between their contained organisms, that the task of enumerating any supposed distinctions or boundary-lines of either group may at first sight appear wholly unnecessary. "What relations, connection, or similitude," one might ask, "is there between a horse and the herbage it crops; or between a bird and the tree amid the foliage of which it builds its nest?" And to such a query we might at first be disposed to reply, that the only relation perceptible between these organisms exists in the possession of a common vitality. Both are organic or alive; but, to the unscientific mind, all resemblance would cease at this stage of comparison.

The difficulty, however, lies not so much in the expression of mere relations, or in embodying relative ideas of the animal or plant, as in the construction of a strict and absolute definition or idea of either. In the latter attempt, the ordinary modes of distinction between animals and plants are seen signally to fail. Nor does the difficulty which besets our task lie so much, or at all, with the higher forms of either series, as with the relations of the kingdoms as a whole. For if we leave the higher members of either kingdom, and descend to the contemplation and comparison of the lowest animal and plant organisms, we shall then arrive at some conception of the arduous and unsatisfactory nature of the task before us. On comparing the *Protozoa*, or most lowly organised animals, with the *Protophyta*, or lowest plants, we find that most, if not all the points of distinction, which in the case of the horse and the grass appear so certain and determinable, utterly fail us in the separation of many of these lower forms of life. Yet the *Protozoa* are to be regarded as no less true animal forms than are the *Vertebrata;* nor are many of the *Protophyta* less typical plant-forms than their higher neighbours. Consequently, if our definition or idea of an animal or of a plant is to be of any utility, it must of necessity be universal in its application, and must serve to include all organisms which belong to either life-series. Hence we must take cognisance of the lower as well as of the higher forms, and it is in the consideration of the former group, in both kingdoms, that we experience our greatest difficulty.

Nor has the unsatisfactory nature of our present subject been made apparent of late years only; or in the more philosophical eras of biological thought. We may discover in the records of the older naturalists an enumeration of many organisms, which, on the grounds of form, mode of life, or the possession or want of locomotive power, they could not definitely or satisfactorily place in one kingdom or in the other. Sponges, for example, have formed a kind of *bête noire* to the naturalist in this respect; and even in the present day there are some

authorities who, in defiance of generally accepted views, and on grounds of philosophical and scientific nature, would seek to support the views of the ancients, and regard sponge as essentially a vegetable organism. And when we further reflect that up to the beginning of the eighteenth century the *vegetable* nature of red coral had not been disputed, it will readily be understood how little had been done in the way of ascertaining the exact limits and characteristics of either group of organisms.

Even in this advanced era of scientific progress, and in these days of ascertained facts and observation, together with the advantages of extended opportunities and means of research, the almost hopeless nature of accurately and absolutely defining and limiting the animal and vegetable kingdoms, has induced some biologists to suggest the formation of a third or intermediate kingdom, for the reception of organisms, concerning the nature of which there is reason to entertain any doubt. Of this description of " biological No man's land,"—as Huxley terms this intermediate series—the " Regnum Protisticum " of Hæckel may be selected as a typical example. And biologists, following the example and tenets of this distinguished naturalist, would accordingly place in this debatable territory a good many of the *Protozoa*, and not a few *Protophyta*, which by other authorities would simply be included in either animal or plant series. The views of Hæckel have not met with any very general acceptation from biologists at large. Year by year we are led the more hopefully to entertain the belief that the distinction and differentiation of the two great life-series, or at any rate the exact and intimate relations of both, will be demonstrated. And hence we are justified in declining to avail ourselves of this biological make-shift, the recognition of which is nearly tantamount to admitting at once the hopelessness of the task, and the futility of further research. Professor Huxley well expresses himself with regard to this matter, when he declares that the recognition of a " Regnum Protisticum " " merely doubles the difficulty which, before, was single."

At the same time, we must candidly admit and face the difficulty, such as it is. And in the present state of our knowledge the relations of the animal and vegetable kingdoms may be aptly diagrammatised by drawing two circles which shall touch one another at a point in the circumference of each; in other words, at this point the circles will merge into each other. This point, in the case before us, is the neutral ground where the *Protozoa* and *Protophyta* meet; and with the last remark that our diagram of the circles expresses the relations of the animal and plant worlds, conditionally, and relatively to the future progress of scientific inquiry, we may close these purely introductory considerations.

We may compare animal and plant forms, with a view to the determination of their relations, according to five points. These points are:—(1.) *Form;* (2.) *Motor Power;* (3.) *Chemical Composition;* (4.) *Intimate Structure;* and (5.) *The Nature and Mode of Assimilation of the Food.* On the first four of these heads we shall have occasion to notice how the ordinary modes of drawing distinctions between animals and plants fail; and similarly, on the fifth and last point we shall observe that this latter head—the "Nature and Mode of Assimilation of the Food"—affords the only warrantable basis on which we may found lines of demarcation between the animal and plant series.

Firstly, then, we may notice how the *Form*, or external characteristics of animals and plants are inadequate for the purposes of distinguishing between them. Obvious enough as this distinction may seem from a popular point of view, and when applied to the higher groups of the series, there are yet many animal forms, of comparatively high structure and organisation, which, on this ground alone, could not be distinguished from, but on the other hand would most certainly be confounded with plants.

Examples of such plant-like animal-organisms—are depicted in the accompanying illustrations. A large group of animal forms, known as the *Hydrozoa*, or *Hydroid* Zoophytes or Polypes (Fig. 4, *a b c d*), exemplify how

deceptive a distinction mere form or external configuration constitutes. In this case we observe a structure essentially plant-like in its conformation and in all its details (Fig. 4, *a c*). It grows from a fixed point, and further shows its external relations with the vegetable world in that it reproduces itself by a process of "gemmation"

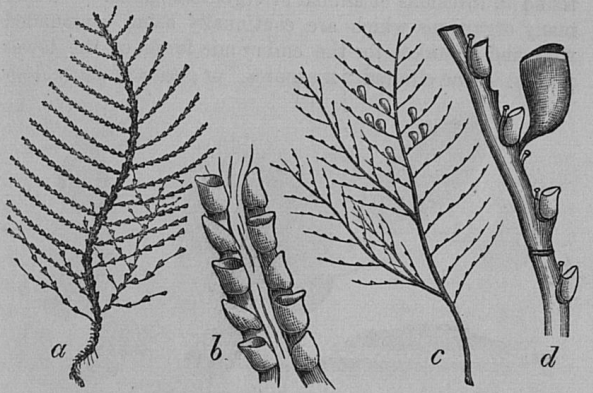

Fig. 4. HYDROZOA (after Hincks).

a, Portion of the "hydrosoma," or entire organism of *Sertularia fusca*, one of the "Sea Firs" (a little larger than natural size); *b*, part of a branch of *a*, greatly magnified, showing the horny cups or "hydrothecæ," in which the "zoöids" or polypites are contained; *c*, "hydrosoma" of *Plumularia frutescens* (natural size), with reproductive capsules; *d*, portion of a pinna or branch of *c* (greatly magnified), showing the cells of the "zoöids" and a reproductive capsule.

or "budding." Yet a microscopic examination of the *Hydrozöon* at once shows us that the tree-like structure is undoubtedly an animal organism, but of compound nature; and we can readily observe the little semi-independent "polypites" or factors (Fig. 4, *b d*) of which the colony, or compound organism, is made up.

Then, also, we notice the well-known Coral-polypes—of historical interest—as being long mistaken for plants, until the observations of Jean Peysonnel demonstrated their truly animal nature. A piece of Red Coral in its

living state, with its living bark, containing the little organisms or "polypes," expanding and contracting their tentacles, like so many flowers, is by no means a bad imitation of a vegetable organism in full growth.

Amongst the *Protozoa*, and particularly in the case of the *Infusorial* animalcules—so called from their being found in infusions of animal or vegetable matter—we find many organisms which are continually being confounded with and mistaken for the embryonic forms of the lower plants. The ciliated "zoospores," or germs of many *Algæ*

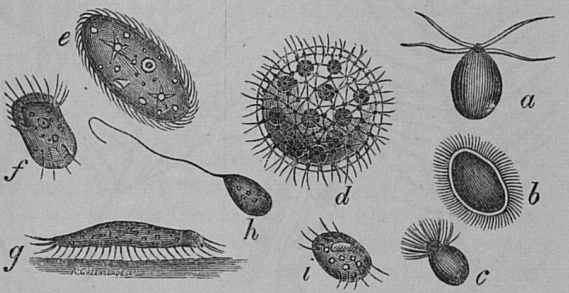

Fig. 5. Infusoria and Algæ.

a, Zoospore or locomotive germ of a lower or *Confervoid* plant (*Chætophora*), with four vibratile cilia; *b*, zoospore of lower plant (*Vaucheria*), with numerous cilia; *c*, zoospore of *Conferva*, with tuft of cilia; *d*, *Volvox globator*, one of the lower *Algæ* in its adult state, long considered of animal nature; *e*, *Paramœcium aurelia*, a true *Infusorian* animalcule; *f*, *Euplotes Charon*, an *Infusorian*; *g*, *Oxytricha gibba*, one of the *Infusoria*; *h*, *Peranema globulosa*; and *i*, *Aspidisca lynceus*, two *Infusorian* animalcules (all greatly magnified).

or Sea-weeds (Fig. 5, *a b c*), are in many cases not to be readily distinguished from certain *Infusoria* (Fig. 5, *e f g h i*); these little plant germs exactly resembling their animal neighbours in all the outward details of existence.

In the *Volvox globator* (Fig. 5, *d*), an organism commonly found with *Infusoria* and other forms in stagnant water, and which is familiar to every microscopist, we find a typical example of how nearly in form even an

adult plant may approach to an *Infusorian* animalcule. To see this organism rolling over and over upon itself, propelled through the water by means of the circle of "cilia" or eyelash-like filaments which fringe the margin of its body, would at once tend to make the uninitiated observer believe he was looking upon an undoubted *Infusorian* form. Yet its truly vegetable nature has now been placed beyond a doubt. And, as ranking amongst the *Protozoa*, a sponge, in so far at least as mere external appearance is concerned, might more readily be assigned to the vegetable than to the animal creation.

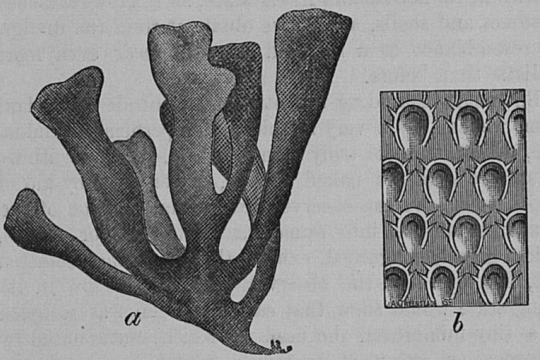

Fig. 6. MORPHOLOGY OF FLUSTRA, OR "SEA-MAT."

a, Cœnœcium or entire organism of the "Broad Hornwrack" or "Leafy Sea-mat" (*Flustra foliacea*), natural size; *b*, a few cells of the same, greatly magnified.

But, lastly, and even more typically than in the preceding cases, the resemblance of an animal organism to a plant-form is seen in the *Flustræ*, or "Sea-mats" (Fig. 6, *a*). These organisms must be familiar to every sea-side visitor as forming part of the chaotic mass cast up on the shore by the tide, and to which the very characteristic and appropriate term, "rejectamenta," has been applied. The illustration will serve to convey an idea of the appearance of a familiar species, from an inspection of

which the essential features of the organism will be readily apparent.

We firstly notice its essentially plant-like form—so plant-like, indeed, that it is commonly collected by sea-side visitors as a seaweed, and, as such, frequently occupies a prominent position in seaweed herbaria. Nor can we altogether afford to ridicule the mistake, since its resemblance to seaweed is so close, that it requires some previous knowledge to separate "the sea-mats" from the heterogeneous mass of marine vegetation with which they are generally cast upon the beach. Or, if we saw the *Flustra* in its normal and living state, as it grows attached to stones and shells, and as we obtain it from the dredge, its resemblance to a seaweed would appear even more realistic than before.

But notwithstanding this strange similitude to a plant form, we can, by a very simple and superficial examination, demonstrate its truly animal nature. If we scrutinise its surface with the naked eye, or, better still, by aid of a pocket-lens, we can observe the external division of the plant-like surface into numerous little cells or spaces, which, greatly magnified, exhibit the appearance depicted at *b*, Fig. 6. And the observation of the *Flustra* in its living state would show that each little cell was occupied by a tiny inhabitant, the head of which, surmounted by a corona or crown of tentacles, would be continually waving backwards and forwards in the surrounding water. And a more minute examination would reveal, contained within the cell, a simple but characteristically animal organisation (Fig. 9), which will be noticed at a subsequent stage in our studies. Each little cell of the "sea-mat," and its contained inhabitant, is the exact prototype of its neighbours, and of such cells the entire organism is made up. It is, therefore, like the *Hydroid* zoophyte, a "compound" organism; it reproduces itself after plant-like fashion, and as a result developes an organism in the similitude of a plant.

Thus not only is the *Flustra* of undoubted animal nature, but it also occupies a very definite and by no means lowly

place in the animal world. For when we consider that it belongs to the great division of the animal kingdom known as the *Mollusca*, and that in this division are included all our ordinary shell-fish (oysters, mussels, cockles, whelks, etc.), as well as those higher forms known as cuttlefishes, it will be seen that the "sea-mat," so far from being an animal of humble organisation, ranks comparatively high in the created scale.

The consideration of these and other examples, which but a very slight acquaintance with systematic zoology will readily afford, may serve to demonstrate that, under the head of *Form*, we cannot distinguish between the animal and plant series.

A sufficiently popular and obvious distinction between the animal and plant series would appear to consist in the possession by animals of *Locomotive* or *Motor power*, and in the opposite and generally fixed condition of plants. Let us briefly inquire whether this second mode of distinction be more trustworthy or reliable than the previous one.

Do all animals move about? are they all possessed of motor power? And conversely, are all plants fixed and rooted to the soil, and so destitute of locomotive means? A little consideration will at once suffice to enable us to answer both queries in the negative, and so to dispute the validity or correctness of this second distinctive point. Look at the sponges, the coral-polypes, the hydroid zoophytes, the sea-mats, the sea-squirts, and many other animal forms which are entirely destitute of locomotive means, and which spend their lives in a permanently-rooted and fixed condition. Or, on the other hand, witness the free and locomotive habits of many aquatic plants, which serve to disprove the assertion that vegetable existence is necessarily of a fixed description.

The locomotive spores and germs of many aquatic plants (Fig. 5, *a b c*), or other and adult *Protophyta*—such as *Volvox* (Fig. 5, *d*), *Diatomaceæ*, etc.—which are never fixed and rooted at any period of their life, but live an entirely free and independent existence, exemplify

typical cases, in which the presence or absence of *motor power* is shown to be no safe or reliable criterion of the exact nature of any disputed organism.

Whilst, therefore, in the abstract, or in a general sense, the power of locomotion may be considered as distinctive of the animal organism, it is also to be noted that the special value of the present mode of distinction does not rank any higher than that of *Form;* and this latter point we have already seen to be of no service in defining for us the relations of the two kingdoms.

Thirdly, it may be asked, Can the chemist, under the head of *Chemical Composition*, aid us in the task of framing distinctive points between the animal and vegetable creation? To this query, also, a negative reply must be returned. Indeed, so far from assisting us in our labour, the chemist's evidence but renders the task still more hopeless and confusing.

His statements, relative to the intimate or elementary composition of animals and plants, show that carbon and its compounds form the chief elements of importance found in the analysis of plant tissues; whilst nitrogen and its compounds may be said to hold a similarly prominent place in the composition of animal textures.

More intimate inquiry, however, will show us that this statement is only of abstract and indefinite value; and that chemical composition—in so far at least as relates to the discovery or recognition of certain elements as specially distinctive of plants on the one hand or of animals on the other—can afford us no certain means of diagnosis between the nature of the plant and that of the animal. Many elements and compounds are common to both plants and animals, and conversely, no one element or compound can be said to be specially characteristic of or peculiar to either series.

But the chemist's evidence does not end with this very general statement. Another aspect of the subject tends to prove that his testimony will go very far to weaken the case for the distinctive character and value of this third

head. He may further inform us that certain substances long thought to be peculiar to vegetable organisation have now been detected entering largely into the composition of animal textures; and in this view the chemical analysis of a living being cannot be said to at all aid us in founding distinctive characters of its nature. Thus "cellulose," a substance entering largely into the composition of vegetable tissues, and of which woody fibre and the walls of plant-cells are chiefly composed, has now been ascertained to form the greater part of the outer covering of *Ascidians* or "Sea-squirts"—*Molluscous* animals allied in a manner to our ordinary shell-fish. The fact of so characteristic a vegetable product being found thus intimately associated with animal structure, was, to use Huxley's expression, "justly regarded as one of the most remarkable facts of comparative physiology."

In the case of "chlorophyll," or the green colouring-matter of plants, a similar result has been found. This latter and characteristic vegetable product is observed to impart the green colour seen in many *Infusoria*, in the *Hydra* or "fresh-water polype" (Fig. 7), and in many other animal forms. Neither cellulose nor chlorophyll, in themselves sufficiently well-marked vegetable products, can therefore be said to be characteristic of the plant creation.

And chemistry furnishes us with many similar but less familiar examples of this seeming interchange of products. The liver and placenta of most *Mammalia* are known to manufacture or secrete, among other products, a substance known as "glycogen" or "animal starch," and this latter substance appears to be of nearly similar composition to the starch obtained from and elaborated by plants.

Such examples, therefore, tend to show that, for our present purpose of distinction, chemical science can afford us no more definite or reliable aid than form or motor power.

Fourthly, we may inquire whether the microscopist can render us any better assistance than the chemist? Will the microscope enable us to detect in the *Intimate structure*

of animals and plants any perceptible and decided difference between the two groups or series?

If we microscopically examine the tissues of a plant, we find them to consist of certain elementary bodies known as "cells" and "vessels;" or if we called development to our aid, we should find that the primary form of plant structure would be referable to the "cell" itself—the "cell" consisting of a more or less rounded structure, generally of small or microscopic size, and composed of a cell-wall, cell-contents, and a little contained particle, the cell-centre or "nucleus" (Fig. 19). Or, if we sought to trace development prior to the formation of the cell, we should find that elementary constituent of plant structure to be in turn formed from a uniform life-basis or bioplastic mass, or from the aggregation of organic particles known as "molecules."

Turning now to the investigation of animal textures, the microscopist finds that the tissues of the animal are built up of elements similar in kind to those he observed in the intimate structure of the plant. Bone, muscle, tendon, nerve, skin, and every other tissue found in the economy of the animal, is composed of certain definite cell-structures, which, under the microscope, are capable of being readily and certainly recognised. And in the progress of animal development, the process, as observed anterior to the formation of the cell-structures, is essentially the same in kind as that seen in the production of the plant-form.

The science of "Histology," or that which investigates the minute structure of bodies and tissues, both in itself, and from its bearings on the developmental process, thus reveals a striking identity in form and composition. The difference between the intimate structure of plants and animals is therefore one of degree only; variations in form, composition, or texture, having no effect in modifying the typical plan upon which the elements of the animal or vegetable body are built up and arranged.

The Nature and Mode of Assimilation of the Food, constituting the fifth and last head, forms, as we have previously

remarked, the only sure and definite ground on which we may separate the animal from the plant world. And this latter point has therefore reference to the distinctive characters to be drawn, firstly, from the *kind* of nutritive material necessary for the maintenance of animal and plant organisms respectively; and, secondly, from the *nature of the process* by which such nutrient matter or food is elaborated and rendered fit for the due support of animal and of plant life. And if, to these primary considerations, we add those relating to the *results* of the conversion and assimilation of the food, in each case, we shall find the distinctions deducible from our considerations to be of a very definite and satisfactory kind.

The *nature* of the food of the animal differs essentially from that of the food of the plant. Animals require for their due sustenance *organic* material—that is, matter which has been derived from the bodies of living organisms, and which has therefore been already elaborated. Plants, on the other hand, subsist on *inorganic* material, or upon matter devoid of life, and derived simply, and without previous preparation or elaboration, from the external world.

Primarily, therefore, the nature of the food, thus briefly stated, shows a very important source of distinction between animals and plants. Beginning in a natural order with the nutrient interests of the plant, we find the vegetable world subsisting on the three great compounds which we have previously noticed to unite in the formation of the "matter of life," or "protoplasm." These compounds are water, carbonic acid, and ammonia; and if to these we add the very general presence of certain mineral salts, such as the compounds of lime, soda, potash, flint, etc., we shall have completed the very modest bill of fare which the plant requires for its nourishment and growth.

Such being the nature of vegetable food, what are the results of its assimilation within the plant organism? Roughly stated, these results are evinced in the production and manufacture by the plant, in virtue of its

characteristic and inherent vitality, of the proteine or protoplasmic compounds. The vital chemistry of the plant, in other words, converts the inorganic material into organic or living matter; living protoplasm is thus produced, as we have previously remarked, only by the intervention and operation of an already living organism. And the plant, in the exercise of its vital functions, therefore, converts compounds of simple and inorganic nature into organic and highly complex compounds.

In the consideration of the nutritive process in the animal economy we are met by a result totally different, and as nearly as possible opposite to that seen in the plant. The animal requires for its sustenance, as already remarked, organised or living material. This term is synonymous with matter that has undergone elaboration by the vital chemistry of a living being, and for this material the animal is dependent, primarily, upon the plant creation. It obtains the organic matter necessary for its sustenance from the plant world, and in this view plants therefore form the great bulk of animal food. But with the reception into its body of this organic nutritive material, a series of actions widely different in result from those seen in the plant economy, are now to be noticed in the assimilative process of the animal. The vital chemistry of the animal has a direction and operation entirely different from that of the plant. The complex compounds formed by the plant, and offered as food to the animal, are, in the animal economy, reduced to much simpler and less complex bodies, and these latter are finally inorganic in character. The carbon contained in the food of the animal in this way is returned to the atmosphere as carbonic acid, the nitrogen is got rid of chiefly in the form of "urea," whilst the hydrogen of the organic compounds derived from the plant, reappears in an inorganic form, and in greater part as water. Thus the waste products of the nutritive process in animals are essentially inorganic in nature, and result from the absorption, assimilation, and elaboration, of organic nutritive material.

The animal thus lives on organised material; the plant

subsists on inorganic matter. The animal converts such organic material, consisting of highly complex compounds, into inorganic and simple compounds. The plant converts the inorganic matter, consisting of simple compounds, into organised matter, and into highly complex compounds. The stable elements, or compounds of inorganic substances, are, by the plant, converted into highly unstable compounds of organic nature, and which serve the animal for food. The whole course of plant life is a process of reduction, deoxidation, unburning, and of building up organised material. The whole course of animal existence is a process of oxidation, burning, or breaking-down of organised matter as the result of tissue-waste, into inorganic or non-living material. The plant constantly produces, and the animal as continually consumes.

Several other points, of subsidiary importance to the preceding considerations, may appropriately be noticed at the present stage. Thus the food of animals is generally *solid* in its nature, whilst that of plants is usually liquid or gaseous; this latter rule being of very constant nature, in so far at least as plants are concerned.

An important and further ground of distinction between the animal and plant worlds, and one which is closely related to the nature of the food, is found in the respective effects or reactions of animals and plants upon the atmosphere. This latter point has reference to the gaseous interchange which takes place between the animal and plant kingdoms, and which affords an apt illustration of the great law prohibiting waste and mismanagement, which Nature seems to inculcate and exemplify throughout all her dominions, and in all her operations.

The animal requires for the due performance of its vital functions a certain amount of oxygen gas, which it derives from the atmosphere by which it is surrounded. This oxygen is therefore absorbed by the animal, which in turn excretes or gives out to the atmosphere, as the part-result of its tissue-waste, a certain proportion of another gas known as carbonic acid. This latter gas is exceedingly deleterious to animal life, but plants, on the

other hand, absorb and inhale the carbonic acid, which is to them what oxygen is to the animal; and we have already noticed how the carbonic acid is elaborated by the subtle chemistry of the plant, to aid in forming the protoplasmic compounds so necessary for the support of animal life.

The plant, in the exercise of its vital chemistry, next retains to itself the carbon, and sets free the oxygen, which also forms part of the carbonic acid. The free oxygen is thus returned by the plant to the atmosphere, to be again made subservient to the life and functions of the animal. The chemist represents carbonic acid by the symbol CO_2, signifying that Carbon (C), and Oxygen (O), combine in certain proportions to form carbonic acid; and we may roughly diagrammatise the action of the plant, if we suppose it to retain for its own use the C, and to allow the O_2 to return to the atmosphere. The animal thus absorbs what the plant excretes (oxygen); and the plant absorbs what the animal excretes (carbonic acid). In this way, therefore, those substances which we might consider to be the waste and useless products of one economy, are, in virtue of nature's wise plan, utilised and made subservient to the welfare and nutrition of the other.

The *mode* in which the food is assimilated in animals and plants respectively, forms the second division of our present subject. This latter consideration essentially assumes the nature of a comparison between the nutritive organs of plants and of animals. Broadly stated, the nutritive and absorbent organs of plants are *external*, that is, are situated on the outer surfaces of the organism. Conversely, in the animal, the nutritive organs are *internal*, and we generally find that a distinct cavity or tract is apportioned off from the internal surfaces of the body to subserve the digestive or nutritive function.

Even in the lowest animal organisms (*e.g.* the *Amœba*, Fig. 1), in which a true and distinct digestive cavity or stomach is not specialised from the general protoplasm of which the body is composed, we find that a temporary

internal digestive cavity is formed as occasion requires, and food by this means is received into the interior of the organism. Thus, in an *animal* form of nearly the lowest grade of organisation, the generalisation concerning the relative position of the nutritive organs in the animal and plant series still maintains its validity.

The primary process of nutrition in plants is subserved by the root and leaves, the absorbed materials being exposed to the action of the sunlight chiefly through the medium of the latter organs. In plants, however, we find an internal system of cells and vessels, to which a circulatory function may be correctly assigned; this latter system distributing throughout the organism the elaborated products of the nutritive process. Such a system bears a close and undoubted analogy to the circulatory system of animal forms; but the primary processes of nutrition are subserved in the plant by external organs, whilst in the animal we find the food directly received into the interior of the body.

The presence of a distinct mouth or oral aperture for the reception of food, is by no means a constant or unvarying characteristic of the animal series. The lower forms of animal life, in common with their want of organisation and the non-possession of distinct structures and parts, are generally destitute of a special aperture for the reception of nutrient matter, and in some forms of comparatively high structure, a distinct mouth, and, in some cases, even a distinct digestive system, are also wanting. Notably in the *Tæniada* or Tape-worms, and in other parasitic forms, is this the case; such organisms living by the simple imbibition of the already elaborated fluids of their hosts. Yet we cannot doubt that, even in this latter case, the food must, in the interior of the organism, undergo a further degree of elaboration.

Lastly, and in concluding the consideration of this important series of distinctions, it is of importance that the broad relations between the animal and plant series be clearly borne in mind. The illustration formerly adduced—namely, that of expressing the relations of the

two series by drawing two circles so as to touch each other at a point in their circumferences, will, if its terms be correctly appreciated and understood, recall to mind the position of the one kingdom as regards the other.

Each possesses an entity distinct in kind from the other. The two form a great tree, consisting of two main stems, united in their lower part, but diverging from each other the more widely as we proceed upwards. Hence the two economies do not, and cannot, from the nature of the case, form one long linear series, which would have its origin in the lowest plant, and its termination in the highest animal form. The point in the diagram of the circles, in which each circle merges into the other, or the union of the two great stems of the tree, is represented in the real case by the union of the *Protozoa* and *Protophyta*, in the strange and confusing identity of form and relations we have already discussed.

We cannot, by any gradation of any kind, pass from the higher plants to the lower animals, and onwards to the highest animal forms. No such unbroken line or continuous series can be formed, since it is only in their lower boundaries that the animal and plant worlds show any tendency to merge into each other. In other words, the two series are to be placed side by side, as in the circles, and not in any continuous linear arrangement. The higher forms of each kingdom diverge so widely from each other, that it requires no scientific aid or acumen to readily distinguish the nature and relations of either or both.