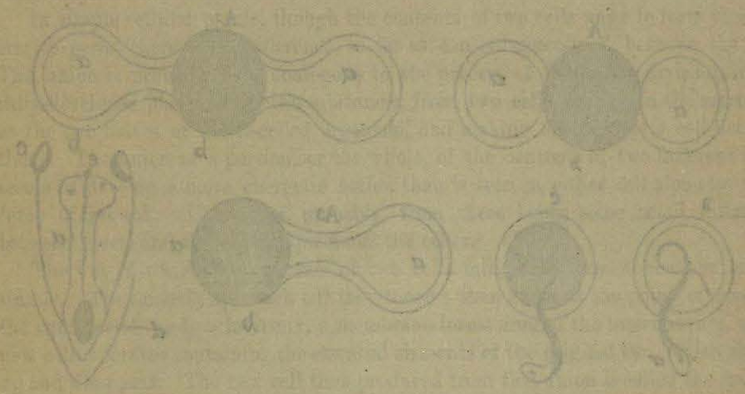
the process of reproduction. It will also show that the old poetic dream of the *loves of flowers* is probably a reality! Any one who has studied the curious ways in which the male and female organs of flowers unite, how they bend, and turn, and twist, to come together for a short embrace, and the close union they form, can scarcely help thinking that pleasurable sensation, of some kind, must accompany the process. It is, perhaps, really the same in kind as love in animals, only different in degree.



PART XI.

PARTHENOGENESIS, OR VIRGIN GENERATION; AND THE ALTERNATION OF GENERATIONS.

CHAPTER XXV.

VIRGIN GENERATION.

In some of the lower animals the process of reproduction presents a most remarkable peculiarity. We find in them, at some period or other during their career, both males and females, and, of course, the two sexual elements, and they propagate in the usual way by uniting them.

In addition to this, however, there is a period in which the female propagates alone, without any concurrence with the male; in fact, at that time no males exist. This is called Parthenogenesis, or virgin generation.

The best illustration of this remarkable mode of propagation is found in the green Aphis, or plant-louse. These insects are always to be met with, during spring and summer, on the young shoots of the rose tree, which are often covered with them. They are small and plainly visible to the naked eye, plump, round, with six legs, and bright green in color. In front the aphis has two long feelers, and behind two odd-shaped spikes. It has no jaws, since it lives entirely by sucking the juices of the plant on which it lives, and from which it seldom moves, unless forced to do so.

The aphis is always full, and frequently even overflowing with the plant-juice, thus causing that peculiar sticky, sweetish, varnish-looking substance called honey dew, often seen on the leaves and stems of plants. Ladybirds, ants, and several kinds of grubs, feed on these plant-lice, not eating them, but using them as we do cows. They tap them, or milk from them the juice they contain, and which they keep continually drawing from the plant.

It may readily be supposed these insects are terribly hurtful to vegetation, and indeed gardeners consider them among their worst foes. One particular kind, which lives on the hop-vine, often causes in England a loss in revenue alone of upward of a million dollars in a single season. They propagate with such extraordinary rapidity that when the season is favorable for them, nothing can withstand their power of destruction. And yet the greater part of this astonishing multiplication is effected by females only!

During the early summer all the aphis are wingless females, and a brood of them begins in this way. An egg is laid the previous fall, usually in the axis of a leaf, which in the warm spring hatches out into a wingless female insect, with six legs, as above described. In a few days this wingless female produces eight more living creatures, just like herself.

And each of them, in like manner, soon produces eight more, and so on, for six, eight, and even ten, successive generations! This ratio of increase would make it possible for one single egg, in one summer, to produce ten thousand million insects! We need not wonder, therefore, at their astounding numbers, and at the rapidity with which they multiply.

But the most remarkable thing, connected with this prolific propagation, con-

sidered physiologically, is that it all results from virgin females only, not a male being produced! Where then, it may be asked, does the egg come from with which we started?

It comes in this way: toward the end of the summer the production changes, and the same wingless females bring forth aphides with wings, and which are both male and female, perfect. These copulate in the usual way, and the female deposits her eggs on the plant to be hatched the next spring, and to commence the same round as before. Then both parents die, and no more males, or winged females, are seen till next autumn.

It is supposed, therefore, that the influence of the autumn impregnation is continued through the ten or more generations of the next spring. But why only females should result from it for so long a period, and yet finally perfect males and females both should result, we do not know.

It would rather seem as if the early broods were real virgin productions, and all female from lack of vigor in the parent. As the season advances, and the plant juice becomes richer, the parent may become more vigorous, and capable of producing perfect males and females.

It will be seen that the reproduction of this insect depends entirely upon the production of the egg at the end of the season. The aphis itself perishes entirely in the winter, but the egg survives, to be hatched when warmth returns in the spring. The one way to lessen or destroy them, therefore, is to destroy the eggs, for a single one hatched is enough to produce thousands of millions of the aphides.

We do not know that the eggs have any destroyers, though fortunately there are plenty for the insects themselves; but in spite of all, the plant-louse never fails.

The following plate shows the progression of this remarkable creature from its commencement in the egg.

It has been suggested that the so-called wingless females may really be hermaphrodite, but no trace of a male apparatus has been detected in them. Even if they were, it would still be a strange anomaly for them to produce finally true males and females; and besides these true males and females produce only eggs, while the wingless insects produce *living* insects, like themselves.

Consider it in whatever light we may this abnormal mode of propagation is very wonderful, and gives rise to many plausible speculations.

The generation of the hive bee is, in many respects, analogous to that of the aphis. We find among them three different kinds of beings—the males, which are produced only at certain times of the year—the workers, which are only imperfect females—and the true females. These three varieties all result from eggs laid by one female, and the difference between them is brought about in a very curious manner.

One female produces all the eggs that a hive requires to form a new swarm, some thirty thousand or more, so that only one is reared. If two are produced they always fight till one is killed, the males making no interference. When ready for impregnation, the single queen takes a flight through the air, a kind of nuptial journey, during which the males attend and impregnate her, probably repeatedly. After this is effected she returns to the hive, and enters upon the business of laying eggs, the workers forming the cells, making the honey, and attending to her and the eggs. The males being no longer needed soon die off.

This single impregnation suffices to fecundate all the eggs she afterward lays; the semen she has received being stored up in a peculiar organ adapted to the purpose. This seminal reservoir communicates by means of a tube, with the oviduct, down which all the eggs pass, and it is so made that she can open and close it at will.

All the eggs which are to produce workers, or future queens, are impregnated as they pass down the oviduct, the seminal tube being opened at that time to let the semen reach them. But when the eggs pass down that are to form future males, the seminal tube, it is said, is not opened, and so they are not fecundated at all. This has been apparently proved by destroying the tube which conveys the semen, in which case the female produces nothing but males.

If this be really the case, and it would seem to be so, then all the males are produced by the female only, and have no male parent at all. In support of this it may also be noted that when two kinds are crossed the males all resemble the queen only.

Some naturalists, however, contend that the eggs of insects are of no sex, but may be developed into either, according as the resulting larvæ are fed and treated. And this possibly may be the case, for as before explained, all cells are primarily alike, and male and female are only different stages in their development.

Parthenogenesis occurs in many other beings, besides those above described, but the process is essentially the same in all.

The occasional imperfect organisms developed in the human virgin, from her ovæ, are of course true cases of parthenogenesis, and it is quite conceivable that in some former state of the world, among beings very different from what exist now, it may have been a frequent occurrence.

It has been suggested that the wingless aphides, produced by the virgin females, should be regarded only as buds, like those formed on plants, and not as true sexual products, while the final perfect males and females should be regarded as the flowers and seeds which the plants finally produce.

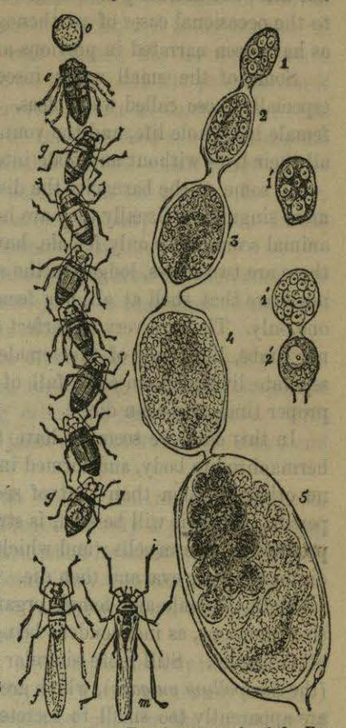


FIGURE 90.—*Parthenogenesis of the Rose Aphis.*

o, is the original egg laid on the rose stalk in the fall. *e*, is the first insect hatched from this egg in the spring. *g*, to *g*, are seven different generations, each one produced by the one before it, and all wingless females alike. *f*, and *m*, are the ninth generation, or sometimes the tenth or eleventh. They are produced last in the season, and are perfect male and female. These copulate, and the female lays the eggs to be hatched the next spring. The male has organs like testicles, which secrete a true sperm, and the female has an ovary which produces eggs, like the more perfect animals.

From 1 to 5 shows the *ovarian tube*, in which the aphis is developed. Beginning at 1, we find a small number of *germ vesicles*, which, as they develop and multiply, passi nto 2, 3, 4, 5, successively. 1', 2', represent single vesicles magnified.

These successive enlargements of the ovarian tube are needed to accommodate the continually increasing brood. In each chamber the larva has become more perfected, till finally in 5 it is ready to come forth as the grub *g*.

By some, each of the imperfect stages of the aphis is regarded only as a kind of budding, the true sexual reproduction occurring only in the final stage.

Regard it as we may, however, the whole process is very wonderful, and highly suggestive.

This explanation is more ingenious, it seems to me, than well-founded, and does not meet the difficulty so well as that given above. Nor does it seem to apply at all to the occasional cases of parthenogenesis in the higher animals, and in plants, such as have been narrated in previous articles.

Some of the small water insects exhibit the phenomenon of parthenogenesis, especially those called water fleas. In some of these one impregnation will last the female her whole life, and the young females which she produces will produce young all their lives without any male intercourse whatever.

In some of the barnacles the disposition of the sexual elements and organs is still more singular. Usually they are hermaphrodite, but not in the ordinary way. The animal seems to be only female, having no separate male organs, and instead of them there are two males, lodged in the same shell, which impregnate only her. They do not leave that shell at all, nor fecundate any other female, and evidently serve the one only. They are very imperfect as animals, having neither mouth, anus, stomach, nor limbs, like those of the female. They seem, in fact, to be nothing more than separate living sperm cells, full of sexual animalcules, which they discharge at the proper time, and then die.

In this case, we seem to have the male testicles separated from the rest of the hermaphrodite body, and formed into living organisms by themselves. They perform no other function than that of secreting semen, and when that is discharged they perish. This, it will be seen, is strictly analogous to those cellular organisms which produce only germ cells; and which may be considered as living female ovaries, which discharge their ovæ and then die.

Both the male and female organs, therefore, may live, and perform their respective functions, as independent beings, without being structurally connected with any other bodies. Still more singular than this, there are other beings, of a like kind (the *Scalpellum vulgare*), which are also hermaphrodite, but in whom the male organs are apparently too small to secrete enough sperm to insure fecundation. To compensate for this, there is always found closely connected with them a number of independent males, which by their seminal secretion make up the deficiency. These males never separate from the hermaphrodite body, and when no longer needed, die. Their sole purpose evidently is to make up for the smallness of the male organs which form part of the parent body. They serve, in fact, the same purpose as those before described, but are more perfectly organized. They never pair with simple females, but only with the hermaphrodite they live with.

In what is called alternation of generation, parthenogenesis frequently occurs, with change from one mode of generation to another. The common tapeworm is an instance of this, and a very instructive one.

In their perfect state tapeworms are always found in the intestines of warm-blooded animals, their presence causing much sickness and distress. How they come there, and the change they undergo, is understood by few of those who suffer from them.

This animal, as usually seen, is composed of a number of flattened joints, all alike, connected together like a chain, sometimes of immense length. The real animal, however, is but small, constituting the round upper end, called the head, or sometimes the nurse. It is very curiously formed, having a circle of hooks, or suckers, or sometimes of both, by which it holds on to the inner wall of the intestines. It has no digestive organs, and no mouth, so that it lives entirely by absorbing the fluids of the body to which it is attached.

The joints, as they are called, which stretch out, one below the other, downward from the head, are all simply so many hermaphrodite propagating bodies. They are all alike, each one having male and female organs, and being capable of producing ovæ, or eggs. The head itself, the real animal, has no reproductive organs, and apparently could not, alone, continue its kind. All the propagation is effected by the joints. Whether there be any nervous system in the tapeworm has not been ascertained. There is, however, a kind of tube on each side, running the whole length of the animal, called the water vascular system, which binds all the parts together. At each joint a small tube goes across from one side to the other, like the rounds of a ladder, and thus all the joints are organically connected. In the last joint this cross tube opens into a peculiar contractile vesicle.

The joints are all formed from the head, by budding, one after another, each new one being produced between the head and the nearest joint, so that those nearest the head are always the youngest, and the end ones the oldest.

Each separate joint has both male and female organs, perfect, consisting of an ovarian tube, and a seminal tube, which both open together into a small projection on the side, and are ejected through an opening called the generative pore. This pore is placed alternately on the right side of one joint and the left of the next, and so on.

What is called a tapeworm, therefore, consists of the real animal, the head, and the joints (named proglottides). It may be altogether only a few inches long, or many yards; every joint, or proglottis, being nourished by what is imbibed from the intestine through the head. Possibly the joints may also absorb, by osmose, from the fluids in the intestines. It is, in fact, a fearful parasite, feeding all the time on its victim, and perpetually multiplying itself.

The most remarkable thing about this creature, however, is the way in which it is developed, for it does not reproduce its kind directly, nor where we usually find it.

The sexual joints, which form the eggs, are produced only in the intestines of warm-blooded animals, as in man, but the eggs never hatch there, so that no new worms are ever formed there, and usually there is but one. This is why it is sometimes called the "solitary" worm. Before the eggs can be hatched they must be swallowed by some other animal, as they never develop in the one in which they are formed.

The joints, one after the other, when their contained eggs are all fertilized, become fully ripe, detach themselves, and are expelled from the body with the excrement. After this discharge, they soon become decomposed, and the contained eggs are liberated.

Each egg is covered with a firm capsule, or sac, which protects it from injury, and it often contains the rudiments of the young worm so far developed that its head and suckers can be distinctly perceived, though very minute. At this stage the egg must be swallowed by some warm-blooded animal, and so be carried into its intestines, before its development can proceed any farther.

When once in the intestine, the capsule is soon ruptured, or dissolved by the gastric juice, and the young tenia is liberated. It is then ordinarily only like a small vesicle, or sac, but it is provided with three pairs of flinty spines, or borers, with which it bores its way through the walls of the intestines, and so reaches some of the neighboring parts, or some blood-vessel, which it enters, and may then be carried in the blood to some internal organ, often the liver.

It is now called a "*proscolex*," and having got so far, immediately sets to work to develop further. Wherever it may be, it forms around itself an inclosure, like a round sac, called a cyst, in which it lies, and at its posterior end it develops a small round vesicle, filled with fluid. It is now called a *scolex*, or sometimes a hydatid. While in the cyst it consists only of the head, with its hooks and suckers, and the vesicle of fluid attached behind. It has no other organs of any kind, and it is unable to proceed further with its development where it is. It may, however, propagate in this encysted stage, by simple budding, but only produces a scolex, like itself, except very rarely. In some exceptional cases it produces an organism like a half-developed tenia, but never a perfect one.

If the scolex, however, reaches the intestines of a warm-blooded animal, by being swallowed, it attaches itself by its hooks, or suckers, and soon forms the perfect head of a new tapeworm. The vesicle drops off, and the formation of joints commences.

When first formed, the joints are not perfect, but as the chain of them is gradually lengthened, those first formed ripen, the eggs are produced and impregnated, and they become finally ready to fall off and begin the circle again as *proglottides*. The whole animal, head and joints together, is called a *strobila*.

The animal, therefore, goes through the following stages: 1st, the *egg*, produced from the generative joint, or proglottis; 2d, the *proscolex*, or embryo, which is set free from the ovum after that has been swallowed by some warm-blooded animal; 3d, the *scolex*, or encysted embryo, a little further developed than the proscolex, but still with no generative organs, though it may propagate by budding, beings like itself (formerly called a cystic worm); 4th, the *strobila*, or perfect tapeworm, with head and joints developed from the scolex after this has been again swallowed by a warm-blooded animal.

The course of one of these worms may be traced in this way: An individual afflicted with tapeworm is constantly evacuating the ripe joints, with their eggs. These are very small, and may either be washed by rain, or otherwise, into water, or they may dry up and be blown about by the wind. There being so many eggs thus dispersed, some of them, if pigs be around, are sure to be swallowed by these animals with something they eat, and once in the pig's intestines each one soon forms into a proscolex, which bores its way into some part of the body, and becomes a scolex. Usually they pass into the muscles, and when in large numbers cause one form of what is called the *measles*. In the pig itself, the animal remains a scolex only, but may propagate by budding, as before explained. If, however, the pig be killed, and a man eats part of its flesh, especially the ham, he necessarily swallows the scolex, and once in his intestines it fastens itself to the walls, and becomes a true tapeworm, or *strobila*, ready to form joints and begin the same round over again.

In the cystic, or scolex state, it was formerly called the *cysticercus cellulosus*, and was chiefly noticed as the agent that caused the measles. Measly pork, therefore, is simply the flesh of a pig infested with tapeworm in the scolex stage.

It would seem almost like what is called poetic justice, that the cat is afflicted with a tapeworm which results from a scolex contained in the mice which it eats, and in like manner the tapeworm of the fox comes from the hares and rabbits it devours. The tapeworm of the dog comes from a cysted worm, which causes the staggers in sheep; and in man there is a variety which comes from measly beef.

What are called hydatids, in the human body, result from the scolices of the tapeworms of other animals, especially of the dog, which by some means obtain access to the interior of the body.

It is very difficult to get rid of a tapeworm, because it is of no use to merely break off some of the joints. If the *head* is not got rid of, the animal is still there. When a part of the joints protrudes, a steady, firm pull upon it, not enough to break it off, will often make the head let go, if the pull be kept up for some time. Several drugs have more or less power over the tapeworm, either killing it, or causing paralysis, so that it looses and comes away. Turpentine is very effective for this purpose, but the new remedy, *kousso*, is the best yet discovered.

It is very certain that the principal source of the tapeworm in man is swine's flesh. And those animals that feed around the most promiscuously are, of course, the most likely to be infested with it. The flesh of all measly animals ought to be carefully destroyed.

Altogether some 200 varieties of tapeworms, and of others resembling them, have been described, about ten of which affect the human body.

In the perfect form, tapeworms are found only in the vertebrate animals, though in the larval, or scolex stage, they are found in some of the invertebrates. In birds they are very numerous, especially in water birds, but they are rare in reptiles, or fishes, except the cuttle-fish. The hog itself, it will be observed, never has the tapeworm, in its perfect form, but only the scolex, which he passes on to man to be completed.

The scolex, it should be remarked, sometimes reaches the *brain*, causing epilepsy, insanity, and even death. Still, old men have been found, after death, infested with them in almost every part of the body, and yet, while living, apparently but little inconvenience resulted from their presence.

The adjoining plate shows the various stages of development in the tapeworm.

In the hydroid polyp, called the *sertularia*, the generative process is still more remarkable. The egg which it produces swims about, for a time, by means of cilia, or hairs, which it uses as oars, but finally becomes attached to some object in the water, and then develops a mouth and limbs, and becomes a new being. It then commences to produce others like itself, by budding—all of them growing together, forming a colony, in which each is independent, though all are united. None of these new beings have any sexual organs, and consequently they are unable to propagate, except like the parent, by budding. After a while, however, some of the buds grow into beings entirely different in

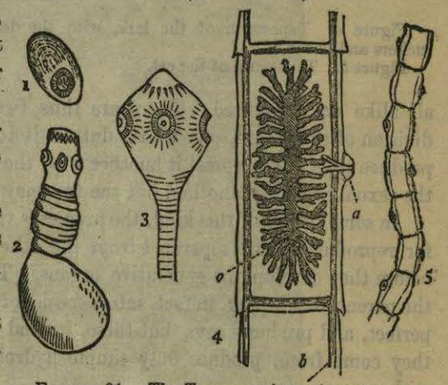


FIGURE 91.—*The Tapeworm in various stages.*

Figure 1. An egg, containing the embryo.
Figure 2. A cysticercus, or scolex.
Figure 3. Head of a tapeworm enlarged, to show the hooks and suckers.
Figure 4. One of the joints magnified, showing the ovary *o*, the generative pore *a*, and the water vascular canals *b*.
Figure 5. A portion of the jointed part of the tapeworm, to show the generative pores on alternate sides.
The water vascular tube on one side is connected with the one on the other side by two cross tubes, one above and one below.

appearance from these, and possessed of sexual organs, which produce fecundated eggs, like the one begun with, and then immediately die. Both kinds remain attached together, and the first kind seem simply to produce nutriment, by which

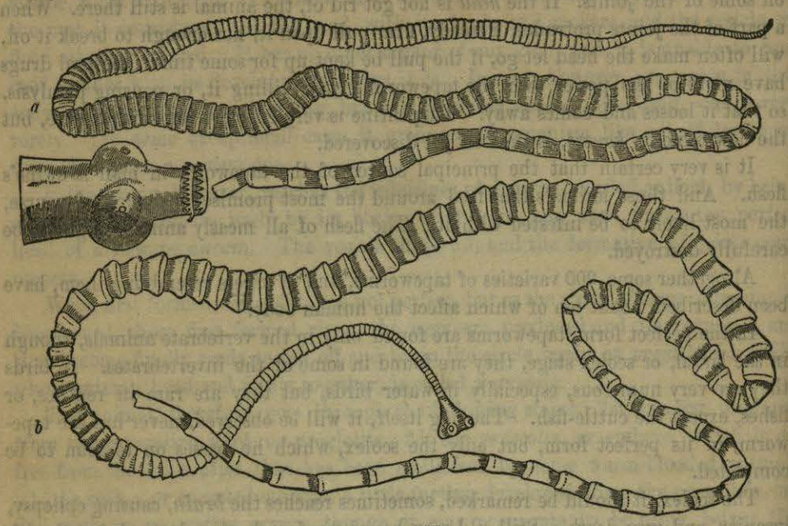


FIGURE 92.

Figure *a*. Tapeworm of the lark, with the detached head much magnified to show the suckers and hooks.
Figure *b*. Tapeworm of the cat.

all alike are supported. There are thus two kinds of beings formed by simple division of the parent, one whose duty it is to provide nutriment, and the other to produce eggs. To express it another way, the stomach is placed in one being, and the sexual organs in another, but the two may still be united together.

In some beings of this kind, the process is varied a little. The new beings destined for reproduction are separated from the others, and live for a while independently before they develop the generative organs. They become also totally different from the parent, developing, in fact, into a species of jelly-fish, or medusa, which is sexually perfect, and produces eggs, but these, instead of developing into jelly-fish like those they come from, produce only simple hydroids, like the original one commenced with.

In some others, again, the primary egg forms into a round, free, swimming body, which attaches itself finally to some object, and then further develops into a being formed like a trumpet, with mouth and limbs, like the hydra. This trumpet-like body propagates abundantly by division, but only beings like itself, without sexual organs of either kind. At last, however, the trumpet-like parent enlarges, changes in form, and splits into several pieces, which swim separately away and form into so many new beings, entirely different from the parent. They become, in fact, medusæ, or jelly-fish, occasionally many feet in diameter, with perfect organs of digestion and finally, also, of reproduction. These, when full grown, give birth to perfect eggs, and then die. Their eggs, however, do not grow into anything like the large jelly-fish parent, but into small hydras, like those with which the circle began.

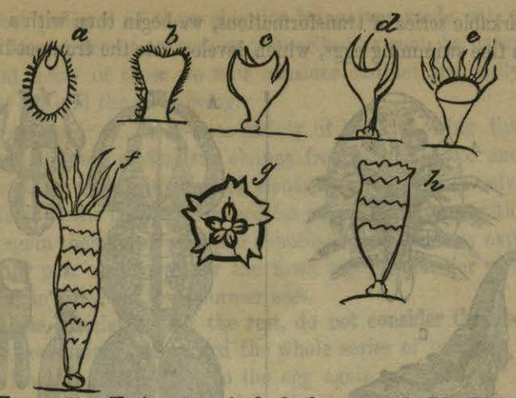


FIGURE 93.—*Various stages in the development of the Jelly-Fish.*

a. The original egg, with its fringe of cilia. *b*. The same attached at one end, and beginning to lengthen, while the top sinks in and the corners rise up. *c* shows a still further change, the corners being lengthened into tentacles, which finally multiply into a large number, as in *d* and *e*. The body then lengthens, and is divided into segments by a series of rings, as in *f*. These segments gradually separate, and are at last held together only by a slender filament down the center. They are, in fact, like so many plates, piled one upon another. Finally, the upper plate separates and floats away, like *g*, and the others follow in succession. The root, however, remains, and continues to form new ones, as in *h*. Each of these segments, or plates, then develops into a perfect jelly-fish, as below, and this produces eggs, which begin the same round over again.

FIGURE 94.—*The perfect Medusa or Jelly-Fish;* resulting from the simple egg *a*, through all the various stages above described.

In this remarkable series of transformations, we begin then with a minute hydra, which produces free swimming eggs, which develop into the trumpet-like bodies, and

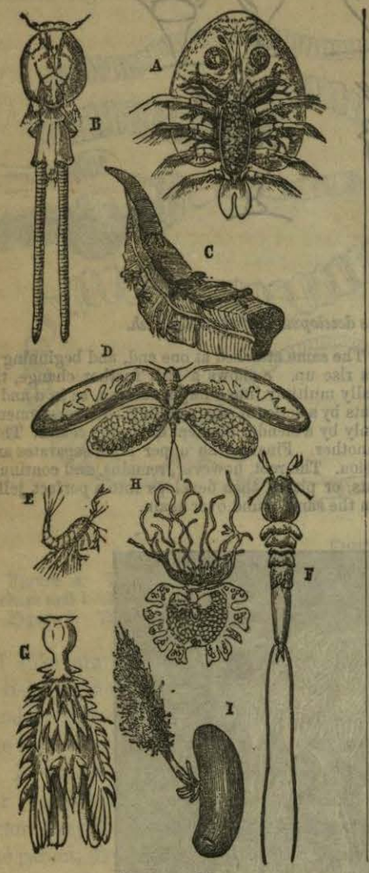


FIGURE 95.

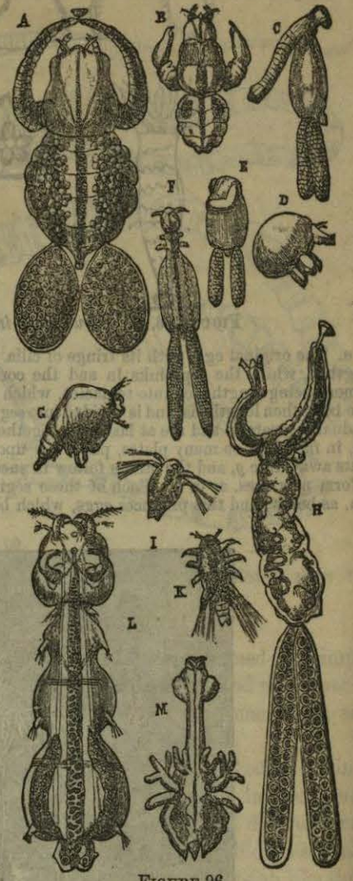


FIGURE 96.

Some of the most remarkable Parasites found upon Fish and Crustaceans.

Figure 95. A is the argulus, which lives under the fins. B. The caligus, found mostly on the cod. C, D, E. The nicothœ, or lobster louse, found chiefly on the lobster's gills. F. The dicheles-tium; this creature works its way under the skin, near the gills, of many kinds of fish. G. The chondracanthus found in the gills of the John Dory. H, and I. Two remarkable parasites found under the abdomen of the lobster.

Figure 96. A. The female perch sucker. B. The male. C and D are the female and male of the anchorella. E is another anchorella. All these infest the backs of cod and haddock. H, I, K, show the various stages in the development of the tracheliastes; in H its two long egg bags are seen protruding behind. L, M. The lampoglena. All these last bury themselves in the flesh in various parts of the body. One of these parasites, the penella sagittata, or sprat sucker, attaches itself to the sprat's eye, and hangs from it.

In short, the variety of these beings is endless. Every part of the fish is affected by them, and they seem often to cause great suffering.

these divide up to form jelly-fish, which may become quite gigantic, and which produce eggs that develop back again into the minute hydra.

Before the real pedigree of these singular beings was made out, each different stage was taken for a different animal, and described as such by naturalists. It is very possible that many of those we now consider distinct are really only similar separate stages of one and the same being.

Similar changes occur in an endless variety of ways, showing that nature can propagate in many different modes, and change from one mode to another, even in the same being. The sexual organs and elements are evidently only the common organs and elements of the body, specialized for purposes of propagation, and sometimes resuming again their former simpler functions. As formerly explained, in the simpler beings any part may serve, for the time, any purpose for which it may be needed, and be again relegated to its former uses.

Some naturalists, Huxley among the rest, do not consider the above process as one of alternate generation, but regard the whole series of changes, from the egg through all the transformations back to the egg again, as one act. Much may be said in favor of this view, and it certainly simplifies our conception of the phenomena; but the whole subject requires further elucidation. No matter how it may be regarded, this strange series of metamorphoses, ending at last with the same being it began with, is certainly one of the most wonderful of nature's operations.

In the vegetable world there is often what is equivalent to the alternation of generations in animals. Some quite large and well organized plants produce no seed, but only small spores, such as form the lowest mosses and lichens. These spores produce a plant inferior to the parent, but which is able to produce a *seed*, and this seed develops into a plant like its grand-parent, and not like the one it sprang from.

The perfect germ cell or seed, is not formed at once, in this case, but by two efforts. The simple spore is only the first stage in the process of its evolution, the final stage being reached when the seed itself is formed.

The parasites which live upon other animals are all very singularly formed, and have very peculiar habits, according to the parts on which they live. Their mode of reproduction is often very obscure.