It is highly probable that they are all only stages of development from the primal germ, by which nature gradually evolves the most perfect of all. Even the highest type, the vertebrate, approximates so closely to the type below, in its most primitive forms, that the two almost merge together. It is possible, also, that other beings exist, or have existed, in which the transition could be still more certainly established. Every day new beings are being discovered, living or fossil, and each new one invariably bridges over some gap that before existed between different kinds.

PART VII.

REPRODUCTION IN PLANTS AND ANIMALS, SEXUAL AND NON-SEXUAL, INCLUDING HERMAPHRODISM.

CHAPTER XV.

REPRODUCTION.

All living organisms, of every type, when perfect, possess the power to originate other beings similar to themselves, by the process of reproduction. The way in which this process is effected, however, varies exceedingly, being sometimes very simple, and at others very complicated. Essentially it is the same in all, but in some the generative organs are more differentiated, and there are more separate stages in the process.

The one general fundamental fact, in which all agree, is this: organisms of every type throw off from themselves some of the cells which have been evolved during their own process of development, and these cells so thrown off grow into a new being, like the parent, just as the parent grew from its primary cell.

These cells so thrown off, to produce new beings, are called *germs*, *eggs*, or *seeds*. In the higher beings these generative cells are not fully developed till after the parent attains its full growth, and their evolution ceases entirely at a certain age. In the lowest orders of beings, however, reproduction begins at once, and goes on without ceasing.

There is also another difference: in the lower beings, there is usually but one kind of cell concerned in the process; but in the higher beings there are always two, called the male and female, or the sperm and the ovum, which must be united together to form the new being. This is called *impregnation*, and it is effected in various modes, as will be shown farther on.

Although the male and female principles of generation, as we see them, are different, and each plays a part of its own in the process, still there is every reason to suppose that they are both only simple cells, but in different stages of development. In the very highest animals at times, and commonly in many of the lower, the female germ, or ovum, will develop into a new being without impregnation by the male sperm at all. This virgin generation is seen sometimes in the human being even.

There is reason to suppose that the female germ, the egg, or seed, differs from the male germ only in this, that it contains a larger amount of protoplasm, which serves as nutriment, by which the new being is enabled to effect its first development. The one germ has more substance, the other more energy, but either, under fit conditions, might develop alone.

This difference is well shown in the egg of a bird. The real germ cell, in the largest of these, is quite small, but it is surrounded by a larger mass of nutritive protoplasm, the yelk, and the albuminous white, which are all used up in forming the body of the young bird; so that when it comes out of the shell the whole substance of the

egg has disappeared : it has been made into flesh, bones, blood, and feathers, by the action of heat and moisture.

The male sperm is not surrounded in this way by nutritive protoplasm, and is therefore small. Such material is not needed in both.

All the different modes of reproduction may be classed first under two kinds, *sexual*, and *non-sexual*, and each has many varieties. We will therefore consider each separately, beginning with the non-sexual.

CHAPTER XVI.

NON-SEXUAL REPRODUCTION.

THE non-sexual mode is confined almost exclusively to the lower animals, and there are two varieties of it.

First. GEMMATION, OR BUDDING.—This means the formation of gemmules, or buds, similar to what we see form on trees. These buds are produced either on the outside of the parent or in the inside. They grow into new beings like the one they sprang from, and may either remain attached to it, so as to form a colony, as in the corals, or they may separate, and each bud grow into a perfect new being.

In some cases the parent gives off a bud from one side, and this another, in the same way, and the process goes on till there is quite a family of them, all developed in *one line*, from the original parent. When this is a shell animal, as in the one called *logena*, a common shell forms over the whole colony, and incloses them.

In the common *sea-mat*, as it is called (*flustra*), the parent begins in the same way, by sending off a bud, and that another, and so on indefinitely, each one developing like the parent, and all remaining attached, so that they seem to form one being, but each one is really an independent organism, and leads a life of its own. In such cases the gemmation may be called *continuous*.

In other beings, however, the buds form, and develop into new beings, like the parent, but then separate from it, and live quite independently. This form of gemmation may be called *discontinuous*, or *disconnected*.

In the animal called the *Hydra*, or fresh-water polyp, we see this illustrated very well. As soon as the buds have sufficiently developed, like to the parent, they are detached from it at once, and begin life on their own account. The *Hydra virida*, a fresh-water polyp, is easily found on the under sides of the leaves floating on ponds, and can be examined with any good lens.

We sometimes see this process of gemmation, or budding, in plants. In the lily, for instance, at the bottom of the leaf-stalks, small black buds form, which fall off, when ripe, and in the ground grow into new bulbs. Buds may also be cut from most trees, and inserted in the bark of others, of the same order, when they will grow into perfect branches. A bud, in short, is only a cell, pushed out from the parent's body, and developed as that was, into a perfect organism.

Some of the lower animals possess the power of reproducing lost parts, by a process almost identical with that of gemmiparous generation. Thus, crabs and lobsters will reproduce lost limbs ; some lizards will form new tails, and some even new eyes. But this is only a process of repairing the individual, not of reproduction of a new being.

Second. FISSION, OR DIVISION.—In this mode of reproduction the parent simply *divides*, or separates itself spontaneously into two or more parts, each of which

grows into a new being like itself. This mode of reproduction has already been shown in the diatom and others.

We commonly practice this form of propagation with plants artificially; as when cuttings are taken, for instance, and planted, to grow into new trees. And the same can be done with some animals. In nature, the parent either divides spontaneously, or it is broken up by some external agency.

In the fresh-water polyp, or hydra, before spoken of, this is very beautifully illustrated. It propagates by buds, ordinarily, but it may be divided artificially into any number of parts, each one of which will grow into a new being, like the parent. We can take one of these beings, and cut it up to almost any extent, and so make any number of new beings, each one as perfect as the original, and each one of them may again be divided in the same way.

The following shows one of the hydras, such as are common in ponds, on the under sides of the duckweed leaves.

In some respects these beings are like the amœbas. They resemble little bags of jelly, capable of protruding thread-like limbs, to take their food with, and convey it to the stomach.

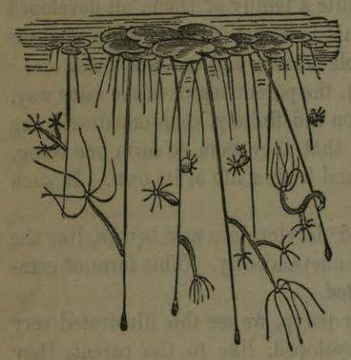

FIGURE 44.—*Hydra, or Fresh-water Polyp.*

In this picture new animals are seen forming from buds all over the parent organism.

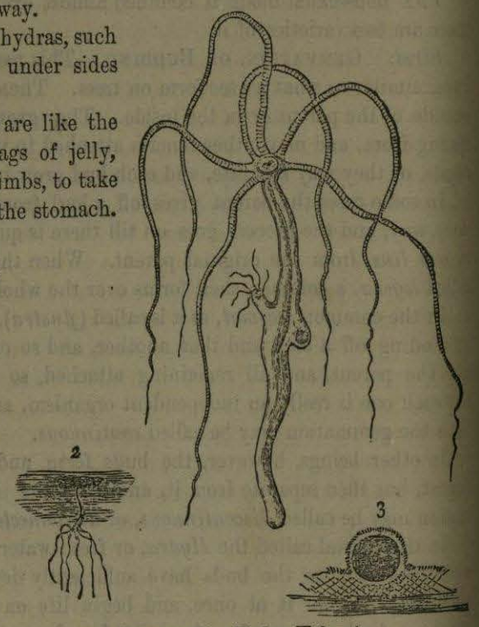

FIGURE 45.—*Hydra Vulgaris.*

1. Hydra magnified. 2. Natural size, attached to under surface of a weed. 3. An egg nearly ripe.

The stomach, however, is only like that of the amœba, made by folding in of the skin, and the animal may be turned inside out without suffering any inconvenience. When this is done the stomach becomes the outer skin, while the outer skin becomes the stomach, and this change may be repeated over and over again. All parts are therefore alike, and this is why it propagates so readily by fission, or simple division, as any part contains all the requisites for a new animal.

It is not a little remarkable that when one of these fissiparous animals is cut in two, each portion reproduces the identical part it needs to form a perfect being. Thus, when a hydra is cut *across*, the upper part immediately produces a new hind part, and the hind part a new head part. If it be cut through lengthways, it doubles up, so that the two ends meet together, forming a new head, while the two halves of the stomach combine to form a new complete one.

Many kinds of worms may be cut into pieces, and each part will soon form a perfect new worm.

In many cases, when the young, formed from buds, are attached to the exterior of the parent's body, their stomachs communicate with the parent's stomach, and they are nourished from that. This continues even after they form limbs, and take food for themselves. It is observable, however, that if the supply of food be limited, the connection between parent and offspring is often shut off promptly, and the new animal is detached, and sent off to seek food for itself elsewhere. The connection will, however, often be maintained indefinitely, even after the offspring has begun to propagate, when the supply of food in the surrounding fluid is abundant, so that there is enough for both.

As long as the parent's stomach can nourish both easily, it continues to do so; but when the task is too difficult, the child is got rid of.

In many cases the buds, or sporules, are loose, instead of being attached to the parent, and they are found in various parts, sometimes in the cavity of the stomach, and at other times scattered in many places not otherwise occupied. These loose buds were probably originally attached, and afterward thrown off. They closely resemble true ovæ, or eggs, excepting that they are not formed by a special organ. Not infrequently they exhibit active motion, darting about as if they were already alive, as probably they are, being most likely one-celled animals. All buds, sporules, and eggs are only animals undeveloped, but truly living, even in that undeveloped state.

Some of these sporules have a kind of hook, by which they attach themselves to surrounding objects.

Fissiparous division, when spontaneous, is usually into two parts, or some other even number—four, six, or eight, for instance. The *Gonium pectorale* divides into sixteen. In many cases the place of division is indicated by a slight crack, or contraction, which gradually deepens till the original body is separated into two or more parts, as already shown in the diatom. In some of the infusoria the division is effected in a very singular manner. A portion of the end of the tail is marked off by a shallow notch, which gradually deepens, making the separation constantly more complete. While this is going on, the part so marked off forms, by degrees, all the organs found in the parent, till finally it becomes perfect, and then drops off and begins life on its own account. That part which was attached to the parent always forms the head of the new animal. All the beings of this kind that now exist, therefore, or that have ever existed, may be considered as only the continuance of the tail of the first one, and this tail may therefore be said, in one sense, to have perpetual life. Among some of the Annelid worms a similar process takes place, but more extensively. When they are going to propagate, two or more rings form round the tail end, and between the first ring and the part in front there is a notch, or groove. The ring develops into a head, with eyes and feelers, like those of the parent, thus making two individuals, united together only by the skin and intestines. All the food needed by both has to be taken by the first one, so that the new-formed one lives at its expense. Still the two are quite independent as living beings, and they may often be seen struggling as if to get free.

After a certain period the body of the new-formed Annelid becomes swollen, and is found to be filled with sexual germs, either male or female, or both, but none are found in the original animal. Finally the two beings become separated, and then the body of the offspring bursts open; the sexual germs contained in it are liberated; and the two kinds, male and female, intermix, so that the eggs become

impregnated, and develop into new Annelids, like the original, which itself does not propagate in that way.

In the case of one such animal, called the *Myriana*, as many as six new beings have been seen to form in this way, each one being sexual, forming eggs or sperm, or both, though the parent has neither. This is shown in the cut below.

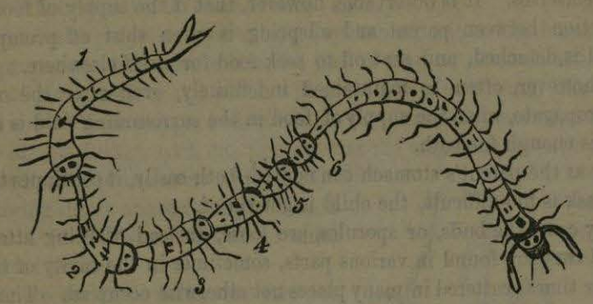

FIGURE 46.—*Myriana, with Six New Individuals.*

It will be seen that No. 1 at the end is the largest, and that they go on getting less toward the head. No. 1 drops off first, then No. 2, and so on, till all are separated, each one growing as large as No. 1 before its turn comes to separate. In these cases, instead of a bit of the parent's body being separated, and growing afterward into a new being, as in the hydra and others, it remains attached to the parent till it is perfected, and then separates. This apparently strange mode of reproduction is, in reality, exactly like the formation of a child in the mother's womb. In both cases the new being is developed from one of the cells of the parent's body; but in one case the development takes place in the inside, in a womb, and in the other case outside. When developed in the womb, the cell is also specialized into a true ovum; but when developed on the outside, it may be only an ordinary cell.

The joints of the tape-worm multiply much in the same way. In each joint, excepting the small ones near the head, there is a long tube, in which the eggs are formed, at certain times, and in the walls of this are other smaller tubes, which appear to secrete a fluid, like semen, or which serves the same purpose, by fecundating the eggs. Every joint, therefore, is capable of propagating by itself, being strictly hermaphrodite.

As each egg hatches, it forms a head joint, which attaches itself to the intestines, and new joints grow out from it, one after another, like a chain, each one of which can form eggs to produce others.

The naturalist Bonnet divided a small worm of a certain species into twenty-six parts, and almost every part formed a new head and tail, and became a new individual. When sufficient time had been allowed for each of these to obtain growth, they could every one be divided in the same way.

In short, in the lower beings, where there is no differentiation of parts, every portion of the organism is alike, and any fragment of it will form a new being, no matter how it may be separated from the parent. A bud, or germ, is, however, a step toward specialization. Below is seen the mode of reproduction, by fission, of the Vorticella.

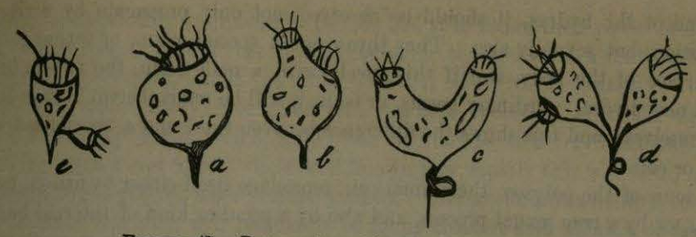

FIGURE 47.—*Propagation of the Vorticelli, by division.*

In this illustration the parent is seen, Fig. *a*, as one globular body, with a mouth, or what serves for one, surrounded by fringes, or threads, used as limbs. In *b* the mouth is dividing into two. In *c* the two mouths are quite separate, and the body also is partially so. In *d* the separation is complete, and the two new beings soon become completely sundered. In one of the new bodies even, a fresh separation is already commencing. In *e* we see a new animal being formed from a *bud*, instead of by fission.

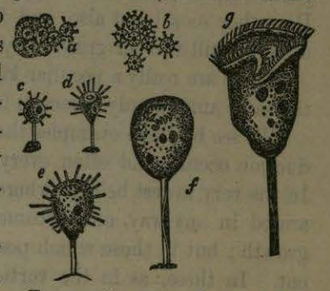

FIGURE 48.—Other forms of Vorticella, showing the gradual development from the germ *a* through *b*, *c*, *d*, *e*, *f*, up to *g*.

In fissiparous generation, the division of the parent organism is not always in the same direction, being sometimes across, and sometimes lengthways, and at other times even oblique, in no particular direction. Owing to this the new-formed beings differ from each other very much, and also from the original, so much so, in fact, that they appear like other kinds of beings altogether. In the vorticella, shown above, the new-formed being often changes in a very curious manner, the head becoming the tail, and the tail the head. The mouth closes up, the cilia disappear, and a single tail-like appendage forms in their place, while at the other end a mouth appears with cilia round it, the same as originally belonged to the opposite extremity.

These new-formed vorticella float about free for some time, and in that state were formerly taken for different kinds of animals, and described as such. After a time, however, the tails become fixed, as a stem, and each forms a true vorticella, as seen above, ready to go through the same changes as its progenitor.

The body of the *Gonium pectorale* is composed of sixteen small transparent globes of jelly, of unequal size, the four larger in the middle, and all lying flat, like a plate. When propagating, it divides into four parts, all exactly alike, each one with a single large globe, and three smaller ones. Immediately the division is effected every one of the four divides into two more, making again sixteen, the same as in the original parent, and so the process goes on.

The *Gonium pulvinatum*, when young, is like a flat piece of thin skin, almost square, which moves about in the water with greater rapidity than might be thought possible from its form. As it grows, the surface is seen to be marked with lines, crossing at right angles, which divide it into small squares. Ultimately these lines deepen, the animal divides, and each little square becomes a new Gonium.

It is quite remarkable how regular this division is, in many of these beings. It is often strictly geometrical, and in this respect approaches to inorganic crystallization.

Some of the hydras, it should be observed, not only propagate by division, or gemmation, but sexually also. They throw out a special ovum, or sexual germ, on the surface of the body, and if this meets with a male germ, the two unite, and form a new hydra. Ordinary germs, or buds, it will be remembered, always develop by themselves; and this shows the difference between them and a specialized sexual germ, or cell.

In some of the polyzoa, the animal can reproduce itself either by fission, by gemmation, or by a true sexual process, and also by a peculiar kind of internal budding. There is a certain band, or cord, which stretches across the parent's stomach, inside, and on which the buds form and grow. As soon as they they are developed to a certain stage they drop off this cord, one by one, and lie loose in the stomach. The parent then dies and breaks up, and the buds are liberated into the surrounding fluid. Here they soon burst also, and further develop into young polyzoons, which have to undergo still further growth, by gemmation, before they fully resemble the parent.

These are really a peculiar kind of bud, and not eggs, or real sexual germs, which the same animal only possesses in another part of its body.

We see by these examples that, in these lower beings, almost every kind of reproduction occurs, and often every kind in the same individual, and at the same time. In the very lowest beings, where the whole organism is alike, any part may be separated in any way, and become a new being, because no change is required, only growth; but in those which possess different organs, or specialized parts, it is different. In these, as in the vorticella, and especially the myriana, given above, the part to form the new being is separated slowly, and gradually forms into a new being, more or less perfect, before it is entirely detached from the parent. The more perfectly the animal is organized, or the more its parts are differentiated, the longer the new being has to be held by the parent, and the more perfect it must become before it is cast off, to give all the organs time to form. This principle is shown in the extreme in man, and all the higher animals.

Buds, sporules, or ordinary germs of any kind, though forming new beings, as eggs or seeds do, are yet different from these. The true egg or seed is a cell that has been specialized or *differentiated*, and is always produced in a special organ, called the *ovarium*, while buds, sporules, or ordinary germs, may spring from any part.

In true sexual beings there are in reality always two specializing sexual organs, the male testicles, to form the sperm or male cell, and the female ovarium, to form the egg, or ovum.

Many of the lower orders of plants propagate by spores or sporules, which are only single cells, separated from the parent organism. This is the case with fungoses, lichens, and ferns. These plants are called *cryptogamous*, meaning secret generation. In the ferns the spores may be readily seen on the under side of the leaves, where they are distributed in regular rows. They are usually brownish in color. When these spores are ripe they separate, and are blown about by the wind. They will grow from any part, unlike seeds, which always have one definite point where growth begins. Spores are, in fact, only single cells, and are much like the pollen grains of regular sexual plants. They are very small, even in large plants, and are produced in immense numbers. A common *puff-ball*, for instance, when ripe, bursts open and emits a perfect cloud of spores.

Like seeds, spores may be kept for years, and may also be submitted to extreme

drought, for apparently an indefinite period, and still retain their power of development. The special part of the plant producing the spores is usually called the *sporocarp* or *sporospore*, but in the mushroom it is called the *hymenium!*

The air is almost everywhere filled with vegetable spores, of all kinds, especially those that develop *mould*, which, under the microscope, is a very beautiful object, resembling often a real forest. It is well known how rapidly this will form, a single night bringing forth the most profuse growth. The ground in a damp forest, on a warm autumn morning, will frequently be found covered with moulds, or funguses, of which there were no signs the previous evening.

CHAPTER XVII.

SEXUAL REPRODUCTION.

In the lower animals, as we have seen, sexual reproduction is only occasional, and occurs along with the non-sexual, but in the higher animals propagation is effected in no other way, they being all sexual.

Sexual reproduction consists in the union of two distinct kinds of cells, one called the male element, and the other the female element. The male element in the animal is called the sperm, or semen, and the female element is called the ovum, or egg. The male element in a plant is called the pollen, and the female element the germ, or seed. It is from the union of these two different elements that the new being results, and, as a rule, each has no power of development without the other; but, in some cases, as before stated, the egg, or seed, will develop without uniting with the sperm, or pollen.

Usually, in animals, the two generative elements are found in different individuals—the sperm, or semen, in the male, and the egg, or ovum, in the female. This arrangement is termed *diœcious*, meaning separate, or in two houses. This, however, is not universally the case, for sometimes the two elements are united in the same body. In plants this is generally the case.

The individual which thus comprises both sexes in itself is called *hermaphrodite*, or *androgynous*, in animals, and *monœcious* in plants, meaning singly, or in one house.

In all cases, the two generative elements have to be brought together, with or without the concurrence of different individuals; and in the diœcious, or separate sexes, many curious and interesting contrivances are found for effecting this, as will be shown farther on.

The first distinction, therefore, among sexually propagating beings is that between the double-sexed and the single-sexed, each of which will be described separately.

HERMAPHRODISM.

The Two Sexes united in One Individual.

Hermaphrodism, or both sexes in the one individual, prevails chiefly among the lower animals, such as the annelids, or worms, and the gasteropods. In insects, the crustaceans, many of the mollusca, and all of the vertebrates, the male and female organs are placed in different individuals, or, in other words, the sexes are separate.

There are two different kinds of hermaphrodites: one in which each individual can impregnate itself, as the holothurias, or sea-anemones, the mussels, and the oysters; and the other in which self-impregnation cannot occur. In this case two individuals always unite, each one impregnating the other, and being impregnated by it in return—a double act on the part of both. This is the case with snails, with earth-worms, and leeches. Sometimes even three, or more, individuals all act

together, forming a chain, or circle, each impregnating the one in front, and being impregnated at the same time by the one behind.

In those beings that impregnate themselves, there are no distinct male and female organs, and no act analogous to copulation takes place. It would rather seem, in fact, as if there were only an ovarium, or germ-producing organ, which evolves the eggs, or germs; and somewhere in the neighborhood there is a part that secretes a fluid, which, being added to the germs, enables them to develop. This fluid, therefore, is analogous to the male sperm, and apparently serves just the same purpose. Still there is not always a distinct semen-forming organ, like a testicle, and this fluid may be only a nutritive one, or a form of protoplasm, which the germs absorb as nutriment. In some beings, in fact, it is produced by a part of the same organ that forms the germs themselves; and in some others it is doubtful if there be any fecundating fluid at all, the egg probably developing of itself.

Strictly speaking, therefore, these beings, instead of being double-sexed, are either imperfectly sexual, or only of one sex, the formation of the germs in them being often, in fact, little more sexual than the formation of sporules in cryptogamous plants.

In the common mussel the eggs are contained in a kind of sac, or bag, just underneath the skin, and at the period when they are ripe a fluid is secreted by this sac itself, which flows over the eggs and impregnates them, after which they develop into little mussels, before they leave the parent inclosure, and may be seen with a lens quite readily, each one covered by its tiny shell. The mussel, therefore, brings forth its young living.

In the oyster the process is very similar, there being really but one sexual organ, which acts as both male and female, and the young are brought forth alive, like the young mussels. They are very minute when first emitted, and are called the *spat*. As soon as free, they attach themselves to any suitable surrounding object, and there remain and grow. In some others, as in the barnacles, the male and female organs are a little more distinct. There are real testicles, in which a true seminal fluid is formed, which is conveyed by a long tube through the whole length of the animal's body, to the place where it meets with the eggs, and then it fecundates them, and they are thrown off.

This kind of hermaphrodism is the first and simplest form of true sexuality. The two principles are to some extent *differentiated*, and a first step is taken toward separate and distinct male and female organs. There is no instance known in which both male and female organs, in a perfect state, and capable of sexual union, are found in the same individual; so that, strictly speaking, there are no true hermaphrodites, who can form and impregnate their own germs, by the act of copulation. In one sense, however, the beings already described are true hermaphrodites, because each individual can propagate its kind by itself, without the concurrence of any other individual. If only one were left, therefore—say one mussel—it would be able to continue the species.

In the next kind of hermaphrodites, we have distinct male and female organs; one secreting semen, and the other forming germs;—but they are so placed that they cannot co-operate, so that the individual cannot impregnate itself. Two individuals, or sometimes more, unite in the double act, being impregnated, and impregnating in return. This kind of hermaphrodite, therefore, although more perfect, as far as the sexual organs are concerned, than the kind first described, is yet less perfect in

regard to propagation, because it cannot impregnate itself, and one individual would not be able to continue the species.

Among those hermaphrodites that perform this double act, there are many curious varieties of structure and function, some of which we will describe.

In the common snail we find in each individual a true ovary, and true testicles, so that it makes both eggs and semen. It also has a curiously formed penis, a kind of tube, which can be drawn in or thrust out, like the finger of a glove. In the interior of the right side of the body there is a kind of canal, with which the ovaries are connected, and in which also lies the penis. This canal opens on the right side of the head, between the great and little horns.

When the eggs are ripe they are passed into this common canal, where they await impregnation. The animal's own testicles, however, do not communicate with this canal in such a way that their semen can be thrown into it, so that it cannot self-impregnate. They empty only into the penis. When two individuals meet, however, each one projects its penis outward, and thrusts it into the other's sexual canal, where it emits the semen among the eggs there lying. This is done by both at once, so that each one impregnates the other, and is impregnated by it in return; or, in other words, each acts both as male and female at the same time. They often remain united in this way for a considerable period.

A similar double union occurs in earth-worms. When they lie on the ground in a dewy morning, they may be seen to be united at two places, in a way that enables each one to perform both sexual acts at the same time.

The same thing occurs in leeches, and many other beings of the same class. Eels are also hermaphrodite.

There is one species of snail, however—the *Helix pomatia*—which possesses a special sexual organ of a very singular character, whose real nature and uses are not known. In the common sexual canal of this animal there is a tube, or long sac, which has at its lower end a little projection which secretes a bony material that forms into a kind of long needle, called the *love dart*, which can be thrust out like the penis. When two of these snails meet, they push out these darts and thrust them into one another, apparently to cause amative excitement, for after having done this, they proceed to copulate. There is, usually, quite a long period of dalliance before the dart is actually used, the two beings rubbing their bodies together, in all parts, and touching one another in various caressing ways. When this has gone on for some time, one of them suddenly projects his dart and tries to prick the other with it, but the one attacked draws quickly into his shell and avoids it, making, perhaps, a similar attack in return. This love battle often continues for a long time, till one or both are pierced; then the mimic combat ceases, and they perform the double sexual union.

The dart is often broken off during the fight, and many observers formerly imagined it was really *thrown;* but this is now generally acknowledged to be an error. The dart is almost square, having four sharp ridges and a tapering point. When one is lost, or broken, another is soon formed, so that the animal is never long without one. The use of this curious instrument is probably simply to stimulate or cause excitement, so as to make the act of conjugation more perfect, and possibly more pleasurable. It is formed only in the season of copulation.

There are various other parts, more or less connected with those named, but as we do not know what part they play, it is not necessary to refer to them any more.

It will be understood, of course, that these parts are shown as they appear when dissected out of the body and displayed. It would not be possible in a picture to show them just as they are in the snail. This will serve, however, to show how they are connected, so that their mutual action in the process of copulation can be understood.

Both the testicle and the womb are ordinarily quite small, but in the pairing season both enlarge very much, and the womb seems to fill with eggs. The penis is a very singular organ, resembling a long whip-lash, but hollow. It is shown in the

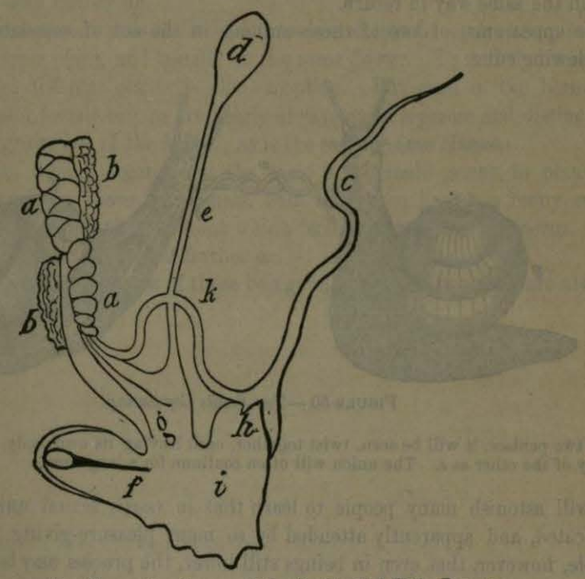

FIGURE 49.—*Generative Organs of the Snail called Helix Pomatta.*

a a are the ovaries; *b b* the testicles; *c* the penis; *d* the bladder; *e* the tube leading from the bladder; *f* the love dart; *g* the beginning of the passage leading to the ovaries, the lower part of which may be called the vagina, and the upper part the womb; *k* is the vas deferens, or tube which conveys the semen from the testicles (*b b*) to the root of the penis; *h* is the place where the semen is emitted; *i* is the common generative cavity with which all the parts communicate. The passage to the womb (*g*) ends in it, and also the tube from the bladder (*e*), and the seminal tube (*k*) ends in it at (*h*). It also contains the love dart (*f*). It is supposed to be cut open and spread flat. The actual use of the part called the bladder (*d*), and of the fluid it contains, are not known, and there are some other parts connected not here shown, because nothing is known about them, and this is intended merely to show those parts actually concerned in copulation and impregnation.

cut protruded, and it can be drawn in on itself, like a glove finger, till it is quite small, and easily contained in the body.

The testes, *b b*, and the womb or ovary, *a a*, which contains the eggs, it will be seen, are associated together, but with no actual connection, so that the animal's own semen cannot impregnate its own eggs. Instead of doing so, it is conveyed by the vas deferens, *k*, to the penis, *c*, and by that is conveyed to the eggs of another snail, whose penis does the same in return. The copulating passage is the common generative cavity, *i*, which opens exteriorly on the outside of the head. The fluid secreted by the bladder, *d*, is thought to be used in covering the eggs as a kind of varnish; but this is not sure.

The act of copulation will now be understood. When two snails meet, and are amorously inclined, they begin a series of coquetish dalliances which may last for an hour or more, and during which their activity belies the old adage, "as slow as a snail." When this has continued long enough, they begin to use the love darts, in the way already described, and when both have been pierced by them, the real copulation begins. The two penises are thrust out, and each one inserts his into the common generative cavity of the other, till it reaches the womb by the passage *g*, and impregnates the eggs. Each one, therefore, impregnates the other, and is impregnated in the same way in return.

The appearance of two of these animals in the act of copulation is shown in the following cut:

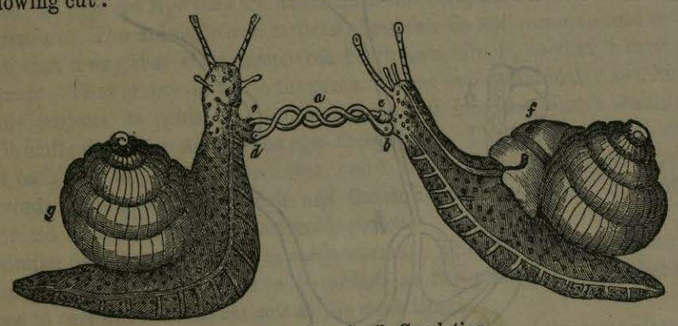

FIGURE 50.—*Two Snails Copulating.*

The two penises, it will be seen, twist together, each leaving its own body at *d*, and entering the body of the other at *e*. The union will often continue for a long time.

It will astonish many people to learn that in *snails* sexual union should be so complicated, and apparently attended by so many pleasure-giving processes. It is probable, however, that even in beings still lower, the process may be equally curious and equally pleasurable.

In some snails the male organs are at one end of the body, and the female organs at the other, and that is why three or four individuals must always unite together, in order that each one may be brought into play.

In other similar beings the generative apparatus is still more curious and complicated; so much so, in fact, that the uses of many parts of it cannot even be conjectured. Some others of them have a kind of love dart, besides the one above described, but differently situated, and whether used in the same way or not is unknown.

Snails have a great power of reproducing lost parts. If their horns be cut off, new ones will grow again; and, in fact, if the whole head be removed a new one will be reproduced. Nevertheless, they do not propagate by either fission or budding, but by eggs, which may be found in clusters, at the proper season, on the under sides of leaves. They are, therefore, truly sexual and hermaphrodite.

Many of the water-snails are also hermaphrodite, but they have the separate male and female organs so far apart, and so situated, that two of them cannot copulate, like the Pomatia, above described. There must always be three at least, and when there is but three, it is only the middle one in which the double act is performed. One of the others can act only as male, and the other only as female, to the one

between them. Usually, however, a number join together in such a way that each one can act both male and female with two others, and long chains or rings of them thus act together.

These snails lay eggs, also, like the others, but they develop in the water.

Hermaphrodites in the higher animals are only monstrosities, from malformation of the parts. None of them are truly hermaphrodite naturally, although at one period of its growth even the human embryo is neither male nor female, or more properly speaking, it cannot be told which it is, for there is no difference in the two sexes, as will be seen farther on.

In plants hermaphrodism is the rule, the male and female organs being in nearly all cases on the same plant, and usually on the same flower. To find them separated on the same or on different plants is the exception. But even in the hermaphrodites the male and female organs are nearly always quite separate and distinct, even where the male grows out of the female, as is the case in some classes.

The male and female organs, and the male and female germs, in plants, correspond very nearly to those in animals, and they even have, in many cases, a similar function of *copulation*, without which fecundation would not occur. This, however, will be better understood farther on.

We will now proceed to speak of those beings in whom the two sexes are always in separate individuals.