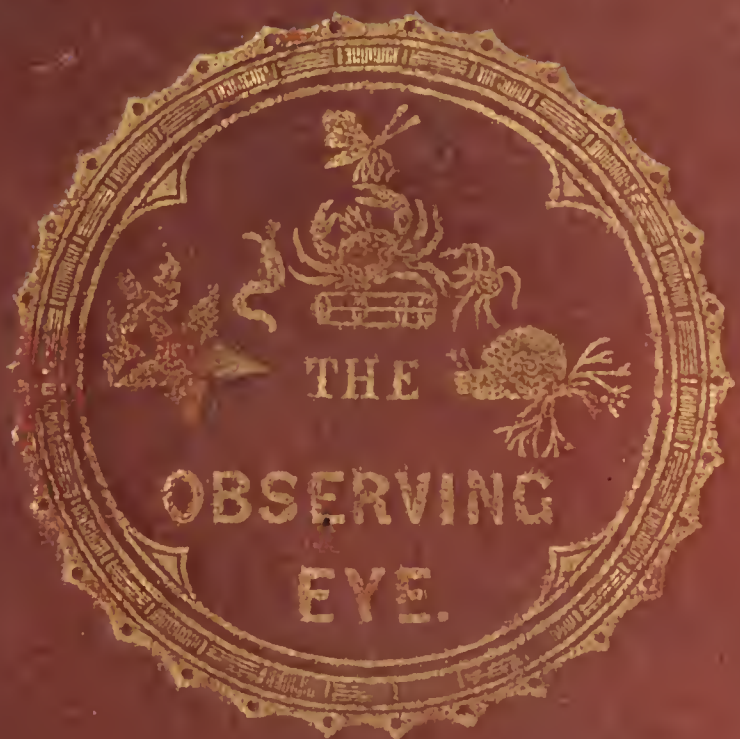
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"Everything that is made displays the power and wisdom of God."—Page 107.

THE OBSERVING EYE;

OR

LETTERS TO CHILDREN

ON THE

Three Lowest Divisions of Animal Life.

THE RADIATED, ARTICULATED, & MOLLUSCOUS.

By the Author of "Our World; its Rocks and Fossils;" "What Mean ye by this Service? or Scripture Sacrifices Explained," &c.

SIXTH EDITION.

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PREFACE.

MOST of the following letters on the Lowest Races of Animals were addressed to a young family, in consequence of questions started by an intelligent boy of about eight years of age, whilst rambling one morning amongst wooded grounds interspersed with streams of water.

During the correspondence that followed this ramble, the works of Cuvier, Roget, Kirby, and many other writers were consulted, and their modes of expression frequently borrowed; but no idea being entertained of publishing the letters, marks of reference were seldom given. This neglect the writer is now unable to remedy; although every reader acquainted with the above authors, will frequently detect in the following pages the print of their footsteps.

The study of natural history is found to possess a great moral influence over children, supplying them with cheerful motives for active employment and intelligent research; whilst the constant displays of wisdom and power which it unfolds, tend to elevate the mind in admiration of the great Creator, and fill the heart with praise. Leigh Hunt observes with animation, "What do they not lose, who are strangers to serious meditation on the wonders and beauties of created nature! How gloriously the God of creation shines in His works! Not a tree, nor leaf, nor flower; not a bird, nor insect, but proclaims in glowing language, 'God made me!'" The refining tendency of this pursuit was practically understood by a schoolmaster residing in the neighbourhood of London, when he promptly remarked, "Of all the boys committed to my care, I find those lads the least disposed to stray into vicious habits, who delight in the study of living creatures."

Buxton, 1859.

PART I.

THE RADIATED ANIMALS.

"O what an endless work is *here* in hand,
To count the sea's abundant progeny!"

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Explanation of Terms in the Radiated Division.

Acalephæ. Floating animals, composed of jelly water.

Albumen. An animal substance, something like white of egg.

Animalcules. Creatures which live in water, and are too small for the natural eye to see.

Cilia. Hair-like short threads, forming fringes.

Coral. A name given to the hard or tough habitations, in which a set of creatures, called polypes, live.

Gemmule. A jelly bud that falls from sponge and coral.

Horn. An animal substance, composed of lime, of glue, and of albumen.

Hydra. A jelly tube animal.

Mammalia. Animals that give milk to their young.

Nerves. Soft white threads spread over the bodies of animals, to give them feeling, and power of motion.

Polype. An animal made of jelly, in the shape of a tube or cone.

Polypifera. Polypes and their houses, or polypes living together in hard habitations of their own forming.

Radiated Animals. Animals having arms round a centre, and therefore daisy-like in appearance.

Tentacula. The very sensitive arms of radiated animals, which move, something like the horns of a snail.

Zoophytes. Animals, like plants. *See Radiated.*

Explanation of Terms in the Articulated Division.

Abdomen. Last division of an insect's body.
Albumen. Animal substance, something like white of egg.
Annelida. Worms.
Antennæ. Threads or feelers on the heads of insects.
Arachnida. Spiders.
Articulata. Animals made with rings and jointed.
Branchia. Same as gills.
Ganglia. Nerves tied into knots.
Gills. Breathing parts of water animals.
Horn. An animal substance, made of lime, glue, and albumen.
Jaw Feet. Instruments by the mouths of lobsters and insects for breaking their food.
Nerves. Soft white feeling threads, coming from the brain of animals.
Spinnerets. Knobs belonging to bags of gummy silk in the spider's body.
Thorax. The middle part of an insect's body.
Tracheæ. Air tubes, running along the sides of an insect's body.
Vertebrated. Having a back-bone.

CUVIER'S ARRANGEMENT OF ANIMALS.

Animals are divided into 4 *great divisions; the Divisions are separated into* 19 *Classes; the Classes into* 77 *Orders; and the Orders into many Genera.*

The First Division consists of the Vertebrated, or back-boned animals; and is divided into 4 classes.

- 1st class, the Mammalia; or men and beasts.
- 2nd class, the Birds.
- 3rd class, the Reptiles.
- 4th class, the Fishes.

The Second Division consists of Molluscous, or soft-bodied animals; and is divided into 6 classes.

- The 1st, 2nd, and 3rd classes are headless Molluscs, called the Acephala; — such as oysters and mussels.
- The 4th, 5th, and 6th Classes have heads and feet, and are called the Encaphala; — such as snails, murex, and nautilus molluscs.

The Third Division consists of the Articulated animals, or animals surrounded by rings; and is divided into 4 classes.

- 1st class, the Annelids; or worms.
- 2nd class, the Crustaceans; or crabs and lobsters.
- 3rd class, the Arachnides; or spiders.
- 4th class, the Insects; or flies, beetles, &c.

The Fourth Division consists of Zoophytes, or Radiated animals; that is, of animals like plants; and is divided into 5 classes.

- 1st class, the Echinodermata; or echinus, star fish, &c.
- 2nd class, the Acalephæ; such as the jelly medusa.
- 3rd class, Internal Worms.
- 4th class, Polypes, 3 orders — Fleshy polypes, sea anemone; Gelatinous polypes, hydra; Polypifera polypes, corals, and sponge.
- 5th class, Animalcules, 2 orders — Rotifera—wheel animalcules; Homogena—monads.

LETTER I.

RADIATA.

Difference between Plants and Animals.

My dear young Friends,

I have received your kind note, and am glad that you desire a few letters on Natural History, because I hope a little instruction may lead you to observe objects in Nature with increased interest.

An ignorant mind is incapable of noticing a vast number of the curious things that surround it;* whilst a little information gives a person an *Observing Eye;* and with some observation, a man may find amusing company everywhere. It signifies not

* Knowledge is power—ignorance is darkness.

whether he be in the house or in the garden, in the fields or in the road, by ditches, by ponds, or rambling over the glittering wet sea-beach, still something is generally at hand to delight the awakened mind. Yet I must own I am puzzled to know where to begin our stories, for our great Creator has filled the world with such hosts of living creatures, it is difficult to know which to notice first. All naturalists, (that is, men who study the life and habits of animals,) have found this difficulty; therefore to assist their powers of observation, and to help their memories, they have divided these hosts of animals into sets or groups. Cuvier, a very clever French naturalist, has made *four* excellent *divisions*, which I think we cannot do better than adopt.

In the first division or group of animals, he put all those which have back-bones, and called this the VERTEBRATED division: in it are men, beasts, birds, reptiles, and fishes.

In the second division he put all animals with shells over their soft bodies, and called this the MOLLUSCOUS division; in it are snails and shell-fish.

In the third division he put all animals that have hard coverings, made of rings on the outside of their bodies, and called this the ARTICULATED division; it contains worms, insects, spiders, lobsters, and crabs.

In the fourth division he put all the animals that are almost like plants, and called this the ZOOPHYTE or RADIATED division; this contains the sponges and corals, star-fishes, and sea anemones.

Amongst these sponges, corals, and star-fishes, Cuvier also placed another set of curious little creatures, called the animalcules; not because the animalcules are like plants, but because they are so unlike any other kinds of animal, that he did not know where else to place them. It is of this lowest great division, called the Radiated, that I propose first to speak; and we shall find that it contains the feeblest kind of animals, which our Creator has seen it good to place on this globe of land and water.

When I first studied the strange tales belonging to the history of these lowest creatures, I was greatly amused and delighted. I was astonished to find that many of them are so much like plants, that it is often difficult to believe they are animals. Indeed it is only within the last few years that naturalists have decided that some of them are actually living creatures; for the fact that they all required air and food, did not of itself settle the question whether or not they were animals.

Only observe the air and food which a tree requires to keep it alive. Its roots suck up the juices which they find in the earth; and by some wonderful power which the great Creator has put in

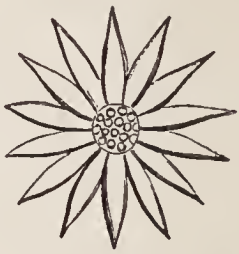
a tree, these juices are made to run up the stem. They run up partly under the bark, but mostly through the cells or holes in the fresh wood that was made during the former year; and these juices run up the stem, something in the way that water runs up the sides of a piece of loaf sugar: only in the tree these juices do not stop, but on they go till they reach the leaves. Now every leaf is full of innumerable little holes, through which air and water rush in and mix with the drawn-up juices; and as every leaf is made up of a top skin and of an under skin, with fine fibres running between them, the fresh sap runs first along the top part of the leaf, and then passes to the under side of the leaf. During this passage through the leaf, the air changes the quality of the pumped-up juices. Sometimes the air prepares the sap to become sweet, sometimes sour or bitter; sometimes it prepares it to turn to a clear gum, sometimes to a thick juice like tar, just according to the laws the wise Creator has seen it good to establish. As soon as the air has made this change, the sap flows back into the tree, and going down under the bark, it forms a band of new wood, and likewise nourishes the woody fibre of the great trunk.

Animals have no roots by which to gather up the nourishment they require: their food is received by a mouth, and passes down into a cavity called the stomach, where it is melted or dissolved. The

juices drawn out of the received food, are then carried all over the animal by innumerable little tubes, called arteries and veins. Yet air must always mix with these juices, or the animal will die. Some creatures draw the air into their blood through little holes in their sides,—flies do this; others draw the air in by gills,—such as fishes; others draw air down into the chest by breathing. In the chest the air meets with the new juices, and turns them to a bright red. This bright red blood keeps the bodies of all back-boned animals warm, and makes them grow.

So far we have seen that both vegetables and animals want two things—they want food and air. What then is the difference between a plant and an animal? The great difference is, that vegetables always absorb, or take up their food by the roots or outside of their bodies, whilst animals always absorb, or take up the juices of their food from cavities in the inside of their bodies. And these two modes of support make an important difference in vegetable and animal life. Vegetables become fastened down to one place, that their roots may absorb the moisture around them; whilst animals, carrying their food within them, are generally left at liberty to move about. Then again, vegetables have no feeling and no wills; whilst animals feel pain, and not only move about from place to place, but have strong wills.

All the higher orders of animals have two sides to their bodies, and these two sides match one another, just as the one half of our faces matches the other half; but plants have no two sides alike; they grow round and round a centre. Their flowers grow in the same way. Look at a daisy; it has a middle, and all its petals, or ornamental parts, grow round that middle. In this round way the lowest of all the animals grow; for we shall find that the creatures, which are scarcely superior to vegetables in their powers, are formed with a middle like a daisy. In this middle is their mouth, and round this middle stand the few organs, by which, at their own good will, they take in their food. Therefore naturalists have agreed to call these kinds of animals by two names. One name is *Zoophyte*, which is a Greek word, meaning animal and plant. The other name is *Radiated*, or rayed. These radiated or zoophyte animals mostly live under water, and seldom move from the place where they first settle down.



My next letter will describe the sponge, which is a creature that stands in the very lowest scale of animal life; indeed, it is scarcely like an animal, for it has neither mouth nor arms, such as all the other zoophytes possess; yet I think we shall find

that the sponge shows some marks of being a live animal.

And now, believe me,

Your affectionate Friend, &c.

LETTER II.

RADIATA.

On the Sponge.

My dear little Friends,

Last week I promised you the history of the sponge. I suppose you have observed, that the sponge we use at home is of a brown colour, that it is soft, and will quickly suck up or absorb water. But have you ever closely examined the substance of a sponge? Have you seen that it is made up of fine fibres, which are flexible, or will bend; that these fibres are elastic, or will spring back again after being pressed, and that the whole of its substance is pierced with many pores? I

think it would be well to have a piece of sponge by you whilst we study its history. And now I must tell you, that the fibres of the sponge which you can squeeze in your hand, are made of three different materials; partly of the earth called silex, of which flints are formed, partly of lime, and partly of the materials of which horn* is made.

You have lately been staying by the sea. That mighty ocean, which covers so large a portion of our globe with its briny waves, is the home and dwelling-place of the live animal called sponge. Probably this is the first time you ever heard sponge called an animal! I am not surprised at this, for older heads, and wiser heads than yours have for hundreds of years called it a vegetable; yet sponge really seems to be something like an animal. In its form it is little better than a vegetable, for it has neither head, eyes, ears, mouth, stomach, feet, nor fins; nor in feeling does a full-grown sponge differ from a vegetable, for it has been cut, torn, burnt, and pulled into pieces, without appearing to shrink, or to show the least mark of sensation. The great French naturalist, Cuvier, has thought it right to place sponge amongst the lowest of the zoophyte or animal plants, because when the sponge is young it moves about, and then it shows a little sense of

* Horn is a thick net-work substance, formed of three things—glue, phosphate of lime, and albumen, which is animal matter something like white of egg.

touch; and afterwards, when it has grown large, it shows some will of its own, by drawing food into itself at its own pleasure. Do you remember at this moment what makes the difference between a vegetable and an animal? *(See page* 15.*)*

Let us now watch the history of the sponge's life, beginning with its infant state. Suppose you were standing on a rock in a warm situation, such as by the Pacific Ocean, or the Mediterranean Sea, and that this rock on which you stood, jutted a little way into the sea: it is very likely that in such a situation, you might see, what many an observing person has seen, a pile of sponge fastened under the waters on the rock; and as you watched it, your eye might every now and then catch sight of a little jelly-like looking thing falling from off the side of an old sponge, somewhat of the shape of a pear, but exceedingly small. This little thing is called a *gemmule*, from the Latin word Gemma, a bud. You would see there was no shell to cover this gemmule, no skin to cover it, but that it looked exactly like a clear drop of the white of an egg, without head, eyes, ears, stomach, feet, or fins. Instead, however, of falling to the bottom of the sea like a dead thing, you would see that this little jelly fellow, feeling life in itself, kept afloat in the waters, and that it immediately began to lift up and down with amazing quickness a number of fine threads or spikes, that cover more than half of its body, and which are

called *cilia*, from the Latin word *cilium*, eye-lashes or bristles; these cilia the gemmule whirls about most rapidly, making quite a hubbub in the water; and then pushing with the roundest part of its body foremost, off it swims; and as it moves along, it keeps up a perpetual bustle in the water, never ceasing to vibrate its cilia, for by them it is ever drawing food into its body.

* Gemmule of the sponge. *Natural size. Magnified.*

As it swims, it looks as if it did not know what it wanted, nor where it was going. But God, its wise Creator, knows, for it is He who cares for it, and draws the little sponge gemmule far away from the old sponge, that it may live in another place, and so spread the good of its existence over the sides and bottom of the sea. If two of these live gemmules happen to meet and to strike each other, they instantly stop their moving arms. The next moment they turn themselves round and round, and then off they go to work again. After wandering about for three days, they seem tired of roaming, and then prepare to settle down upon some piece of wood, shell, or rock, which from that time becomes their fixed home. They begin by fastening the narrow end of their bodies to the hard substance

* The gemmules of the sponge are often so minute, it requires the aid of a microscope to see them.

they have found, and all this time their tendrils or cilia go on making the same stir around them; but in a few hours after they have fixed themselves tight, their cilia grow quiet, they lie down flat on the rock, and never again move all their lives long, but rest quietly sucking in the sea water.

Very soon after the gemmule has become quiet, a great number of dark spots are seen loosely floating in its clear little body. These dark spots are the fibres of the sponge beginning to grow in the live jelly, and the fibres are made of the three materials we named before—silex, lime, and horn:* which three substances the cilia had drawn into the body of the gemmule out of the sea water.

These little spots of sponge soon join together like net-work, and make a sort of frame-work or skeleton for the live jelly to rest upon. Our bones make a frame-work or skeleton for our flesh and muscles to rest upon, and as our bones grow, our flesh increases; so, as the sponge's frame-work grows in the gemmule, its live jelly grows too, and the jelly fills all the tubes and holes of the sponge, and even covers quite over the outside of the sponge.

When the jelly is much grown, and the sponge much grown, a great many fine spikes are sometimes seen to shoot out of the sides of the sponge tubes; it is supposed these fine spikes are made to grow

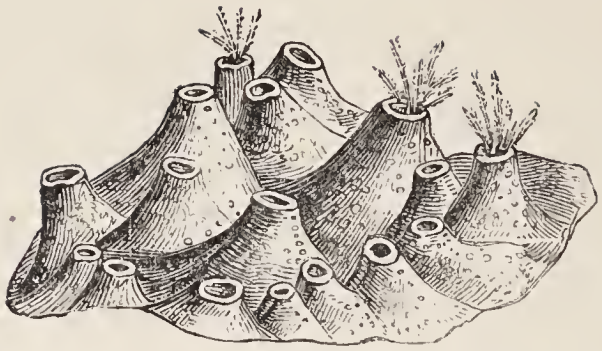
* See note, page 19.

in the inside of the tubes, to prevent the weight of the growing sponge from pressing too heavily upon the live animal jelly. All round that part of the sponge which is fastened on the rock, you may see a clear rim of jelly spread out; and when two sponges grow so close that these rims touch one another, they immediately grow together and make one lump.

Some men have tried to take hold of the living jelly of the sponge, in order to see what it is like, but they are always disappointed, for as soon as it is taken off the sponge, it turns to a kind of thick oil or glue, and soon dries up.

As the sponge grows on the rocks, it throws up many round heads with large holes on the top. The sides of a sponge, you can see, are full of little holes or pores; it is by these little holes that the sponge draws the sea water into its substance, and after letting the water run through the whole mass of its body, the living creature seems to vomit out what it does not want, through the large holes at the top, and often sends the water out with such force, that it has been seen to rise up in the air like a little fountain. A small piece of live sponge placed in a basin was seen, by the help of a microscope, to throw out this water for five hours together; after which, as if it were tired, it stopped to rest for a time.

These sponge animals are of many shapes,



Morsel of Sponge magnified in a basin, vomiting out the rejected water.

according to their species. Some grow like shrubs, some like trumpets, and vases, and tubes, and some like globes. I saw some beautiful specimens of these varieties in the Museum at Manchester. All the sponges stick so tight to the rocks upon which they are fastened, that the furious dashing of the mighty waves hardly ever tears them off. In some places they are seen to cover cliffs and rocks, in other places their soft bodies line the walls of caves deep under the waters, and sometimes they hang in dropping branches from the roofs of the caverns. Sponge is found in all parts of the sea, from the north pole down to the hottest part of the ocean. In some parts of the Pacific Ocean, it grows like the most beautiful branches of a tree; but in cold seas it grows in a much closer and denser mass. A good deal is found in the English Channel, and I have gathered up little pieces on the Cromer beach; but none of these northernly

sponges are so strong for use, as those which grow in the Mediterranean sea.

How wonderful are the works of our God! We shall soon find there is an immense portion of life going on in the waters of the world. Myriads and myriads of animalcules dancing, leaping, and chasing each other, in drops and in pools of water, as well as in the heights and depths of the ocean; whilst the sponge, in the joy of its hidden life, sends forth its fountains in the deep paths of the sea.

In Rev. iv. 11, we may read for whose pleasure all these things were created. Yet has our Heavenly Father given to man, both the dominion over, and the use of all the creatures He has placed on the earth. See Gen. i. 26, 28. Gen. ix. 2. Psalm cxv. 16.

My next letter will give you a description of the animalcules, which are the most minute animals yet discovered by man amongst the works of his Creator.

Believe me, very affectionately, &c.

LETTER III.

RADIATA.

The Animalcules.

My dear young Friends,

We are now to commence our tale of the *animalcules*,* which are little specks of living creatures that swarm in almost every pool of water, but which are so small that the naked eye of man sees them not, and his finger feels them not; nor did it enter into the mind of man to suppose such minute creatures lived in the world, till about one hundred years ago: at that time some observing men discovered, that when they fixed several glasses, something like spectacle glasses, into a brass tube, these glasses obtained a power, by means of which the

* Animalcule—from animal, a little animal: The word animal comes from the Latin *anima*, air or breath.

rays of light were spread out so wide, that a tiny object appeared to be many thousand times larger than it really was. This instrument is called a microscope. A bee's sting placed under a microscope, looks like a large needle; and a drop of water, magnified by some of these glasses, looks as wide round as a great carriage wheel; and a set of lively, merry little creatures, can then be seen swimming, and chasing each other, as they dive up and down in this one drop. I hope in some future letter to give you a longer account of this useful instrument—the microscope, but at present I only wish to speak of the minute creatures which it has laid open to our wondering sight.

Perhaps you may scarcely think it worth while to enquire after creatures so minute, that we cannot behold them without a magnifying glass. Let us therefore ask if animalcules are of any benefit to man? These minute specks of creatures are useful when alive, because they eat up decaying morsels of vegetables, which if left to ferment, would injure the air; and they also eat up many other things that render water offensive. Again, their swarming myriads are of great value, because many of the larger races of animals feed upon them; fish devour large quantities, so also do some birds, and many insects live upon them.

The bodies of animalcules are also useful when dead. Did you ever look at a *hone*, that hard

substance upon which men sharpen their knives? If you have a hone in the house, look at it, and tell me if it looks like the hard cases or coverings of insects and beetles. I know what you will say—"No, it is a stone!" But now comes the wonder. The microscope shows us that a hone is entirely made of the hard jackets or cases of dead animalcules, glued together by the earth called silex, or flint.

When these minute animals died, their cases, which are made of silex, and are as transparent as glass, fell to the bottom of the lake or pond in which they lived; and just as you may observe that a brown crust will settle on the sides of a jug in which water is left, so does silex, or the earth which forms the chief part of flint, gently fall out of the quiet waters of a lake, and settle down upon the piled-up clear siliceous* coats of the dead animalcules lying there, and thus they become glued together into one hard stone.†

* Siliceous means belonging to the earth, silex; sea-sand is chiefly composed of silex.

† Children in a village school having expressed surprise that the cases of animals could form a substance as hard as stone, were requested to look at the windows. The glass in those windows, they were told, was chiefly made of the flinty earth, called silex; that is, of the very same kind of silex which forms the thin clear coats of the hone animalcules. One pane of glass is quickly broken, but if all the panes of glass in those windows were taken out and glued together, then they were asked, if they did not think the new glass substance would become both hard to the touch, and, from its thickness, a dull substance to look upon; just so, millions upon millions of clear silex animalcules glued together form a hard and thick substance like hone.

A great deal of this animalculæ stone, called hone, is found in the mountains of Hungary and Turkey. The earth that forms these mountains was once the bottom of a lake; but being raised up by the force of volcanic fire and earthquakes, now towers on high in the form of lofty hills.

Tripoli is a red powder, which is used by men who wish to polish steel very highly. This tripoli is chiefly composed of the cases of other kinds of dead animalcules; and very often, every rub the workman gives with his red powder, breaks to pieces millions of their perfect little cases. A great deal of tripoli is brought for our use from Asia Minor.

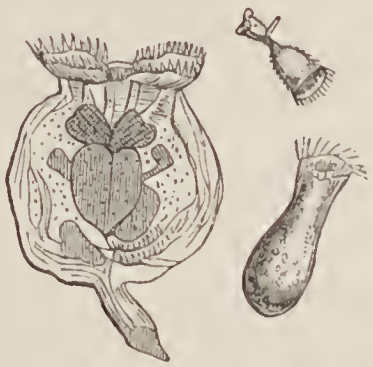
By the shores of a lake in Sweden, a vast quantity of fine white powder is met with. It looks like chalk or flour, and is called by the natives mountain meal, because they mix it with their bread, and find it nourishing. But what do you think the microscope says this mountain meal is? The microscope shows us that it is nothing but the shelly coverings of immense masses of animalcules, that once lived under the waters of a lake, where their coats, collecting for ages, and not being glued together by silex, have formed thick layers of mealy earth. The same work of depositing the coats of animalcules is now going on in the clear bright waters of some lakes; a portion of the mud from the bottom of these lakes has been placed under the microscope,

and it is found to be full of animalcule remains. Yet it is no wonder we cannot see these swarming multitudes swim about in the transparent waters, when the microscope teaches us that hundreds of these minute creatures can lay in the thickness of a line made by a fine pen. If these facts were not made very clear, and proved to be true, we should say they are too wonderful to be believed.

These mites of living things are not all of the same size. We can almost see some of them with the naked eye, whilst others are so excessively small, that a dot ○ would be a good-sized field for hundreds to play in; and they dance to and fro, and hurry backwards and forwards in a drop of water, as gudgeons would in a good-sized pond. A grain of sand is a mountain to some of these little beings. Animalcules are also of various shapes, as well as of various sizes. Some are oval, some are like a bell, some are like a pear, some like an eel. They are very voracious, very active, and generally live in water.

The French naturalist, Cuvier, devoted his life to the study of animals. At the age of nineteen, he was staying at Caen in Normandy, which place is near the coast of France, and observing a variety of shells on the sea and river beaches, he began to examine them; and from that time to his old age, he pursued the subject of natural history with delight. When he examined the animalcules, he found

there were two great points of difference in the formation of this wonderful family. Some had heads, mouths, stomachs, and arms. To these, Cuvier gave the name of Rotifera, or wheel animalcules; and he chose this name, because he observed this set had usually two lumps or lobes on the head like wheels.



Wheel Animalculæ magnified.

These lobes are covered with horny little spikes called cilia,* which the little animals are always moving or shaking; and this motion causes the water to whirl round their heads, just as twisting a wheel round and round in a pond causes the water to run round in fast whirling eddies.

To the other set of animalcules Cuvier gave the name of Homogena and Monads, because they look all alike, just like one little live lump; their clear transparent bodies having no appearance of any organs, besides having several bags or stomachs. And these monads increase in numbers, by little

* Cilia, from *cilium*, eye-lashes or bristles.

nobs or buds growing on their sides, which keep falling off and making new monads.

Monads magnified.

The little round monads are so excessively small that the largest magnifying glass only makes them look like specks. It is even said that five hundred millions of monads can live in one drop of water. Now, on the face of the whole earth, there are not quite one thousand millions of men. Is it not then a wonderful thought, that one drop of water is able to contain half as many living creatures in it as there are men walking on the face of the earth! and that each one of these minute animals should enjoy its life, and find plenty of room to move about in this small space!

What a marvellous Creator is our God! By the help of the telescope we lift up our eyes to the distant stars, and the sight of their large orbs teaches us two lessons: one lesson that nothing is too large for our God to create: and the other, that nothing is too heavy for His almighty arm to uphold.

The microscope lays open to our eye a scene of living creatures so minute, that by its help we learn two other lessons: one lesson that nothing can be too small for His wisdom to create; and the other,

that nothing can be so minute that He will forget it. Such wonders are

> "The unambiguous footsteps of a God,
> Who gives His lustre to an insect's wing,
> And wheels His throne upon the rolling worlds."

Do you know who is the Maker of all these wonderful works? Does not the Bible say it is Jesus? even that Jesus who so loved us, that He died for us? See John i. 1—4. John x. 14, 15, 18. Col. i. 12—17. Heb. i. 1—3.

In warm weather, animalcules are always to be found in quiet water. If you were to put hay at the bottom of a basin, and were then to fill it with water, and leave it quiet for a few days in the summer, you would see a bright-coloured skim spread itself over the top. That skim is nothing but live animalcules; and these animalcules that arise from vegetables steeped in water, are given the name of Infusoria.*

Animalcules of one sort or other are found everywhere, both in Europe, Asia, Africa, and America, and both in fresh water and in sea water. Why such immense shoals of living creatures should have the enjoyment of life given to them, so that not one drop of water can long be without a host of inhabitants, is a wonder we cannot understand; only we see by this fact, that our heavenly Father delights in life. We cannot stand on the scorching sands of the

* From being infused or steeped.

equator, nor climb to the top of the loftiest mountain, neither can we visit the icy poles of the earth, nor grope into the darkest caverns of the sea, without finding that our God has been there, blessing vast multitudes of creatures with life.

Can you give me a verse in the New Testament which tells us that God watches over His inferior creatures? Matt. x. And where is it said in the Psalms, that He tenderly provides for the wants of all His creatures, both great and small? Psalm cxlv. 9, 15, 16. For this great goodness, what should His works do? Psalm cxlv. 10.

If you wish to read further particulars of the animalcules, you can open that nice little book called "The Wonders of the Waters." My next letter will bring you the history of the hydra, a small animal, looking like a tube of jelly.

Now believe me, &c.

LETTER IV.

RADIATA.

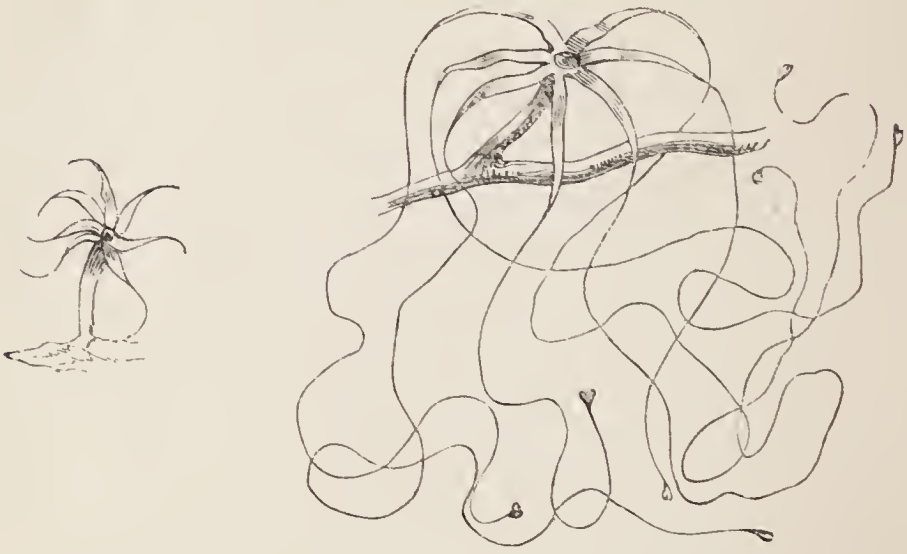
On the Hydra.

My dear young Friends,

We are now to consider the history of the hydra, a curious active little jelly creature, made in the shape of a tube worm, but so small, that it looks something like a short piece cut from a fine stalk of hay.

The hydra is one of the zoophytes, which, as we said before, are sometimes called radiated animals, because their organs are placed like the rays of a daisy round their mouths. Amongst these rayed animals, all those that are made in the shape of a *cone*, or of a *tube*, and have a fringe of arms round

the mouth, are called *polypes.** The hydra is a polype, being a jelly tube with arms. The arms of the hydra are sometimes long, sometimes short, and they are often as fine as the ravellings of delicate muslin, and not unfrequently of a green colour.



Short-armed Hydra. Long-armed Hydra.
Magnified representations.

There is yet more to be told of the hydra, for it is not only a *polype*, which means that it is one of the tube class, but it is called a *gelatinous* polype, because its body is nothing but jelly, having no skin, no shell, nor any house to cover its body, like some of the other polypes.

All these polype animals are a feeble race of jelly creatures, yet they are a highly interesting and most

* The name polype is taken from the Greek words, *poly*, many, and *pous*, foot, and means many feet or roots.

busy set of little beings. They stand higher than the sponge in the powers of life, because they have tentacula or arms, and many of them have curious stomachs for dissolving their food. They are very quick to know when they are touched, and try directly to hide themselves, yet they never feel what we call pain. You may cut a polype worm into four or five pieces, and it hurts it no more than cutting our hair into four or five parts; this is because God has seen it right to make the jelly tube of a polype without any nerve of feeling in it. But its Creator has given the polype a sense of light, as well as some will of its own; and many of them build houses of stone. The stone-building polypes live in the sea, but the hydra is a fresh-water gentleman; and it is not unlikely that he may be a near neighbour of yours, for he lives in weedy ponds, and in the slow-moving waters of ditches: about May, the hydra is found abundantly in the ditches round London.* You and I may have often passed by without observing him, for he looks like a delicate thin hair or tube, about the length of one of your finger-nails; and if at all frightened, he curls himself up into a small round O.

These hydras were first observed about one hundred years ago by a Mr. Trembley, of Geneva. This gentleman was fond of looking at plants, and one day, when he was closely examining some water

* The hydra is found on duck-weed and other water-plants.

plants which he had placed in a basin, his attention was caught by something that resembled small strings of the stalk, sticking to the leaves. He watched these strings or filaments, to see what they could be, and very soon he found they moved, and snapped up insects and even worms. He saw these little strings did not like to be in the dark, for they crept round to that side of the basin where the most light fell. Do you think Mr. Trembley threw his basin of plants away? Oh no! he was deeply interested; he felt sure that he was looking at some little creatures no man had before observed. For several years he kept these little creatures on the leaves of water plants, and fed them with insects and small water worms. He often examined them with his microscope, and then found that the hydra has neither head nor feet; that it has no shell over it, no skin, no bones, no muscles; but that it is altogether one soft transparent tube of jelly flesh, open at both ends, having only a few spots or grains in its flesh, which spots some think are made of lime.

One end of the hydra's tube is narrower than the other; this narrow end some call the tail, some the foot, because when the hydra curves up the edges of this end of its tube, it forms a sort of cup or sucker, and by this sucker it sticks tight to the stems and leaves of plants. The widest end of the tube is called the mouth, and this mouth has a

crowd all round it of ten or more tentacula, or thread-like arms, as fine as the most delicate baby's hair. These fine tentacula are hollow, and the hydra can either push them out or bury them in its tube body, just as a snail draws in its horns.* When the hydra wishes to send forth its tentacula, it fills them with a little fluid, which it forces into them from the inside of its tube; and when it wants to draw in its tentacula, it empties them, and then they shrink down close to the mouth.

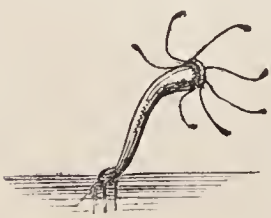
Mr. Trembley found the hydra a very voracious creature. It was always casting its tentacula about like fishing-lines, and prowling over leaves in search of insects, small worms, and shell-fish. If an insect did but touch one tentaculum, the hydra felt it in a moment, and quick as thought twirled two or three more of its tentacula round the struggling captive, pouncing upon it like a spider on a fly. As soon as its prey was safe, it bent its tentacula round, and twisted the worm or insect into its mouth; then opening wide its tube, it would often swallow a portion of food that looked bigger than itself. Mr. Trembley once saw two hydras throw their long arms over the same worm. They pulled and tugged to get it away from each other, till at last the largest and strongest conquered, and drew both the captive worm and the smaller hydra

* The name of tentacula is given to these thread-like arms, from *tendo*, to *stretch*, because they stretch out or draw in.

into its mouth. "Poor little hydra, now you are dead," thought Mr. Trembley, but this was a mistake; to his astonishment he beheld the little hydra very happily landed in the inside of the bigger one's tube, and there it lay, sucking away at the same worm, which the juices in the large hydra's tube were dissolving. And when the worm was all eaten up, the big hydra cast the little one uninjured out of its mouth. Another time Mr. Trembley was desirous of knowing what the inside of the hydra's tube was like; therefore he turned the hydra's tube inside out, like the finger of a glove. Do you think this killed the living hydra? Not it; it mattered not to the hydra which was the inside, or which was the outside of its body; and the turned hydra went on eating as if nothing had happened. When the hydra has eaten all it wants, it usually looks like a quiet round ball, having its arms drawn short in round its mouth.

Hydra filled with food.

When the hydra wishes to walk upon a leaf,* it



fixes the sucker end of its tube tightly down, and then stretches out its body till the mouth end leans on

the leaf; then loosening the sucker, it gently draws

* These hydras are magnified representations.

the sucker foot close up to the mouth, and a-

gain fastening it down, throws its mouth forward; thus it travels on. But before its mouth is thrown forward, the hydra always seems to stop as if thinking what to do next, so it takes this gentleman a long summer's day to travel seven or eight inches. But if the hydra is in a great hurry, it falls to, making somerset after somerset, like a boy, and so rolls itself fast onward.

In the water the hydra glides along most pleasantly. It begins by raising the foot end of the tube out of the water to dry its flat edges; then gently pulling the dry foot just under the water, the water shrinks away from the edge of the dry foot, and rising a little way up round the tube, a sort of cup or hollow is left between the water and the end of the dry sucker. This little hollow keeps the hydra from sinking; and till its foot becomes wet, it hangs in the water at its ease, gliding across the pond or ditch; and all the way as it swims, it casts its fishing lines about for food.

The jelly flesh of the hydra has no nerve in it to occasion pain, and this renders the hydra very tenacious of life; indeed it seems almost impossible to kill the little creature. Mr. Trembley one day cut a hydra into two pieces; neither of the pieces shrunk or curled itself up, but the mouth end began

to fish, and presently he saw a new foot beginning to grow at the cut end; and to his surprise, the foot piece, which he had cut off, had in four or five days a new mouth, and fresh tentacula thrown out. Even a single tentaculum, when it was cut off, soon made a perfect hydra; at one end a mouth sprouted out, and at the other end, a sucker or foot appeared. From this circumstance we find, that the powers of life are the same in all parts of the hydra's body, just as we find that in the cuttings of a geranium there is perfect life in each little piece of a cut-off branch: one end throws out a root, whilst branches come forth at the other end of the stalk. And it has been observed, that hydras which grow out of cut-off pieces, are always larger than those which are born of a parent. When they are born, they seem to grow on the sides of the parent like buds on a tree. These little jelly buds or gemmules keep growing till they become a tube, having a mouth end crowned with tentacula, and a foot end with a sucker; and when these are complete, the little hydra falls off the parent, and walks or swims away.

I have now told you all I know of the hydra; perhaps some day you may have the pleasure of finding one of these small creatures, and then be able to examine it yourselves under a microscope. But whether you see a hydra, or only hear of its curious life, we may well use the words of the Psalmist, "O Lord, how manifold are thy works!

in wisdom hast thou made them all: the earth is full of thy riches." Psalm civ. 24.

In the sea there are a great variety of these small jelly-tube creatures; and some are so much like the hydra, that they are called the *hydroids*, or hydra-like. My next letter will speak of these hydroids, and also of the great family of polypes which make the corals. For the present believe me,

Your friend, &c.

LETTER V.

ON THE POLYPIFERA ORDER.

RADIATA.

The Hydroid Polypes, and the great works of the Coral Polypes considered generally.

My dear young Friends,

I am glad you have been amused with the history of the hydra; I have always thought him a curious little fellow. And now suppose one of you gathered a leaf in a ditch, and observed that a small green-looking stalk hung to it, would you not ask, "What is this?" Another, on watching it, might say, "The stalk is alive! it moves! it eats!" But when you looked again, you might say, "It has arms round the mouth, it must be some kind of radiated animal; oh! I see! it is a tube with

tentacula; surely it is a polype."* "So it is," cries another, "and do you not see that it is made of nothing but jelly, and lives alone? Yes, yes, I know what this little piece of green stalk is: it is a radiated polype, of the gelatinous order, and of the genus hydra; we have found it out; take care of it, carry it home, and examine it under the microscope."

And now I must tell you these polype animals are divided into three sets or orders; and according to their different habits of life, they are called the gelatinous, the polypiferous, or the fleshy polypes.

Our friend the hydra is a polype of the gelatinous order, because his body is nothing but jelly flesh, and we have learnt that he lives alone in fresh water. These polypes of the simple jelly order, are often called by naturalists, the naked polypes.

The next order of polypes do not walk about like the hydra, but live together in immense numbers, dwelling in the most perfect harmony in one common habitation, which habitation is made by a juice that flows out of the skin of their own bodies. Among some of these polypes the juice from their bodies makes a horny dwelling, amongst others a chalky one, and amongst others a firm dwelling, something like sponge. All these sociable polypes live in the sea, and are called the polypiferous or polype-bearing order. This name is given them

* Polype means an animal made of jelly in the shape of a tube or cone, with tentacula.

because of the hundreds and thousands of polypes that live together in one dwelling; yet in this common home every little polype, let him be ever so minute, has a cell to himself, out of which he spreads forth his tentacula to catch up the food that floats past.

HYDROID POLYPES, OR SEA HYDRAS.

One set of these sociable polypes, called the *hydroid* or hydra-like family, are so exceedingly small, that we cannot behold the little creatures without the help of a magnifying glass. The polypes of this hydroid family, make their habitations entirely of horn, and frequently build them in the shape of plants, small ferns, or seaweed.

Coryne Hydroid, natural size and magnified.

Sertularia Hydroid, and a few cells magnified.

Some of these sociable hydroids live in deep waters, therefore, it is only when they are drawn up in nets, or when they are torn by violent storms

from their resting-places in the sea, that we have any opportunity of beholding them. Other kinds of hydroids build their plant-like homes close to the shore, either in rocky pools, or in the shallow water just beyond low-water-mark; and as each of these sets of hydroids abound in the seas that surround our British islands, portions of their plant-like habitations may often be seen by those who ramble on the shore.

Sertula Hydroid, with horny cups magnified.

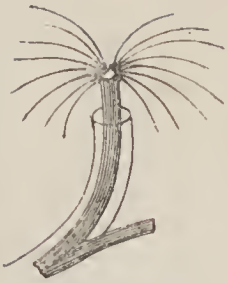
Several pieces of sponge in my cabinet, that were cast up on the Norfolk coast, bear upon their summits a tuft of the upright horny dwellings of these hydroid polypes;* and the stiff brown feathery tufts seen on the tops of oyster shells, are also the delicate horny habitations of sea-water hydras.

* Called the lobster's-horn-coralline, or sea-beard.

For a knowledge of the growth of these minute families, we are greatly indebted to the observation of a Scotch gentleman, named Sir John Dalyell. During many years he closely watched their habits, and, as he frequently kept them in bowls of sea-water, he sometimes noticed that little jelly buds swelled out on the sides of their habitations: these buds soon grew into the form of tubes, and when, like the fresh-water hydra, these tubes were crowned at one end with tentacula, he observed that the young hydroids, instead of moving away, mostly stayed upon the parent stem, and added a new piece to it; but sometimes they fell of, and then they crept away to a short distance. Other kinds of hydroids threw off jelly eggs or gemmules, covered with cilia, which often moved about for a short time, and then, like the gemmules of the sponge, they settled down for the rest of their lives.

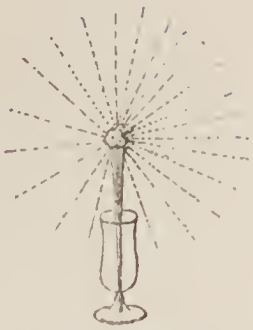
Very soon after the young jelly hydroids became quiet, Sir John Dalyell saw that a transparent cup or sheath of horn, was formed around each little hydra, covering it up with an exquisite little bag or case as clear as glass; and whenever one of these hydras had a mind to shelter itself, it shrank down into its horny bag.

Natural Size of many Sertularia, on their branch.



One kind of Hydroid magnified.

Natural size of many Hydroids on their branch.



A Sertularia Hydroid, magnified.

A small hole is found at the bottom of these sheathy bags, through which the horny juice, made by the skin of the animal, flows out, and is constantly building up the common habitation in which such vast numbers live together.

When any of the hydroid gemmules, or of the tube animals, travelled away from the parent stem, and so required a new home, Sir John Dalyell remarked, that the horny juice from their little cups, was allowed to spread itself out like a root upon the rock, or shell, or piece of seaweed, upon which they had settled themselves down. And no sooner was this root made, than they suddenly lifted themselves up, and then the juice from their skins flowed beneath them, and reared in the sea-water a hollow stem, shaped like a plant. As the hydras belonging to this stem grew in numbers, they arranged themselves along its sides, one beyond the other, in long rows, so as to give their habitation the plant-like appearance of branches and twigs. But what the

rule may be, that each little hydra follows when taking its place on the stem, no man can tell; all that the keenest naturalist can know is, that according to the different ways in which the wise Creator has directed the little hydroid creatures to proceed, whilst arranging themselves along their branches, so the shape of their dwellings is found to vary. But in every hydroid branch, there runs along the inside of its stems a fine thread of jelly pith, which is joined to the body of every living hydra, and when this thread is injured the little animals die.

Many of the hydroid habitations that are cast upon our beaches, are mistaken for dry twigs of notched sea-weed; but when the hydras that formed them were alive, and pushed their tentacula out of their cells, then these dead-looking sprays were blossomed all over with little animals, resembling carnations or roses, drooping from their stems.

A net having one day been cast into the deep sea that lies between the coasts of Ireland and Scotland, some of these hydroid habitations were drawn up, and as they rose through the waters, they appeared like one mass of delicate scarlet flowers, each little hydra's head being full of life and motion. It is, however, but seldom that the living hydras can be seen, for they generally die on being lifted out of the water.

I lately gummed down upon a sheet of paper, a brown twig of a fern-like hydroid, called the sertularia, which was picked up on the beach at Yarmouth. By the help of a magnifying glass, I can see on its delicate sprays, some of the exquisitely clear little snow-white horny cups in which its hydras once dwelt; but so small are they, that even as seen through the glass, these cups only look like the points of minikin pins.

Thus we find, that it is the habit of thousands upon thousands of these sociable hydras to spread themselves out one beyond the other; and to let the horny fluid from their bodies so unite the mass together, that their jelly tubes, horny sheaths, stems and root, make at last but one live thing full of mouths. The whole mass enjoying one common life, whilst at the same time, each separate hydra performs the work appointed it, of eating, drinking, and building up their general home.*

CORAL POLYPES.

The next polypes which we shall consider in the vast family of the polypiferous order, make their habitations of chalk; and these chalk-building polypes form all the corals that are found in the

* For further information on the Hydroids, read from page 236 to 264, in a charming work, adapted for young people, published by the Christian Knowledge Society, called "Things of the Sea-Side." Price 4s.

seas. The little creatures of this set or genus of polypifera, are of a tube shape, yet rather different in form to the hydra. Like the hydroid polypes they never walk about, but remain fixed in vast numbers in one common home. But do not suppose the coral polypes are idle, for truly all the polypifera race are a very busy set of creatures; and this they have need to be, for our Heavenly Father has given them a great work to accomplish; such a great work, that some men have called them the mighty scavengers of the ocean. Do you know what a scavenger is? Perhaps you have seen men sweep dust, and dirt, and straws away from the streets of a city; such men are called scavengers, and we are greatly obliged to them for the work they perform, since decayed animal and vegetable substances, when they become putrid, injure the air we breathe. Impure substances also injure water; therefore, to assist in cleansing the seas, the Lord God has seen it good to make the polypiferous family the great scavengers of the ocean; and a very numerous and happy set of workmen they are, ever delighted in their appointed labours. They have no brooms to sweep with, no carts to hurry away what they collect; but every bad morsel of decaying substance that floats past them, they fold in their arms, and with joy they pour the offensive

One kind of Coral Polype, taken out of its tube. *Much magnified.*

bits of refuse into their living tubes, where the juice in their bodies turns what they take into part of their own living substance.

The chalk-making polypes do not all rear the same kind of habitation; indeed the homes they build are so different, that men have given them different names. There are the Corallines, the Madrepores, the Sea Pens, the Sea Mats, and many others. The builders of these substances are generally all of them very small tube polypes, with delicate tentacula. Some of these polypes are not so wide round as a hair of our heads, but some are a great deal larger. In some kinds of coral, each polype makes for itself a hard chalk or horny tube to live in; others live in a thick gluey skin that is over the chalk; and thousands upon thousands, joining their tubes together, side by side, form masses of wall, miles and miles in length.

Cells of the Coral Polype, without its live jelly covering.

If all the barns, houses, churches, and castles, men ever built in Europe, Asia, Africa, and America, were put together, we should find that the delicate worms of the polypiferous order, have built a far greater amount of solid wall than all the men on earth ever reared. Navigators tell us, that in the South Pacific Ocean, near the coast of New Holland, there is a ridge of coral wall one thousand

miles long. The beautiful group of islands called the Society Islands, seem to be one mass of rock, formed by the coral and madrepore families. Their work was silently carried on under the boisterous waves of the sea; and when they had finished it, God lifted up the crust of the earth and brought their labours from under the waters. Sea-weeds soon gather upon these raised coral rocks; and when a little mould is formed, birds come and often drop seeds; floating pieces of timber and matted portions of vegetables from other islands are dashed up on their shores, bearing grass and other seeds; and it is wonderful how soon, by these means, a coral island becomes a land of plenty and of beauty for man to inhabit. Though coral reefs sometimes look like solid walls, yet the coral polypes more frequently pile their cells together in the shape of large trees with huge branches; whole forests of these living trees are to be seen under the waves of the sea.

"Deep in the wave is a coral grove,
Where the purple mullet and gold-fish rove;
Where the sea flower spreads its leaves of blue,
That never are wet with the falling dew,
But in bright and changeful beauty shine,
Far down in the green and glassy brine."—*Percival.*

These tender little mites of things build their walls immensely strong. Occasionally portions of their coral are broken off, and ground to powder by

rolling amongst the waves of the sea; but the mass of their habitations is so strong, that compared with their works, a poet has said, that the proud city of Babylon was only like a wreath of sand raised by the passing wave, to be washed away by the next coming tide. Nebuchadnezzar the king was very proud of his city, Babylon. (See Daniel.) Its walls were built of bricks like massive stones, and were fastened together with strong bitumen or pitch; and so extensive were they, that men had to walk sixty miles to go round the city; and so wide were the walls, that nine carriages could stand in a row on their tops; yet this great Babylon is fallen down, and its bricks are crumbled to dust! Not so the coral walls built by the slender little polypes. These soft jelly workmen, having been taught by their Creator to rear their stupendous and lofty mounds, they stand like vast catacombs,* "filled with the dry mummies of their builder worms," firm and beautiful from age to age.

"Millions of millions thus from age to age
With simplest skill, and toil unweariable,
No moment and no movement unimproved,
Laid line on line, on terrace terrace spread,
To swell the heightening, brightening gradual mound,
By marvellous structure climbing toward the day;
Each wrought alone, yet altogether wrought;
Unconscious, not unworthy, instruments,
By which a hand invisible was rearing
A new creation in the secret deep.

* Catacomb, from cave, to bury in.

Omnipotence wrought in them, with them, by them;
Hence, what omnipotence alone could do
Worms did. I saw the living pile ascend,
The mausoleum of its architects,
Still dying upwards as their labours closed;
Slime the material, but the slime was turn'd
To adamant, by their petrific touch.
Frail were their frames, ephemeral their lives,
Their masonry imperishable."

Montgomery's Pelican Island. CANTO ii. *p.* 27.

Having just hinted at what the coral polypes can do, I intend in the next letter to give you the history of the coral polype from its infant state, just as I gave you the history of the hydroid and of the sponge.

Yours affectionately, &c.

LETTER VI.

RADIATA.

History of the true Coralline Polype.

My dear young Friends,

The beginning of the history of the coral animal is very much like the early part of the sponge's history; for gemmules, or little buds of clear jelly, (which vary in size like different flower seeds,) may be seen to fall from the sides of a pile of coral in the sea; and as soon as the little coral gemmule drops into the water, off he swims, pushing his narrow end first; but the thickest part of the jelly, instead of remaining round, like a pea, soon turns flat like a piece of money; then the gemmule throws its narrow end down, and by this act, the flattened part is raised up in the water like a wheel placed on a knob; this done, away the gemmule

goes, spinning round and round, all the while vibrating, or shaking its cilia with the greatest rapidity; and thus it glides swiftly on through the waters. Sometimes it may be seen to stop suddenly, and without touching anything, as if in play, it draws in the broad end of its body, and then off it goes again. Sometimes the coral gemmule floats for some days, sometimes only for a few hours; but when once it fixes itself on a piece of old coral, or on some other hard substance, it moves no more. For three days it lies as quiet on its side as if it were asleep, doing nothing, excepting that it draws water into its body by the vibration of the cilia. Yet, in fact, the live jelly is all that time fastening itself tight upon the rock. At the end of three days the cilia grow quiet, and then the gemmule begins to swell. It does not swell out broad like that of the sponge, but rather lifts itself up in the shape of a tube, and round the edge of this jelly tube, there quickly appears a delicate thick-looking white rim, which surrounds the whole edge. This white rim is the beginning of the animal's strong chalk cell, the house in which it is to live. The chalk is deposited by the live jelly out of its own substance, and looks at first like a milky fluid; but it soon becomes hard, and then the sides begin to rise up and up, like a fine pencil case. For a time, the clear jelly lies very quietly inside this white tube, but soon a dull spot comes in the middle of the quiet jelly,

and out of this spot rises up a knob; sometimes this knob is only about the size of a needle's point, sometimes much larger. This mite of a knob looks something like a daisy, made up of eight or ten pieces. Now what do you think this very, very small daisy thing is? It is the mouth and tentacula of a polype. Quickly these fine hair-like tentacula or arms go to work pushing themselves out, and drawing themselves in, like the horns of a snail; and with all their might catching up the food the polype requires; this being the great work their Creator has given the coral animals to do.

As soon as the tentacula are made, the rest of the jelly takes the shape of a very little tube polype,* and in this state, the coral polypes go on building up the mighty works of which you read in the last letter.

Well might Pliny, the naturalist, say, when speaking of the smallest animals, "In these beings so minute, and as it were nonentities, what wisdom is displayed! what power! what unfathomable perfection!" Yet Pliny never knew who made these minute beings, for he had no Bible to tell him there is but one God.

As the tentacula go on bringing food into the stomach of the little polype, its outside case goes on growing up higher and higher, and the more the milky juice flows out of the stomach into the tube

* For meaning of polype, see note at the beginning of Letter IV.

of the polype, the healthier and stronger is its body. The jelly polype follows up after the growing walls of its house, and always keeps its mouth just below the top of the walls, but high enough to thrust out its tentacula.

The coralline polype, as I told you, does not live by itself; thousands and tens of thousands, millions past our arithmetic to count, build up their pipes or cells, side by side, and live together in one pile. The chalk pipes which they build around their bodies, are not dead walls, like stone or brick walls; for so long as the polypes are in their tubes, little vessels run out of their bodies into the chalk walls, just as little vessels run out of our flesh into the bones, and this makes both body and wall one living thing. All the live polypes and all their live walls, in one pile, are joined together by these vessels into one great living creature, so that what one polype eats passes on to assist in nourishing the rest. But when the coral polypes mount up into a new part of their tubes, the old part below remains standing in the sea, as a dead hard wall or tree, so that it is only whilst the polypes are living in it, that the coral is alive.

Coral walls are made of lime; and more than this, corals have a little phosphorus in them. Phosphorus is a substance that burns with a bright shining flame; the jelly bodies of many sea-born animals abound in this light-giving phosphorus.

We have also a little phosphorus mixed with lime in our bones. Chemists are able to take this phosphorus out of the bones; and then the moment it is exposed to a draft of warm air, it bursts into a bright flame. All the chalk and phosphate of lime forming the coral walls, are extracted by the body of the coralline polype out of the food that it eats. And as the chalk very soon leaves its body, and settles round its jelly tube, the polype is always adding a new bit to its house, and consequently lifting itself up higher and higher. As the coral polypes want food for two reasons, first, to feed their jelly bodies, and secondly, to build up their houses, we cannot wonder they are voraciously hungry. Millions upon millions of their tentacula are floating for ever under the sea waves. Sometimes their tentacula lie quietly on the water like delicate threads of sea-weed; sometimes they are spread out like beautiful starry flowers of the richest colours; but let them be of whatever shape they will, they are ever at work, clasping hold of every thing that comes in their way. It matters not, whatever the prey of the polype be, whether morsels of live or dead fish, morsels of lobsters, crabs, or insects, all is equally good to them. And there is plenty for them to feed upon. So abundantly is nature stocked with life, that not a drop of water in the ocean is without some living or dead substance in it; whilst multitudes of fragments, too small for

us to see, swept away by heavy rains from our lanes and streets, go tumbling and rolling down the river stream, till lost in the mighty ocean, they are gladly welcomed by these scavengers of the sea. And no sooner has the coralline polype conveyed one morsel of these odds and ends into his daisy-like mouth, than out he spreads forth his tentacula again, ever seeming to say, "Give me more! Give me more!"

The coralline polypes love the light of the sun, and the warmth of the sun; they cannot live in water that is deeper than three or four hundred yards, because deeper waters are too cold and too dark for them; therefore God teaches the little gemmule always to begin its house on some rock that lies hidden at a moderate depth under the water; and they cannot live out of the water, for when they have built up to the top of the waves, they die.

Some corals are as white as snow, some are black, and some are of a beautiful red. Corals are used by men for making ornaments and toys. In Arabia they build houses of the Madrepore rocks, and in several parts of the world, coral rocks are burnt into lime.

Almost all the coral polypes spread a thick coat of jelly flesh over the outside of their hard walls, so that it is often difficult to see the coral, until the flesh is taken off. Sometimes the little

polypes live entirely in this fleshy covering, and when they make their cells in this flesh, the hard stone they deposit under it is left smooth.

The sea is everywhere supplied with some kind of coral polypes, but it is most abundantly filled with them in hot parts, because dead matter remaining under the influence of a burning sun, becomes very rapidly offensive, therefore that God, who kindly provides beforehand every thing that is for man's good, has placed an immense profusion of polypifera in all the warmest regions, like those of the Red Sea, and the South Pacific Ocean.

And now, whilst we are learning the history of these curious and useful little animals, do not let us forget to praise Him whose power made them, and whose wisdom still sees fit to use such minute instruments for the two great works of purifying the ocean, and of raising up new islands. Let us at the same time joyfully remember, that this kind and wise God permits us, His intelligent children, to call Him by the endeared name of Father. Can you tell me in the New Testament where this permission is given? and what is of still more importance, can you tell me how it is possible, that our God, who is both holy as well as wise, can pardon sinners, and make them His beloved children, heirs together with Christ, of His own glory? See Eph. i.—Gal. iii. 26.

My next letter will give you the history of

another set or genus of polypes, whose tentacula are broader, and more of a starry form, than the corallines.

Believe me, affectionately, &c.

LETTER VII.

RADIATA.

The Asteroids or Star Polypes. The Red and Black Corals. The Sea-fan, the Alcyonia, Tubipores, and Sea-pen.

My dear young Friends,

I conclude that you understand by this time, that polypes are animals formed of jelly tubes, having thread-like arms round their mouths; and that those which make for themselves hard habitations, are called, together with their habitations, the polypiferous or many polype corals. There are several different genera, or kinds, of these polypiferous creatures. In our last letter we examined the true white corallines, and then remarked, that red and black corals are much used by men in

making toys; indeed, there is so great a demand for these coloured corals, that many fishermen gain their livelihood in the Adriatic and in the Mediterranean and Red Seas, by dredging for them.

But if we examine the history of the polypes that form these coloured corals, we shall find that they are rather different in their shape to the true white corallines. The coralline polypes, as we have seen, live in hard chalky cells with thin jelly over them, and have their mouths surrounded by beautifully fine hair-like tentacula or arms. The polypes of the black and red varieties, on the contrary, make their cells in the thick fleshy jelly that is deposited over the solid chalk; both the chalk that settles under the jelly, and the jelly itself, being formed by their own bodies. And then, instead of having beautifully fine hair-like tentacula, the polypes that live in the hard jelly flesh, have short wide leaf-like tentacula round the mouth, somewhat like the rays

Starry polype, *magnified.*

of a star-fish. This starry form of their tentacula, has led naturalists to call this order of polypes the

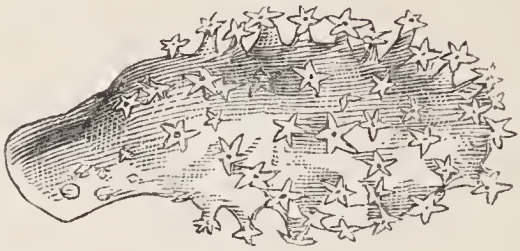
star polypes, or *Asteroid* order, from *Aster*, star, and *eidos*, form.

Some of these star polypes, make the solid part of their dwellings mostly of horn. There is a beautiful coral of this kind, called the sea-fan, which forms a horny net-work for its gluey flesh to rest upon. The fibres of its net-work are of a red brown horny appearance; but when the sea-fan is alive, it is covered all over with thick jelly, in which there live a vast number of polypes. The end of this hard stem acts like a root, to keep the sea-fan tightly fastened on its supporting rock, whilst its broad and beautiful fan, like an immense leaf, waves about in the waters, blossomed all over with richly-covered tufts of starry tentacula, that float at ease amongst the rolling waves; each tuft reflecting the hues of the rainbow—blue, green, purple, and yellow.

> "There with a light and easy motion,
> The fan coral sweeps through the clear deep sea;
> And the yellow and scarlet tufts of ocean,
> Are bending like corn on the upland lea."

Amongst these star polypifera, there is one called the alcyonian coral, which is often thrown up on the shores of our British Islands. This alcyonian coral looks so much like a dull yellowish tough sea weed, that numbers of people might pass by it, never supposing it belonged to the polypifera family; but take it up and place it in a glass of sea water, and

if it be still alive, the little animals that dwell in its fleshy substance, will push out their leaf-like tentacula through the little holes that cover its surface; and then all blooming over with starry flowers, it becomes a joyful and beautiful sight.

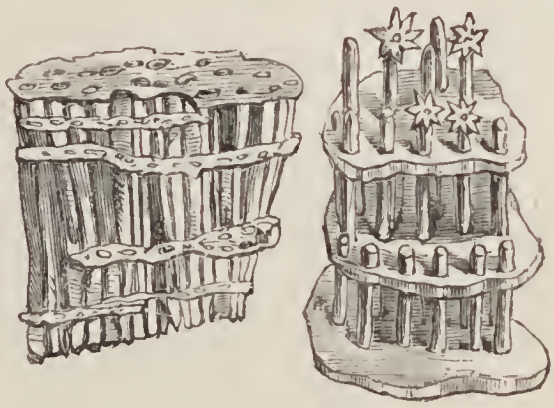


Alcyonian Coral.

This coral has no solid stick of chalk under its flesh, but the space between the two skins is filled with a thick mass of jelly, divided by fine plates of a horny matter, so that the alcyonian coral often looks very much like sponge, and might be taken for sponge, were it not for the beautiful little polypes pushing out from the holes their leafy tentacula; whilst the real sponge, you will remember, has no tentacula belonging to it. If the polypes on an alcyonian coral are teased or frightened, they draw themselves into their cells, and then the whole spongy coralline contracts into a firm, leather-like mass. When the fright is over, they come out again and unfold their leafy arms, and take in a large quantity of water, which runs through all the tubes, so that the alcyonian coral

swells out to two or three times its smaller size, and becomes soft, and clear, and spongy again.

From this alcyonian coral, where all its polypes are buried in flesh, let us next turn to another starry coral, called the tubipore, which has no jelly flesh of any kind belonging to it, but all the little polypes live in separate pipes, as distinct from one another as reeds in a bundle, or as the pipes of an organ: and because of its form, the tubipore is sometimes called the musical coral. These separate



Tubipore Coral.

pipes are formed out of the lower part of the skin of the little polype; a mixture of lime and hard substances turning the skin into a firm tube for the creature to live in. The tubes are often of a fine crimson colour, and the polypes of a bright green, and then they present a very beautiful appearance. These polypes often draw themselves entirely into their tubes, and close up the opening with a little

fold of skin. As their bodies grow upwards, the tubes follow them; and every now and then the whole colony of polypes, thus growing up side by side, take it at the same time into their heads to make a little knot, which knot divides the mass of tube coral into a sort of floor, and from the top of this floor, the polypes start up with fresh tubes, and again work on till they deem it suitable to make another floor. Every floor is wider than the one beneath it, because a number of new little polypes have begun their tubes in it, so that the whole mass is larger at the top than at the bottom; just as a loaf of sugar would be, if it were turned upside down.

I have one more group of these starry corals to describe to you, and that is the extraordinary one, called the pennatula, or sea-pen genus. This name is given, because the sea-pen has a hard chalky stick like the stem of a goose's quill. One end is blunt and naked, like the part of the quill we make into a pen; and just where the goose quill becomes feathery, the pennatula also becomes feathery; but the down of the pennatula is not like the insensible down of the bird's feather; for that which looks like down on the sea-pen, is all alive! Each separate little bit of the feather which our fingers can brush up on the side of a quill, is, in the pennatula, a long line of polype houses; each fine line having many polype tubes arranged along it. Row after

row of these peopled streets rise up on both sides of the stick to its very finest top; and really the

The Pennatula, or wonderful Stick.

One fibre of the Pennatula magnified shewing its chalky tubes and polypes throwing out their tentacula.

whole thing looks as if the polypes had been trying to make their habitation as much like a large goose's wing-feather as possible.

Do you not think it must be a curious sight to behold a pen full of life? having twelve or fourteen inhabited houses in each fine strip of the feather, and all its hundreds and hundreds of inhabitants busy at work, throwing out their quick-feeling tentacula for food.

The sea-pen is not fastened to any rock as the other corallines are, but floats loose in the waters all the world over. It is carried up and down the seas, just where the wind, the tides, and the

currents of the water send it. Sea-pens abound off some parts of the coast of Ireland, and there the fishermen give them a name that means the "wonderful stick." Some of these sea-pens are large, some are small. They have a large amount of phosphorus in them, and in the night they sparkle most brilliantly. What one polype of the sea-pen eats, passes on through the whole line of habitations, to contribute to the good of the whole tribe, just as it happens amongst the corallines. The sea-pens have a curious habit of bending themselves into the form of a bow; but whether the polypes consult one another as to when they ought to bend their pen, or when they ought to straighten it, is more than man can tell; it is only He who made them, knows why they are impelled to change the form of their general habitation. Indeed, we are obliged to acknowledge, that most of the works of the great Creator surpass our powers of comprehension; though what we can notice by our sight, often compel us to exclaim,

"Lord! how Thy wonders are display'd,
Where'er I turn my eye."

My next letter will describe the madrepore corals and the sea mats.

Yours affectionately, &c.

LETTER VIII.

RADIATA.

The Madrepore and Sea Mosses.

My dear young Friends,

Whilst examining the starry or asteroid family of polypes, we roamed at large in the wide seas, looking in one place at a sea-fan, in another at an alcyonium, at a tubipore, or a sea-pen. But if we would examine the madrepore family, we must set sail for the warmest latitudes of our globe, for only there shall we find the madrepore fast anchored in ocean's bed.

The madrepore polypes are like the corallines in their habits, but the form of their bodies is roundish,

and more resembling the sea anemone:* the shape of their cells is also very different to the corallines, and they build their habitations so rapidly and so strongly, that sailors passing amongst the East Indian Islands, and round the South Cape of America, find them an alarming set of workmen. They often block up the tracks through which the ships have been accustomed to go, obliging the pilots to find out a new channel; and sometimes before the sailor is aware of the changes these little polypes have made, ships are dashed to pieces upon their newly risen and living rocks.

Some madrepore polypes fasten their live jelly tight on a rock, just as the true corallines do, mixing up in a wonderful way, amongst the lime that is to form a root for their dwellings, a kind of animal glue or albumen, which produces a toughness in this part that the rest of the building has not. The madrepore polypes do not often build a wall upon this root, they most commonly raise up a stem after the fashion of the trunk of a tree, which stem is sometimes short, sometimes long. If the water be deep, they build the stem very high, lifting it up till within a little of the surface. On the top of this stem they spread out chalky heads, either shaped like round lumpy knobs, called brain stones, and which are thickly covered with the tough flesh in which the polypes live; or else these heads are

* See picture of sea anemone, page 83.

shaped like mushrooms, and the whole of them are spread out and arranged like the top of a tree. Sometimes these heads form many short thick branches, whilst the polypes live, either in the chalky cells of these heads, or in the flesh that covers them.

The distinguishing mark of the madrepore rocks is, that the polypes always deposit the lime of

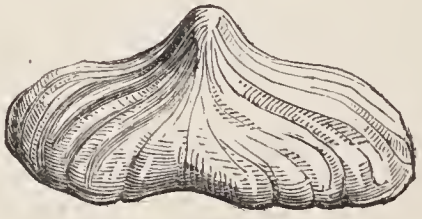
One Madrepore Head.

their cells in radiating leaves, that is, in thin plates round a centre. And this arrangement of chalky plates arises from the form of the polype's own stomach. Much of the food that he eats turns to liquid chalk, and this chalk immediately settles itself into a number of fine empty divisions that lie between the fleshy foldings of the polype's body. When these foldings are full, he seems as if he lifted himself up, leaving a part of his chalky skeleton below him, and

Branching Madrepore Coral.

then goes on filling his fleshy cells again, yet keeping his body down within the walls he has formed, and so sends his tentacula out between its partitions.

Whilst the polypes are alive, men do not see the beautiful solid form of these madrepore heads, because, like the corallines, they are covered with a coat of tough jelly; but when the polypes reach the surface of the water and die, the flesh falls off, and then the hard, chalky, ray-like layers, become very curious objects to behold. Some of the madrepore heads look like a quantity of sheets of white paper drawn up in the middle to a bunch, with the edges of the leaves sloping down, and a little separated, like the leaves of a book slightly opened. These lines of layers are often a little twisted.



Madrepore Head.

The head of the madrepore tree, when alive, is very beautiful. Its broad spreading top, being covered with gay-coloured rosettes of tentacula, that resemble rich starry flowers, ever rising and falling over its surface; and as the light plays upon these tufts of moving arms, it covers them with one con-

tinuous sheet of most brilliant and ever-changing hues. I believe the madrepore polypes are never met with in European seas. I suppose the water is not warm enough for them, but they abound in the South Pacific. Sometimes their coral appears like vast walls and rocks; at other times it presents more curious and fantastic forms, resembling wheat-sheaves, mushrooms, cabbage-leaves, or some of the innumerable varieties of figure to be seen in plants and flowers; and much is the sea-bound voyager astonished, when he beholds them glowing beneath the water in their vivid tints,

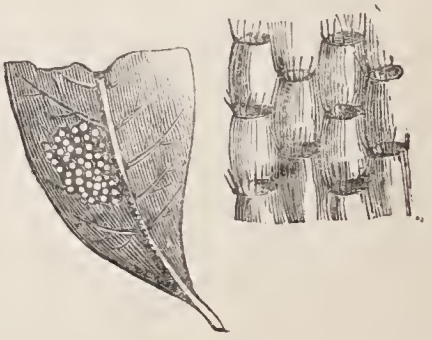
"That in the colours of the rainbow live."

"Silently, as a dream, their fabrics rise:
No sound of hammer, or saw is there.
No forests fall
When they would build: no quarry sends its stores
T'enrich the wall; but they can stem the floods,
And make their marble in the glassy sea."

There is one other kind of the polypiferous family besides those of which I have now told you, and this kind contains a set of such minute polypes, that they are sometimes called the sea mosses, and by others, sea mats. One of these sea mats is called the flustra, the cells of which are joined together something like the combs of bees. The polypes of the sea-mat make no root, but fix their cells on some smooth substance, such as a piece of sea-weed.

Should such a piece of sea-weed have chanced to fall in your way, I do not believe you have guessed from its appearance, that thousands of living creatures were settled upon it, each one dwelling in his own little tent. To all appearance, the cells of the sea-mat genus are nothing but rough-looking plaistered surfaces on the face of the smooth sea-plant. On the coast of Scotland there is a sea mat, called the flaxen sea mat, where eighteen hundred cells of these little polypes are built side by side upon one square inch of sea-weed.

1800 cells on this square inch.



The Flustra (a Sea-mat) clustered on sea-weed, and its cells magnified.

Another sea-mat, called the leafy Flustra, has twice that number of polypes in a square inch. The polypes that form this leafy flustra, do not work upon a piece of sea-weed, but build the whole of the leafy substance themselves, placing their oblong cells back to back, like the cells of honey-comb. This flustra is often thrown up on our

shores, and looks like numerous leafy branches about as thin as paper. It is of a dull yellow hue, and is rather rough to the touch, from having four spikes set up round each cell. Thirty-six thousand little cells of this kind of polype have been counted on a space of ten square inches, all containing inhabitants actively engaged in seizing food, and throwing out their arms, amounting in this case to three hundred and ninety-six thousand; and all these arms continue rapidly shaking and vibrating, so as to cause the water to eddy round them. Dr. Grant says the number of cilia, or little moving spikes round the mouths of eighteen thousand of these polypes, would be at least four hundred millions; and yet these little wonders of living animals can keep all these cilia in action, or stop each one at their own good pleasure. As the use of these cilia is to form a current in the water, to send the food which the polypes require, within the reach of their tentacula, most likely they are ever going by night and by day. What a busy scene then must such a morsel of living substance

A few cells magnified. Flustra Foleacea.

present! but the unassisted eye of man sees it not; it is only by the aid of the microscope that this world of busy life is understood.

Sometimes these small sea-mat polypes have a lid to their cells, and when they are satisfied with eating, they draw their arms gently into their cells, shut down the lid, and lie quietly in repose. But again, the unassisted eye of man sees not these wonderful works of our God.

Small as these polypes are, they are very beautifully made. They are not simple tubes, like the polypes already described, but these polypes have a long gullet or swallow; they have gizzards, like birds, with which they grind their food, and a stomach below the gizzard.

Valkeria Coral, or Sea Moss.

The natural size of the Valkeria Polype is shewn in these stems (full of cells), each cell holding a polype like the magnified one.

Tentacula.

Gullet, or Tube.

Intestinal Canal.

Muscular Gizzard.

Stomach.

Muscles.

Magnified Polype of Valkeria Coral.

These minute polypes are very choice in selecting their food, and very indefatigable in seizing upon what they approve. Sometimes an animalcule may be seen in the act of slily escaping out of the current of water, that is rushing into the mouth of the polype, when all of a sudden, he bends down one of his tentacula, and with a sharp blow from it, the truant is brought back into the stream, and quickly swallowed.

This letter closes our history of the corals. Their story has shown us, that the finger of our God can work out marvellous things by very weak instruments; whilst a knowledge of the vast works performed by the busy life of the coral family, makes us ready to exclaim with king David, "The floods have lifted up, O Lord, the floods have lifted up their voice," proclaiming that "God is King of all the earth;" for "whatsoever the Lord pleased, that did He in heaven, in earth, and in the seas, and all deep places." Psalm xciii., xlvii., cxxxv.

Next week you will receive the account of the sea anemones. Till then,

Believe me, affectionately, &c.

LETTER IX.

RADIATA.

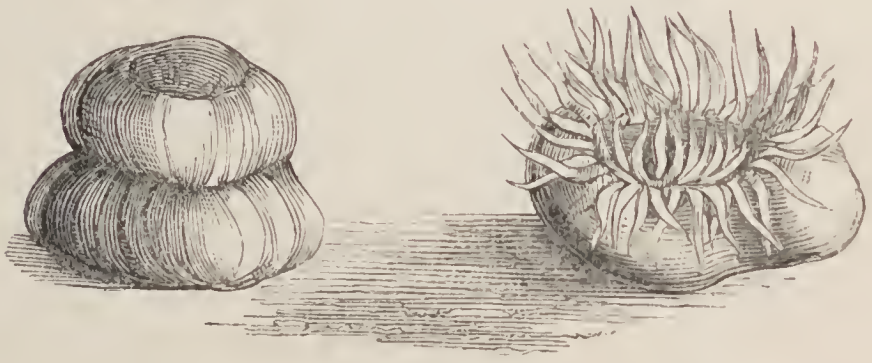
The Sea Anemone.

My dear young Friends,

Now for the sea anemone! Perhaps you have never observed in a sea-water pool, this curious round animal, clothed with its wrinkled tough yellow-brown skin. Indeed it is often mistaken for a vegetable. There are many found on the beach at Cromer, in Norfolk. In Devonshire I have seen them of a large size; sometimes they are eaten, and have, when boiled, almost the scent of a crab.

The history of the sea anemone will finish our account of Cuvier's three orders of the class polype. We have learnt that the gelatinous order of polypes,

and the polypiferous order, consist of soft jelly tubes with tentacula: that the polypes of the first order live alone, and that the polypes of the second order live many together in hard habitations; but the polypes in the order which we are now to consider, are animals of a cone shape, having tough fleshy bodies with many cavities in them, and all covered over with a tough skin. The round body of the sea anemone is furnished in the middle with many fleshy tentacula; and sometimes several rows of these fleshy arms are placed round the



(*Shut.*) Sea Anemone. (*Open.*)

mouth. The under part of the body has a large sucker, and with this sucker the sea anemone is able to stick very tightly to the sides of rocks and stones. When the sunbeams play upon the hard skin of the sea anemone, as it lies on a rock under the waters, its colours are often brilliant; and when spreading out its many short thick-set

tentacula, it may easily be mistaken for a conical flower, not very unlike the garden anemone.

The sea anemone is extremely sensitive to touch; the moment you lay a finger upon its body, it hides up its tentacula, and shrinks down into a regular cone-shaped lump. These animals stick so tight to the rocks upon which they fasten, that it is sometimes impossible to take them off without tearing them to pieces. Not so, if they wish to move themselves: then they allow a little water to flow under the body, and this stream immediately loosens the sucker, and sets them at liberty to crawl or float to another place. In general they are very stationary creatures; but at any time, when they desire to cast themselves among the heaving billows, they draw into their bodies a little sea water, just sufficient in quantity to make their cone-shaped forms about as heavy as the water into which they are going to fall. This curious power of knowing how much water will balance the weight of their own bodies, and so keep them afloat, saves the creature from falling to the bottom of the sea, and enables it to go smoothly rolling on amongst the moving waves.

Who taught this brainless, headless living thing, so dexterously to weigh the pressure of the water which is inside, and outside its body, acting in this matter, with all the skill of a wise and calculating being? Is it not He who teaches the ant and the

bee to store up their treasures? By the living works of creation we obtain some glimpses of the wisdom and power of our God, and by them we learn both to admire and to fear Him; but the works of creation do not tell us how He will treat His intelligent creatures, who have broken His laws. A knowledge of the power of God brings no comfort to the sinner; it rather makes him wish to fly from so strong a God; it is only when His mercy is understood, that we, erring creatures, desire to draw near to our Maker; and from no source on earth can we gain this knowledge of our God, but from the BIBLE,—see Rom. xv. 4, John iii. 16.

But to return to the sea anemone. When it has rolled itself as far on in the waters as it pleases, it stops at some piece of stone or rock, suitable for a new home, and throwing the water out of its mouth, fixes its sucker tightly on its new resting place; and again becomes strongly fastened down.

The inside of the sea anemone's body is rather more curiously made, for the purpose of digesting its food, than the inside of most of the polypes in the other orders. The sea anemones are a hungry set of creatures. They will seize hold of fish, whether it be dead or alive. They love shell-fish, such as shrimps and small crabs, and also devour numbers of a jelly animal, called the medusa, which is very abundant in the seas. It is no uncommon thing for a sea anemone and a crab to have a

desperate battle; but the conflict ends, as soon as the sea anemone can bend its tentacula round its prey, for the crab is then twisted, shell and all, into the mouth of its foe, where it soon dies, and in about ten or twelve hours, the hard empty jacket is cast out of the sea anemone's mouth.

All sea anemones are exceedingly fond of the light of the sun. On a fine sunny day, they spread forth their fleshy arms in the shape of a broad and waving circle, bright with all the colours of the rainbow. If the sea anemone loses a tentaculum or arm, a new one soon grows up; and if the whole body be cut into two pieces, the creature is not killed, but in eight or ten months the divided body makes two good sound ànemones.

The first time I noticed one of these curious looking creatures, was on a warm summer's day, when a little party was rambling in the beautiful, but small bay of Babbicombe, in Devonshire. The tide was low, and as we stepped over the wet rocky shore, the sight of some bright colours caught my eye playing up and down in a pool of clear water. Had you been there, you would have heard me exclaim, "What have I found on this rock? Look! here is something gay-coloured, nearly round, quite soft, yet sticking tight! and it has a fringe all round the middle. Can it be a flower?" Would you not have run to look? And then you might have heard me say, "No, it is not a flower; when I touch it,

it hides up its fringe; and see, how it keeps moving and waving its fringe about, sometimes drawing in one piece, sometimes pushing out another! surely it is alive! What can it be?" By this time, if you had ever read of the animals called polypes, I think you would have remembered there is just such a description given of a set of polypes, called the fleshy order. One of our party then told me it was a sea anemone. I was glad to hear it had a name; but as I knew nothing of the history of any of these animal plants, I still went away from the rocky pool puzzled in mind.

Let me now ask you a few questions about these animal plants, and will you try to write the answers down?

1. What is that division of animals called, in which the living creatures are made almost like plants?*

2. What is the fringe round their mouth or edges called?†

3. What are the tentacula for?‡

4. What is the name of that radiated class, which contains all the jelly animals, both tube and cone-shaped, having tentacula?‖

5. How many different sets or orders does the class of polypes contain?§

* Zoophytes, or radiated animals.

† Tentacula. ‡ To catch food. ‖ Polypes. § Three.

6. Name the three orders of the polype class.*

7. Of what kind of substance, and of what shape, is the third order of polypes ?†

When you have answered these seven questions to one another, it may be well to write down Cuvier's mode of arranging the sea anemone, in its division, its class, its order, its genus, and to fill up the names of each.

Now if I received a letter from a friend travelling in America, telling me that he had found a new animal; and if he sent me the name of its division, order, and genus, as written above, one glance of my eye would teach me a good deal of this new animal's history.

Its radiated division would tell me, that it was an animal like a plant, therefore it had no bones, no head, no eyes, no ears, but it had a mouth.

Its polype class would tell me, that it was either a jelly tube, or a fleshy cone-shaped animal, with tentacula.

Its fleshy polype order would tell me, it was of a cone shape, and that it had a hard tough skin over its fleshy body.

The name of its genera would teach me its likeness to some creature that I have seen before.

And lastly, the name of its species would be the

* The gelatinous, polypiferous, and fleshy polypes.
† They have fleshy cone-shaped bodies, with tough skins and many tentacula.

particular name its discoverer had been pleased to bestow upon it; and this name would enable me afterwards to remember it as a distinct animal, so that whenever I might speak of it, it would come before my mind like an old friend; that is, as soon as I had learnt to know its appearance.

I must now bid you good-bye, just saying, that I hope next week to send you some account of the jelly-swimming medusa.

Yours truly, &c.

LETTER X.

RADIATA.

Jelly Fish, or Sea Nettles.

My dear young Friends,

I received your nice little notes, and it gave me much pleasure to find my questions so correctly answered, as well as to hear that you found some interest in searching for the names of the classes and orders. The next time you ramble on the sea-shore, and meet with a sea anemone, I hope you will find new pleasure in admiring it, because you have now gained some knowledge of its habits. I had no such intelligent enjoyment the first time I saw the curious creatures we are to study in this letter, for I knew nothing of their history.

The creatures we are now to consider, are called the Acalephæ, from the Greek word *nettle*, because

they sometimes sting the fingers of sailors who touch them. These sea-nettles are floating live jelly bodies, which are found in all parts of the sea. Cuvier, the French naturalist, has placed them in the radiated division of animals, therefore at once we know they are without heads or feet.

The first time that I observed these creatures, was in passing over the sea from the town of Weymouth, to the Island of Portland. The day was very warm; the water over which the boat glided was very deep, and as clear as glass. I was delighted with the sights that met my eye; sometimes the great sea was one bright blue colour, at other times it was one sheet of sparkling whiteness. Low down under the waves lay in one place a pavement of bright-coloured pebbles, then rose up a line of black rocks covered with sea-weeds, and ever and anon portions of those gay-coloured weeds floated past, as if sporting under the waves; but what most surprised me, was the sight of a vast quantity of strange lumps of jelly, looking something like the heads and stalks of huge mushrooms, which kept heaving their bodies up and down, like the flappings of a parasol. The smooth round tops of some were as white as snow, whilst others often changed their hues like a soap bubble. Several times I asked the sailors what they could be! but they only answered me, "Oh, ma'am, they are always here in fine weather!" Now I cannot say when I looked down

into the deep sea, that I was without observation, for by the use of my eyes I watched these odd things; but as my mind was ignorant, my observations helped me very little, and I could only look and wonder. I did not know what to think of them, whether to fancy them sea-weeds or parts of fishes.

But now observe the pleasure of information. About three years after we had taken this delightful sail, I happened by accident to open a book, in which I saw an exact picture of those very lumps of jelly which I had observed off the Island of Portland. My mind was instantly on fire to read the story it told of them, and I never laid the book down until I had learned all it could tell me of the history of these strange sea-jelly things.

To my great astonishment I read that the floating masses we had seen during our sail on the waters, were actually living animals, to whom the great Creator had given the power of eating, drinking, and enjoying life. I have since found that they belong to a higher class of the radiated animals than the polypes do. They stand higher than the polypes in man's division of nature's forms, because they move about, whilst most of the polypes are as fixed as vegetables. There is a variety of these moving jelly creatures, but all their bodies are simply made up of water and skin. The skin looks like a net-work of animal substance, covered over

with a film, and the spaces that are vacant within the netted film, are filled up with water; so that when a sea nettle is caught, the water soon dries away, and nothing remains in your hand but filmy skin. These sea nettles abound in all seas; but in warm climates they grow to the largest size. Some measure several feet across, and have been known to weigh fifty pounds; but in cold climates they are much smaller, and vary in size from the width of an umbrella to a pin's head; indeed, some are so minute, that even where they swarm immensely, the eye can only discern their presence by the hue which their painted jelly bodies give to the water. About Greenland, shoals of them extend for hundreds of miles, where their floating masses tinge the ocean pink, or brown, or green. They do not like rough waves, because their bodies are soft; but in fine weather they may be observed in every sea.

Amongst the sea nettles there is found a large family, called the family of the *Medusas*. Of these medusas there are not less than three hundred different kinds or species. The most common appearance of the medusa, is that of a flat roundish substance, without head or arms. Another kind, nearly as often seen, has a bowing top like a mushroom, with arms or tentacula hanging down underneath, looking altogether like a good thick mushroom stem. The tentacula of these mushroom medusa

are often very long, and they are very sensitive, that is, full of feeling.

The mouth is on the under side of the body, and the stomach fills up the space under the bowing top. The medusas eat worms, shell fish, and little fish. They catch their prey by their arms, and either carry it up at once to the mouth, or else they keep it fastened on their tentacula, until the pores which these contain have sucked out all the juices of the food they have caught.

One kind of Medusa Jelly Fish.

The medusas are always at work, flapping up and down the top part of their bodies; and it was this action which looked to my eye so like the opening and shutting of a parasol. It is supposed they keep keep themselves afloat in the water by this movement; and so regularly do they repeat the flaps, that any one may sit in a boat, and for hours count fifteen flaps every minute. When they wish to descend low under the water, they let the umbrella part straight down by the side of the tentacula, and then sink as far as they please.

From all parts of the body of the sea nettles there oozes out a stinging fluid, that occasions on our skin a sharp pain, like the sting of a nettle, and it is on this account sailors have given them their present name. This pain will often last for days.

The naturalist Spellenzani once touched the skin of a sea nettle with his tongue, which brought on a burning sensation for hours; and a drop of the fluid having fallen into his eye, he suffered acutely. Sea nettles have a great deal of phosphorus in their bodies, and shine most brilliantly at night. The Mediterranean Sea, the Red Sea, and the German Ocean, are often highly luminous, from the presence of these creatures. Sea-weeds and some kinds of fish also give out this light; but it is the minute medusas or sea nettles, which principally give the brightness that is seen in the waters.

"Those living jellies which the flesh inflame,
* * * There's not a gem
Wrought by man's art to be compared to them;
Soft, brilliant, tender, through the wave they glow,
And make the moon beam brighter where they flow.

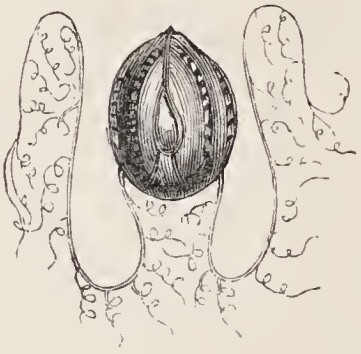
"Cast but a stone, or strike them with an oar,
And you shall flames within the deep explore,
Or scoop the stream, phosphoric as you stand,
And the cold flames shall flash along your hand."

Crabbe's Borough.

So minute and so transparent are the bodies of many of these sea nettles, that if we take up a pail full of sparkling sea water in the dark night, nothing can be seen in it when daylight comes.

There is one very beautiful species in the family of the medusa, called the Beroe. This species is often found in the seas around our British Islands, especially towards the north, and is about the size of a boy's marble. The round jelly body of the

beroe has eight ridges of skin, like the stripes on a melon; and from these ridges rise up a set of delicate membranes that look like paddles, and produce as they move, a beautiful play of colours, sometimes casting a bright greenish light round the body of the creature. From the sides of



The Beroe, or Jelly Ball, with Tentacula.

the beroe extend two tentacula or arms, that seem to support its jelly-ball like wings, and upon these arms are placed threads like long hairs, which the beroe can spread out or draw close in at its pleasure. The elegant little beroe is ever changing its position, dancing up and down, expanding or diminishing its body, and moving to and fro; constantly delighting the eye by its frolicsome gambols and beautiful rainbow hues. The food of the beroe is animalcules, small shrimps, and crabs, which, from the transparency of its body, may be seen in the stomach some time after they have been swallowed.

If, on a fine summer's day, you fasten to the sides of a boat a gauze net, and then row very gently over

the sea, it is most likely that you may catch one of these graceful little beroes, and by placing it in a tumbler, you can examine it for yourself.

Cuvier gives to the round jelly masses which we have been considering, the name of simple sea nettles. There is, however, another order of these jelly creatures, which he calls the air sea nettles,* because they have an air-bladder upon the top of their bodies, by the help of which the creatures can swim on the surface of the waves.

There is one species amongst these sea nettles that are furnished with air bladders, which is called the Portuguese man of war. These Portuguese men of war are the most beautiful of all the tribe. Their jelly bodies are of an oval shape. On the upper part of the body is the air bladder, and above this air bladder is a skin or crest, of a beautiful purple colour, which serves it for a sail. Far out at sea on the Atlantic Ocean, a large fleet of these beautiful little fellows are often seen ; and it is said, nothing can exceed the beauty of the sight. Rearing their purple crests on high, they quietly sail along, looking like large

Portuguese Man of War, with its sail folded down by the air bladder.

* Or hydrostatic sea nettles.

painted air bubbles, ornamented with bright fringes that hang down beneath, often fifteen or twenty feet long. If the slightest wind chance to ruffle the water, the whole fleet disappears at once, sinking down to the quiet depths below.

The great use of the sea-nettle family seems to be, to afford a large quantity of food to the numerous inhabitants of the deep sea. Whales and other fish, and even the sea anemones, feed voraciously upon them.

My next letters will contain the history of a new class of animals, the star fishes and the sea hedgehogs. Their forms and habits are so very different to the other zoophytes, that Cuvier has placed them in a group by themselves; and I hope, when we examine this new class of radiated animals, we shall find much amusement and instruction.

And now, believe me, affectionately, &c.

LETTER XI.

RADIATA.

Star Fish.

My dear young Friends,

I have read your notes with great pleasure, and find that I am not writing to idle, thoughtless children, but to those, who, whilst they love play, can spare a little time for the higher pleasure of gaining knowledge.

As I have much to tell you in this letter, I must at once set off with my story. The star fish is to be its subject; and this star fish is a radiated animal, belonging to the Echinodermate class. The name of this class is taken from two words; the first of which is *echinus*, which means prickly skinned, and the second is from *derma*, which means a coat or

covering; and this double name is in itself a very suitable description for the star fish, as this animal has a coat which is both tough and prickly to the touch. The animals in this class have their organs, like other radiated animals, placed round a centre in daisy fashion; but their skins are more perfectly made than any other radiated creatures. They have several vessels in the inside of their bodies, something like those of the higher orders of animals, and they also possess some delicate little white cords, called nerves, which give them some sensation. In them we also catch sight of organs, serving the purposes of feet. They have likewise a supply of weapons for defence, being armed with sharp-pointed moveable spines. These prickly-skinned animals are divided into two sets or orders. In the first of these orders, a great number of holes are regularly placed all over the outside of the animal's coat or covering; and through many of these holes, little tentacula, like the horns of a snail, are pushed out at the pleasure of the creature, to be used as feet. The second order consists of these echinodermata, which have no feet to push out.

The star fish, which is often found on our sea shores, belongs to the first of these orders. If any one had told me some time ago to look at the feet of the star fish, I should have been puzzled to know where to find them. But if you and I were to take a magnifying glass, and to examine the tentacula

that the star fish pushes out of the holes in its skin, we should find that each tentaculum is tipped with a little cup or sucker; and by fixing these suckers on the ground, the star fish is able to drag its body along.

Did you ever take up a dead star fish? I have many times, and always thought it rather a heavy, clumsy thing. But now that I know more of its

The Common Star Fish. They are sometimes as large as a man's hand.

history, I greatly admire it. If you were to hold a star fish in your hand, how would you describe it? Would you not say, "It seems a round body, with five rays or arms; it has a mouth on the under side of its round body, and it has a tough, leathery skin, which is covered with scales and prickles." This would not be a bad description of one sort of these creatures, but there are others which have more rays or arms around their mouths.

The rough feeling of the star fish's horny skin, arises from the presence of little specks of lime,

which are placed all over it; whilst around the mouth, and along the edges of each ray, sharp crystals of lime stand up like spikes. So far, our eyes and our touch have helped us to observe the star fish's outer substance and form; but how little should we guess from its outward appearance, what is to be seen beneath its skln!

In every star fish, there is a whole frame-work of one thousand little hard substances, answering the purpose of bones, all curiously fastened together. Round the mouth are many of these little shelly bones, and down each ray, they run in a jointed range of a great many pieces, so that the rays can be easily made to bend. Between each of these little pieces of shelly bone, a small hole is left, which is about the size of a pin's point. If you turn up one of the rays, you will observe on the under side, a groove or furrow in the skin, running down each side of the bony ridge. These grooves are full of little holes. A naturalist, named Reaumer, counted 304 in each ray; you can, therefore, easily tell how many holes there must be in the star fish's five rays. And now, for what use do you think all these little holes are left? The magnifying glass shews us, that they are pierced through the skin, on purpose to enable the star fish to put forth its small fleshy feet. Each one of these feet has, as we said before, a small cup or sucker at its point. When the star fish

wishes to be quiet, these tube-like feet lie out of sight quietly under the skin; but when it wishes to move, it fills the inside of the tubes with a little fluid, which instantly pushes them out through the small holes. The star fish can draw in, or send out as many of these tube feet as he pleases, either a single one, or two, or several hundreds at a time. The suckers at the end of its feet, not only enable the star fish to drag itself along the ground, but they also give it power to climb, so that it can walk on the flat sand, or mount up the steepest rock with equal ease. When the star fish intends to mount a steep place, it stretches out its five rays, in order that all its 1520 feet or suckers may go to work, and give it power to stick tightly to the surface of the object it is trying to climb; and as it travels on, the animal may be seen, loosening first one sucker and then another, so as to lift up ray after ray, which enables it to move on with a regular gliding advance; but in consequence of the shortness of its tube feet, notwithstanding their number, the star fish walks slowly, moves with difficulty, and presents rather an awkward appearance. Should you happen to pick up a star fish that has been left on the sand by the retiring waves, and were to place the poor, helpless, almost dead little animal in a deep glass tumbler, you would soon be able to enjoy the beautiful sight of its living movements. You would first see the

star fish slowly stretch out its rays, and then, as it began to move towards the sides of the glass, it would send out of their small holes hundreds of its feet, each one of which, in its turn, would be fastened down on the smooth surface; and as it mounted up the sides of the glass, all of its suckers would come into action. Some would be fastened tight, that it might hold itself up by them; others would be loosened from their hold, that it might draw itself on; and thus, by an even gliding movement, the star fish would be seen to mount to the top of the tumbler.

The suckers at the bottom of its many feet, not only enable the star fish to walk and to climb, but they also serve for fishing hooks. When the star fish lies at its ease in the water, its short tentacula feet hang loose; but the moment a morsel of fish, or crab, or lobster, touches one of them, the sucker fastens upon it; the next sucker foot then catches it off, sends it forward to the next little foot, and so the captive bit is drawn up the whole range of the feet, until at last it reaches the mouth, and is devoured.

The star fishes are a very hungry set of creatures; and in endeavouring to gain their food, they often fight fierce battles with shell-fish and crabs. When a star fish has made up its mind to seize some strong creature, such as a crab or lobster, it raises itself up on its five rays, and bends them slightly

inwards towards its mouth. In this attitude it patiently waits, till the proper moment has come to grapple with its prey; then darting one ray round it, it holds it tight. If at this moment the crab be quick, it may pinch the star fish's ray off with its claws; but if the crab be slow, its doom is fixed, for the star fish then quickly grasps it with all its rays, fixes down its suckers firmly upon it, and then, let the crab struggle as it will, all its efforts are vain, for it is dragged closer and closer, and at last forced into the wide open mouth that is gaping to receive it. So widely can the star fish open its mouth, and so largely can its stomach be stretched, that it can swallow crabs, lobsters, and shell-fish, of an astonishing size; and it does not even stop to remove the hard shell from them, but swallows them all; and in a short time, as we have seen in the case of the sea anemone, when the juice in the stomach has dissolved the softer parts, the hard shell is cast out at the mouth.

If many star fish settle upon a bed of oysters, they make sad havoc in it. Yet it sometimes happens that when a star fish has caught a famous oyster, it is fairly puzzled to know what to do with it. The oyster-shell proves too large to swallow, and too hard to crack, and yet the prize is too good to be parted with. If a hungry school-boy caught an oyster, he might try for a long time to open it with his fingers, and he would not at last be

able to succeed. The rays of a star fish are not so strong as a boy's fingers; what then can it do? Has the star fish any oyster knife to help it? Yes, it has, but not one made of bone or of iron! it is the softest knife you ever heard of; this knife is a little bladder! As the star fish folds its rays tight round the hard oyster, it presses its mouth close to the edges of the joined shell, and four or five little bladders are then seen to rise round its mouth, and a little fluid, drop by drop, oozes out upon the edge of the shell. What this fluid is, I cannot tell you, but it seems wonderfully to stupify or to kill the oyster; for presently the strong hinges of its house give way, the oyster-shell opens, and the star fish feasts upon its plump body. But as soon as the star fish raises its mouth from the shell, all the little bladders sink into the skin and are seen no more.

Besides the ranges of holes through which the star fish's sucker-feet are pushed forth, many holes, much more minute, are pierced all over its skin; and these holes are filled with minute tubes, supposed to be for the purpose of drawing air into its body, to breathe by.

If the star fish has the misfortune to lose one of its rays, it is not greatly troubled, for in a short time a new one grows in its place. A star fish has been known to lose four out of its five rays, in some fierce battles; and this is the reason why they are

often found lying on the sea shore with deficient, or with injured rays.

As all the radiated animals live under the water, and generally perish when they are taken out of it, it is really wonderful that men have learnt so much of their history. But, difficult as it must be to watch them, we find that a determined mind can accomplish great things; we are therefore greatly obliged to those persevering men, who have explained to us so many of the wonderful works in natural history, carried on under the rolling waves of the sea.

The history of each one of the animals we have now considered, teaches us that our kind God watches over the wants and the pleasures of the meanest of His creatures. We see that He gives to them, not only the sagacity and the instruments which they require for catching their food, but that He also provides them with some means of defending themselves.

We learn, by their history, that His gracious eye watches under the mighty waters, as well as over the earth, and that no creature can stop doing His will without His eye seeing it. How closely then must He be watching the thoughts and actions of His creature man, whom He has made the lord of His creation! Every thing that is made displays the power and the wisdom of God; but can you tell me what act of the Lord displays the immensity of

His love towards us, His highly-gifted but fallen children? See 1 John iv. 9, 10; John iii. 16; John vi. 30.

Your affectionate friend.

LETTER XII.

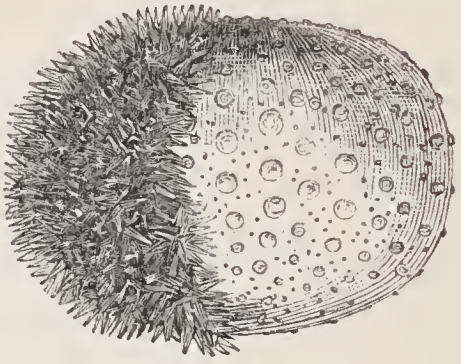
RADIATA.

The Sea Hedgehog.

My dear young Friends,

As you have now had a few days to consider the history of the star fish, I think it is time that we should trot the Echinus, or as it is often called, the Sea Hedgehog, out of its snug little hole in the sea beach. What do you think this echinus, or sea hedgehog, is like? Perhaps you have never seen one; if not, I think you must have seen a picture of it in some book. Its appearance is something like that of a brown ball, covered over with the bristles of a hedgehog. Let us now see how it is made.

Fancy to yourselves a star fish flat on its back, with its five rays lying straight out, and next imagine that you take it up in your hand, and bend its five rays up, so that they almost meet together in a point, and form a ball, shaped like an orange; such



The Echinus. Half shell exposed and half with spikes on.

is exactly the shape and the nature of an echinus; only that whilst the star fish has usually but five rays, the echinus has ten—five small ones between its five large ones. These ten bent-up rays make a box, in which the echinus or sea hedgehog animal lives. The box is lined with a skin, which has more nerve in it than the star fish possesses, so that the echinus has more power of feeling. If you look closely at an echinus, you will see there is a hole on the top of its box; this is its mouth.

The rays of the star fish, as you know, are made up of a vast number of soft, bone-like pieces, covered over by a rough, leathery skin; but the rays of the echinus are made up of a vast number

of little thin plates of shell; the outside of these plates is covered with a tough skin that is full of small spikes or prickles; the plates and prickles making altogether about 10,015 separate chalky pieces.* The beautiful thin plates of shell which compose the echinus box, are chiefly made of carbonate of lime. These plates are not fastened together, but are laid so closely by each other, that when the outside skin is taken off, they look like one round whole shell. On the five large rays of this box, many long moveable spikes stand out amongst the small prickles that cover the box, all of which are rooted in the tough skin. That end of the long spikes, which is furthest from the shell, is as sharp as a needle; but the other end, close to the shell, has a cup-like hollow, which is made to fit exactly over round-headed nobs, that grow upon the shell under the skin. By this cup-like contrivance at one end of the spikes, the sea hedgehog can play and roll its spikes up and down over the knobs, either setting them up or laying them flat down, just as easily as a child can roll about his ivory ball in the saucer of his cup-and-ball toy.

The five small rays of the echinus' shell are full of little holes, through which the animal can push forth hundreds of long thin tubes or tentacula, each of which is tipped with a sucker. These sucker-tubes the echinus uses as feet, just as the star fish

* Grant and Agassiz.

does; by some of these tubes it also draws air and water into its body.

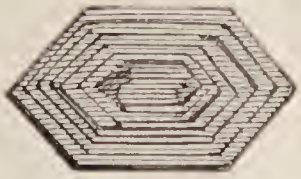
So you see the box of the echinus is made up of five parts:—1st, of a thin sensitive skin over the animal; 2ndly, of shelly plates laid upon this skin; 3rdly, of a tough skin over the outside of the shelly plates; 4thly, of spikes;* and 5thly, of the tentacula feet with suckers. The young echinus and its shell are at first very small, but as it eats, it grows, and then of course it wants a larger house. How then do you think this house of shell can be enlarged? The round shell is generally made up of 2,015 six-sided shaped plates.† If a

few of these plates were to grow larger, the shell would be made uneven, or one-sided. But it is never found to be so; therefore, to keep the shell perfectly round, every little piece of the shell is made to grow bigger at the same time. If you had to make all these plates bigger at once, I think you would be puzzled to know how to set about it; but He who made the echinus was at no loss. For God has so ordered the growth of the shell, that the carbonate of lime, which comes out of the food the echinus eats, settles at once all round the rim of every little piece of shell. For this purpose, the skin which covers the soft body of the animal, is made to push itself up between each little plate and

* There are 8,000 of these spikes.

† The number of these plates varies, in some slight degree, according to the species, or age of the animal.

there to deposit a liquid that hardens into a shelly rim, so that a young echinus has 2,015 plates of one rim, a rather larger one has 2,015 plates of two rims; and one older still, 2,015 plates of many rims. Thus the echinus keeps adding rim to rim to each piece of its shelly home, adding also a few new plates according as its body grows.



The echinus, round as it is, is able to walk, to climb, and to bury itself in the sand. If it be in a hurry to get out of sight, it rapidly moves the spines which are at the lower end of its shell; this motion tosses up the sand, and forms a small hole; down it sinks into this hollow, and as it goes lower and lower, more of its spines toss up the sand, till at last it vanishes so quickly from sight, one wonders where it can be gone. As the echinus sinks into this hole, it sets up the spines around its mouth, in order to keep a little space open, to act as a passage or tube in the sand, by means of which air and water may flow down to support it. But that little passage is enough to shew where it has so snugly hidden itself; and people on the coast of the Mediterranean Sea, who seek to catch the echinus, in order to roast and eat its roe, find it out by these passage holes.

When an echinus walks, it looks as if it were rolling along on its spines; but that is not the case,

for it is not by its spines, but by its sucker-feet, that it drags itself forward, turning over and over. When it climbs, it uses its many hundred suckers as the star fish does; but because it is round, it always seems to be rolling over when it moves.

The mouth of the echinus is very curious; it is made of several shelly bones, which are surrounded by fringes for lips, and on the edges of the mouth are set five strong teeth. These teeth are arranged in such a way, that they rub together, and by this action they keep themselves sharp. By the side of the mouth are also placed some long arms or spikes, and some kinds of echini can push them out a long way.

The echinus lives on shell-fish and coralline polypes, which it seizes with its sucker feet, and then crushes them with its five strong teeth.

There are many kinds of the echini; some of them are longer, some flatter, and some rounder than others. At the island of Raiatea, in the Pacific Ocean, is found a curious black species. A person of the name of Bennet, searching one day for fish, in the hole of a coralline rock, presently felt a sharp pain in his hand, and on looking at his fingers, he found them covered with slender black and grey spines. They stood out from his fingers like arrows in a target; and their points being barbed like fish-hooks, he could not draw them

out, so that they remained for some weeks like black specks in the skin.

He could not at the time, see this fierce echinus which had pierced him with its spines, because the hole, in which it lay, was deep; but afterwards, he saw many of the same kind in the hollows of the rocks; and the people, who lived in the island, told him to be careful not to touch them.

Our next letter will speak of two other species of radiated animals, and then we shall have finished with the zoophyte division of life.

Yours affectionately, &c.

LETTER XIII.

RADIATA.

Encrinites and Sea Cucumbers.

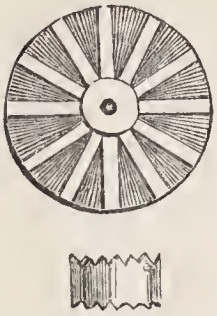
My dear young Friends,

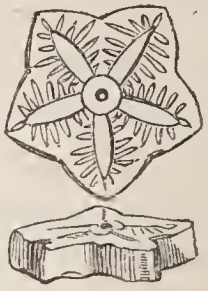
My two last letters gave you the history of the star fish and sea hedgehog, both of which radiated animals have organs something like feet, that enable them to move from place to place. We are now to consider some other animals belonging to the same hard-skinned class, but which have no feet, and which are called the order of the *Encrinites.* These encrinites are a very strange looking set of animals, exactly resembling star fishes set upon stalks and stems ; having their stems fastened to the bottom of the sea.

When an encrinite is alive, its shelly skeleton is covered with skin, with flesh, and with suckers: and its stalk, being composed of an immense number of plates, is rendered so pliable, that it easily bends about at the will of the animal. Such a pliable form was no doubt wisely given to the stem of the encrinite, to enable this stationary creature to wave itself about, and so to catch upon its suckers the prey that passes within its reach.

Encrinites.

When an encrinite is dead, and its skin has fallen off, we can see that the shelly pieces of its stem are very numerous, and that they are placed very close





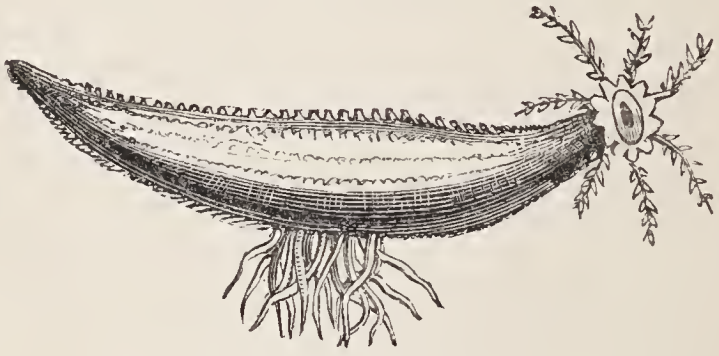
to one another. Should the form of these pieces be round, the animal is called an Encrinite; but should they be five-sided or pentagonal, the animal is called a Pentacrinite. Very few of this family of encrinites are now alive in the waters of our globe, and those that are met with are of a small size. I have heard of a poor one that was taken off the coast of Ireland, and of some few others that have been discovered in the warm parts of the Pacific Ocean; but in ages long gone by, they must have swarmed in vast numbers in the sea; for we find that one-half of the blue and black marble found in the hills of Derbyshire is made up of the round and pentagonal skeletons of these creatures. But why our great Creator should have allowed the encrinites to abound in such numbers at one time, and then should have seen fit almost to destroy them, I cannot tell you: all that we know of their history is the one great fact, that in some by-gone time, God saw it good to send vast streams of muddy lime over the bottom of the sea, which buried up all the encrinites then living there; and since that period, it has not pleased Him to allow

these creatures to multiply again in any great abundance.

When this limy or chalky mud was spread over the encrinites, a great weight must have heavily pressed upon them; and the sea water, as well as the ground, was probably warm, because we find that both the encrinites, and the muddy lime which flowed over them, are together turned into vast layers of marble. To prove that heat, with a great pressure, will soon turn chalk into marble, a chemist once took a lump of chalk, and rammed it very hard into the barrel of a gun; he then put the gun-barrel into a fierce fire, and after leaving it there for some time, he took it out, broke the barrel, and down fell to the ground a perfect little piece of marble.

As all the encrinites, and all the lime that now constitute the Derbyshire marbles, once lay quite flat at the bottom of the sea, perhaps you may wonder what lifted them up into the form of hills. This great change took place through the rending, bursting, and upheaving force of vast explosions of fire, which have at different periods taken place in the central parts of the globe, and which occasion such mighty earthquakes, that the solid parts of the earth are altogether thrown about, and altered in their forms; some parts being thrown up into high mountains, whilst other parts are sunk down into valleys.

The last family in the radiated division of animals now left for us to notice, is the one called the Holothurias, or Sea Cucumbers. These are a very curious set of creatures, that crawl and swim about in the ocean with great rapidity. They are found in almost every sea; and in the South Pacific Ocean they grow to nearly one foot and a half in length.



One kind of Holothuria.

They have no shell over them, but they are covered with a thick elastic skin; and when they are touched, they bend up the body, and then spring it back with such force, that they sometimes squeeze part of their insides out at their mouths. Some of these creatures have a bunch of tentacula under the centre of the body; others have short sucker feet pretty nearly covering them, by the help of which they manage to crawl along the rocks. The mouth of these sea cucumbers is formed of several pieces of a shelly nature, and it has also many branching tentacula around it.

There are several different kinds of creatures which greatly resemble the sea cucumber, but which are without feet or suckers. These are called the footless order. These footless echinoderms are enclosed in elastic skins, are full of spring, and have hard plates around their mouths; yet in appearance they are a good deal like our common earth-worms. The Chinese eat many of these creatures, and for this purpose they dig them out of the sand; fishermen, also, on the coasts of the Mediterranean Sea, catch them for bait.

We have now said as much about the radiated division of animals, as it may be needful for you to know. During our examination of its families, we have had to dwell on much that is curious and beautiful; and I think the history of its different creatures has taught us that our God is very good to all; that He is kind to the frailest worm, as well as to the highest form of life that His hands have fashioned. But before we bid adieu to this portion of our subject, let us look back and see where we have been roaming during the last few weeks.

First, we entered the deep sea caves, and hunted the sunken rocks for the living sponge. Then one drop of water opened to our notice the history of the animalcules. Next we dabbled in weedy pools for the hydra. Again returning to the sea, we dived under its blue waters in search of various coral

groves; and after threading our way amidst the beautiful Islands of the Southern Seas, we rose again, and took a quiet look round upon the smooth sea beach, where we beheld the sea anemone dozing in its shallow pool. Then, quickly plunging into the sea, we rapidly chased the jelly fishes, as they floated up and down amidst the heaving tides that run round our world. Next, we found ourselves ankle deep in water, handling the star fishes and sea hedgehogs; and there we staid for some time to watch them as they crawled and tumbled along the sea shore. Then glancing back at years long gone by, we asked questions of the marble hills of Derbyshire, because we wondered at their masses of encrinite skeletons. Again plunging into the ocean, we traced up the sea cucumbers; and having gazed at their strange forms, our work was done, for our race amongst the four classes of the *Radiated* or *Zoophyte* animals is ended.

King David calls upon all beasts, and cattle, creeping things, and flying fowl, to praise the Lord our God. And shall not we, who are given powers to observe the wonderful works of our God, join with all the hosts of creatures which are upon the earth, and in the heavens above, in ascribing honour, and power, and glory, to the great "I AM?" Even unto Him, "whose tender mercies are over all His works."

In a few weeks we shall begin the history of the

Articulated Animals, which are the worms, lobsters, crabs, spiders, and insects: till then believe me to be,

Yours affectionately, &c.

End of the Radiated Division.

PART II.

THE ARTICULATED ANIMALS.

Worms, Lobsters, Spiders, and Insects.

"The heart is hard in nature, that is not pleased
With sight of animals enjoying life,
Nor feels their happiness augment his own."

COWPER.

Explanation of Terms.

Abdomen. Last division of an insect's body.

Albumen. Animal substance, something like white of egg.

Annelida. Worms.

Antennæ. Threads or feelers on the heads of insects.

Arachnida. Spiders.

Articulata. Animals made with rings and jointed.

Branchia. Same as gills.

Ganglia. Nerves tied into knots.

Gills. Breathing parts of water animals.

Horn. An animal substance, made of lime, glue, and albumen.

Jaw Feet. Instruments by the mouths of lobsters and insects for breaking their food.

Nerves. Soft white feeling threads, coming from the brain of animals.

Spinnerets. Knobs belonging to bags of gummy silk in the spider's body.

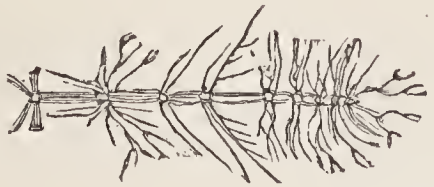
Thorax. The middle part of an insect's body.

Trachæa. Air tubes, running along the sides of an insect's body.

Vertebrated. Having a back-bone.

THE ARTICULATED,

OR

Third Great Division  of Animal Life.

The 3rd Division consists of the animals surrounded by rings. These animals are separated into 4 classes.

- 1st class, the *Annelides*, or Worms: this class is divided into 3 orders.
  1. Abranchiata—breathing by holes—the earth worms.
  2. Tubicola—covered with tubes, and breathing by gills—the serpula.
  3. Dorsibranchiata—having tufts for gills—the nereis.
- 2nd class, the *Crustaceans*, or Crabs, &c.: this class is divided into 7 orders.
  1st order—crabs, lobsters, &c.: 91 genera in this order, and all good to eat.
  In the other 6 orders are 67 genera of shelly-ringed animals.
- 3rd class, the *Arachnideans*, or Spiders: this class is divided into 2 orders.
  1. Pulmonaria, breathing by lungs—spiders.
  2. Trachearia, breathing by air tubes—mites.
- 4th class, the Insects: this class is divided by some naturalists into 9 orders.
  1. Coleoptera—sheath-winged—beetles, some thousands of genera
  2. Orthoptera—straight-winged—crickets and locusts, &c.
  3. Neuroptera—nerve-winged—dragon-flies, &c.
  4. Hymenoptera—membrane-winged—bees, ants, &c.
  5. Strepsiptera—twisted-winged—stylops.
  6. Lepidoptera—scale-winged—butterflies, &c.
  7. Hemiptera—half-winged—plant-lice, water scorpions, &c.
  8. Diptera—two-winged—flies, gnats, &c.
  9. Aptera—without wing—fleas, &c.

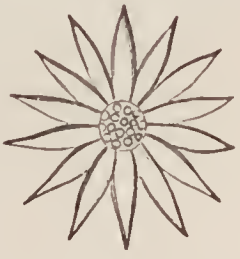
LETTER XIV.

ARTICULATA.

General Remarks on Articulated or Jointed Animals.

My dear young Friends,

My former packet of thirteen letters, finished the history of animals that have arms* placed, something like the flowers of a daisy,† in rays round a centre, and which on this account have received the name of the *Radiated Animals.*



I shall now write a new set of letters, in order that I may send you the history of the *Articulated or jointed Animals.* In this division you will find that

* Or Tentacula. See note, page 39.

† Each separate piece of a daisy is a perfect flower in itself.

Cuvier has placed worms, lobsters, spiders, and insects;* and if I can succeed in directing your attention to examine some of these hosts of curious creatures, it will give me great pleasure.

Our first glance at the animals in the articulated division, convinces us that God has been pleased to form their bodies very differently to the bodies of the animals in the radiated division. The arms of the radiated animals sweep round a centre, but amongst the articulated animals, as in worms, crabs, and flies, this daisy-like figure is gone, and all the organs of feeling and motion run in a line on each side of the body, giving to both of its sides the same appearance.

Amongst the radiated animals, but few of the soft feeling threads, called nerves, can be seen; but in all animals which have two sides alike, a vast profusion of these nerves are spread over the frame. And these nerves not only give sensation, but they also quicken the powers of the animal, for they act somewhat in the manner of electric wires, carrying down in a moment of time, the desire of the will to each member of the body, prompting it to action.

All animals in the articulated division, have their bodies formed by rings of either horn or lime, which are wrapped round their soft insides; and these rings, being united together by a tough skin, easily

* Cuvier placed these four sets of creatures in the same division, because his observing eye saw, that in some respects, their bodies were all made in the same way.

bend at their separate joints. The habits of the animals in this jointed division, are different to the habits of the animals in the radiated division. Most of the zoophytes or radiated creatures live in one place, and mostly in water; but the articulated animals, such as worms, lobsters, crabs, spiders, and insects, have bodies fitted either for flying, swimming, creeping, walking, leaping, or running.

Some live in the air, some on land, some in water, and some in all three. It matters not whether the hard rings of these creatures be far apart, as in the worm, or whether they be pressed close together and look like one firm jacket, as with crabs, flies, beetles, and spiders; in either case they are called articulated or jointed animals, because rings in some form or other are present in their bodies.

Another mark that distinguishes the articulated animals, is the regular way in which their nerves run. These jointed creatures have the brain placed in a ring round the throat, and from this band of brain run two threads of nerve all along the under side of the stomach. These two threads of nerve are often tied together into many knots, called ganglia, and each knot throws out a vast number of fine nerves, that run all over the animal, even down into its limbs; so that

Nerves of a Beetle.

scarcely a pin's point can pierce the skin without wounding one of these feeling cords. Each little knot or ganglion in the body of an articulated animal, is like a little brain, and gives life and feeling to the part it belongs to: from this cause, when a worm or a wasp is cut into two pieces, each divided part moves about a short time after the separation.

One or two articulated animals breathe by the nose or mouth, but the rest draw air into their bodies through little holes that are left by the side of their rings, or else through gills made like those of fishes. The insides of these articulated or jointed animals are very simple, but there seems no end to the curious variety of instruments which are placed on the outside of their bodies, and which are given them for the purposes of moving, clinging, cutting, sawing, boring, weaving, and building. The greater part of these instruments are placed either on their heads, or on their feet.

The great naturalist, Cuvier, divides these jointed animals into four sorts or classes.

He calls the 1st class, Annelides, or worms: the 2nd class, Crustaceans, or crab-like animals; the 3rd class, Arachnideans, or spiders and scorpions; the 4th class, Insecta, or all insects.

Observe the two peculiar marks which belong to all the creatures of the articulated division: first, they have rings of horn or lime to form the outside

of their bodies; and secondly, they have two long nerves, tied into many knots, which run under the stomach the whole length of the body; and if you have not been told, you cannot imagine the hosts of creatures that are made in this way. Of insects alone, it is computed that four hundred thousand different sorts live in the world. In these letters I shall only speak of one or two animals in each of the four articulated classes; but should you wish to know more of the different kinds, you must examine what learned men have written respecting them in books of natural history.

In a few days you will see me come before you with a worm in my hand; till then believe me,

Affectionately.

LETTER XV.

ARTICULATA.

Earth Worm.

My dear young Friends,

According to my promise, I now present to your notice an earth worm. I expected to say very little upon this family of worms; but the works of God are so rich in wisdom, and so rich in variety, that the simplest-looking animal calls forth a wondrous tale.

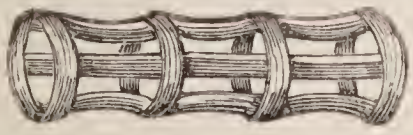
Cuvier gives the names of *Annelides* (or ringed creatures,) to all worms; but all worms do not look exactly like the earth worm, although they are somewhat after the same fashion.

The common earth worm is often seen creeping in, and creeping out of the earth. It has a long,

round, smooth body, made of soft jelly flesh, surrounded by about 120 horny rings or hoops; and on examining it, we find that these rings are placed at a little distance from one another. The earth worm has a sharp pointed head; it has no distinct eyes, but two specks on the head seem to shew that it may perhaps know light from darkness. It has no teeth, no tentacula, nor any formed feet, but it has minute hairs or bristles on the skin, which are placed over each ring, and serve in the place of feet. Two cords of nerves run under the body, and these nerves are tied between each ring into knots, which knots of nerve are called ganglia.

These nerves give to the flesh the power of feeling, and on this account, when touched, the worm draws itself hastily up; but perhaps the worm has not much of that feeling we call pain; for when its body is cut in two, the end upon which the head is left generally lives.

The first ring in the body of a worm makes the head, the last ring makes the tail; all the 118 rings between these, are kept in their right places by four strong bands of muscles made of tough flesh. Two of these bands of muscle are fixed to the rings at the top of the back, the other two run along the under part of the body, as in this picture.



When the worm shortens its four long muscles, its whole body looks contracted or drawn up, and the flesh swells out in wrinkles between the rings. I have often seen this contraction take place in garden worms.

But if the worm shortens two of its muscles, suppose we say the two muscles under its stomach, then its back rises up into an arch; just as a set of curtain rings, drawn close together at the bottom by a piece of string, would spread far apart from one another at the top, and thus form an arch above, like the back of a worm.

Besides its four long muscles, the worm has many muscles that run round the body between the rings, and when the worm tightens these round muscles, its long ones are forcibly pressed down; by this act the head is thrown forward, and the body is lengthened out. In the flesh of the worm are many other small muscles, which enable it to pull a few rings at a time, sometimes on one side, sometimes on another; and it is this movement of a few muscles which makes a worm twist about in all sorts of folds and bends.

To prevent the worm from slipping whilst it is shortening or lengthening its body, a great number of very minute hairs are placed on the skin all round each ring. When a worm wishes to creep into the earth, it fixes the bristles of its hind rings firmly against the earth, and contracting or drawing

tight its round muscles, the long muscles become pressed straight out, by which act its body is pushed forward, and its head is forcibly driven into the mould; the bristles in the front part of its body next take hold of the earth, and the worm now contracting or shortening its long muscles, the hinder part of the body is drawn up. The next movement of the worm is again to contract its round rings, which throws its head forward, and so it travels on.

The earth worm breathes by a number of air bags placed on each of its sides; and to let the air pass into these air sacs, two little holes are left in the flesh of the back, between each ring.

Almost all worms have red blood; and this is very curious, as no other animals without a back-bone have red blood. The red-blooded worms have one, two, or three little vessels, like hearts; and they have two sets of tubes to carry the blood all over their bodies; one larger set to carry the blood from the hearts, and another smaller set to bring the blood back again.

The earth worm generally lives in moist earth; too much wetness or too much dryness kills it.

Earth worms are beset by many dangers and difficulties. The angler hunts for them to bait his line; the gardener cuts them in two with his spade; birds eat them, and the mole pursues them under-ground. Worms seem afraid of a mole; for if the

earth be a little shaken, the worm that feels the movement will pop out its head into the air. One bird, called the lapwing, knows this so well, that at noon, when its dinner time is come, it will stamp with its feet on the ground, and then snap up the frightened worm that peeps out.

Worms are very useful on account of the work they do for man. They open holes in the ground, through which the rain and air reach the roots of grass and trees; and as they live upon decayed vegetables, straws, and leaves, by drawing these into the ground, they help to enrich the soil. Worms often swallow a good deal of earth with the decayed vegetables which they eat; and as soon as the bits of vegetables are dissolved in the worm's body, it throws the earth out of its mouth.

These worm-heaps spoil the appearance of a garden, but they do the land a great deal of good. They make the earth light and fine. A field having been coated with marl, became so hard that it was left unsound; yet in eighty years, this piece of land was found covered with a crust of earth one foot in thickness; all of it having been thrown up by the worms, which had pushed their little earth heaps through the marl.

I told you that the works of God are rich in variety; even the earth worms are numerous in their varieties. Savingny found, when he looked

diligently, that no less than twenty-two different species burrow in the ground round the city of Paris. In the sea, as well as in the fresh water of ponds and rivers, many different kinds of worms are found. These water worms have different kinds of dresses on their heads, and different nobs and bristles on their sides; and the habitations in which their Maker has taught them to hide their naked bodies, also vary exceedingly.

So great is the variety of worms, that Cuvier has found it convenient to divide them into three orders. He places in the first order, the worms that breathe by drawing air into their bodies through pores or holes in the skin. In the second order, the worms which live in cases, and drink in the air through gills placed on their heads. In the third order, he places the worms which take in the air by gills running along their bodies. There is not much to be said about the water worms; but as my letter is already long, I must send you the short account of their family another time.

Yours affectionately, &c.

LETTER XVI.

ARTICULATA.

Water Worms.

My dear young Friends,

I have already told you that worms are divided into three different kinds or orders, and that they are distinguished by the manner in which they draw the air into their bodies.

Earth worms draw air into their bodies through pores in their skin;* and they have often little air sacs connected with the pores on the sides of their bodies. Other kinds of worms which live in water, breathe by gills. Some of these water worms have their gills placed on the head like plumes; and

* These earth worms forms the Abranchiate order.

because they cover their defenceless bodies with cases, they are called the Tubicola or tube-dwelling order.

Others have their gills placed like soft velvety tufts or bunches along their sides or backs, and these tufty worms form the Dorsibranchiate order.

Now, do you know what gills are? "Oh yes," you will answer, "we have often seen them on fishes." But can you tell me the use of gills? As I cannot hear your reply, you must excuse me, if I suspect that you know very little about them; and therefore allow me to tell you, that animals which live under the water require air to breathe, as well as animals that live on the land, for without some air they would perish. In order, therefore, to catch up the scanty supply of air to be found in water, God has been pleased to place near the heads of most water animals, many ranges of fleshy fringes, to which we give the name of gills. These fringes or gills are set in rows, very much like the fibres on the plume of a feather.

The skin on each side of these delicate gill fibres, is full of the most minute veins of white blood. These fine blood-vessels coming close against the water, imbibe or drink in the air that is in it, and thus it mixes with the blood. That you may have some idea of the abundance of fine skin which it takes to cover the delicate gill fibres of a fish, try to carry out the following thought: suppose that you

wished to measure the breadth of a shut book, and took a piece of string, or perhaps a roll of ribbon, to lay over the front of its shut leaves, you would find that whilst the book was closed, a quarter of a yard, or even less, would be sufficient to go round it; but if the fancy took you to open the book, and to place a strip of the ribbon down each side of the opened leaves, then you would find that yard after yard would be required for its measurrment. In the same way, the gills of a fish when laid down look narrow, but when the fish spreads out its gills, we see that they are formed of a vast number of separate pieces; indeed I have been told that it would take almost as much skin to cover the leaves of a large fish's gills as the body of a man requires. And all this fine skin over the gills is as full of blood-vessels as a piece of muslin is full of threads.

The gills of worms are made something like those of fishes; but their colours are finer, often being tinted with purple, pink, and deep golden hues.

I have said that the gills of some water worms rise up like plumes on the head, whilst others lie in soft velvet-like tufts, on their sides or backs. In both cases they reflect the most beautiful rainbow hues; and when these bright worms glide about in holes and crevices of rocks filled with clear sea water, it is an interesting sight to watch their waving forms pass amongst the loose stones and floating pieces of sea-weed. A few water worms have feelers

or tentacula round the mouth, but most water worms have bristles on their bodies, which resemble bunches of stiff hair; and it is these bristles that often give the bright golden colour to the surface of the worm; some of these bristles are tipped with hooks, which enable the worm to cling close to the substances around it. Sometimes the bristles serve for feet, and then several little sets of muscles, acting like strings, are attached to the bristles to move them backwards and forwards.

Water worms are supposed to live chiefly on animalcules. Many of these worms are soft, and have no means of defending themselves; therefore, for safety, they bury themselves in sand at the bottom of the sea, or hide themselves in the ooze or mud at the bottom of ponds and streams.

Worms that live in tubes, form around their bodies various cases of sand, or mud, or of the ooze of vegetables, in the midst of which they live. Some worms have a sticky moisture on the skin, and with it they glue around their soft bodies morsels of shell, of stick, small pebbles, straw, or clay, and then move about with their patch-work tubes over them. Others have a slime which oozes out of their own bodies, and this slime hardens around them into a rough case of lime. These worms in lime cases, generally attach themselves to some firm object. You must often have observed that an oyster-shell looks very rough, and plastered

over with long twisting tubes of lime; those tubes were made by a worm called the Serpula, and formed the house in which he lived.

Groups of Serpula, with the worm raising its head out of the tube.

All worms living in their own tubes have gills on their heads. If you were to place an oyster-shell with a live serpula upon it, in a basin of sea water, you would probably see it spread out its fan-like plume of gills, and then you would be delighted with its richly tinted hues of lively reds, varied with yellow and violet. But it is only when the serpula is at ease that it spreads out its plume; if alarmed, it draws it in and causes its body to shrink down

into the long twisting tube, leaving only the edge of the plume to catch the air.

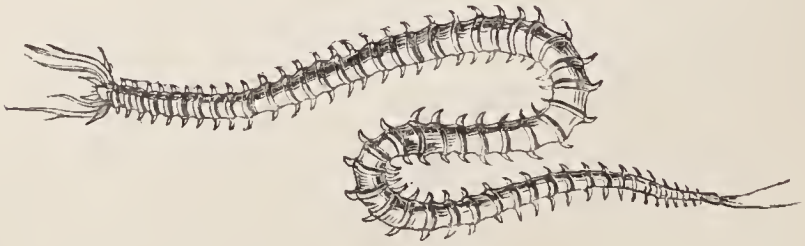
Many of the worms* which have their gills placed in soft velvety bunches along their bodies, have heads curiously supplied with strong instruments for catching and holding their food. These worms do not grow very large in our cold seas, but in the South Pacific they have sometimes around them four or five hundred rings, and swim by the undulation or waving of their long pliable bodies.

A few worms in this tufty order, cover themselves with patch-work tubes, but most of them live in the mud, or swim in the seas. There is one worm of this tufty order found in our English seas, which can separate its rings so widely, that fishermen on the Devonshire coast, who sometimes catch it in their nets, believe that it can stretch itself to what length it pleases. But this is a careless way of speaking, for the longest I ever heard of did not exceed thirty feet, and when it lies quietly on the sand or in the sea, it does not measure above eight feet in length. So great is the power of contraction in these worms, that a gentleman once put a very long one into a bottle of spirits of wine, upon which its rings were instantly drawn so close together, that the worm did not measure more than one foot.

The great naturalist, Linnæus, has playfully given the name of Nereis to this long worm, from the

* Called the Dorsibranchiate order.

history of the Nereides, which were imaginary beings spoken of by the Greeks. The Greeks and Romans had no Bibles to tell them the truth of this world's creation, so they imagined in their ignorance that one god ruled the sea, and another god ruled the land. They called Neptune the god of the sea, and supposed he must live there! and as they did not think it good that Neptune should live alone, they fancied that some merry young nymphs, whom they called the Nereides, dwelt with him in the great halls or caves in the ocean's bed. It was from hearing this tale, that Linnæus said he would call the merry fast-swimming worms, the Nereides. When the Nereis is tired of swimming, it buries itself under the sand of the sea, and by the help of its bristles, and the knobs on its sides, it travels along for considerable distances.



Nereis Worm.

Worms are often mentioned in scripture. They are sometimes used as emblems to point out the weakness of man, his earthly-mindedness, his exposure to danger, and his liability to corruption. When Job was very ill, and was deeply cast down,

he said that a worm was his nearest relation. King David prophesied, that even the Son of God, when clothed upon with our flesh, would compare Himself to a worm. In the 22nd Psalm, we read that the Holy Spirit of God directed David to write down beforehand, the mournful cry, which the sufferings of Jesus would draw from Him, at the time that He was despised and rejected of men, and lifted up on the cross unto death, causing Him to exclaim, "I am a worm and no man." Do you ask why Jesus, who is the Lord of life, was so afflicted and abased? This question the Apostle Paul answers, telling us it was *love*, and that "For our sakes He became poor, that we, through His poverty might be made rich." 2 Cor. viii. 9.

Our next letter will begin the history of the lobster. Believe me,

Affectionately, &c.

LETTER XVII.

ARTICULATA.

Armour of the Lobster.

My dear young Friends,

As I am fearful you may have forgotten the description that I gave you of an articulated animal, you must allow me to repeat, that it is distinguished by having a firm case of rings to form the outside of its body, and that two cords of nerve run along the under side of the stomach.

You will remember that we found the annelides, or worms, had flesh between their horny rings; that they had pores or gills for breathing, and bristles to be used in moving. We have now to

examine the second class of articulated animals, which are called the crustacea, from *crusta*, to harden, their outside coverings being of the nature of a firm crust or shell; such are crabs and lobsters. The rings of these hard-crusted animals are chiefly made of lime; no flesh is found between their rings, which are either divided from one another by a tough skin, or are drawn so closely together that they form one hard case. These hard-crusted animals breathe by gills, and have jointed feet and legs.

If we examine a lobster, we shall understand the way in which most of the crustacean animals are made.

Handle a lobster, and you will find that it is hard; its soft flesh being covered with a jacket of rings: these rings are formed of carbonate of lime and phosphate of lime, mixed with a gluey substance that flows out of the skin. When a lobster is alive it is black, when boiled it turns red. But whether it be black or red, it is at first sight quite difficult to believe that its hard jacket is nothing but a bundle of chalky rings; yet if you look at it closely, you will be able to trace the marks of these rings. The tail shows them the best; there they overlap one another like tiles on a house, and are fastened together by hinges made of a thick skin or membrane.

We can also see that the legs are jointed or

made up of several different tubes, which are fastened together by a membrane of tough skin, like that of the tail hinges. Its back looks as if it were one solid piece; but even in this solid piece, which is called the carapace or shield, lines may be seen, pointing out the position of rings, or segments, as they are sometimes called. The lobster has no neck, for its head comes close out of its shield.

If the body of the lobster had been left to roll amongst the waves in a naked state, the stones at the bottom of the sea would have hurt its soft flesh, and it would also have been greedily devoured by the first fish that passed by. But behold how beautifully the lobster is cased up in armour, that it may be defended from blows, and from the attacks of its enemies! Look also at the easy play of its joints; had there been no rings and no joints in its hard case, its tail, legs, and claws, would have stood out like the stiff branches of a tree; but ringed and jointed as it is, the lobster moves about in its hard dress, both easily, beautifully, and dexterously. So well is the lobster's shell put together for defence, that it is most probable, when men fought with battle-axes and bows, that they took the armour of the crustacean animals as a pattern in making their coats of iron.

I shall never forget a visit which I once paid with several of my friends to the Town Hall of Solure, in Switzerland. There we saw the thirteen

complete suits of armour, which had been worn in the year 1513, by the thirteen brave men who made Switzerland free, and divided their country into twelve cantons.

We did not know we were to see these suits of armour, and when the guide opened the door of the hall, I was quite startled, for round a huge old table, there appeared to be sitting on chairs, thirteen great men in solemn state, shining in dresses as bright as silver. Helmets of steel stood high, as if covering real heads, and rings of thin iron net-work fell in front of the helmets, as if hiding a face. Scaly plates of bright steel served to conceal the body, and boots of polished iron appeared as if supported by legs and feet. The man who opened the door presently told us that these were the very suits of iron mail in which the thirteen freemen of Switzerland had fought for their country's welfare, 330 years ago. And as we looked at these strong iron coats, and remembered the uses to which their owners had put them, we admired the skill of their manufacture. The firm iron plates that overlapped each other, looked suited to resist the darts of arrows and the furious blows of battle-axes, whilst their numerous joints rendered them so pliable, that the warriors who wore them, could bend their arms, wrists, and knees, almost as easily as in a cloth coat. Little, however, at that time, did we think that the workmen who made them,

had borrowed the plan of these dresses from the rings that God has placed around the crustacean animals.

This is rather a short letter, but it will serve as a beginning of the lobster's history, for we have yet many curious things to learn concerning him. The next letter will therefore bring more tidings, both of the good things that have been given to him, and also of what he has been taught to do for himself; and now believe me,

Affectionately, &c.

LETTER XVIII.

ARTICULATA.

Lobster Life.

My dear young Friends,

We are now to finish the history of the lobster. If you have one in the house, look at it; but if not, endeavour to remember its appearance, for I should like to know how many sets of feet you believe it to have upon its long body. Cuvier tells us it has three sets. The first set consists of three pairs placed by the mouth, which are called jaw-feet, these are used for dividing and breaking its food; the second set of five pairs, placed on the chest, are used for walking; and the third set, composed of many little limbs called false feet, are

placed on each joint of the tail. These false feet are used by the lobster in swimming; they also serve for the female to fix her eggs or spawn upon; and there the eggs rest until they are ready to be laid in the sand for hatching. Four pairs of the legs on the chest are each of them divided into five pieces, and all these four pairs of chest legs end with hooks; but the fifth pair of the chest legs, or those which are nearest to the mouth, are much larger than the others, and they end with strong claws or nippers. If you observe these large claws, you will see that they are not both alike. One is made like a saw, and is intended to catch hold of, and to mince up the food; the other pair has knobs upon it, and with this knobbed pair, the lobster seizes tight hold of the stalks of sea plants, and other objects, in order to steady itself amongst the waves and currents of water. The three pairs of little limbs by the mouth are called jaw feet. These feet take the food out of the claws, and turn it about to see if it be good and proper; if it be approved of by the lobster, the jaw feet again divide it, and then convey it to the mouth, where there are three more pairs of jaws, one after another, to crack and crunch the food; and when it reaches the stomach, another pair of teeth are waiting to finish the grinding operation. This food is generally some kind of dead fish, insect, or animal.

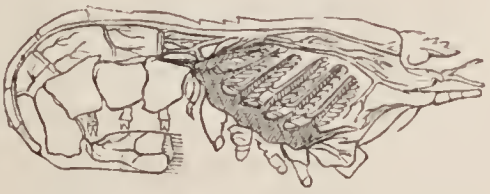
All lobsters have by the mouth four long threads,

or lashes, each of which is articulated or ringed; these threads are called feelers or antennæ. At the bottom of the lowest pair of these antennæ, the lobster's ears are placed. Great and sudden noises terrify lobsters; a loud clap of thunder, or the roar of cannon, has been known to make them cast off their great claws. Sailors know this so well, that when great ships sail past the lobster catchers' boats, the men will sometimes for a joke threaten to fire their cannon over them; but I hope they are never so unkind as to execute their threat, because the poor men could scarcely sell their lobsters when the great claws were gone.

Lobsters have two eyes, that project forward on moveable foot stalks. They are also said to have the faculty of smelling.

All living animals breathe, that is, mix air with their blood. We have already seen, when considering the worms, that some land animals draw air into the body by the mouth, that others draw it in through pores in the skin, whilst those which live in water, chiefly draw it in by the aid of gills.

In the lobster, the gills are placed just under the front part of the shield; and two small holes in the shelly shield, allow the water to keep constantly running in a stream over the gills.



Lobster cut in two, shewing its gills.

Some of the crustacean animals, such as land crabs, which live for months out of the sea, have a cavity near the gills, which is filled with soft flesh, somewhat resembling a sponge. When this sponge is filled with water, it supplies the gills for a long time with moisture. Other crustacean animals have the gills placed on their feet, or on their antennæ.

The lobster has a heart under the top part of its shield; large vessels carry its white blood over its body, and smaller veins bring it back to the heart.

Lobsters sometimes crawl at the bottom of the sea, but they are chiefly made for swimming. The end of the tail is divided into two pieces, and serves both for an oar and for a rudder. The lobster generally swims backwards; it strikes forcibly against the water by a quick, sharp folding up of its tail towards its body, something like the quick clashing of our fingers on the palm of the hand. This sudden bending of the tail causes the water to rush forwards, and at the same time the water re-acts upon the tail, and drives the lobster backward. It can strike with such prodigious strength in this way with its tail, that it darts through the water as a bird does through the air, and knows so well how to direct its motion, that it can leap backwards when alarmed, full thirty feet at once, and land safely in holes of rocks.

Both lobsters and crabs are very quarrelsome. In their battles, they will seize one another by the

leg, and will hardly ever separate until one has a broken limb. The injured leg, or bruised claw, is then generally moved from side to side as if it were in pain, till on a sudden a gentle crack is heard, and the limb falls off below the injured joint, when in a few weeks a new claw or leg, wonderful to say, supplies its place.

Lobsters, when young, are very small, as you may reasonably suppose, when you recollect the size of the spawn or eggs, out of which they are hatched. At first, young lobsters are soft, but in a little time the black armour comes over their bodies. And now perhaps you may ask, how are they to manage when their bodies enlarge; for they grow fast, and their armour will not stretch like the skin of back-boned animals; they cannot add a new selvage to their garments, as the sea hedgehog does to the shelly plates of its abode; the lobster is tightly wedged into its dress, and as it grows it must become pinched in its hard jacket; some change must therefore take place, but what can that change be? This is indeed a puzzling question, and one we could never have answered, had not naturalists and fishermen closely examined the habits of these creatures. From their observation we learn, that the black armour of the old lobsters grows soft once in a year, and with the young lobsters, many times in the year; the flesh also becomes thin: when this is the case, the animal puffs and swells

itself out till the shell on the under side of its body splits open at the seams. At the same time the claws burst open at the hinges. Then the lobster draws out its claws and feet, as if it were pulling them out of a pair of boots. The head next throws off its case, with all its jaw-feet, antennæ, and eye coverings; and lastly, the soft body creeps out of its shield. In this naked state the lobster drags itself into some snug hole, where, tired and weak, it lies down out of sight of its enemies. Many crustacea die during this moulting, but those that live increase very rapidly in size; after about forty-eight hours, a gluey substance settles upon the skin or mantle that covers the soft flesh: very soon after, chalk is thrown out from the skin, and joins with this glue in making a new suit of armour; so that in the short space of a few days, a new garment, of a large and roomy kind, is finished and wrapped around the lobster's soft body, and then once again it fearlessly sallies out, amidst rolling waves and threatening foes.

There are many crustacea that somewhat resemble the lobster, but yet differ from it in size, colour, and somewhat in shape. Such are the cray fish, river and sea prawns, shrimps, &c. We cannot dwell upon these varieties, but must proceed in the next letter to examine the crab, which is also a crustacean animal.

Yours affectionately.

LETTER XIX.

ARTICULATA.

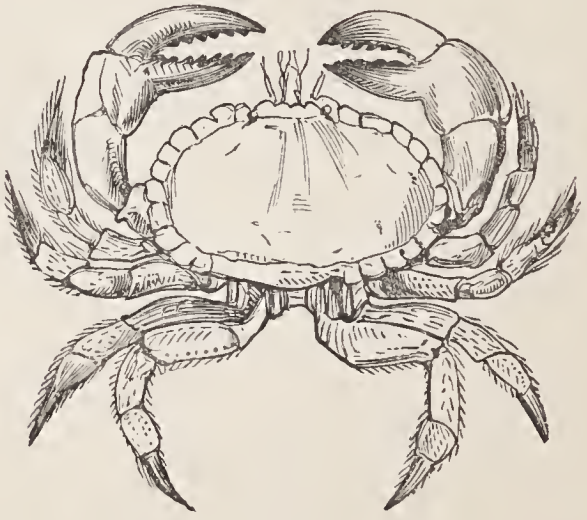
Crabs.

My dear young Friends,

In this letter we are to examine the crab. I suppose you have often seen crabs in boats, or in the baskets of fishermen, and perhaps you may have seen them when alive, slowly sideling over the sea shore.

Crabs belong to the Crustacean class, and we learn from books of natural history that there are several sorts; we can, however, only find time to speak of a few. Some crabs are very small, some large, some long, and some short. All crabs have rather broad backs, and generally the tail is shorter

than the body. Sometimes the tail is so short, and bends so close up to the carapace, or hard shield that covers the body, that it is quite hidden under it. They have hard chalky armour over their soft bodies, and their heads, eyes, ears, antennæ, jaws, jaw-feet, shields, jointed feet, claws, and gills, are formed much after the fashion of the lobster's, with



Crab.

this exception, that whilst the gills of a lobster, as we have seen, lie near to its head, the gills of a crab lie in the centre of the body; and consist of those many loose fringes which are to be seen on the under side of the shield. Crabs and lobsters are so much alike, that naturalists have put them into the same group, and have called them the Decapode order of the crustacean class.

There are ninety-one genera, or different sorts of crabs and lobsters in the decapode order; some

have short tails, and some long tails, but all of them are good for food.

Crabs carry their eggs about them like the lobster. Have you not often seen the roe or eggs of a lobster lining the separate piece of its tail? Every mother carries her eggs with her till they are ready to hatch, and then she lays them on the sand. When the young one of the common crab comes

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Size of Crab just out of the egg.

from its egg, it is very small, and if this little naked crab be magnified, its body is found to bear no resemblance to its mother's; it is long, and of a

Shape of the young Crab when magnified.

much more suitable shape for swimming. After a time a chalky shell grows over the little naked

creature, and then its figure changes into that of a real crab.

Crabs shed their coats in the same way as lobsters; and Dr. Darwin tells us they are an intelligent set of creatures. During the moulting season, a good sound crab, who is not at that time going to change his jacket, is often observed to paddle about in front of the snug hole into which the poor naked ones have crept for safety. This sound crab is doing duty as a sentinel, and tries to keep all enemies off. In general, crabs are shy and fearful, but when on duty, the sentinel becomes perfectly bold, and will advance fiercely, with up-lifted claws and clattering pincers, to attack any foe that comes near; and fishermen, who are looking out for soft crabs to put into their nets for bait, are frequently able to discover their hiding place, by the bold daring look of this fierce fellow.

Crabs are very voracious, and mostly feed upon dead animals. They generally set out in the night to search for food; and great numbers will wander together, prowling over the sea-shore after dead fish, birds, or animals. If they find a good-sized prize, numbers climb upon it and soon clear it all away. Sometimes they stay so long eating the delicious morsel, that the tide falls before they have finished; then finding themselves stranded, with no water left to help them to paddle back into the sea, they hunt after a quiet hole in which to hide; and if they

cannot find one, they draw their feet under their bodies, squat down on the sand, and patiently wait till the next coming tide flows in. I have often seen little crabs lie in this way, resting as still as the pebbles around them; but if you touch them, off they run. Crabs will also feed upon live fish. Gilbert White, of Selborne, tells us, that when a crab desires to dine upon an oyster, (and this is often the case when it lives near an oyster bank,) it will squat itself down close by the side of a shell, and wait patiently till the oyster lifts up its lid, in order to obtain a little fresh air, or a drop of fresh water. As soon as the shell is opened, the crab throws in a little stone with a quick jerk of its claw; the poor oyster, finding an enemy close at hand, would then fain shut down the strong door of its house, but the stone prevents it; and now, being quite defenceless, and within the grasp of its ruthless enemy, it very soon feels the crab's claw creeping into its snug home, to draw it out from thence, never more to return. Other people besides Gilbert White have seen crabs perform this dexterous feat.

Lobsters are made for swimming, and crabs for crawling in shallow water. Some crabs run very fast, but they always move sideways; this action arises from the muscles of the legs pulling chiefly on one side of the joint.

Crabs often dig holes in the sand; some crabs in

India and on the coast of Africa, live all the day long in holes at a distance from the sea, and only go down to the water at night. If these crabs be pursued, they will run so fast, that a man on horseback can hardly keep up with them. Bishop Heber tells us there is a small land crab which swarms in the grass of the Deccan in India, and runs with considerable swiftness. These Deccan crabs feed upon grass, and upon the green stalks of rice; and the Bishop says, it is an amusing sight to see the little fellows sitting upright to cut their hay with their pincers, and then waddling sideways off to their holes with a bundle of food almost as big as themselves.

There are some crab-like creatures very different in their appearance from the common crab, possessing no jaw-feet, but having instead, long, projecting beaks. These crabs never eat solid food, but live upon the juices which they suck out of the bodies of animals.

We might now close our history of the crab family, did I not wish to tell you of one or two curious species. One species, called the Violet crab, is found in the West Indies. Immense numbers of these crabs live together in the mountains, hiding themselves for the greater part of the year either in clefts of rocks, in the hollow of trees, or in holes of the ground. In the months of April and May very heavy rains fall in the West Indies;

and just as the rainy season sets in, these crabs wish to go to the sea to lay their eggs or spawn on the shore. They set off in vast crowds, often forming a line three miles long, and thirty or forty yards wide, covering all the fields, gardens, woods, and roads, which they have to pass in their way. The scrambling of their bodies over the ground makes so loud a noise, that it may be heard a great distance off. They mostly travel by night, and divide themselves into companies like an army. The males set off first to clear the road; the females follow next; and lastly comes a motley crowd of old, sick, and weak ones. Nothing can stop this host of noisy crabs; on they go, as straight as a bird can fly. They scramble over rocks, hedges, ditches, walls, houses, and whatever comes in their way, eating all the vegetables and fruit they find. If the doors be open, they rattle into the houses, and should anyone attempt to stop them, they lift up their claws, and clatter them together in a noisy and threatening attitude. When they reach the sea, they wash themselves in the waves, and then retire into holes; afterwards they come out, and lay their spawn on the shore. Then again they hide themselves; the seams in their old chalky coats burst open, and, casting off these old dresses, they wait patiently for the growth of their new ones. This work accomplished, they set off to go back to the mountains; but they look tired and weak, and as they travel

along, great numbers die or are caught by the people for food, so that not one-half of the host that set out from the mountains three months before, ever return to them again.

As soon as the spawn that was left on the sea shore is hatched, all the new little crabs follow their parents to the mountains. Myriads upon myriads, like red dots, creep and scramble along, looking like brick-dust sprinkled over the ground. A gentleman travelling on horseback through this country, expressed the astonishment he felt at the sight of these moving fields of young crabs. He could not get out of their way; and for fifteen miles together, numbers were killed each time his horse's foot was set down on the ground.

There is yet one other crab I wish to tell you of, which is called the Hermit crab; but as this letter is already a very long one, I must wait a few days.

Yours affectionately.

LETTER XX.

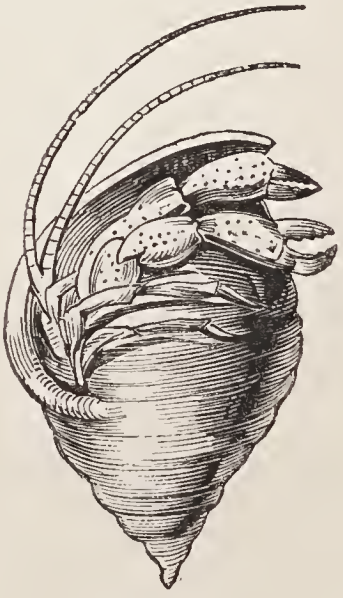
ARTICULATA.

Hermit Crab and other Crustacea.

My dear young Friends,

The Hermit Crab is this time to be the hero of our tale. This crab differs from all the crustacea which we have yet examined; for, whilst its head and claws are covered with shell, its tail, which is as long as a lobster's, has only a skin to cover it, excepting at its tip end, upon which there grows a hard point in the form of a hook. In this naked and defenceless state, the hermit crab would soon be destroyed by fish, if its Maker had not given it a curious propensity to hide itself in an empty shell. And I am told that it is very amusing to stay an

hour on the sea shore, to observe the hermit crab as it parades the beach in search of a new and larger home than the one in which it has been living.* Carefully passing along the line of pebbles and shells formed by the highest wave, the crab stops on coming to a shell, looks at it, and turns it over: if it does not like the shell, it passes on and goes to another; but if it approve of it, it slips its tail out of the old shell, and tries the new one. Should this shell, however, not answer, it quickly returns into the old one; and in in this way



Hermit Crab.

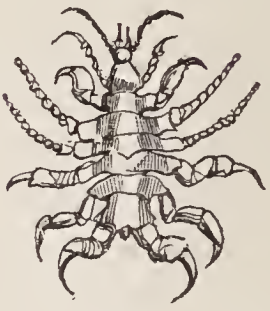
the hermit crab may be seen to try many, until it finds one that is light, roomy, and commodious.

* Hermit crabs are found in many places off the coasts of England and Ireland, and amongst the West Indies.

Into this good shell the crab settles its tail and body; and folding its feet and claws over its mouth, lies safely hidden up. But it is not always that the hermit crab obtains quiet possession of its new home; sometimes it happens that two crabs cast their eye on the same shell, and when this is the case, a terrible conflict often ensues; for they will strike and bite at each other with their claws, till the weakest is obliged to go away. Then the conqueror, clothed in his new shell, marches backwards and forwards on the shore, as if to boast before his antagonist of his riches. I hope the crab has no such proud insulting wish: but as men often boast over the fallen, they are apt to think animals may have the same evil propensity.

There are seven orders or varieties of crustacean animals, as you may observe in the chart upon the articulated division of animal life, at the beginning of this second part. The Decapode order contains all the lobsters and crabs, of which, as we said before, there are ninety-one genera, or kinds. Amongst the other six orders in the crustacean group, there are some creatures which have jackets made of a fine thin-jointed kind of shell. Many of these shelly crustacea are so exceedingly small, that we need the help of the microscope before we can see them. Yet these small shelly creatures have all the characters that belong to the crustacean family,

for the dresses of their bodies as well as of their feet, are articulated, and they breathe by gills. Some of these small crustaceans live in the sea, and many of them in the fresh waters of our ponds and ditches. One of the largest of them is called the Cyamus; and this gentleman is very troublesome to the great whale. Such numbers often stick to it, to suck up the juices of its body, that the sides of the enormous fish look white from their presence.



Cyamus.

Another of these crustacea is called the Phronima. This little creature contrives to enter the soft body of some jelly fish; and nestling down in it, as in a living boat, the phronima is carried about without the trouble of swimming; but when it wishes to dive under the waters, it drops out of the jelly fish, and falls by its own weight to the bottom of the sea.

The wood louse is another kind of crustacea, having an articulated horny coat, and breathing by gills. The wood louse can live with less moisture than almost any other crustacean animal, yet it loves to find a damp place under stones, or in decayed wood.

The centipede also, with its hundred legs, belongs to the crustacean class, for it has a horny coat, its feet are articulated, and it has gills. The centipede,

like the wood louse, loves dark damp places; it nestles under moist stones, in the bark of trees, and in the ground, and is often found in over-ripe fruit.

As we have next to enter upon a new class, in which spiders are placed, I must say "Good-bye" for the present.

Affectionately yours.

LETTER XXI.

ARTICULATA.

Remarks on Spiders.

My dear young Friends,

Having finished the history of crabs and lobsters, which are animals that breathe by gills, and have soft bodies enclosed in chalky rings, we have next to consider the Arachnida* or spider class, which consists of animals enclosed in horny rings, and which breathe by holes in their sides.

Whilst we examined the history of the crab and lobster families, we kept hovering over the sea shore; but to find up the wonderful little spider, we must search the land. We must peep into dusty

* The name of *Arachnida* is given to this class, because in Hebrew, this word means to *weave*.

holes and corners in stables, barns, and houses:—we must ramble in the garden, and search amongst shrubs; we must look into rolled-up leaves,—into the cups of flowers,—into holes in stones, and holes in the ground: we must examine brick walls;—we must look carefully, and step lightly over the dewy grass and the fresh stubble field. And if we wish to do more, we must mount a high church steeple, and lifting up our eyes, we shall perchance see spiders sailing in the air still higher above us.

Do you think our hunt for spiders would then be over? No, indeed! If we went to some of the fen ditches in Norfolk, we might happen to find a large spider, floating on the water in a boat of its own making. And if we looked far down into the clear water of some ponds and ditches, we might perhaps see a spider all alive, comfortably nestled in a bright silvery house of her own preparing. There she sits, fearing no evil; for just as her Maker has taught her, so she has filled her little house with air, and fastened it down by silken cords to the quiet green leaves at the bottom of the pond.

If we notice the habits of these spiders, we shall find that some can run, some can leap, and some can fly on streamers of silk of their own spinning; that some lay snares, and others hide in ambush. We shall find that they follow different employments; that some are weavers, some are tent-makers, some are masons, and some are carpenters; that

some are hunters, some jumpers, some swimmers, and some wanderers.

During the winter, spiders are sleepy and dull; but for the greater part of the year they are busily employed in catching their food, and in tenderly caring for and rearing their young. In all they do, spiders show great activity, energy, perseverance, and industry; and display so much skill, that they may truly be said to be most wonderful little creatures.

A spider is an articulated animal, because around its soft body are many horny rings or hoops: which rings in some parts are joined together by a tough skin to form joints, and in other parts they are pressed so closely to one another, that they make a firm case.

The rings of crabs and lobsters are formed of hard lime or chalk, but the rings of a spider are softer, being made of more horny materials. And when horn is thin, it possesses the valuable property of elasticity, or slightly yielding with a spring. Spiders have no gills; some species have two, and others eight holes in their sides, through which they breathe. These holes open into little tubes that take the air down into sacs or bags in the body. The inside of these tubes is lined with a skin that folds over in plaits, and these plaits are full of little veins that take in the air, and mix it with the blood.

Did you ever remark, as a spider ran past you,

that its body was divided into two parts? The front part is called the thorax. The thorax is the hardest portion of the body; and all the principal organs of the spider, such as its head and legs, are fastened to it. The other part of the spider's body is soft, and only covered with a thick skin; this is called the abdomen. The abdomen contains the stomach, the air sacs, and the bags of gummy silk, from which the spider makes its threads. These front and hinder parts are joined together by a slender tube.

The male has generally four pairs of legs; the female five pairs, one pair more being given to her, that she may carry her silken bag of eggs, and yet be able to do as much work as the male spider.

Male Spider.

The legs of spiders are rather long. You know how fine a spider's leg looks; and yet this fine leg is jointed, and has several strong muscles or little cords running down each of its sides. These muscles give the spider power to move quickly, and to hold tightly; and they also enable it to lift its body up from the ground, and to keep it steady upon its many-jointed legs. The worm has no legs; crabs and lobsters scrape their stout limbs slowly along, and lay them close to the ground; but the tight trim legs of the spider stand up, and are as

tough as wire, and in their action as nimble as thought. The flat end of the spider's leg is its foot; the ends of some of its feet are tipped with hooks, while others are lined with fine short hairs, that make a soft brush; this brush is said to be the cause of enabling spiders to walk on ceilings, and to run up walls.

The spider has jaw-feet on its head. In some spiders a few of these jaw-feet are tipped with sharp hooks; and in other spiders they are tipped with pincers, resembling crab's claws. The microscope shews us, that at the end of these hooks or pincers, there is a little hole, from out of which flows the very least drop of poison, and this enters the wound made in any captured insect.

Spiders are intended to live upon flies, moths, and gnats, just as we are intended to live upon vegetables, fish, meat, and fowls: therefore, the spider must catch these insects, and afterwards kill them; and I cannot tell you how delighted I was, when I found that our kind Creator had given the spider an instrument which is beautifully contrived for quickly putting its poor harmless captives out of suffering. I used to think, when a fly kicked and bounced about in a web, that it was in great pain. I was afraid the spider had begun to eat it up alive; but now I find that when the fly makes such an uproar, it is chiefly because it does not like to be entangled in the web. When a small fly is caught,

the spider runs along the fine threads of its web, darts its hook or pincers into the body, and then goes away. In a few minutes, and sometimes even in a few moments, this poison kills the fly.

If the spider finds that a large fly is caught, and fears that its bouncing about will break the web, the spider quickly bites through the threads that are close to the fly, and lets it go away. But if another fly, not quite so large, tries to fight the spider with its legs and wings, then the wary fellow spins a little more web out of its own body, and throws these threads over the fly. When the spider finds that this silken cordage has well bound down the rebellious captive, off it runs to some quiet corner, and there waits till the poor fly has fairly tired itself out with struggling: as soon as it has become quiet, the watchful spider runs along the net, and darts its jaw-feet into the body. The poison in its hooks shortly kills the prisoner; and then the spider comes back, and lifting the fly out of the web, carries it away, to dine upon it in a snug corner close by.

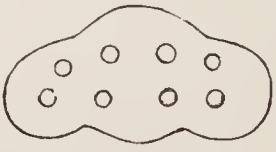
The spider poison is strong enough to kill insects, but on our skin it only produces the same feeling as the bite of a gnat; generally it is not even strong enough to make the part swell up: yet a bite from some kinds of large spiders in hot countries, will occasionally bring on fever.

Spiders can live a long time without eating. For days together no fly may be caught: yet they will

patiently sit and watch for the movement of their webs. They have even been shut up in tight boxes for six months without food. This long fast made them very thin, but one good meal began to plump them up again.

You know that crabs and lobsters cast off their old shells, and that new ones soon grow over their soft bodies. Spiders also shed their coats; that is, they moult or change their skins. When the old skin is going to fall off a spider, a crack may be seen on the stomach; and through this crack the spider draws out its limbs, and often leaves its old coat hanging in the web.

The spider has several brilliant and sharp-seeing eyes, which are said to shine in the dark, and to have the power of seeing by night. Sometimes the spider has four eyes, sometimes eight or ten. These eyes never move, but they are like round specks of glass, set in rows on the top of the head.



Top of Spider's Head.

One of the most remarkable things belonging to the spider's history, is the beautiful silk which it is able to spin out of its own body. With this silk spiders make webs, line their dwelling-places, and spin bags for enclosing their eggs. So fine is one

thread of this silk, that it would take ninety such threads to make one as thick as a silk-worm's; and yet every one of them is composed of four or five thousand lines, which were separately drawn out of the spider's body, and afterwards drawn together. We shall have to speak more of this silken cordage in our next letter, which will relate to the house spider.

Yours, &c.

LETTER XXII.

ARTICULATA.

House Spider.

My dear young Friends,

We are now to look at the house spider. This spider is an old acquaintance, yet such an one as we are always trying to drive away; for no sooner has the poor little creature spread out its delicate web in our rooms, than in great displeasure we seek to destroy it; seldom even waiting to observe the curious manufacture of its delicate home.

On the abdomen—that is, on the hinder division of the spider's body, there are four, and sometimes six little fleshy knobs, each about the size of a small pin's point. These little points are called spin-

nerets, and belong to bags of gummy silk in the inside of the spider's body. Very strong magnifying glasses shew that each spinneret has a thousand holes in it. When the spider wishes to spin, it lifts up one of its legs, and presses it against its spinnerets. This makes the gummy fluid fall to the little holes; and as the spider draws its legs along the sides of its spinnerets, the silk issues from the holes in delicate fibres or threads. The thousand fibres thus issuing from one spinneret, then come together and form a thread; and the instant that the four or six spinnerets have dropped their separate threads to about the distance of a tenth part of an inch, the spider, quick as thought, turns up its two little hind legs, which have delicate hooks upon them, and catching hold of the falling threads, with these hooks it guides them into one coil or rope. The beautiful little hooks on the spider's feet are as nimble as fingers, and being jagged with small teeth like a saw, they never miss their hold.

Magnified Claws of Spider's Foot, with which it directs the silken fibres; generally using only two of them.

Thus you see, that from its fineness, we never can behold the thread that falls from one of the spinnerets; it is only when the threads from all the four or six spinnerets have become united into one rope, that our eyes see the spider's silken cord. This silken cord is so light, that it easily floats in the air; and yet so exquisitely is it made for strength, that before it breaks it will bear the pressure of a weight six times heavier than the spider that made it. Oh, how busy and how quick must that spider be in uniting its many thousand fibres into one cord! If the spider were slow, the glue upon the fibres would dry before they came together; but this little creature is not idle, it never seems to allow its cords to spoil from want of care. For a certain time spiders seem able to throw out as much silken gum from their bodies as they please; and they also seem able to make their thread thick or thin, for the web in which they wrap up their eggs is much stronger and whiter than the web they weave for catching insects. When the house spider has found a place she wishes to live in, which is generally some corner of a room, she begins her web by pressing all her spinnerets against one of the walls; this causes the four or five thousand little holes in

One spinneret, with its falling fibres magnified.

her spinnerets to gum down their silken fibres tight to the wall. This beginning of her cord is not united into one close substance, but its fibres are spread out like the roots of a tree, in order to give the cord she is going to spin, a firm hold upon the wall. Directly the silken fibres are tight, the spider moves forward; by this act she draws out more silk, and then her web begins; very soon, however, she stops in her work, and her beautiful little feet, with their hooks, take up the new-made cord, and give it a pull, to see if it have stuck tight; if she thinks it will hold, she creeps along the wall, spinning her thread as she goes; or else she takes a dart across the space between the two walls, and then again presses down her spinnerets on the other side; and turning round, she travels back upon the new-made rope, taking care to fasten another cord upon it, to make it thicker. The spider is very particular in making her first cord strong; she appears to know that it will be a rim or selvage for the rest of the web to pull against, so she runs backwards and forwards upon it, to double and treble it. When satisfied that the edge of the web is firm, she draws out more lines and lays them loosely side by side, and often one over the other, until she deems her

Fibres of the Spider.

net is wide and thick enough. This newly-made web is at first rather gummy, so that its threads are apt to stick to the spider's legs as she goes over it; but to check their drawing up and becoming entangled, she quickly raises a few stiff hairs, which are on the lowest part of her leg, and runs them in between the threads, as if she were using a comb; and having thus smoothed down the disturbed fibres, she very cleverly lays them again on the web.

When the body of the web is finished, the spider will sometimes stretch out a few long lines of cord beyond the net, for the purpose of catching any rambling fly that may pass that way. The house spider does not live in her web, but hides in some crack in a wall close by; or if there be no crack, she spins for herself a little silken house, into which she crouches down out of sight. Into this hiding-place she carries, from the edge of the web, a great many loose threads, and the moment one of them trembles, she darts out to see what is going on.

> "Oh! the spider's touch, how exquisitely fine,
> Feels at each thread, and lives along the line."

As I have already mentioned the spider's treatment of the entangled fly, in pages 174 and 175, I need not again enter upon the detail of her housekeeping.

Some spiders cannot bear a dusty web; they

have been seen to lift up the net with one of their feet, and to give it a good shake; but this business is performed with great skill, the jerk being always just strong enough to throw off the dust, but never rough enough to break one cord. You will seldom see any broken wing or leg of a fly left on a web, for spiders generally carry all fragments into their snug little home close by; and often they may be seen carrying a dead fly on their backs, as a man would carry a sack of corn.

Have you not sometimes seen a spider hanging by its thread, suddenly drop from the ceiling of a room, and then all in a moment change its mind and run up its thread, as if it were a ladder? But what becomes of the ladder? The spider does not leave it behind, for when the spider is out of sight, its thread is gone too! Yes, it actually carried away its silken ladder, rolling it up into a little ball as it re-mounted to the ceiling; and this ball is formed with a claw or hook, that lay snugly hidden between the two carding hooks on its hind legs; this small claw being seldom brought into use, unless the spider wishes to seize upon a dropped cord.

Spiders cannot always continue spinning their webs; there comes a time when the body loses the power of forming the gummy fluid. Naturalists who have watched them believe that they can only make six or seven webs during their lives. What

then are they to do? for webs they must have, or they will starve. The only plan seems to be, for an old spider to seize upon the ready-made net of a younger one, and this they often try to do; but there is always a desperate battle between them, which generally ends in the death of one. Some spiders live very amicably together, but more generally they are quarrelsome; yet men have sometimes made spiders quite tame. A Frenchman, who was very desirous of obtaining the silk of spiders, in order to weave it into dresses, tied many lines of pack-thread across the ceiling of a garret; after which he put 800 spiders into the room. He used to feed these spiders with plates full of flies at a time, and they grew so tame, that they would come down as soon as he opened the door; but after making one pair of stockings with their silk, he gave up the trial, for he found it would require the webs of seven hundred thousand spiders to make one pound of silk, and he was obliged to twist 1800 of their threads together to make one thread strong enough for his purpose. A few threads are, however, still collected from spiders' webs, for the use of astronomers, when making some of their most curious telescopes. Have you ever heard the history of one French spider, the spider poor Pelisson tamed when he was shut up in the dark cold prison of the Bastile in Paris? No window lighted up his dismal cell; but there was a chink in the wall, that

threw one ray of light into his gloomy room. A spider had spread out its net on the edge of this chink; and as Pelisson watched it, he noticed it so gently, that the spider forgot to be afraid, and seemed almost to love the poor man. When he made a signal to it, or gave a little sound that it knew, the spider would come down and sit on his knee, and eat a dead fly. Do you know the sad end of this spider? The cold-hearted governor of the prison heard of it, and learned that poor Pelisson loved the gentle creature; but he had no pity, no kindness in his heart, so he went one day into the prison, snatched up the spider, and crushed it to death! Oh! how sad it is to have a hard heart; an unfeeling heart makes a man like Satan, for he loves to spread disappointment, sorrow, and pain, because he is miserable himself. See John viii. 44; 1 Peter v. 8. A hard cold heart makes a man unlike God, for God delights in the circulation of joy, being Himself the fountain of all pleasures, and His tender mercies are over all His works. See Psalm cxlv. 9; 1 John iv. 7.

Our next letter will speak of some of the garden and field spiders. Believe me,

Your affectionate friend.

LETTER XXIII.

ARTICULATA.

Garden and Field Spiders.

My dear young Friends,

We are now to examine a few spiders less commonly seen than the house spider. The one that most nearly resembles our house friend, is called the Geometrical or Garden Spider. Observing eyes may often see the silken cords of this spider's web suspended in the autumn, amongst the sprigs of plants. I remember, when quite a little girl, pausing from play to look at a geometrical web that was fastened to the leaves of a garden shrub. I suppose it was the first I had ever seen, for I stood before it with astonished delight, and for some time watched the spider in its widely spread-out net.

I saw that the cords of this garden web were not loosely thrown together, or piled one upon another, like those of the house spider's web, but that each line was skilfully laid at a regular distance from the rest, just as a wheelwright would arrange the spokes and rims of a wheel.

Geometrical Spider's Web.

I longed to know how this web had been made, but no one was by to tell me, nor did I, until many

years after, learn the manner of the geometrical spider's proceedings. Should your eye have noticed such a web, perhaps you may also wish to know how the spider sets about weaving its silken wheel.

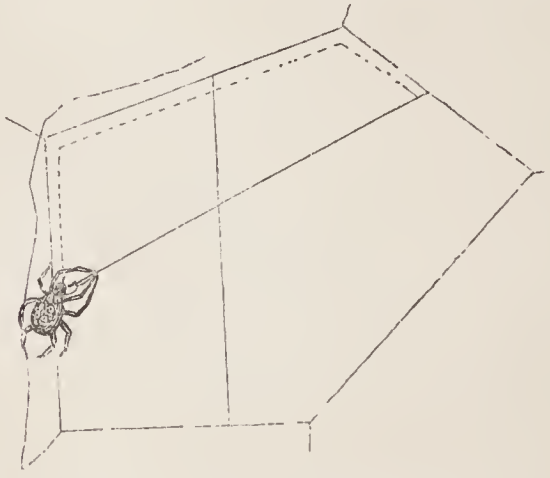
Then fancy a good plump spider standing on the twig of a tree, and pressing its spinnerets against the wood, to cause the silken fluid to flow out. The next moment you might see it lift itself up; and then, without moving away, draw out a long thread, and send one end of it loose into the air, for the wind to waft it to some neighbouring leaf or branch, where the moist gum upon the thread would glue it down. As soon as this thread ceased to flap about, you would see the spider give it a good pull; and if it held tight, he would make a bridge of it, passing and re-passing over it, often not less than six times, each time laying down upon it a new and gummy thread, to cause the line to become very strong. This done, you might next see the spider creep to a fresh branch, or else stand at the end of the bridge cord, and send out another line into the air, to fall upon some other twig; as soon as this second thread was caught, he would thicken it like the first cord. In this way a garden spider will sometimes throw off at random three, four, or five threads; all of which it thickens, because these threads are to form the strong selvage or outline cords for its round web. These spiders do not seem to care where their loose threads fasten; being equally well

pleased if the wind blow them into the form of a square □—a triangle △—or into any other shape; for each spider knows full well by the instinct its Creator has given it, how to suspend its wheel-formed net, amidst these rambling lines.

To begin its round web, the spider runs to the middle of one of the strong selvage cords, and lays upon it a drop of the silken fluid from its spinnerets; and then, drawing its line after it, down the spider drops, as straight as an arrow, to a lower branch, or to the ground; and there it gums down the straight thread it has brought from the top selvage cord. This done, the spider runs up the line till mounted once more upon the outline cord; it will sometimes move a little way off, and again drop perpendicularly down, to form another perpendicular line; but more generally it makes a horizontal line, that is, a line straight across the perpendicular line.

And now mark, how dexterously the spider has been taught by its Maker to form this horizontal line. Softly creeping upon the top outline cords, it travels on till it gets a long way from the line that fell straight to the ground; here the spider stops, and gums down a new silken thread. This done, it continues its walk upon the outline cords, spinning as it goes; and as it trudges on, the new-made thread keeps floating loosely behind; but, fearful lest the wind should blow the new and sticky thread against the outline cords, upon which it is walking,

the spider keeps pushing the loose thread off with one of its hind legs. When it has walked as far as it thinks suitable, which is generally to a place nearly opposite to that on which the thread it is now dragging after it was fastened down, the spider stops, and gives the loose cord a good pull; this



Dotted Line, the track by which the Spider brought its line.

draws it tight across the perpendicular line, and the spider then runs along this horizontal line, till it comes to the middle, that is, to the place where the two lines cross one another; and from that middle it proceeds to carry up to the outline cords, twenty, or thirty, or fifty radiating threads; the web then begins to look like the picture in the first part of this letter; and so quickly does the spider make these threads, that it seems as if it were flying up and down the lines. When all the threads are made, the spider gives each one of them a good

pull, and if any one should crack, or appear to be loose, it immediately mends it.

The web being so far made, the spider next begins to weave many threads round and round across the radiating lines, always commencing this work at the centre. And on crossing each line, the spider gums the new cross-thread down upon it, leaving also some loose gummy drops upon the thread, to entangle flies that may be caught in its meshes. Having finished the web, the spider tries every crossing thread with its front feet; and as soon as it is satisfied that the web is well made, it very often bites out the centre bit, where all the lines have met, and places itself in this hole to watch for flies, gnats, and moths. Sometimes it makes a little nest close by, and carries a few threads into this nest, that it may know when the web is touched.

Sometimes another spider has been seen creeping over the threads, to pay its friend a visit; but, as geometrical spiders have not a character for good temper, the stranger is often afraid of venturing far without permission: so the visiting spider gently pulls a few of the threads to give notice it is there. If the owner of the web does not like this visit, it very rudely sends the new comer off, and as soon as it goes back to the middle of its net, pulls each thread to see whether the intruder has injured any one of them. In Proverbs, Solomon beautifully

represents the spider handling the strings of her web as a musician, "taking hold with her hands," as the fingers of a musician take hold of the strings of his harp. By this remark we see, that the wisest of men closely observed and admired the works of creation.

There is one spider called the Gossamer spider, which, mounting to the top of a blade of grass, or upon the top of a rail, will throw out many loose threads; then folding its feet close together under its body, will turn on its back, and lying down upon one end of its light threads, allow the air to lift up the silken streamer; and thus, upon its own thread, it is wafted high over grass and corn, hedges and ditches. Sometimes in the autumn, whole grass-plots and fields are covered with the long white threads of these gossamer spiders, which fall down in the cool of the evening; and, when loaded in the early morning with dew, glitter like silver.

Other flying spiders, when they have thrown out one thread, keep folding it backwards and forwards, till a delicate bed is constructed, like a flake of snow. Then each little spider, lying down upon its light silken chariot, is carried by the winds high into the air. So high are they sometimes lifted up, that people have seen them sailing far above the top of the highest tower of York cathedral. These flying spiders are generally young; older spiders appear too heavy to rise so high.

Some spiders hide themselves in the edges of leaves, and throw over the green shrubs a few scattered threads to entangle their prey. Some hide in the cups of flowers, and patiently wait till a passing fly peeps in, to search after the sweet juices hidden there.

There are yet several other kinds of spiders to be described. I hope to send you some account of these in another letter, but now believe me, &c.

LETTER XXIV.

ARTICULATA.

Various Spiders.

My dear young Friends,

In continuing the history of spiders, let me remind you, that the whole of their family is termed the Arachnida class.* Some are called *Sedentary* spiders, because they live in webs from which they seldom move away. Others are called *Vagrants*, because they form snug little nests in concealed corners, from whence they watch for passing insects; and the moment that a heedless fly chances to wander that way, they run out, and with dexterous agility pounce upon it. Others are called *Hunters*, because

* The word *Arachnoid* means spider-like. The Hebrew has a similar root, meaning *to weave*.

they incessantly wander about in search of food, and spring upon their prey like a tiger. Others are called *Floaters*, because they form oval nests, which they line with silk, and mounting upon them, glide over ponds and ditches.

Amongst the *vagrant* spiders, one is amusingly quick in following the movements of the insect it wishes to catch. A person named Evelyn observed one day, on looking out of his window in the city of Rome, that a small fly had settled upon the window-sill, and immediately after he saw a vagrant spider, with a slow and noiseless step, creep out of a crack in the wood. On came the spider, fixing upon the fly its keen little eyes; and as it approached the fly, it was exactly as if one spirit animated the two, for the spider watched, and turned, and moved, just as the fly moved; sometimes twisting its body sideways, sometimes sliding backwards, sometimes stepping forwards, until at last, by one bold spring, the spider darted upon the fly, and bore it off in triumph to its own lurking-place in the wood.

There is also one spider that lives under the quiet water of ponds. This spider has an oily varnish over its skin, which keeps the waters from touching its body; and between this varnish and the water, there is a small space filled with air. When this spider sets about building her house under the water, she is observed to spin several long threads, and to send them loosely floating about, in order that they

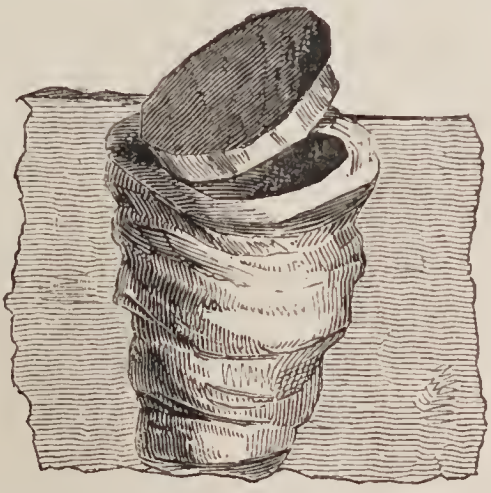
may fall upon the leaves of water plants which grow at the bottom of ponds. As soon as she has fastened down several of these long threads, she takes her stand upon them, and spins away until she has formed an oval silken chamber, bearing something the shape of half a pigeon's egg, with the bottom left open. Over this nest, the spider then spreads a gummy fluid that looks like clear glass, and most likely this fluid is the same oily varnish, with which God has taught her to clothe her own body. As soon as the water spider's glassy roof is finished, she rises to the top of the pond, catches up a bubble of air, and looking, with this bubble around her, like a drop of quicksilver, she sinks through the water to her clever little house amongst the weeds, and passing under its roof, drops her bubble of air in the midst.

No sooner has this bubble of air driven out some of the water, than out she comes again, and rising once more to the surface of the pond, catches up another bubble of air, with which she again sinks down. And this work she will repeat ten or twelve times, until her chamber is filled with air and emptied of its water. Having now made her silken hall fit for her residence, she nestles down in it, quietly watching for the water insects that may chance to creep past; and immediately that one is entangled amongst her scattered threads, she darts out, and brings it into her diving-bell, where she feeds upon

it at her leisure. Many of these spiders are found in the ditches round London.

The water spider that is found in the Norfolk fen ditches, is of rather a large size. This spider is said to watch for leaves, for bits of stick, for straws, or for any odd thing that may happen to float near, and mounting upon them, will fasten them together with a few silken threads. When this foundation is firm, the spider spins upon it an oval ball, which is sometimes as much as three inches across, and then seating itself upon this raft of silken-bound weeds, the spider is wafted away over the water; but as soon as it catches sight of a drowning insect, off it jumps, seizes upon it, and carrying it back to its weedy boat, eats it up at its own convenience.

One species of spiders, termed the *Mygale* or *mason* spiders, make their nests by boring long holes into the ground, and they generally select for this



Tube or Nest made in the ground by the Mygale Spider.

purpose some sloping, dry situation. These holes or tubes they line with delicate silk of dazzling whiteness, and make a door at the entrance, of layers of silk and layers of clay, which fits like a lid. A fine thread of silk is fastened to one side of this door, and as the spider carries this thread down to the bottom of its cell, it knows in a moment when anything touches it.

The largest spider ever heard of is a mygale or mason spider, found in the Brazils, in South America. The mygale can stretch its legs over a space of ground eight inches long and eight inches wide; quite as far, I should think, as from the end of your father's fingers down to his wrist; and is not that a very large spider?

The mygales do not spin any web for the purpose of catching their prey, but they use a great deal of silk in making their nests. When the large Brazilian mygale has finished boring its hole in the ground, it first lines the hole with a coating of coarse silk, over which it lays a coat of clay, and sometimes it will repeat these layers of silk and clay sixteen times. The outside web is always coarse and brown; but the web which lines the inside is like white satin. The door of this mason spider's home not only fits most exactly, but the edge which is opposite to the silken hinge, is made just so heavy with clay, that when the spider passes in or out, the weight of this heavy edge causes the door to fall to of itself.

All mygales catch their prey, either by running, by jumping, or by springing from their hiding-places under leaves, wood, or stones. The large mygales chiefly live upon ants, and will thrust their hooks directly into the body of these little animals. Sometimes a whole crowd of a large species of ant will fall into such a rage at being disturbed by one of these visitors, that they will jump upon the mygale and sting it most dreadfully. If these South American spiders cannot find ants enough to satisfy their hunger, they will sometimes seize upon small humming birds.

Most spiders spin a silken bag around their eggs, and in some species their eggs are so numerous, that 1800 have been counted in one bag. The mother spider displays strong affection for her young: go where she will, she carries her bag of eggs with her, sometimes holding it with her fifth pair of legs, sometimes gluing it to her chest, and then she will rather allow herself to be torn limb from limb, than part with her precious bag. When the little ones are hatched, they run merrily around and all over their mother. I have even seen them covering her legs, as well as her head and body. She mostly feeds them till they have changed their first skin,* and after that time, she expects they will take care of themselves.

* See the mode of the spider's moulting, in page 176.

In the Arachnida class, naturalists have placed not only spiders, but scorpions and mites. My next letter will contain some account of these animals, and then we shall have finished with the Arachnida family.

And now that we have closed our spider history, I would ask, have you not been struck by the admirable fitness of the spider's body, for performing the work she is given to do? The front part, you may remember, is hard and firm, to support the limbs; the hinder and softer division is supplied with bags of fluid silk, that end in delicate points, full of holes, through which the silken fluid oozes out. Her legs have many joints, which render them nimble in catching up the falling threads. Some are tipped with hooks, others with brushes, and some are bordered with stiff hairs to comb down the threads when entangled; whilst her jaw-feet end with poisoned hooks, that quickly destroy the insects she catches. On her head are many sharp-seeing eyes, that she may know what is going on. And, finally, the spider is given an instinct, or active wisdom, by which she turns her silk to account, either weaving it into nets, or using it as a lining for her nest. If I ask you who made these parts of a spider so well to aid one another; that is, to harmonize together for wise ends; will you not tell me, "It must be God!" and that *His* power, which made them on the fifth day of creation, still pre-

serves in life each one of the race, now breathing the same air with ourselves.

"Praise ye the Lord, beasts and all cattle, creeping things and flying fowl. Let every thing that hath breath praise the Lord. Let them praise the name of the Lord: for He commanded and they were created." Psalm cxlviii. and cl.

Believe me, yours affectionately, &c.

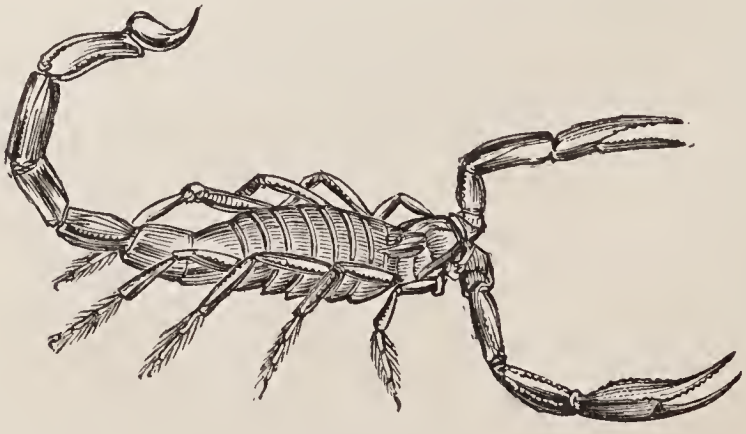
LETTER XXV.

ARTICULATA.

Scorpions and Mites.

My dear young Friends,

As I suppose you have never seen a scorpion, which is the animal that we are next to examine, I must tell you that it is almost like a thin brown lobster with a long straight tail; yet the scorpion is



Scorpion.

put into the Arachnida, or spider class, because it has a covering of horny rings like a spider, and because it breathes by air sacs and tubes, whilst the crustacea, or lobster class, have rings of lime, and breathe by gills.

Now let us see in what the scorpion differs from the spider. The jaw-feet of the scorpion are much longer than the jaw-feet of the spider. The jaw-feet of the scorpion end with pincers, whilst those of the spider are generally tipped with hooks that are poisoned. The abdomen of the spider is round and soft, but that of the scorpion is drawn out into six long rings, and the last ring ends in a formidable sharp point. Under this point are two little holes communicating with a bag of white poison, which is placed inside the last ring. The scorpion can bend the abdomen about as he pleases: very often when he is frightened or angry, he curls it over his head. The sting at the end of the scorpion's tail, is both his instrument of defence and of attack, and the wound which it makes is very painful, but not generally dangerous.

Scorpions that are found in England are rather small, not much exceeding one inch in length; but in the hot lands of the tropics, they are sometimes one foot long. Scorpions generally live on the ground, in dark moist places, under stones and among old ruins, though they will sometimes run into houses.

In the East Indies, where the scorpion is about the size of a small lobster, you can hardly move a piece of furniture in a house, without finding one of these creatures hidden up. When they are afraid or angry, they draw their jaw-feet in; and, as I remarked before, throw up the tail over the back, and bend it quite up to the head.

Scorpions like best to live alone. The hole which they make in the ground, is something the shape of the inside of a watch glass; and in this they will squat all day, but towards evening they creep out in search of food. They run very quickly, keeping their jaw-feet out before them, and their long tails dragging along the ground. They seize hold of worms, wood-lice, and different insects with their pincers, and sting them with the sharp point of their tails, and as soon as they are dead, they grind them to powder and eat them. They are very fond of spiders' eggs, and indeed of the eggs of all insects. They are very voracious, and have been known to eat their own little ones. If they are shut up together, they fight desperately, and at the end of the battle the weaker is sure to be devoured by the stronger. Some years ago, Baron Cuvier had four hundred living scorpions sent him from Italy as a present; but they fought so desperately, that in a short time very few were left alive. When the mother scorpion is not angry, she is very kind to her little ones. She carries them on her back; and for the

first few days after they are hatched, she never comes out of her snug hole. She watches over them for a month, and after that time, like the spider, she expects they will take care of themselves.

Scorpions and spiders, as I have before told you, have air sacs in their bodies. The air enters these sacs, through little tubes which open under the abdomen. These tubes are lined with a skin that is plaited, or folded over and over so closely, that the edges of the plaits look like the leaves of a book; by this contrivance, there is much space afforded, in which the little blood-vessels can meet the air; and as soon as the blood has taken up the air, it flows back into a long heart, running on the top of the abdomen.

Spiders and scorpions with air sacs and hearts, are called the Pulmonary, or lungs order of the Arachnida class. The other order or set of creatures in the Arachnida class, are called the Trachean order. The creatures in this last order have no hearts, neither have they any air sacs. They have only plain tubes filled with air, and these tubes pass all over their bodies.

In the Trachean order, we find that there are many creatures which resemble odd-looking spiders; and in this order are also placed those tiny mites of things, that look like brown powder, such as we see at times rolling in old flour tubs, on dried meats, and on the dried specimens of birds and insects;

and sometimes they are found even on the skins of living animals. These mites of living things are called *Acari*, and have generally a soft body with eight legs. By the help of strong magnifying glasses, we can see they are covered all over with bristling hairs. And now for a great wonder! each one of these tiny hairs is found to have a hook on both sides of it; it is by these hooks, that the speck of a mite clings to whatever substance it is upon. The little creatures also seem to have the power given them to lift up either one, or both of these hooks at a time; thus we learn, that every hair on a mite must have two muscles belonging to it. How plainly does this wonderful fact shew us, that nothing is too minute for our God to form, or can be so small that He will forget it. His mighty hand, that "made the mountains fast," helps every little brown powdery mite of an animal to creep about, and to lift up the barbs on either side of its tiny hairs. And are we not told that the eye of God watches still more closely over His creature man! That He not only counts the hair on our heads, but notes the very thoughts in our hearts! If this mighty God be angry with us, we cannot hide ourselves from Him; but if we know that He loves us, great is the joy that ever we were born! Who then can tell us whether or not God loves us? The wonderful works of creation display His power and His wisdom, but they have no voice to utter His

marvellous love in desiring to forgive the sinner, that He may cherish him for ever! To catch the whisper of forgiving love, we must open our Bibles, and there we shall find One Name, and only One Name given under heaven, whereby God can both pardon and freely love the repenting sinner.* It is the excellency of this one dear Name which makes us glad to sing,

> "How sweet the name of Jesus sounds
> In the believer's ear!
> It soothes his sorrows, heals his wounds,
> And drives away his fear."

In Him we are forgiven and blest for evermore! To know Him, therefore, and the power of His salvation, is above all other knowledge.

We have now studied three of the classes in the articulated division. Before we go further, let us cast our eye back upon what we have learnt.

First—How is an articulated animal to be known? It is to be known by its body being covered with rings, and by having two cords of nerve running along the body.

The first class of articulated animals contains the *Annelides*, or worms. These animals have long soft bodies, and between their rings they have air holes. They possess hardly anything like feet, but move their bodies by drawing up or separating their rings.

* To see who gives pardon and repentance to a sinner, look at Acts v. 30, 31. But no one understands these verses till the Holy Spirit opens his understanding. See Eph. i. 17, 18.

The second class in the articulated division is that of the *Crustacea.* These animals breathe by gills. They have never less than ten legs, which are jointed. Their rings are mostly made of chalk, and are compressed or drawn close together, so as to make a hard covering.

The third class contains the *Arachnides*, or spiders. These animals have horny rings, and their bodies are divided into two parts; one part being generally softer than the other. They have eight or more thin jointed legs. Most of them breathe by air sacs and air tubes, and are supplied with bags of silk and bags of poison.

The fourth class is that of the *Insects.* This class contains very wonderful creatures; curious in their shapes, curious in their habits, and beautiful in their appearance. In my next letter I shall send you one leaf in the book of their history; but their variety is so great, and their works are so interesting, that were we to indulge ourselves, we might fill a whole book with the description of their sportive and industrious hosts.

In less than a week you shall hear from me again.

Your affectionate friend.

LETTER XXVI.

ARTICULATA.

Use of Insects.

My dear young Friends,

This letter is to introduce to your notice a new set of living creatures in the articulated division, called the *Insect* class. Many of this great family are well known to us, for scarcely a foot of earth can be found free from the presence of some of these active and ever-shifting little beings. I have frequently been surprised, whilst sitting on the shingly sea beach, at observing the variety of large and small flies which have alighted for a moment on my dress, and then spread their gauze wings and flown off again! Do we not also hear their busy

hum, and see their light flitting forms in our houses, gardens, fields, woods, and lanes?

"Lo! the bright train their radiant wings unfold,
With silver fringed, and freckled o'er with gold;
On the gay bosom of some fragrant flower
They, idly fluttering, live their little hour;
Their life all pleasure, and their task all play.

"Their wings with azure, green and purple gloss'd,
Studded with coloured eyes, with gems emboss'd;
Inlaid with pearls, and marked with various stains
Of lively crimson through their dusky veins.
Some shoot like living stars athwart the night,
And scatter from their wings a vivid light."

Naturalists tell us there are sixty thousand different species or kinds of flies, seven thousand and sixty different kinds of butterflies, and many thousands of different kinds of beetles. If we were to place together all the different sorts of flies, bees, gnats, moths, butterflies, ants, and beetles that are to be found in the world, there would not be less than four hundred thousand different kinds for us to examine.

Insignificant as a few insects may look, yet when God permits them to increase very rapidly they become a pest and a plague, injuring our persons, eating our food, and destroying our goods. So little power have we to destroy them, that in the Bible, insects are called "the army of the living God," because He alone can control their numbers. But in accordance with the usual wise arrangements of

our kind God, they do us but little injury, and are in some instances of great value to us. They act so important a part in keeping the air fresh, and the ground clean, that we may truly call them the mighty scavengers of the land. Offensive pieces of decaying substances are quickly visited by some kinds or other of their tribes; a portion of these substances they devour, and upon the rest they lay their eggs; and no sooner do their grubs escape from the egg, than they begin most voraciously to consume some of the putrid lump in which they have been hatched.

Linnæus tells us, that if a dead horse be allowed to lie on the ground, exposed to the air, a kind of beetle called the Histers will soon find it out, and clambering over it, will pierce the skin; then follow large flies, which attack it so sharply, that Linnæus says three flies of one particular species, can devour a dead horse as quickly as a lion: not that the flies eat much of the flesh themselves, but they cover it with such multitudes of eggs, that one of them is said to lay not less than 20,000 in a short time; and when the grubs creep out of these eggs, they set to work to eat so manfully, that in twenty-four hours they consume meat enough to make themselves 200 times heavier than when they began; so that in five days, these rapidly and enormously eating horse-fly grubs attain to their full size. Besides laying eggs, some flies bring to the carcase their young which

are already hatched. And no sooner have these horse-flies and their young ones consumed the softer parts of the body, than many beetles follow; then wasps, hornets, and ants keep up the race, till there is nothing left of the dead horse, but a few dry bones.

When a large old tree falls in the woods of America, it is surprising how quickly insects and rain will bring it to a state of powder. Vast troops of beetles attack the bark, then follow hornets and flies, which bore holes in the wood. Some eat of these substances, and also lay their eggs in them; so that in a short time the fallen tree is bored, and split, and made alive with grubs. The rain and the dew then settle into the holes made by the insects; this wet softens the wood, upon which vegetable fungi and mosses begin to grow, so that between the work of insects, and the growth of new vegetables, the hard, but prostrate wooden monster, is soon turned into a little rolling dust.

The grubs of gnats, which live in stagnant water, also devour many offensive materials, which, if left to decay, would taint the air with unwholesome gases.

Thus you see that insects are appointed to clear away much of the animal, the vegetable, and the slimy refuse that is ever forming on land and in the water; and what is very remarkable, let them revel in whatever offal they will, their bodies are so wisely

prepared for their work, that we never see a beetle, a fly, or a maggot soiled by running amongst the decaying substances they attack.

The laborious works of insects are likewise of great value to us. They supply us with honey and wax, and with silk for our dresses; with gall-nuts for our ink, and with lac for our sealing-wax and varnishes. The cochineal insects yield us beautiful dyes; and some flies are made into blisters. So that without insects, the world would not only lose much of its beautifully animated life, but the air we breathe would be injured by decaying refuse; we should be deprived of many useful things which they make, and many birds and fishes would find an empty larder.

Hosts of insects are to be seen in the day-time creeping and flying about; yet an immense number, such as moths, gnats, and some kinds of beetles, "stir not till sober twilight, and eat only in the shadows of the night." Naturalists who closely watch the habits of insects, tell us that all their works are performed with admirable exactness and dexterity. They always set about their business in the best way to gain their object. And they accomplish their work with "diligence, industry, judgment, prudence, foresight, economy, and frugality; yet with all their skill they are modest, diffident, and ardent lovers of their young." Indeed, it is during their watchful care over their little ones, that men

have the best opportunity of observing their habits. At other times they fly from the eye of man.

My next letter will give you an account of the changes that an insect undergoes from the time it leaves the egg, until it becomes a perfect and winged fly.

Yours affectionately.

LETTER XXVII.

ARTICULATA.

Eggs of Insects.

My dear young Friends,

Having now to consider the different stages of an insect's growth, I must begin by reminding you, that insects are generally hatched from eggs.* Their eggs are of different colours and shapes, and often not bigger than small grains of gunpowder. You have seen hens' eggs, sparrows' eggs, and many other eggs, and you know that after the mother bird has sat some time upon her nest, the young bird bursts the shell of the egg, and comes out somewhat resembling its mother; but the mother fly has no sooner laid her eggs than she usually goes away,

* The house fly and some other flies are exceptions to this rule, the little grub being born alive.

leaving her eggs on leaves, wood, and other substances, and most generally dies.* In warm summer weather, the eggs of insects are frequently hatched in a few days, but others will keep for months; and when at last they spring open, out creeps, not a perfect little fly, but a thin delicate worm; and before the real fly, or the moth, or beetle, or butterfly, comes to its finished state, it generally has to pass through three great changes. It is first as we said, a worm, which is called its larva state, then the worm or larva falls into a chrysalis or quiet state, and out of this chrysalis state the perfect insect bursts into its winged life.†

Had flies, moths, and butterflies been hatched with delicate wings, and light bodies, fit only to fly and to revel on sweet juices, they would not have been able to clear away from the face of the earth the decaying pieces of vegetable and animal refuse, which is the great work their Maker has appointed for flies and beetles to accomplish. Therefore, to carry on this labour, God has seen fit to make them first in the shape of worms, giving them long stomachs and enormous appetites, that they may eat abundantly. And He has taught the mother insect always to lay her little eggs in the right place for her young ones to find the food that is suitable to make

* The bee and a few others are exceptions.

† There are one or two exceptions to this rule. The earwig is one, which comes out of the egg almost like its mother, only it wants its wings, which do not unfold for some time.

them grow. The mother insect is very obedient to the will of her Maker in this respect, for the food which her little ones require is very different from the food which she herself can eat; yet she never fails to look out for that kind of provision which will nourish the beloved little grub she is not permitted to see.

The butterfly cannot eat any part of a cabbage, yet she glues her eggs very carefully down upon its green leaves, and when her eggs are hatched, out creeps, as we have before said—not a little butterfly—but a small worm, called a caterpillar, a maggot, or a grub. Some butterflies, and some small green insects, fold up the end of a leaf and glue their eggs under the folded part: some beetles lay their eggs in the bark, and some in the wood of trees; some insects, such as wasps, grind wood to powder, and then glue it together to make a cell; some beetles, moths, and butterflies make holes in the ground, and before they lay their eggs in this cell, they store it with a dead fly, or some other kind of food proper for the expected brood. A large moth was one day seen to drag a spider into her nest, and then with her legs she covered the top of the hole with earth. Many large flies, and some long delicate ones, lay their eggs in the flesh of living animals. Some spin silken balls for their eggs; others, like the bee, make waxen cells. Some moths lay their eggs on wool and furs, some roll

them in dust. The flea lays twelve little eggs at a time, either in dust, or at the roots of hairs on animals, or on the down of linen and flannel; and when the delicate fine worm of the flea is hatched, it is very lively, and curls itself about on these things, living upon the down, or upon the scurf of the skin; in a short time it spins a few silken threads round its body, and after a sound sleep of a few days, it comes out a perfect flea. People who shake things, and often use brooms, have fewest fleas.

The common gnat glues 250 or 300 of her eggs into the shape of a little boat; this boat she fastens by a fine silken thread, to the leaf of some small weed, and then leaves it to float on the surface of water in ponds and ditches. But by far the greatest number of beetles and flies lay their eggs in the offensive refuse of animal and vegetable matter; so we see, that wherever the mother insect tenderly deposits her eggs, there she generally leaves them to the care of that God, who has taught her to provide for her little ones.

The Gnat's Boat of Eggs. They hatch in three weeks or a month.

One beetle rolls each of her eggs in a separate ball of manure, and then leaves the balls to dry. As soon as these balls become hard, she returns to the place, and walking backwards, endeavours with her hind legs to push them altogether into one heap. Sometimes a lump of earth lies in the road,

and over this difficulty the poor beetle strives to push her little pellet; but often, just as it is mounted to the top, down it falls. Time after time the beetle will try, and sometimes succeed, but if she be fairly mastered by the difficulty in her way, several other beetles will run up and help her, all pushing at the pellet with their hind legs, till it is borne triumphantly over, and safely placed amongst the pile of little pellets already collected.

Insects vary in the number of eggs they lay; some lay only a few, others thousands upon thousands. The silk-worm moth lays about one hundred eggs. The great goat moth, one thousand. The female wasp lays thirty thousand, and the queen bee about forty or fifty thousand; and some female ants are said to lay as many as one hundred thousand eggs in the year.

Our next letter will contain the history of the larva and chrysalis states of insects;

And now, believe me, affectionately, &c.

LETTER XXVIII.

ARTICULATA.

Larva, Chrysalis, and Perfect State of Insects.

My dear young Friends,

Having noticed in my last letter, the care that insects take of their eggs, I have now to describe the different changes of their growing state.

THE LARVA, OR FIRST STATE.

As soon as an insect is hatched, its body comes forth in the shape of a worm, being formed of horny rings, with flesh between them. Some of these worm-like grubs are naked, whilst others are covered with hair. Naturalists call these grubs by the name of larvæ, (which means a mask,) from their large

bodies hiding up the real fly. In this worm state they have large stomachs, and eat voraciously, and change their skins several times.

The hole we often see in a filbert, is bored by a beautiful little beetle, with two wings; having two wing-cases striped with yellow bands. This beetle is called a weevil; it has six feet, and a long and slender ebony beak. When it has bored a hole with its beak, in the soft skin of a young filbert, it lays in it one little brown egg. As soon as the warm sun has hatched the little weevil grub, it sets about eating the inside skin of the filbert shell, always taking care, as its own body grows bigger, to nibble a piece off the side of the hole which its mother had made, that it may be able to escape when it pleases.

When the skin of the filbert grows hard and dry, the little grub turns its head down to the nut, which by this time has grown to a good size; and should

we chance to break the filbert, containing such an inhabitant, we should find a small white maggot, in the joy of its new life, gnawing fast and revelling upon the sweet food of the oily kernel. But should we leave such a filbert alone, it would fall from the tree in September, and then the little white maggot would creep out, and hide itself in the earth, where it would sleep in its chrysalis state till the following May, after which it would come forth a beautiful little beetle, like its mother.

Flies and beetles, in their perfect state, never increase in size, but in their larva state, they grow fast; and it is during that time that all the parts of the future insect are formed, under the skin of the grub. The body of a dead caterpillar having been stripped of its skin, by boiling it a few minutes in water, the wings of the future butterfly were clearly seen, lying neatly folded up on its sides; not that the wings were so far made as to be ready to be unfurled; they were only preparing for the time when the worm should be changed into the winged insect: just as teeth are preparing in the gums of young children, but are not ready to come forth till the child is old enough to eat solid food.

When the larvæ or caterpillars have grown to their proper size, and cease to eat, they begin to look out for a quiet hiding place, suitable for taking a long sleep in. Some creep into the earth: many shelter themselves under the bark of trees; and

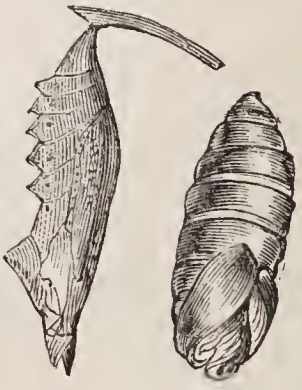
when men rive wood, they often see them roll out of their hiding places. Vast numbers of caterpillars quit the trees, upon whose green leaves they have been feeding, and creep away to some old wall, or clamber up between wooden pales, and there they spin from their mouths a silken thread, and by this thread they suspend their bodies. Other caterpillars spin one great roof, or canopy of coarse silk, under which numbers nestle down; whilst others make, each one for himself, his own separate bag of silk; others gum together the sides of a leaf with a few silken threads, and then suspend themselves from the stem.

There is a small caterpillar found abundantly in September, in marshy ground, which afterwards turns to a small orange-brown moth, called the Frittillary moth; this caterpillar is hatched from the egg about July. It feeds, in fine weather, upon the leaves of marshy plants; but if only a cloud passes over the sun, it stops in a moment, and will not again nibble its leaf till the sunny beams return in bright warmth. These caterpillars are very sociable, and numbers of them live together for eight months under one common web of coarse silk, which they all helped to spin from a gummy fluid at their mouths. During the winter, the caterpillars of the frittillary moth lie dull and stupid, neither feeding nor moving; but on the opening of spring they begin to stir, and to eat away at the bursting leaves.

By the end of April they come to their full size; then they leave their common home, and each little caterpillar draws down for itself the tops of two or three blades of grass; these bent-down pieces of grass it ties together with a few silken cords, and under this tiny roof it suspends its body by the tail for a fortnight; the tops of the blades of grass hiding each caterpillar from the sight of birds, and defending it also from wind and rain. At the end of this fortnight, the little caterpillar is changed into an orange-brown moth, which spreads out its wings, and sails away in the air.*

CHRYSALIS STATE.

Very soon after the different kinds of larvæ or caterpillars have finished eating, and have settled themselves in their new habitations, the horny hoops or rings round their bodies draw close together, and the long caterpillar becomes a short, thick lump, called by naturalists pupa, or chrysalis. The skin of some of these chrysalides turns to a tough leathery substance; others become hard and horny; other chrysalides



Chrysalis of a Butterfly, suspended by silk from Wood.

Silkworm's Cocoon, or Chrysalis.

* Should any one wish to observe the habits of this caterpillar, he should look out for it in September, on marshy land, and then cut the flag upon which they live, and carry it home.

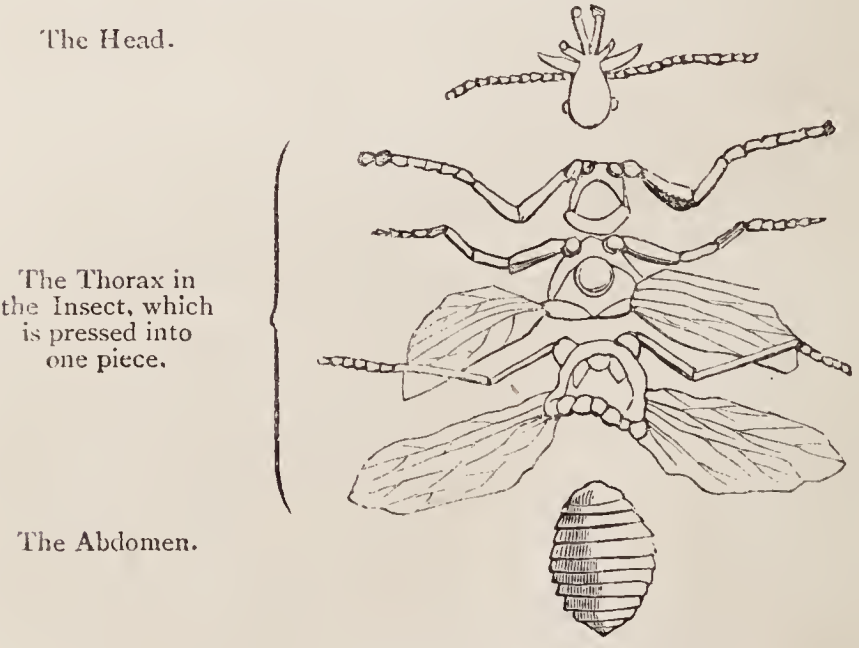
cover themselves over with earth, which they have moistened with glue out of their own bodies; others, like the silk-worm, spin balls of silken threads around their compressed bodies; and ceasing to eat, they lie quietly as if they were dead. In this quiet state some chrysalides remain a few days, some for weeks, others for months, and a few continue in this state for two or three years, patiently waiting for the hour when their great Creator shall command their little tombs to open.

During the time that insects sleep in their chrysalide states, God changes their worm bodies into new and exquisitely beautiful forms; making some fitted to sail through the air, and others to run fast on the ground. No sooner is this change completed, than the families of the brilliantly polished beetles bite through their chrysalis cases, and come forth, prepared to saw wood, to burrow in the ground, and sometimes to soar aloft. Innumerable swarms of flies, gnats, moths, and butterflies, bursting their silken bands, or tough skins, rise high on the wing, and in airy circles merrily dance away their short lives. Sometimes they sweep down, and touch with light foot the earth, intent upon seeking a nest for their eggs, or upon drawing from bright flowers the sweet juice each one loves best. Very beautifully does the poet Rogers address the butterfly, when he says,

"Child of the sun, pursue thy rapturous flight,
Mingling with those thou lov'st in fields of light;
And where the flowers of Paradise unfold,
Quaff fragrant nectar from their cups of gold,
There shall thy wings, rich as an evening sky,
Expand and shut in silent extasy!"

But whatever form the perfect insect takes, or whatever be the place appointed for it to live in, each one bears upon its body traces of the horny rings of its worm state. In some parts of the perfect insect, these rings are consolidated; that is, they are pressed together so as to form but one piece; whilst on others they remain separated, and therefore can be more distinctly seen. I believe, however, there is no exception to the rule, that the body of every perfect insect is divided into three

PERFECT STATE OF INSECTS.



Insect, divided into three parts.

great parts: called the *head*, the *thorax*,* and the *abdomen*.

The head is formed very differently in different insects, but in all it is richly supplied with ornament, as well as with tools for work.

Some of their jaws are made like awls, chisels, saws, knives, scissors, trowels, spades, and pickaxes. Their feet also have hooks and brushes upon them. Insects supplied with such good tools for cutting, nipping, sawing, boring, grinding, digging, shovelling, brushing, and smoothing, may well be considered accomplished and well-furnished workmen. And their works prove them to be such; for either in their larva state, whilst preparing for their chrysalis state, or during their perfect state, they turn out to be "silk manufacturers, paper makers, confectioners, architects, musicians, geometricians, carpenters, masons, boat-builders, upholsterers, miners, soldiers, and tailors."

Naturalists have divided all insects into companies or orders; mostly taking the number or form of their wings for the rule of their divisions. The four-winged and the two-winged insects, are put into separate companies, or orders; half-winged insects, and nerve-winged, and scale-winged insects into other orders, as you may notice in the chart at the beginning of this articulated division.

It would take us too long to speak of these com-

* The thorax, or middle part of an insect, is sometimes called the *trunk*.

panies or orders; but when you are a little older, you will find there are many delightful books on insects, by reading which you may satisfy the curiosity of an awakened mind. At present we can only notice some of the interesting particulars that belong to insects in general. A few more of these general remarks I shall send in my next letter.

From your affectionate friend.

LETTER XXIX.

ARTICULATA.

Perfect Insects.

My Dear young Friends,

Having traced in my last two letters the three stages of an insect's growth,* we have next to examine the light and beautiful forms of their winged life. And, in this state, the slightest examination of their delicate limbs and often brilliantly tinted bodies, is calculated to delight both the eye and the mind. Our taste is charmed by the gracefulness of their movements; our curiosity excited by their skilful works; and our surprise aroused, by the strength of their movements, and the rapidity of their flight.

We find that the wings and the feet of insects are joined to their bodies by strong muscles; so powerful are these muscles, that had a horse as much

* The egg, the larva, and the chrysalis states.

muscular strength, in proportion to its size, as the cockchafer possesses, when it flies booming past us of a summer's evening, it would be able to carry a load six times heavier than any horse now living can bear. And if an elephant were made as strong for its size, as the stag beetle is, it would be able to tear up the largest trees by the roots. The locust is able to leap two hundred times its own length: and so powerful are the muscles on the hind legs of a flea, that it is able to leap a greater number of times the length of its own body, than almost any other animal.

Air tubes.—Insects are rendered very light, in consequence of the large quantity of air which they can draw into their bodies. All insects have several holes in their sides, which are called *spiracles;* the air rushes through these holes, into two straight tubes, one of which is laid on each side of the body.* Out of these long tubes, the air is again driven forward into a vast number of little vessels, which are much finer than a baby's finest hair; and these delicate air tubes run all over the insect's body, crossing and interlacing each other, something like the light network of fibres to be seen in a leaf, after it has been robbed of its green covering by the moist wintry air.

This delicate lace-work of fine air tubes, is part of the living frame of an insect, as you may see in the picture of the water scorpion. And lest anything

* These two long tubes are called the Trachæ tubes.

Water Scorpion; an insect common in Fresh Water.

The Breathing Parts; that is, the Air Sacs, Trachæ, and small Tubes, in the tail of the Water Scorpion, highly magnified.

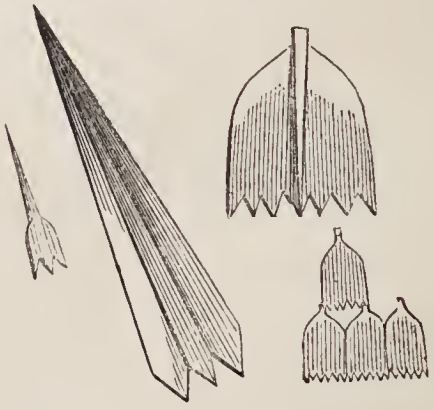
should press upon these minute vessels, and flatten them, so as to drive out the air, an exquisite contrivance of rings has been provided. These rings are small hard fibres, which are placed, one after another, along the inside of the air tubes, so as to form in them an entire lining. Sometimes they become a complete spiral lining rolled around the tubes like the spire of a cork-screw.

Magnified Air Tube of an Insect, shewing its lining of Rings.

Wings.—The wings of insects are amongst the wonders of nature; they are beautiful in their forms, and light in their make; they are easily folded up, and yet become broad when expanded; and thus

formed to act like sails, they can bear the insect up, or waft it onwards through the air. And to give these delicate wings power to strike boldly upon the air, they are fastened by strong joints, into the horny hoops of the thorax, or middle part of the body.

The wings of all insects are composed of a netted frame-work of many fine hollow air tubes, each tube being kept round and open by its internal spiral thread; and over both sides of this delicate net-work of air tubes, is stretched a thin and transparent skin, making the wings look like gauze. A vast proportion of insects have no covering over this clear gauze; but, in the wings of butterflies and moths, it is completely spread over with plumes, or scales, of brilliant hues. These scales are so fine, that to the naked eye they look like dust; but the microscope enables us to see that they are regularly arranged in rows, which overlap one another, each separate scale being fixed tight by a root into the fine skin of the wing. The shape of these scales varies very much in different species; and they are so numerous, that upon a quarter of an inch of a peacock butterfly's wing, [ ] (and a quarter of [ ] an inch is this size) there were



Different wing scales of Butterflies magnified.

counted seventy rows, each row having ninety scales in it; thus making altogether 6300 scaly plumes on that little square.

Many of the beetle family burrow in the ground, and to protect their delicate sailing wings from injury, thick plates of a horny substance are placed over them. Some of these horny shields are brown, others are jet black, and others are of the most brilliant colours.

When a beetle wishes to fly, it draws tight a set of muscles that are attached to these horny cases, by which means they are lifted up, and then its neatly folded gauze wings are spread out, and by them the beetle is borne aloft in the air.

So exquisitely are the wings of insects adapted for the work of sailing through the air, that nothing can exceed the lightness, the grace, and the rapidity of their movements. Our common house flies seem jocund with mirth whilst they chase one another, and dance their giddy rounds in the sun-beams. One moment they are seen, the next they are lost in the distance: a dog runs fast, a horse gallops fast, but the busy fly that buzzes around their ears makes sport of their pace. Have you not seen a fly play over the head of a fast-trotting horse, then dart before him; then return and whirl round his head, and again be off! you know not where? It has been said, that when a fly is frightened, it will cut through the air at the rate of more than a mile

in a minute. Even the heavy silk-worm moth can fly one hundred miles in a very short time.

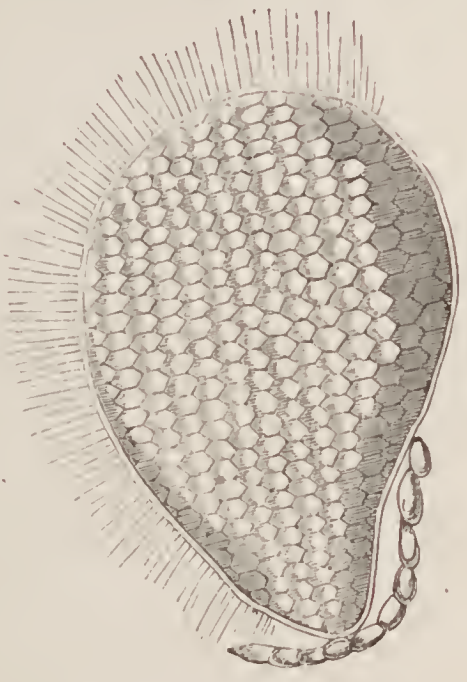
Eyes.—The eyes of insects form a wonderful part of their bodies. Some of them are embedded or set in the head; some stand out on a kind of thin stalk: but no insect can roll or turn the eye in the socket, as we can turn or roll our eyes; the eye of an insect never moves. To make up for this want of action, a new plan is contrived. Each insect has usually two eyes, but if it be intended, like the whirl-gig, which lives in our ponds, to see objects both in the air and in the water, it is supplied with four. Some insects have nine, and others have not less than sixteen eyes.

Gyrenus, or Whirl-gig.

The eyes of bees, butterflies, and dragon flies, are made in such a way, that they become multiplying glasses. An immense number of little crystalline lenses,* (each one of which is not only shaped something like a watch-glass, but is also cut at the edges like a diamond,) are placed all over the outside of the eye-ball, so that the insect can see all round it at once. The microscope has enabled men to count the astonishing number of forty thousand of these lenses in the eyes of a butterfly, and the insect can see any object through each one of these lenses as distinctly as if it were itself a perfect eye, so that

* A lens is a transparent substance, with a surface rounded something like a watch-glass.

a butterfly may be said to have forty thousand eyes! no wonder then that it flies away so quickly when we stretch out a hand to catch it; but in looking at a near object, it only uses one lens at a time. A dragon fly has fourteen thousand lenses, whilst our house fly has four thousand; and twenty-five thousand have been counted in the eye of one kind of beetle.



One Eye-ball of a Butterfly, covered with its Lenses.

In order to discover whether objects can really be seen through each lens, a person named Puget, placed the eye of a flea under a microscope, and in such a position, that he could look through it; a soldier who happened at that moment to pass by, was instantly turned into an army of pigmies; for whilst the lenses in the flea's eye multiplied the number of objects, they also diminished their size. The arch of a bridge became a spectacle more magnificent than anything that could be made by human skill, and the flame of a candle seemed the illumination of thousands of lamps. Leewenhoech tried the same beautiful experiment by

looking in the same manner through the eye of a dragon fly ; and he not only saw one house in the distance increased to many, by looking at it through the dragon fly's fourteen thousand lenses, but he saw each of these houses so distinctly, that he counted the windows, and could tell whether they were open or shut. Oh how perfect is our God in all His ways, and how much does He delight in the high beauty and finish of His own works : consulting in the formation of every little feather, muscle, bone, or eye, not only the use, but even the joy, the convenience, and the happiness of His living creatures.

There are other particulars in the history of insects that have not yet been touched upon, but I think this letter is long enough.

Believe me,

Your affectionate friend.

LETTER XXX.

ARTICULATA.

Antennæ, Mouths, and Feet of Insects.

My dear young Friends,

Continuing my description of insects, we shall now proceed to examine their antennæ.

Antennæ.—All insects have two fine threads or lashes projecting from their heads: these are called their antennæ. In butterflies they are generally long, and are mostly ornamented with feathery additions; but on the greater number of insects they are plain and short. The antennæ on the heads of some beetles, which burrow in the ground, can be drawn, at the pleasure of the animal,

Various antennæ magnified.

into small cases contrived in the sides of the head, and by this means they are protected from rubbing against the hard earth.

These threads, or antennæ, are not made in one whole piece, but are generally hollow, jointed pieces, laid close upon one another, so that they can easily be bent in all directions. Insects seem to use their antennæ as feelers or guides. Before a beetle, which lives in the ground, comes out of his hole, he always appears to try how the air feel, by pushing out his antennæ. Some people think these threads enable insects to hear; certainly they do seem to give insects the power of talking to one another, for both ants and bees have been seen to cross their antennæ upon meeting, as if in conversation, and afterwards to separate suddenly, as if bent on some important mission. The crossing of antennæ in a hive of bees, when the queen bee is lost, is evidently an affair of very hurrying and pressing importance.

The Mouth.—When insects are in their caterpillar state, their mouths have always teeth for cutting and grinding food. But when they lie folded up in their chrysalis state, God carries forward His work, and changes their mouths into new forms, more suitable for the life that awaits them as soon as He opens their sleeping tombs.

There are several thousand different kinds of beetles; and those beetles which are to eat flesh, wood, and other firm substances, have two sets of

strong horny jaws given to them. The lower jaws are sometimes formed for holding the food; whilst the upper jaws, called mandibles, which are the stronger of the two sets, are made for tearing and cutting. These jaws are variously formed to be hooks, spikes, or saws; whilst others are made like shears for snipping leaves; and others again are smooth, like the surface of grindstones, for reducing wood to powder.

Do you not think, after God has taken so much pains to make the body of a beetle perfect, that He is much displeased, when He sees an idle, ignorant child in very play, stamp its foot upon the living trophies of His skill, and call them "ugly, dirty things!" I wish that every child knew how happy insects are, because God smiles upon them as His own good workmanship. But when man is injured by animals, or can be benefitted by their death, he may destroy them, being granted this permission as "lord of the creation."

Sucking insects, such as bees and butterflies, have slender hollow tongues, some of which are three inches long. In butterflies, this tongue is rolled up like the mainspring of a watch; but the insect has power in less than a quarter of a moment to unroll it, and to dart it to the bottom of any flower-cup from which it seeks to draw the delicious juice it loves.

The tongue of the bee is made with a joint, in

order that when it is not in use, it may be folded up and kept from injury.

Other insects have their hollow syphon tongues enclosed in sharp pointed sheaths. These sheaths pierce the surface of the food they attack; and, immediately this is done, the tongue finds its way into the incision, and pumps up the fluid.

Feet.—All insects have six legs, which are each jointed with several articulations; that is, the leg is divided into several pieces, and between each piece is placed a joint or hinge of tough skin, such as we had to notice in the legs of lobsters and crabs. The last joint in the insect's leg is called the *Tarsus;* and this tarsus generally ends with a claw like a cat's talon. By this claw the insect is able to fasten its foot to the rough sides of a perpendicular wall, and so to walk upon it. Many heavy-made insects have, on the under side of their feet, soft velvetty cushions of fine hairs. These cushions receive the first shock when they alight upon the ground, which prevents their bodies from being jarred or bruised on leaping down from a height. Several flies, and amongst others the house fly and the blue-bottle fly, have suckers, or loose pieces of skin tied fast by fibres to the soles of their feet. These pieces of skin can either lie flat down, or they can be drawn up in the middle by a muscle, so as to form a sucker cup.

When a fly wishes to walk on the smooth surface

Under side of a Blue-bottle Fly's Foot, with large suckers, magnified.

3 sorts of suckers on Flies' feet.

Cushions on Grass-hopper's feet.

of a pane of glass or on the ceiling of a room, it gently draws up the middle of its sucker, and this causes the air on the outside of the little cup to press heavily against it, so that the heavier the body pulls, the tighter the foot sticks. And this sucker cannot give way, till the fly's own will loosens the muscles, and lays the sucker flat.

Insects, which like the gnat, walk on water, have a brush of fine hairs at the end of their feet; the dry points of which keep the water off; but if the brush gets thoroughly wetted, the fly's foot sinks, and the poor little fellow is drowned.

Nothing has yet been said of the stings of insects. Most children know how sharp and painful those small lancets are; but perhaps they do not know that the swelling which rises from their wound, is caused by a drop of poison pressed from out of a bag lying at the root of the sting. This poison passes down a hole, which is bored through the

whole length of the sting, and so runs into the wound which the lancet has made.

I think I have now said enough to convince you that insects are a set of wonderful little beings. If you consider the varied works they are appointed to accomplish; if you look at the beautiful perfection of their light airy bodies—at the expanding breadth of their wings—at the strength of their muscles—and at their various instruments, I think you will be compelled to own, that every insect, from the least to the greatest, bears upon its workmanship the stamp of wisdom and power. This truth prepares the mind to bow to the Bible statement, that He who spread out the starry heavens, and set a bound to the waves of the sea, is also the Maker and the Preserver of all the winged tribes that surround us.

Should you think of these things when you hear the buzzing of a fly; when you watch a butterfly skimming over the flowers; or see a fast running beetle peep out of his hole; your mind will take fresh delight in noticing the works of our God, and you will reap a still greater harvest of joy, when you remember, that through our Lord Jesus Christ, we are allowed to say, "My Father made them all!"

And now to conclude; let me ask you, can the thinking mind of man gather any lesson of instruction from the histories of these insect tribes? Consider! does not their patient industry, and their eager attention to the duties of every hour,

afford us a striking lesson, to be cheerfully active in all that our hands find to do? And does not their history teach us a still higher lesson, even something of the mighty power that dwells in our God, to overcome the sleep of death, and (if it be His good pleasure so to do,) to re-adorn His creatures with bodies suited to enjoy a higher and brighter region than they have dwelt in before! Of the butterfly, the poet says—

> "Yet thou wert once a worm, a thing that crept
> On the bare earth, then wove a tomb and slept:
> And such is man; soon from his cell of clay,
> He'll burst a seraph in the blaze of day."

The changes in an insect are full of valuable instructions; and with a desire to benefit by them, let us once more review its changing life. We find that God has enclosed within the tiny egg, which the butterfly glues upon a cabbage leaf, all the members of a living insect. And from the Bible we learn, that God has enclosed in our bodies a soul, possessing the powers of an endless life! He clothes the butterfly's grub with a body of flesh, and appoints the worm its due portion of work. Even so has He clothed our souls with tabernacles of flesh, and appointed us the noble work of loving *Himself*, and obeying His laws. We have seen that the worm never refuses to perform its work. But man, with his gifted mind, daily and hourly refuses to perform his happy duty of enjoying and obeying his Maker.

The butterfly worm is shut up for a time in a tomb; and from thence, never having broken its Maker's laws, it bursts forth into the beauty of a higher life. We also shall be shut in a tomb: but seeing that we have all of us broken our Maker's laws, what will become of us? The Bible says, "The soul that sinneth it shall die." Shall we then be cast away as thorns for the burning, and never rise to heaven? The Bible says, no; ye need not be lost; for the Lord God has loaded man with benefits beyond all that his heart could have conceived, "For God so loved the world, that He gave His only-begotten Son, that whosoever believeth in Him, should not perish, but have everlasting life." And the Son of God says to every one, "Him that cometh unto me I will in no wise cast out."

Let us then ask Him to change our hearts—to remove from us the guilt of vanity and lies—and to wash us clean in the precious blood of Christ. And He that heareth the cry of His creatures, and giveth them their meat in due season, will assuredly hear our cry for pardon; granting us even now for Jesus' sake, a free gift of eternal life, and hereafter He will raise us from the tomb, adorned in the righteousness of Jesus, to shine as the sun in the kingdom of our Father—bringing us to Zion, with songs of everlasting joy upon our heads.*

* Matt. xiii. 43. Isaiah xxxv. 10.

"Salvation! O the joyful sound!
What pleasure to our ears!
A sovereign balm for every wound,
A cordial for our fears.

"Salvation! let the echo fly
The spacious earth around;
While all the armies of the sky
Conspire to raise the sound.

"Salvation! O Thou bleeding Lamb!
To Thee the praise belongs:
Salvation shall inspire our hearts,
And dwell upon our tongues."

Desiring from my heart, that through His redeeming mercy, this great salvation may be our rich portion, these letters on the Articulated Animals are concluded. Some time hence I may perhaps send you a few letters on shells, and on the living creatures which inhabit them; for the present I remain,

Your silent but affectionate friend, &c.

End of the Articulated Division.

PART III.

THE MOLLUSCOUS ANIMALS.

Slugs, and Shell-making Creatures.

"Almighty God, Thy power we sing!
* * * * * *
How full the earth, and sea, and air!
How great Thy love!—what constant care
Of all the host is shown;
On great and small Thy bounty flows,
And all creation richly glows
With goodness all Thine own."

THE MOLLUSCOUS,

OR

Cuvier's Second Great Division of Animal Life.

The second division holds the soft-bodied animals. They are divided into six Classes.

The 1st, 2nd, and 3rd Classes are headless Slugs, which are called the *Acephalous* Molluscs.

1. The Tunicata have a cloak or tunic bag over their bodies; such are the pyrosoma and the ascidia.
2. The Brachiopoda are arm-footed; such are the terebratula.
3. The Lamellibranchiata are plate-gilled; such are oysters, mussels, mactras.

The 4th, 5th, and 6th Classes are Slugs, with heads and feet, which are called the *Encephalous* Molluscs.

4. The Pteropoda are wing-footed; such is the clio borealis.
5. The Gasteropoda are body-footed; such are snails, murex, &c.
6. The Cephalopoda are head-footed; such are the octopus, cuttle-fish, and nautilus.

LETTER XXXI.

MOLLUSCOUS ANIMALS.

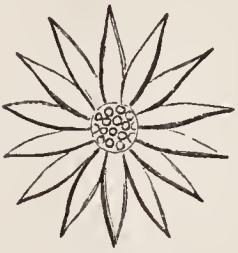
Of Slugs in General. Of the Tunicata or Cloak Molluscs, and of the Naked Molluscs.

My dear young Friends,

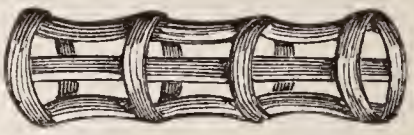
In my former letters on the *Radiated* and *Articulated* divisions of animals, I endeavoured to shew you that life is abundantly spread over the surface of this beautiful globe of land and water; and that multitudes of our fellow inhabitants exist around us on every side, each one performing the commands of its Creator with joy and alacrity. We have now to consider the *Molluscous* division,* comprising fleshy animals without bone, such as the oyster; and in this group we shall meet with creatures of very different shapes and habits to any

* So called from the Latin word *mollis*, soft.

we have examined, either in the radiated, that is, in the daisy-like division, or in the articulated or ringed division.



Radiated.



Articulated.

The animals which compose the molluscous division, are cold, soft-bodied creatures, without any skeleton, being entirely devoid of either bones, rings, or joints in their frames. They are simply masses of soft flesh interspersed with muscles, and with knots and strings of nerve; and their soft bodies are covered with a skin which is constantly giving out a gummy fluid. Molluscous animals are frequently given the name of slugs; they are of various shapes and sizes; some are round, such as the oyster; others are oval, such as the mussel; and some are long, such as the garden slug. Some live on land, others in water; the dry land and fresh water slugs breathe by drawing air in at their mouths; but the molluscous animals which live in the sea, draw the air into their bodies by the help of gills. In oysters these

Planorbis Shell and Slug.

gills are composed of four ranges of fringes, commonly called the beard; but in most other molluscous creatures the gills are arranged in folds, like beautiful flowers, and are set either on their stomachs and sides, or they are fixed like the teeth of a comb in cavities inside their bodies.

Molluscous animals with two shells, such as the oyster, mussel, razor-shell, &c., have no faces and no eyes;* but slugs, which live in shells made of one piece, have tolerably-formed faces, and two eyes, with which they see. On the heads of land snails are four horns, and on the tips of the two largest of these horns, their specks of eyes are placed. The eyes of the one-shelled sea-slugs are generally placed on small swellings at the base of their horns.

The bodies of most of the molluscs, are either of a brown, a greyish white, or straw colour, and these colours are often clouded with dark spots. Such dull hues do not however prevail in all cases, for the slugs of the cowrie shells, of the harp-shells, and of the olives, are sometimes beautifully marked with different hues of vermilion, green, and pink. The body of the harp-shell mollusc is of a rich red vermilion colour; and when the rays of the morning sun dart strongly down into the clear blue sea, which

Harp-Shell.

* These are called the Acephalous class, from the Greek word *a*, which means without, and *kephale*, a head.

flows around the West Indian Islands, this creature can be traced slowly approaching the shore, by the pink glow its bright vermilion body casts abroad in the sparkling waters.*

Molluscous animals may be said to consist of three varieties;—the *bagged*, the *naked*, and the *shelly* molluscs. Those which have their soft bodies covered with a loose leathery bag, are called the *Tunicated* or cloaked *molluscs*. These bagged or tunicated slugs are dull and lifeless-looking creatures. They are found abundantly in the deeper parts of the sea, and often stick to stones and sea-weeds near low-water mark. Some of them grow to the size of a mussel, that is, to about two inches long, and these are called the common Ascidia,† or Sea Squirts, being so named from two openings or mouths in their shapeless bags, from which the living animal within often squirts out the water it has sucked up. After storms, these creatures are frequently thrown upon the sandy beach, and on taking up their bags, a very slight pressure sends the water out as if from a jet. Some of their bags are half transparent, and their surfaces bright with changing colours; but, more generally they are slightly rough to the touch, and darkish in their hue. Other kinds of bagged molluscs are very small, and are as transparent as glass. These minute species do not live alone like the larger brown sea squirts, but are linked together

* Zoological Journal. † Ascidia communis.

in masses, often more than a mile in extent. When a ship sailing tranquilly in the dark night over the deep southern oceans, falls in with a shoal of these minute tunicated or bagged molluscs, the sight is very beautiful: the face of the waters instantly becomes one sheet of pale greenish light, which flies in quick succession, into streaks of every hue of the rainbow.*. Other kinds of minute tunicata are grouped into star-like patterns upon large sea-weeds. On our own coasts we often find the stems of olive-coloured weeds matted together by a firm jelly, the surface of which is marked by radiating stars of blue, crimson, and orange. This jelly is the common home in which the minute-bagged molluscs† spread themselves out into all kinds of forms; each small star being composed of many separate animals.

The second kind of molluscous animals are called the *naked* slugs, and have their soft flesh covered with a close adhering leathery skin. The long-bodied crawling garden slug is one of these. Some naked molluscs, such as the garden slug, dwell on dry land, living chiefly amongst grass and trees. But vast numbers of other naked molluscs, (somewhat resembling the garden slug in their forms) dwell amidst mud and sand at the bottom of the

* The jelly fishes give out a white sparkling light; the Ascidia, or small-bagged molluscs, a coloured light.

† The *Botrylli.*

ocean. Many of these naked sea slugs have tentacula, like the feet of a star-fish, all over their bodies; and many of them are beautiful to behold, from the bright colours that play upon their skin.

Sea-slug, covered with Tentacula.

Amongst the naked molluscs which inhabit the sea, a few sets of creatures are found, very superior in their forms to the soft creeping slugs, being almost equal in organization to the lowest forms in the back-boned division of animal life.* Of these superior slugs, naturalists have made a distinct order, calling it the head-feet order.† All slugs in this head-feet order swim with ease; they have strong tough skins—good eyes—powerful beaks for tearing their prey—long arms or tentacula on their heads, which are lined with numerous suckers—they have a nice arrangement of nerves and muscles in their bodies, and hard chalky-looking substances, which give firmness to their soft flesh. A large

* Or Vertebrated division, which contains the highest order of animals, fishes, birds, beasts, &c.

† That is, the *Cephaloped* order, from two Greek words, the first meaning head, and the last foot.

family in this head-feet order are called cuttle-fish, all of which have broad chalky-looking plates in

The Cuttle-Fish.

their bodies, and are supplied with ink bags, or pouches in the stomach filled with a dark fluid. This fluid the cuttle-fish throws out at its pleasure, and the moment it is alarmed, it pours it forth into the waters, making them so cloudy and even dark, that the creature can easily escape from the pursuit of its enemies. It is from this dark fluid, found in the bags of the cuttle-fishes, that men make the paint we call sepia. Immense shoals of cuttle-fishes are often met with in various parts of the Atlantic and Pacific Oceans. The long, round, and pointed stones found in chalk pits, and which in Norfolk pass by the name of "thunder bolts," are a portion of the inside of a kind of cuttle-fish, called the *belemnite.* These belemnites formerly lived in great numbers in the waters of the sea, but for some wise reason, God has seen it good to destroy almost the whole of their species; but when alive, they were quick and daring destroyers of fish,

driving their beaks into their bodies, and then dragging them low down under the waters to devour them. All these creatures were upright swimmers, and the internal bone or horn, served as a weight or ballast to keep the proper end floating downwards.

Poulpe.

Another mollusc or slug of the head-feet order, now living in our sea, is called the Octopus or Poulpe. This creature is rounder in its form than the cuttle-fish; it swims with rapidity, has large eyes and long tentacula. It is often of immense size, and is a fierce and powerful animal. A hundred and twenty pairs of suckers, "more perfect than the cupping glasses made by man," crowd the under side of each one of its eight long pliable arms. If the poulpe but touch its prey, it is enough; its suckers instantly grasp tight hold. Large fish, and even men, if they happen to swim near, are seized by it; and once caught, no quickness of movement or forcible effort, can deliver the captive from its tenacious hold until the poulpe itself be killed. In the warm southern oceans these creatures grow to their largest size; and it has been remarked, that the few men who have been saved from their grasp, have either died quickly after, or lost their senses: their death arising either from the extreme terror they have suffered, or from some poison which has been infused into their

bodies. Mercifully, these large and terrible molluscous animals have not been permitted to be very numerous; but the number of harmless tribes of slugs, both with shells and without them, is prodigious, their bodies supplying much food to men, to birds, and fishes: oysters, cockles, and mussels, are of this description.

My next letter will more particularly describe the shelly molluscs; but for the present,

Believe me, your affectionate friend, &c.

LETTER XXXII.

MOLLUSCA.

Of Testaceous Slugs, and of Fossil or Ancient Shells.

My dear young Friends,

Having dwelt in my last letter upon the two families of slugs, which are called the tunicated and the naked molluscs; we are now to examine the molluscs that have shells over their soft bodies, and which are called the Testaceous molluscs.* The shells of these slugs vary in size, shape, and colour. Some shells are so small that we require the assistance of a magnifying glass to behold them; and in consequence of their minuteness, immense numbers will run through a hole pricked in paper by a fine

* From *testa*, a shell.

needle; others are equally remarkable for their size and weight. There is a species of scollop-shell, (which is something of the nature of the oyster family)* in which one shell is often found to weigh five hundred pounds. And so wide and deep are these huge scollop-shells, that in Paris, they have actually placed one in a church to be used as a font for baptizing infants.

Should you ask me how shells are made, I would say, recollect the clammy streak which the naked crawling garden slug leaves behind it, as it drags its soft fleshy body along the ground. That sticky fluid, when mixed with a liquid lime, which oozes out of the skins of some slugs, forms the substance called shell; and with this substance, whole tribes of molluscous animals are clothed in powerful armour for the defence of their feeble bodies, whilst at the same time, it forms a tent or habitation for them to live in, and which they carry upon their backs, go wherever they will.

Shells abound both on land and in water. They are seen on the surface of the earth, and they are also found deeply buried in the solid parts of the globe. The substance we call chalk abounds with shells. Now chalk and marbles, and all limestone rocks, were once soft beds of muddy lime, which covered up the coats of animalcules, corals, and hosts of shells, as well as of a few of the higher

* Belonging to the Ostrea genus.

orders of animals:* and these animal remains lie entombed in the earth to this day. To examine the prodigious variety of shells thus locked up in many of the hard rocks of our globe, forms a very interesting study. A poor but thinking Scotch boy, working a few years ago for his daily bread in the stone quarries of Cromarty, in the north of Scotland, was so astonished at beholding the numerous shells, and other animal remains which his mattock laid open to view, that by fixing his attention upon their appearance, he gradually treasured up a fund of knowledge, that not only raised him above the low condition of a hand labourer, but enabled him to supply clever men with much information. For it is by observing the various shapes of these buried shells, and the kind of rock in which they lie, that we gain much knowledge of the past history of our earth. By the mode of their growth we can tell which land was once covered with fresh, and which with salt water. And often their crowded numbers seem to tell us, as with a voice, that countless ages must have been required to complete the rocks which give hardness and solidity to our round world.

No man can tell at what time these rocks and their shells were made. The Bible opens with giving God the glory of creating the earth. "In the beginning God created the heaven and earth," Gen. i. 1.; but we know not when that beginning

* Such as Trilobites, and Saurian or lizard-like animals

was. The Bible was not written to gratify the curiosity of man upon worldly matters: its chief object is to teach man the character of his glorious Creator,* and the nature of his own spiritual condition.† That holy book is therefore silent with regard to the times in which the solid parts of the earth were forming. It points to the Lord God as the Maker of all things, and then sublimely passes on in the second verse to inform us, that the bare earth was made, and that the Spirit of the Lord God moved upon the face of the deep waters that covered the earth. Let any observing person, however, examine the stones and earth around him, and he will quickly be brought to the conclusion, that the great Creator was pleased to employ vast periods of time in the arrangement of the rocky parts of the globe.‡

The observant and thinking man soon perceives that some rocks were made by fire, and that others were formed under water, by means of mud and sand settling into beds or layers at the bottom of lakes and seas. Some of these watery settlements he will find of great thickness; many parts of their masses bearing the appearance of having been

* The Bible describes our God as a Being possessing all power, wisdom, holiness, justice, mercy, and truth; covered "with light as with a garment;" and declares that His nature "is love."

† Man is separated from God by sin, but he is given an offer of pardon, and a free gift of eternal life, through faith in Jesus Christ. Rom. vi. 23.

‡ Pebbly stones are pieces of different rocks that have been broken off and rolled away from their native place, and their edges rounded by rubbing against one another, or against other substances.

driven forward in streams; whilst other settlements he will find to be chiefly composed of thin layers, looking as if they had been gently deposited in water year after year in countless multitudes, one over the other. This arrangement may be plainly seen at the sides of many broken cliffs. Thus the thinking mind of man is able to discover, that the enormous beds of stratified or sedimentary rocks, which now encircle our globe (to the depth, it is calculated, of several miles) owe their origin to the muddy and sandy settlements of ancient seas and lakes. Large collections of shells of all sizes, and in all stages of their growth, lie buried amongst these rocky layers, plainly shewing, that during the time the muddy sediments of the earth were slowly settling or drifting together, successive races of molluscous animals lived, grew, and died, upon their different watery beds, all of which required ages for their formation.

Again, the intelligent mind perceives that volcanic fires, accompanied by tremendous earthquakes, have repeatedly burst open, split, and rent asunder the rocks of the earth, raising up portions of the hardened, muddy beds of the sea, with all their buried shells, into hills and mountains, and causing other portions to sink down in valleys. Facts like these compel us to believe that it pleased the Lord our God to employ long periods in forming the solid parts of the earth, and that the six days' creation.

described by Moses, relates only to the last acts of Omnipotence; or to that time when the voice of the Lord God made the dry land again to appear, that He might prepare its surface for the habitation of man.

Should we, therefore, desire to glean some knowledge of the way in which the Lord our God wrought, when He made the rocks and marbles of the earth, you see we have no other resource but to go, as the intelligent Scotch boy did, and examine the different earthy crusts of the globe for ourselves, looking especially at the steep sides and rent seams of its high towering masses. Throughout the various countries of the world, lofty mountains and hills lift up their stony heads in solemn grandeur, displaying innumerable proofs of the wonder-working power of the Creator. It is in these monntains and hills that whole beds of shells are found turned into hard and enduring stone. Men stamp the history of nations upon their coins of silver and of gold, but God has stamped the history of the earth's changes upon the everlasting rocks, and their stony records have consequently been beautifully called, "*The medals of creation.*"

Many hundreds of families of these buried fossil shells are quite different in their shapes to the present living species. The Terebratula is perhaps the only one that has never been changed in its form, for it is found in all the sedimentary rocks, as well

as now living in our seas. Some shells abound in particular rocks, and then are quite lost sight of in the next range. The limestone and chalk rocks are crowded with shells; the slate and sandstone rocks have usually fewer; but taking the whole of their families together, we shall find that shells people the marble hills and stony layers of the earth, with a greater number of animal remains than are left by any other living creatures, the corals perhaps excepted. These thickly entombed rocky medals, although silent, suggest awful thoughts to the reflective mind. They point back to those vast periods of time long gone by, when the Lord our God was laying the foundations of this rolling orb;* they display much of His wisdom and of His power, and they unfold the glories of His character as a God, ever delighting in life.†

Having supplied you with many subjects for reflection, I shall now close this letter,

Remaining,

Your affectionate friend.

* Job xxxviii. 1—7.

† For further information on this subject, see a simple work on Geology, called "The Globe Prepared for Man," expressly adapted for young people. Adams, 59, Fleet Street, London.

LETTER XXXIII.

MOLLUSCA.

Of the Formation of Shells.

My dear young Friends,

The study of shells is interesting, both on account of the story they tell us of the ancient state of the world, and because the molluscous animals which form shells are at the present day spread over the whole world, affording abundance of food to many animals. They live in all climates, and are found both on dry land, and in fresh and salt water; many kinds, by their rapid increase, covering extensive banks of mud and sand in the sea. Having, in our former letters, glanced at the past, as well as at the present history of the molluscous race, let us

now consider the mode by which their shells are formed.

The soft bodies of all slugs that make shells, have two skins over them: the outside or top skin is mostly loose, one small part of it only being fastened to the shell. This top skin is soft and springy. It is full of fibres or threads made of albumen, a tough animal secretion, which hardens into a substance something like our muscles. This elastic skin is wrapped round the body of the slug like a bag, and is called its mantle. The mantle is an important part of a mollusc's frame, being the storehouse from which is supplied the shell-making sticky fluid, formed out of the food the slug eats. Various chemical experiments have proved that this shell-making fluid is composed of carbonate of lime and phosphate of lime, mixed with the animal substances called glue* and albumen.† As soon as these four substances are prepared in the body of the slug, they pass in a liquid state into the mantle, where they are thrown off in two different forms: some portions of the fluid make a fibrous net-work, and other portions form a limy cement, and these two materials rightly arranged, harden into shell. Some shells have very little of the fibrous net-work in them, but are almost entirely made by a settlement

* Glue is a sticky matter, forming part of an animal's body. The skins of large quadrupeds are chiefly made of glue.

† Albumen, a tough animal substance. White of egg is albumen.

of the limy cement. These cement-shells harden into a crystalline or brittle china-like state, and are often highly polished and of beautiful colours, just as we see in the cowree or cyprea species.

In forming the rough oyster-shell, the mantle first deposits a layer of fibres like thick net-work, which fibres are made of glue and albumen, and upon this net-work the mantle next lays a coarse cement of lime. The shell of an oyster is not made at once; but as the body of the oyster grows, the mantle keeps depositing layer after layer to the edge of the shell, each rim overlapping the other like tiles on a house. If you wish to examine this formation, place an oyster-shell in a gentle fire, and on taking it out, you will find that its rims or plates easily separate and display their mechanical arrangement.

In order to watch the process by which the mantle of a slug performs its work, a hole was one day made in the shell of a garden snail, just on the upper part where the mantle is known to adhere to the shell. In a little while a net-work of fibres, something like a spider's web, was spread over the hole, and in a few days this web was covered with a layer of lime cement. This work of thickening, first with the fibrous net-work, and then with cement, went on for ten or twelve days, till the hole was quite repaired, leaving only a dint in the shell. But when a hole was made in a part where the mantle of the slug did not touch the shell, the life

of the animal being in no danger, that hole was never filled up.

In *bivalves* (that is, in shells made of two pieces, such as the oyster,) the cement is slightly thrown off from all parts of the mantle, though principally at the edge which lies round the inside of the shell; but in shells that are called *univalve*—that is, in shells formed of one piece, the cement creeps out at the end of the mantle, close to the mouth of the shell, which end is then called the collar. Now mark the wisdom of this arrangement. It was no accident which stored up the slug's sticky fluid in the only place where it could be of use to the animal! Had the liquid cement escaped from all parts of the mantle—the inside of a univalve shell would gradually have been filled up, and the naked slug would have been driven out of its home; but God foreseeing this danger, has sent the shelly cement forward into the collar, which is close by the opening; and thus by having the edge of its mantle made a full storehouse, the slug is able, as its body grows, to throw off abundance of lime and glue in the right place to enlarge its abode. If you look at a univalve shell, you will see that it grows wider as it grows longer, shewing us, that just as the slug has grown in length and width, so its collar has deposited its sticky substance to suit the dimensions of its growing frame.

On this collar or edge of the mantle, are also

found many ranges of fine veins, full of the bright colours which paint the growing shell. So clearly can these veins be seen, that men are sometimes able to tell, as the slug pushes its mantle forward, what spots or stripes of pink, purple, blue, or brown, the next new piece of shell will receive.

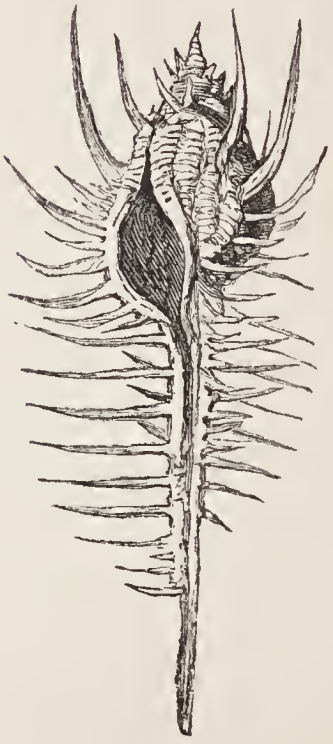
Openings are left in the mantle or bag of the slug, in order that air and water may reach the gills* and the mouth. And also, if the creature have a head or feet, openings are left through which it may push them out, just as a snail pushes out its horns.

The mantle or top skin of the slug is elastic, that is, it is capable of being stretched, and then of shrinking back to its first size. This valuable property enables the slug, at its pleasure, either to push its mantle over the outside of its shell, to draw it into the shell, or to lay it flat upon the wide lip that is formed in front of some species: but wherever the mantle extends, it makes that part of the shell very smooth and polished.

Sometimes the slug will drive a piece of its mantle out, quite beyond the body of its shell, folding it into peaks or tubes for the purpose of drawing water into its mouth. In a short time the shelly cement, which keeps oozing out of the collar of the mantle, fills up the ends of these tubes, and as the cement hardens, the mantle is driven back, leaving the stiff peaks sticking out

* For the form of a slug's gills, see page 251.

like spikes. These spikes may be seen in the front of some shells and all over the bodies of others. Many little knobs or excrescences are also



Murex.

to be seen on shells, all of which arise from muscular lumps that were on the body of the slug, or in its mantle, and over which the cement has settled as upon a mould.

It may well be said, that "in every part of nature we trace the hand of a wise and beneficent Creator." We find that every thing is adapted to the situation it has to fill. Dr. Paley was aware of this, for he

says, "I do not know whether the weight being given, art can produce so strong a case as that of some shells; which defensive strength suits well the life of an animal, that has often to sustain the dangers of a stormy element, and a rocky bottom, as well as the attacks of voracious fish."

My next letter will describe a few of the situations in which shells are to be found, and will also give some account of their modes of increase.

Believe me,

Yours affectionately, &c.

LETTER XXXIV.

MOLLUSCA.

Situations in which Molluscous Animals are found. The Eggs of Molluscous Animals.

My dear young Friends,

In our two last letters, we considered the nature of molluscous animals, and the means by which their shells are formed; we are now to consider some of the habits of these creatures. To notice the habits of a common snail is no great effort, for snugly housed in their shells, some of this family may be found in most gardens, and often abounding on hedge-rows. But it is more difficult to meet with the living inhabitants of shells belonging to the sea. The limpet, and a few others that

live in shallow water, can be readily noticed, whilst for a knowledge of most sea-water shell-fish, we are entirely indebted to the persevering attention of clever naturalists.

The creatures which form shells vary in their habits; some, as I have more than once remarked, live entirely on dry land, others in fresh water, and others only in the sea. Many land slugs frequent dry banks and exposed heaths, and will even creep into sheltered holes in old walls: others loving more moisture, creep to the edges of running streams and into thick woods. The smallest land shells are usually met with in decayed wood, and under dried leaves and mosses which grow at the bottom of trees. In warm weather, small slugs may be found under stones, where they have crept for shelter from the sun's rays. In winter they often lurk in holes of trees, in slits of bark, and in crevices of rocks. The best time for collecting land shells is in the spring, because at that time their inhabitants awake with keen appetites from their winter stupor, and go forth with fresh vigour in search of food.

Fresh-water shells are not so numerous as land shells, yet they may be found in most rivers, ponds, marshes, and even in muddy ditches. Some water slugs bury their shells in mud or in sand, and others fasten themselves upon stones at the bottom of the stream. At times the slugs leave the water to climb up plants which grow upon its banks, so that on the

water lily, on the mare's tail, on duck-weed, and on rushes, small fresh-water shells may be found in all stages of their growth, and with their finest tints upon them. They generally adhere to the surface of the plant, but sometimes the very smallest kinds hide themselves within the folds of the leaves. A pretty little shell, called the *Bulla fontinali*, is often wrapped in the leaf of the common water-flag. The best time to search for fresh-water shells is in the middle of summer.

But sea shells are the most generally admired, having the strongest walls, the greatest beauty and elegance of forms, and the most brilliant colours.

> "Even as the rainbow-tinted shell which lies
> Miles deep at bottom of the sea, hath all
> Colours of skies, and flowers, and gems and plumes."

Many sea slugs fasten their shells upon rocks, others bury them in the sands of smooth flat shores; such are the Tellina, Solen, and Mya, as also some kinds of Whelk or Buccinum. But all the most beautiful and the largest species dwell in the deep ocean beyond the sight of man; these are the Cones, the Olives, the Cypreas, the Volutes, and the finest specimens of Murex and Buccinum. Such shells are seldom seen, unless taken in nets, or thrown upon the shore by violent storms.

EGGS.

All slugs are hatched from eggs. The molluscs that inhabit the bivalve or two-lidded shells, keep

their eggs snugly between the two lids until the little ones are hatched; after which the parent slug pours them out upon mud-banks, sea-weeds, or rocks. Immense numbers of eggs are hatched in this way by the oyster; indeed, so many, that it has been said, if all the little ones hatched by one mother came to perfection, they would fill twelve barrels in the course of the year. Young oysters mostly fall from the parent shell during the months of April and May; they do not fall separately, but in little lumps, "like drops of grease," many being joined together by a sticky fluid which surrounds them. These lumps the oyster-catchers call spats; and as these spats frequently drop upon the tops of old oyster-shells, which lie upon the same mud-bank, they remain upon them and continue to grow there one upon another.

The univalve, or one-shelled molluscs, never hatch their eggs, but the parent slug lays them under lumps of earth, on sand-banks, coral-reefs, sea-weeds, or bits of wood. The land snail is a univalve, and she lays her eggs separately from one another, like the eggs of a bird; but the sea snail encloses her eggs in a jelly which unites them together. This wise difference in the proceedings of dull unthinking creatures, strikingly reveals the ever-guiding and care-taking hand of an all-seeing God. Other sea molluscs, such as the whelk, deposit their eggs in bags of an oval or round

shape, made of a thin pale straw-coloured membrane or skin; these bags are grouped together in clusters like bunches of grapes, each bag having a small hole in it. Such clusters of bags when emptied, may often be seen rolling on the sea shore like lumps of hardened foam.

As soon as a young molluscous animal bursts from its egg, it comes forth with a fine transparent bit of shell either upon its back or tail. This thin piece of shell is formed out of the materials which God had stored up in the mollusc's tiny egg, just as the downy feathers of a young bird are formed out of the materials that were stored up in the egg of the mother bird.

The shell is afterwards formed, by the sticky fluid that exudes or oozes out of the collar of the young slug's mantle; this fluid settles around the small piece of delicate shell with which the slug was hatched, making it thicker, and also rapidly enlarging its edges to the extent the animal requires.

The inside of many shells is lined with a glistening white substance, called mother-of-pearl. To form this substance, the slug throws from its mouth layer after layer of the finest and most delicate net-work of fibres, each layer in its turn being covered with the thinnest and purest limy cement.* To our eye, mother-of-pearl seems lightly tinged with many colours, which are ever changing

* This limy cement is generally called a calcareous deposit.

their hues; but in reality it has no colour, and this effect is given to its white surface in consequence of the limy cement being laid in narrow groves, which divide the yellow, blue, pink, and purple rays of light from one another, as they reflect the light back from their surfaces.

The delicate and much-prized round pearls which are sold for necklaces, and ornament our brooches and rings, are generally made by one particular species of oyster—not that a round pearl makes any part of an oyster's real house. Pearls are accidental things, formed by the slug, either to mend holes that sea worms have eaten into its shell, or else to cover up grits of sand or other substances that have fallen between the valves of the shell, and would hurt the soft body if they remained free. From this cause these beautiful ornaments have been termed the mollusc's "pearly tears." The great Swedish naturalist, Linnæus, was the first person who discovered that pearls are formed by the molluscs to cover substances that interfere with its comfort. To prove the truth of his observation, he drove into some oyster shells a few pieces of thin wire, and on opening these shells some time afterwards, he beheld his pieces of wire entirely covered with pearl. All molluscs that possess this beautiful lining to their shells are able to form pearls. A gentleman lately told me that he has a pearl in his possession that was taken out of the shell of a

periwinkle. So valued are these pure white pearls, that hundreds of men, in different parts of the world, gain their livelihood by diving for the oyster which most commonly contains them. Off the coast of Arabia Felix, the divers tie a stone to one foot and a basket to the other, and plunging under the water, remain on the oyster beds for about a minute and a half. Major Forbes once saw on that coast, thirty thousand pearl oysters brought out of the sea in one day. The high and deep banks of old shells ranged along the shore, shew that it is no new trade amongst the inhabitants. It is wonderful that this constant dredging does not destroy all the oysters in the place; but our Heavenly Father seems kindly to have provided against their extinction by giving the oyster the enormous power of increase to which I have alluded in another part of this letter.

To obtain money, men hunt for pearls with all their might, and dive for them at the peril of their lives. They spread their tents in long lines by the side of the great seas where they are found, and are ready to plunge in at any moment. Shall I tell you a secret the world does not know? Even that a tranquil ocean is close by each one of us. One that is filled with more costly pearls than ever were found in the Red Sea, the Adriatic Sea, or in any other waters on earth! This ocean is the *Bible*, and the oftener we plunge into it, and the deeper

we dive into its meaning, the richer are the pearls we bring up. The knowledge of Jesus and the promises of pardoning love given us in Him, are the pearls of great value that God has placed in this ocean of love. And as our hearts lay hold of them, they become a crown of light about our heads, which shall endure for ever! See the value Jesus sets upon this knowledge, in Matt. xiii. 45, 46.

I must now conclude, but in a few days you shall have a further account of shells from

Your affectionate friend, &c.

LETTER XXXV.

MOLLUSCA.

Growth of Shells, and modes by which they are fastened to hard substances.

My dear young Friends,

In continuing the history of the molluscous animals, let me remind you that shells are of different shapes and sizes—round and oval, spiral and flat, bulging and taper, long and short, wide and narrow; and that all, whatever be their shapes or sizes, grow at their edges.

A young mollusc, as I have said before, leaves the egg with a fine piece of shell upon its back. In the univalve* tribe, this small piece forms the top peak of the full-grown shell: at first this peak is

* Univalve means a shell of one piece.

extremely thin, but as the slug grows it is thickened by the mantle; so that the variety of shapes assumed by shells, depend very much upon the form which it has pleased our Creator to give to this tiny piece, which is made, as it were, the pattern to guide the mantle ever afterwards in its work. When the enlarged size of a slug's body compels it to add a new piece to its house, it drops the front part of its mantle out of the shell, and gives it, as it falls, a swing to the right or to the left, just as we might swing a loop of string, slightly casting the string on one side below the end of a stick. The mantle being always thrown forward in a slanting direction, causes the shell which exudes from it, to take a turn something like the spiral thread of a cork-screw; and that piece of the shell round which the mantle takes its drop, is called the columella or pillar.

The part of the mantle dropped below the pillar soon gives out its limy cement, and forms a new

Inside of the shell, showing its *pillar* and whorls.

piece of shell exactly the shape of the dropped mantle: and as soon as this new piece of shell becomes hard, the slug quits the top chamber in which it has been cramped, and comes down into its new and larger apartment. Addition after addition is made in this way, forming a variety of whorls, until the slug has grown to the full size its Maker intended it to reach; then the shell grows no more, but merely becomes thicker, because the mantle continues to throw off its limy cement. As the mollusc lives on, the form of the growing shell is often quite changed, as you may see by these sketches of a young and old cypræa.

Old Cypræa-Shell.

Young Cypræa-Shell.

During the growth of the mollusc, the mantle of the Cyprea has had a different turn given to it, so that the thin-shaped edge has become changed into a thick lip. The reason why some shells look more bulbous on one side than on the other, is probably, because those parts of the slug's body that lie nearest

to the heart, and to the largest blood-vessels, are the most vigorous, and enable the mantle to throw off the largest amount of its shelly cement.

The Cyprea with its mollusc alive, pushing out its mantle, and throwing a portion of it over the shell.

Many molluscs that live in the sea, close up their shells for security with a lid, which is made of either a horny or shelly cement. This lid exactly fits the opening of the case; it is sometimes fastened to the body of the slug, but at other times it is attached to the sides of the shell. Many land snails during winter make such a lid for the sake of warmth. Even in summer, if a snail be surrounded by lumps of ice, it will begin to seal up its shell by forming an operculum or lid. This operculum is made, by the snail, of a tough horny substance, like that which lies over the mouth of the periwinkle's shell.

Operculum or Lid.

You are aware that shells formed in two pieces are called bivalves. All molluscs which live in bivalve shells, such as oysters and mussels, have neither heads nor eyes; but each one

has a mouth, and in some instances, a bundle of muscles called a foot. Bivalve molluscs are the lowest forms of the shell tribes; they have less power of motion and defence than the univalve slug; Therefore their Creator has taught them, by different contrivances, to fasten themselves securely down, amidst the stormy waters in which they live. Oysters stick to mud, to sand-banks, and to one another; whilst mussels spin long tendinous glossy threads,* by means of which "they moor themselves to rocks and timbers." A mussel, shut up in her thin blue shells, is a very feeble being; but a company of mussels acting together are able to effect works which the arm of proud man could never achieve. In some places mussels cluster so thickly together, that they form banks in the sea; and when sand collects around their shells, the very ocean is kept at bay! The inhabitants of Biddeford in Devonshire, having observed the tenacity with which mussels hold to objects, determined to call in their aid to steady a long bridge of 24 arches, against which the tide rushes so strongly that no mortar can make the stones hold together. Not to trouble the mussels to roll so far, the Biddeford people sent boats to bring up their new fellow-workmen to the place where their assistance was required. Upon being placed by the side of the bridge, the mussels soon fastened their silken threads or beards to its

* A tendon is a tough animal cord, such as the sinews in a chicken's leg.

stone-work, and have ever since supported the bridge, and kept it from being carried away. Care is taken from time to time to bring up a new set of mussels; and a strict law is enforced, that no one in the place shall touch one of these creatures for his own private eating; the transgressor who disturbs so much as a single shell, being sent to prison.

The Pinna family forms another set of thread-making bivalves, which, according to their species, are very large or quite small. The largest pinna manufactures powerful silken threads, by which its long and delicate shell is fastened to sunken rocks, where, like a ship at anchor, it swings in perfect security amidst the buffeting waves. The pinna throws out these threads from a lump of muscles which is called its foot. In these muscles there is a soft piece of flesh, which holds a gummy fluid; this gummy fluid the pinna discharges at its pleasure, into a thread-like groove deeply cut into the muscular mass. As soon as this groove is filled with the sticky fluid, the creature lets the fleshy sides of the groove fall down, and thus a channel or pipe is formed, in which the fluid dries into a silken thread. The moment the pinna feels that its silken thread has become firm, it pushes its foot out of the shell, and resting it upon any piece of wood, or other hard material, fastens one end of the thread firmly down, keeping the other end tightly secured round a knob which grows upon its lumpy foot. The pinna next

lifts up the sides or valves which form the groove, (somewhat as we might open our lips) when the thread instantly springs out of the little bed in which it was made, and floats in the water. Finding its thread afloat, and yet fastened to the hard substance, the pinna next draws its foot back into the shell, and immediately gives itself a good swing round, to try whether the thread be firmly made; if it break, no time is lost in repairing it, but if it prove strong and tightly fastened, the pinna begins to form another tendinous thread in its foot; and thus the industrious creature works on day after day, making four or five threads in the course of twenty-four hours, till at length, a vast bunch is formed; always swinging the shell round each time that a new thread is attached to the rock, to prove its quality.

These pinna shells are much sought after on the coast of Italy, their threads being valued by the Italians, who work them, with other materials, into caps, stockings, and gloves.

The cockle is a bivalve shell, but this mollusc is not fast anchored to one place like the oyster, the mussel, and the pinna. The cockle has some power of motion. It leaps by quickly opening and snapping together the two lids of its shell; and it creeps by push-

Cardium, or Cockle, with its Foot.

ing forth a bundle of muscles, which is called its foot. These fibres of muscles are firmly woven together, so as to form a substance something like the human tongue. And with this muscular foot the cockle works for itself a shelter in the sea-sand.

The solen or razor-shell mollusc has a muscular foot, by which it can either travel along, or lift itself up upon the edges of its sharp shell. The delicate furrows which are often seen on the sandy shore, are generally the work of some mollusc allied to the cockle and the solen, and are made by the creatures dragging the edges of their shells through the sand. The foot of some of these shell molluscs has a kind of spongy substance in it; and when this is filled with water, it becomes very large.

Those who have frequently wandered on the sea-shore, must have observed the limpet, with its broad-based shell and pointed top, sticking tightly to rocks or stones. The limpet strongly adheres to these places by contracting or drawing up the muscles of its body; by which means it forms an empty space or sucker between its body and the broad end of its shell; the air then pressing upon the outside, causes the shell to stick so firmly to the rock, that it is almost impossible to move it without breaking it to pieces. The best way to remove it is gently to lift it up by placing the blade of a knife underneath its outer edge.

Mayo, when writing on shells, says of the limpet,

"Behold
The simple shell on yonder rock!
* * * *
At distance viewed, it seems to lie
On its rough bed so carelessly
That 'twould an infant's hand obey,
Stretch'd forth to seize it in its play;
But let that infant's hand draw near,
It shrinks with quick instinctive fear,
And clings so close as though the stone
It rests upon, and it, were one.
And should the strongest arm endeavour
The limpet from its rock to sever,
'Tis seen its loved support to clasp
With such tenacity of grasp,
We wonder that such strength should dwell
In such a small and simple shell.
And is not this a lesson worth
The study of the sons of earth?
Who need a rock so much as we?
Ah! who to such a Rock can flee?
A Rock to strengthen, comfort, aid,
To guard, to shelter, and to shade.
No Rock is like this Rock of ours.*
* * * *
Then wisely shun (temptation's) shock,
By clinging closely to your Rock."

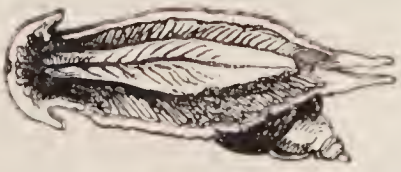
Have you ever noticed the small balani, or acorn shells, that frequently roughen the sides of the limpet? If you watch at low tide on the sea-shore, you will probably find attached to stones and to the largest limpets, a great number of these acorn shells. And if you gather up the stones or limpets with these acorn shells upon them, keep them dry for an hour, and then place them in a basin of sea-water,

* The Lord Jesus Christ.

you will be delighted with the graceful movements of the little thirsty balanus; for shortly after it feels the moisture of the water, it will open the sides of its shell, and send forth a head-dress resembling beautiful plumes. These plumes are the feathery tentacula of the small animal living within, and are sent forth to gather both food and air from the water, rising up and falling down with a graceful waving motion, to the great delight of the beholder.

Plume of the Balanus, or Acorn-shell Mollusc.

The greater number of molluscs inhabiting univalve shells, are not attached to one place, but slowly creep along the bottom of the sea, crawling like the land snail. Others move more rapidly, being aided by a broad space or disc of muscle, which is spread out on each side of the under part of the body. These feet-creeping molluscs are called the Gasteropoda Slugs; and as we remarked in page 251, many of these creatures have beautifully-coloured bodies.



Under side of a Gasteropoda Mollusc's Foot, called its Disc.

This letter being sufficiently long, I shall reserve the account of the Mollusc's Food for another time.

Affectionately yours, &c.

LETTER XXXVI.

MOLLUSCA.

Food of Molluscs.

My dear young Friends,

All living animals require food to satisfy the cravings of nature, as well as to supply materials for their growth. Man feels this need of nourishment as much as any other creature, and to him is granted a wide range of provisions; fish, flesh, fowl, and vegetables and fruits from all parts of the world, are the gifts upon which the lord of the creation may regale his appetite. Cattle, such as sheep and oxen, are given but little variety; they feed entirely upon vegetable food: beasts of prey, such as the lion and the wolf, live chiefly upon flesh: birds devour seeds, fruits, worms, and insects.

The molluscous tribes of animals that we are now studying, take as their food, either animalcules, vegetables, or the juices of flesh.

All the species of molluscs that are without heads, such as the oyster and mussel, which,

> "In their pearly-shells at ease—attend*
> Moist nourishment."

feed chiefly upon animalcules, which currents in the water pour into their partly-opened shells; the oyster, however, does not eat every thing that comes in its way; the lips of its mouth, (and its mouth is placed near the hinge of the shell) are surrounded by fringes, which act the part of sentinels, for they examine every thing before it is permitted to pass into the mouth. If the substance offered be good for food, the fringes accept it; but if bad, the cilia† which border their edges, are instantly put into violent action, and quickly whirl it out of the shell.

Molluscs that live in univalve shells — that is, in shells of one piece—feed upon vegetables and flesh. They have generally heads, eyes, feet, tentacula, and often a boring instrument with which they can penetrate hard substances. The inhabitants of shells which have round mouths, like the Trochus, mostly feed upon vegetables, and these vegetable feeders have horny

* By "attend," the poet Milton meant, wait for.

† Cilia are short hair-like threads.

jaws full of minute teeth. Land snails have round mouths to their shells; and we all know they are great devourers of leaves and fruits. The sea molluscs, whose shells have mouths of the same round form, feed upon a variety of weeds, which grow abundantly in deep waters, and on shallow shores. The glossy green-spreading leaf which covers so many rocks with its thin slippery skin, is a rich pasture for these round-mouthed molluscs; they feed also upon the tough fleshy leaf of the large brown sea-plant, that waves its enormous branches (sometimes thirty feet long,) far down below the passing billows. A great variety of the finer-stemmed red and brown sea-weeds, offer also wide tracts for joyous feeding to the round-mouthed molluscs.

Muddy-red Trochus—a round-mouthed shell.

Most of the univalve shells which have a notch or canal at the base of their openings, such as we see formed on one side of the British whelk or buccinum, contain flesh-eating molluscs. These flesh-eaters have an elastic tube of a mouth, made of a membranous* skin, which they can push out at their pleasure, and then draw back into their shells.

Membranous Tube or Mouth set with teeth at end of boring tube.

* A membranous skin is made of a fine net-work of tough fibres.

The length of this tube varies in different species or kinds, but in all it is armed with teeth like those of a file, and at its end lies a spiny tongue, or a tongue set with prickles. With this tongue some kinds of molluscs are able to rasp away at very hard substances, and so to work a hole into them. With this instrument they often bore holes into other shells, and some people have fancied that they can eject, or throw from their mouths, a strong acid to soften the shell they have begun to bore through. Some of these flesh-eating molluscs, like cannibals, attack with their tube or proboscis their own brethren, whenever they come in their way. As soon as these fierce spoilers have made a hole in the shell they attack, they either feed upon the flesh which they find within, or else they suck out the juices which it contains. It is in consequence of the frequency of these boring operations amongst the molluscs, that collectors find it so difficult to procure perfect specimens, notwithstanding the abundance of beautiful shells that are cast up on various seashores.

My next letter, after giving some account of floating shells, will bring the history of these interesting molluscous creatures to an end.

Believe me, truly, &c.

LETTER XXXVII.

MOLLUSCA.

Floating Shells.

My dear young Friends,

Before we take leave of our molluscous acquaintances, I have a few more particulars to give you of their history; and shall begin by introducing to your notice the *Floating Shells*.

Nearly all the creatures I have hitherto described, live at the bottom of the sea, crawling over its rocky and sandy beds; their mantles ever at work, are constantly making their shells thicker and thicker, and consequently heavier, as they increase in age.

But there is one kind of mollusc that prefers floating freely near the surface of the ocean, to

crawling in its deep recesses. This creature constructs a thin and delicate shell, but little burthened with weight to hinder it from rising in the water. Yet this thin and delicate shell is by no means deficient in strength; for the Workman who formed it had a plan of His own for making it strong as well as light. This plan I shall try to explain to you.

Nautilus.

The thin shell of this floating mollusc is called the nautilus. At the beginning of its life the young creature bears upon its back a small shelly covering, which is rather larger than itself. But as the mollusc grows from day to day, its house in a short time is not found large enough for its body. The mantle is then pushed forward, to make a new and larger chamber in front of the old one, which new piece is again formed of very thin and frail walls. As soon as the new walls grow compact and hard, the mollusc leaves his old inconvenient dwelling, and advancing into the wider space, settles himself comfortably in it. The back of his mantle soon forms a partition-wall of fine cement behind him, which wall runs across the shell from side to side, and shuts out the old chamber. As the animal grows, he adds in this way chamber after chamber; each one being of

larger dimensions than the last which he inhabited. In large and old shells these chambers form many twists or whorls, which are arranged round each

Nautilus shell divided, shewing the Chambers and the Siphuncle, with the Mollusc in front.

other like the folds of a coil of rope. The whole of the delicate shell is thus greatly strengthened by these inside partition-walls that have been raised at different times, and which, from their numbers, give it power to bear a heavy pressure without injury.

As the nautilus shell and its inhabitant are intended to float on the surface of the sea, it is necessary they should be, when joined together, a little lighter than the water around them, otherwise they could never rise from the bottom. And this lightness is afforded them by means of the air that is contained in the deserted chambers of the shell, all of which act as so many bladders in buoying it up. The buoyant power of these air cells is so great, that if

some contrivance were not adopted to give the mollusc the power of compressing the air in them—that is, at its pleasure of making the cells heavier, by filling them with more air—the shell would always float upon the surface, and could no more be kept down under the water than a cork or a log of wood can. In order, therefore, to give the creature the power of sinking when it wishes, all the chambers in the shell are connected together by means of a tube, which is called a *siphuncle.* This tube belongs to an air-chamber that lies within the body of the animal; and by means of this tube, the mollusc, at its pleasure, can drive an additional weight of air down into its shell, and make it heavier. As soon then as the creature desires to sink in the sea, it draws its fleshy body back with a powerful motion, into the front cavity or opening of its shell. This action presses the air in the cavity backward, and sends it down the siphuncle into the chambered spaces, making the air in them much closer and denser by the fresh supply. Thus we find, that the whole quantity of air contained in the body and shell of the mollusc, being now driven down and squeezed into the smaller space of its chambers, the shell is made heavier than it was, and immediately sinks in the water, as all heavy things do. Only think what a beautiful plan this is for making the nautilus sink. Merely frightening its inhabitant, instantly sends it down; for fright causes the mollusc

to shrink back into its house; and this shrinking back, at once squeezes in the buoyant air. Thus wonderfully are the instincts of the creature made to act in its defence. Our heavenly Father, who clothes the lily and upholds the sparrow, does not forget the nautilus that is tossing on the ocean wave.

Only one kind of these beautiful chambered shells now floats in our seas; but in times past and gone the ocean swarmed with creatures of this description. All the mud and sand that lay at the bottom of the olden seas, is now turned, as you have read in pages 261 and 262, into rocks; and in many of these rocks strange stones abound, which, from their coiled appearance, are called Ammonites, or Snake Stones. These snake stones are the remains of shells very similar to the nautilus; but from lying long in the earth, they are now petrified, and filled with stony matter. Yet traces of their shell may often be discovered; and when cut through the middle by a stone-cutter's wheel, the partition walls that were built across the inner cavities of the shell can easily be discerned. All the different chambers in the ammonite shell were connected with each other by an

Ammonite.

air-tube, that acted in the same way as the siphuncle of the nautilus; only the air-tube of the ammonite runs along the outer edge, instead of through the middle of the shell, and in consequence of this, the outer edge of all snake stones is grooved by the remains of the siphuncle.

The shell of the ammonite was thinner than the shell of the nautilus; in order, therefore, to meet this new danger of breakage, its frail walls were made on another plan, by which it was enabled to bear an equally heavy pressure without injury. The partition walls in the inside of the nautilus are smoothly curved across the shell, but in the ammonite these walls were made zigzag and wavy; and every new portion on the outside of the shell, that was added to its front, was dove-tailed in, or joined into the old piece, by means of jagged edges, so that the outside of an ammonite shell never looks even, but is always notched with ribs, which must have greatly increased its strength.

Jagged edges of the growing Shell of the Ammonite.

Ammonites swarmed in the waters of the old seas, and formed very numerous families. More than two hundred different kinds have been discovered

by naturalists. Their very numbers mark them as having been important creatures, and appointed at that time to perform some needful work. Most likely there were a great many crabs, molluscs, and fishes then living, that were inclined to multiply too fast for the good of the rest of the animal creation, just as insects would now, if there were no birds to eat them; and the business of this great crowd of ammonites was probably to feed upon their bodies, and to keep down their numbers. They appear to have been a most devouring set of creatures, and to have been well furnished for their work, for they had great horny beaks, something like a parrot's, by means of which they seized upon and tore to pieces the prey on which they were going to feed. The petrified beaks are often found lying in the rocks that contain the snake stones.

Besides the nautilus, there is occasionally seen in the present day, floating on the waves of the Mediterranean Sea, and also on some of our great oceans, another kind of beautiful shell. This shell is called the *Argonaut;* until very lately it was considered to be a kind of nautilus or ammonite, and from its extremely thin and fine structure has been called the *paper nautilus.* It is shaped something like a boat, and is covered all over with delicate ribs. The creature that makes this paper nautilus is a mass of flesh, with eight long arms branching out, all covered over with suckers; indeed, it greatly

Argonaut.

resembles the strange creature called the Octopus, which we have before examined amongst the naked molluscs in page 256; there is, however, this difference in its form, that two of the arms of the argonaut have broad flat ends, something like the flat part of a bricklayer's trowel. Naturalists have long wondered at the destined use of the singular boat-shell attached to this creature. It could not form a float of changing weight to rise or sink, as in the case of the nautilus, because it has neither partitioned chambers in its interior, nor has it any siphuncle tube. After trying in vain to discover its nature, it was settled that it must be a real boat, and the creature was described as sitting in it, turning six of its arms over the sides as oars, and hoisting the other two flat trowel-like arms as sails.

One of our poets, cleverly taking advantage of this fanciful description, has written the following lines upon the argonaut:

> "Light as a flake of foam upon the wind,
> Keel upward from the deep emerged a shell,
> Shaped like the moon ere half her horn is filled:
> Fraught with young life, it righted as it rose,
> And moved at will along the yielding water.
> The native pilot of this little bark
> Put out a tier of oars on either side,
> * * * *
> And mounted up, and glided down the billows,
> In happy freedom, pleased to feel the air,
> And wander in the luxury of light.

No doubt the argonaut has mounted up, and glided down the billows, and has been pleased to wander in the luxury of light; but this creature never put out a tier of oars in order to row itself along; neither does its shell glide on the surface of the wave, nor sail before the wind, for the argonaut really swims in the water in the same way as the naked mollusc, called the octopus, by waving its arms, and squirting out a jet of water from a tube with which its body is supplied for this very purpose. This jet of water being forcibly poured forth, re-acts upon the creature, and drives it on in the opposite direction with a strong rebound. Persevering attention is an excellent quality at all times, but in the study of natural history it is absolutely necessary; and by its use, naturalists have lately discovered that the argonaut possesses this peculiar formation

of the octopus; and also to their great delight, that its delicate shell is not a boat formed by the mollusc for idle pleasure, but that it is one actually made by the female for the careful protection of her eggs. Whilst the careless observer has hitherto been watching the argonaut with delight, supposing her at play, attentive observation has now discovered that she has always been occupied in a work of duty, protecting her beautiful shell, packed full of precious eggs, and has been brooding over them with the watchful and tender care that mothers only know. The flat trowel-shaped arms that stand up are the projections of the mantle which she uses in the construction of her boat; from their surface she first throws out the shell-making cement, and then uses them to smooth and mould it down to the shape she wants. Her other six arms she turns over the shell as she sits upon its opening, in order that she may safely keep her treasured eggs in their delicate yet strong enclosure. When alarmed, the argonaut dives like the octopus, carrying her boat with her under the water.

In my next letter I shall speak of the multivalve shells, and then conclude our letters on the three lowest divisions of animal life.

Believe me,

Yours affectionately, &c.

LETTER XXXVIII.

MOLLUSCA.

Multivalve Shells, and Conclusion.

My dear young Friends,

Besides the *bivalve* and *univalve* shells which I have already described, a few others are met with that are formed of many pieces. These are called the *multivalve* shells.* These shells are composed of several plates laid side by side, all of which are lined with a skin, that renders them slightly moveable upon each other, so that the shell can, at the pleasure of the animal, be rolled into a ball, as you may have observed is the case with the horny plates of the wood-louse. The molluscs that form multivalve shells, are of a similar nature with the limpet.

* The Chiton is a multivalve shell.

Each one sticks closely to the rock it is upon, drawing tightly down its many-banded shell, as a protecting shield over its soft body. When the shell is covered with water, the mollusc underneath loosens one of the edges, and pushes out from the opening a long slender tongue-like organ, with which it rasps off pieces of sea-weed that may grow around it. These fragments form its food. When the shell is left exposed to the air by the fall of the tide, the mollusc draws its shell close down to the rock, in order that the delicate gills, by which the creature breathes, may not be dried up and injured. The strength with which the shell is held down to the rock is altogether wonderful; it can scarcely be got off unless it be torn away suddenly: and many a rash crow has paid dear for thrusting its beak under the loosened edges of a multivalve shell. It has no sooner made this rude attack, hoping to enjoy the savoury morsel beneath, than the frightened mollusc, instantly snapping down the rim of its shell, holds the poor crow, much against its will, a fast prisoner, until the rising of the next tide makes him suffer for his rashness by the loss of his life.

We have now been strolling for some time over the surface of our globe, pausing first in one place, and then in another, to mark the habits and forms of different creatures in the three great tribes of animal life; known, by naturalists, under the names of the *Radiated*, the *Articulated*, and the

Molluscous divisions. Should our correspondence have awakened your desire to know more of the living works of creation, there are numerous books on Natural History for you to consult; and it will always give me pleasure to hear that your eye has been opened to observe, and your mind quickened to enjoy, with intelligent (or understanding) pleasure, the wonderful works of our God.

When we searched amongst the *Radiated* families, composed of animalcules, sponges, hydras, corals, sea anemones, jelly fishes, star fishes, sea urchins, and holothurias, we beheld astonishing exhibitions of contriving wisdom, and some beauty of forms.

Amongst the *Articulated* animals, we noticed with delight the singular structure of the crawling and burrowing worms. We marvelled at the agility and skill given to the lobsters and crabs, cased in their shelly armour. We admired the wily spider, as she wove her net; as she soared upon her silken streamers in the air; as she sprung from her secret nest in the earth; and not less so when she darted from her diving-bell, under the waters, to hunt, with rapid steps, her frightened prey. In all her adventures we were compelled to say, "the hand that made her is divine." As we admired the countless tribes of *Insects;* we traced their wondrous changes—first, out of the delicate egg; then through their voracious worm-like state; next in their death-like sleep of the chrysalis tomb; and lastly, we beheld them break

from their silken bands, and soar away, high and free, on active wing, in the beautiful bright air.

Finally, on the sea shore we have searched amongst the vast families of the *Molluscs*, or shell-fish tribes. And which most to admire amongst these hosts of creatures, I find it impossible to say. We have not found one creature imperfectly taught, each one being thoroughly accomplished in the mode of performing its work—we have not found one creature out of its place—not one lacking in all that it required for its use and comfort; but whilst breathing, eating, and working, these armies of living creatures have been echoing one harmonious song; even the full praises of *Him* that made *them!*

Had we been disposed to continue the study of natural history, our next step would have led us to the examination of the Vertebrated or back-boned division, consisting of fishes, reptiles, birds, beasts, and men; all of which animals possess more perfect bodies, and delicately-strung muscles and nerves, than the lower creatures we have been examining. With higher powers of body, back-boned animals also possess superior powers of intelligence. These gifts are but slightly bestowed upon the fishes and reptiles, but are rapidly advanced amongst birds and beasts, till we reach man, whose marked superiority over all other creatures makes him stand out in this world as the noblest work of God.

Granted an immortal spirit, and made after the likeness of his Creator, no words can express the importance of his never-dying soul. Our God, who knows all things, alike past, present, and future, has displayed the unutterable value He sets upon man, by sending His only-begotten Son into the world, in the likeness of sinful flesh, to die for sinners; that through Jesus He may be able to forgive us our sins, to renew our hearts in the love of holiness, and to receive us at last as heirs of glory in the world to come.

"O thou, my soul, forget no more
The Friend who all thy misery bore;
Let every idol be forgot,
But, O my soul, forget Him not.

Jesus for thee a body takes,
Thy guilt assumes, thy fetters breaks,
Discharging all thy dreadful debt:
And canst thou e'er such love forget?

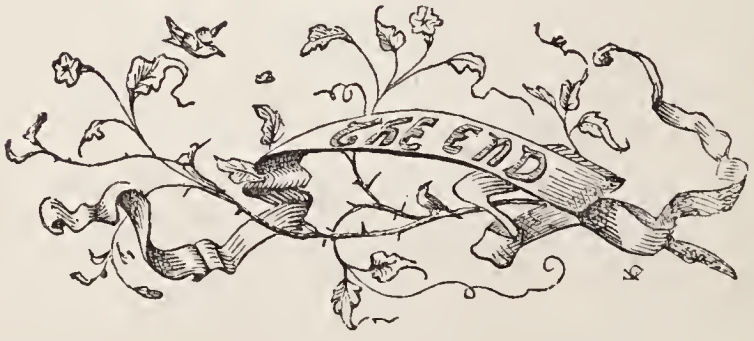
Ah! no, till life itself depart,
His name shall cheer and warm my heart,
And, lisping this, from earth I'll rise,
And join the chorus of the skies."

Adieu, my dear young friends; and may our God of love, whose wonderful works we have been examining, and "in whom we live and move and have our being," be pleased to grant us His own Spirit of grace, that we may understand our superiority over the creatures that are born to perish: remembering that our heavenly Father has not left us

in darkness, but in the Bible has given us a lamp to guide our footsteps to His heavenly land, where all the redeemed dwell in peace, joy, and light for evermore.

Our letters are now concluded: whilst using my pen, I have been your interested correspondent; and when I am silent, and my ink is dry, shall still continue

Your well-wishing and affectionate Friend.



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