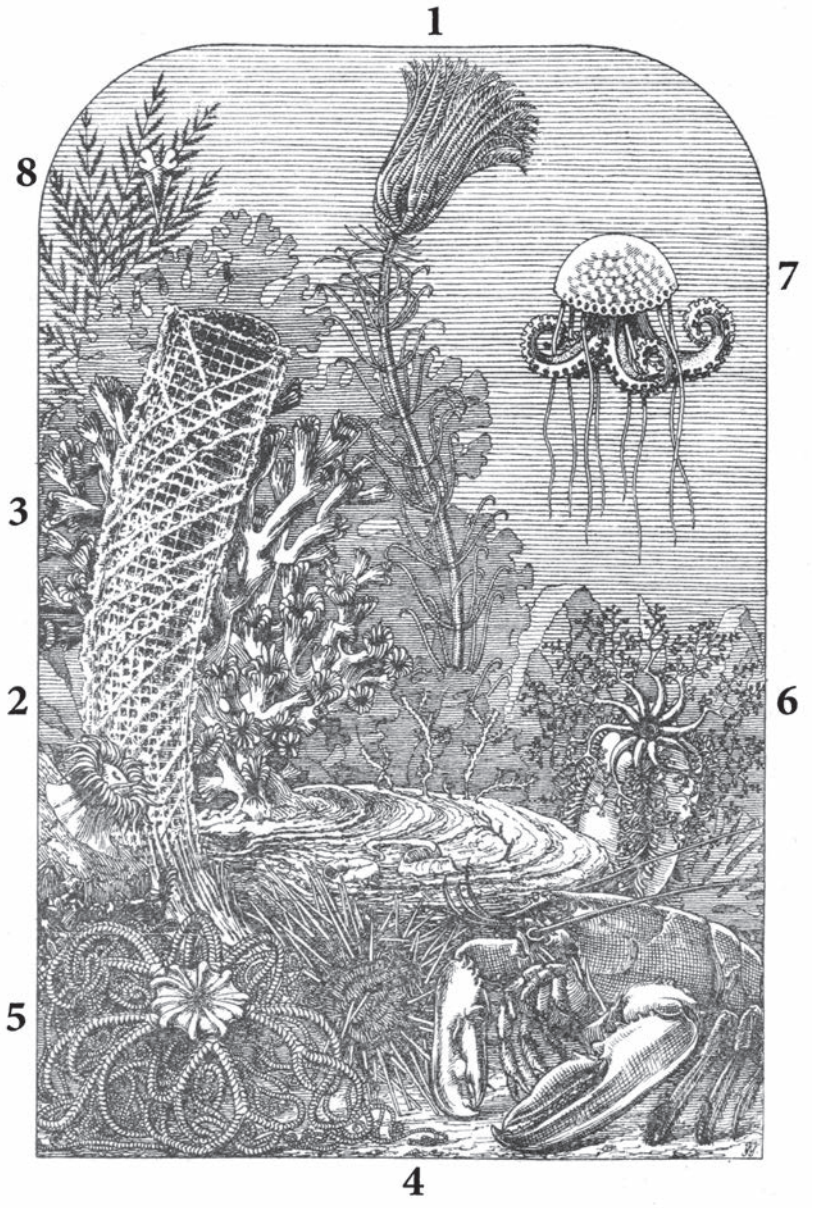
LIFE

AND HER CHILDREN



LIFE IN THE DEEP SEA

1. Sea-Lily, *Pentacrinus asteria*. 2. Sponge, *Euplectella aspergillum*. 3. Coral, *Lophohelia prolifera*. 4. Sea-Urchin, *Echinus elegans*. 5. Basket-fish, *Asterophyton linkii*. 6. Sea-cucumber, *Cladodactyla crocca*. 7. Jelly-fish, *Pelagia noctiluca*. 8. Pteropod, *Clio pyramidata*.

LIFE

AND HER CHILDREN

GLIMPSES OF ANIMAL LIFE

from the Amœba to the Insects

BY

ARABELLA B. BUCKLEY

WITH UPWARDS OF
ONE HUNDRED ILLUSTRATIONS

'He prayeth best who loveth best
All things both great and small;
For the dear God who loveth us,
He made and loveth all.'

—Coleridge

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'His parent hand,
From the mute shell-fish gasping on the shore,
To men, to angels, to celestial minds,
For ever leads the generations on
To higher scenes of being; while supplied
From day to day with his enlivening breath.
Inferior orders in succession rise
To fill the void beiow.'

AKENSIDE—*Pleasures of the Imagination*

PREFACE

The plan of this work is so fully explained in the Introductory Chapter that but little preface is needed. Its main object is to acquaint young people with the structure and habits of the lower forms of life; and to do this in a more systematic way than is usual in ordinary works on Natural History, and more simply than in text-books on Zoology.

For this reason I have adopted the title "Life and her Children," to express the family bond uniting all *living* things, as we use the term "Nature and her Works," to embrace all organic and inorganic phenomena; and I have been more careful to sketch in bold outline the leading features of each division, than to dwell upon the minor differences by which it is separated into groups.

I have made use of British examples in illustration wherever it was possible, and small specimens of most of the marine animals figured may be found upon our coasts at low tide.

In conclusion, I wish to express my great obligation to Mr. R. Garnett of the British Museum, for his most kind assistance in finding works of reference on the special subjects; and to many men of science, especially

Mr. Lowne, F.R.C.S., and Mr. Haddon, Demonstrator of Comparative Anatomy at Cambridge, for their valuable criticisms on the proof-sheets.

The Illustrations of the marine animals have been drawn by Dr. Wild, artist of the 'Challenger' Expedition, and those of the insects by Mr. Edwin Wilson, to both of whom my thanks are due for the care and assiduity with which they have carried out my instructions.

Arabella B. Buckley.

London, *November* 1880.

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LIFE AND HER CHILDREN

CHAPTER I

Wisdom and Spirit of the Universe!
Thou Soul, that art the Eternity of Thought!
And giv'st to forms and images a breath
And everlasting motion! — WORDSWORTH

I WONDER whether it ever occurs to most people to consider how brimful our world is of life, and what a different place it would be if no living thing had ever been upon it? From the time we are born till we die, there is scarcely a waking moment of our lives in which our eyes do not rest either upon some living thing, or upon things which have once been alive. Even in our rooms, the wood of our furniture and our doors could never have been without the action of life; the paper on our walls, the carpet on our floors, the clothes on our back, the cloth upon the table, are all made of materials which life has produced for us; nay, the very marble of our mantelpiece is the work of once living animals; and is composed of their broken shells. The air

we breathe is full of invisible germs of life; nor need we leave the town and go to the country in search of other living beings than man. There is scarcely a street or alley where, if it be neglected for a time, some blade of grass or struggling weed does not make its appearance, pushing its way through chinks in the pavement or the mortar in the wall; no spot from which we cannot see some insect creeping, or flying, or spinning its web, so long as the hand of man does not destroy it.

And when we go into the quiet country, leaving man and his works behind, how actively we find life employed! Covering every inch of the ground with tiny plants, rearing tall trees in the forest, filling the stagnant pools full of eager restless beings; anywhere, everywhere, life is at work. Look at the little water-beetles skimming on the surface of the shady wayside pool, watch the snails feeding on the muddy bank, notice the newts putting their heads above water to take breath, and then remember that, besides these and innumerable other animals visible to the naked eye, the fairy-shrimp and the water-flea, and other minute creatures, are probably darting across the pond, or floating lazily near its surface; while the very scum which is blown in ridges towards one corner of the pool is made up of microscopic animals and plants.

Then, as we pass over plain, and valley, and mountain, we find things creeping innumerable, both small and great; some hidden in the moss or the thick grass, rolled up in the leaves, boring into the stems and trunks of trees, eating their way underground or into even the strongest rock; while others, such as the lion,

the tiger, and the elephant, roaming over Africa and India, rule a world of their own where man counts for very little. Even in our own thickly peopled country rabbits multiply by thousands in their burrows, and come to frolic in the dusk of evening when all is still. The field-mice, land and water rats, squirrels, weasels, and badgers, have their houses above and below ground, while countless insects swarm everywhere, testifying to the abundance of life. Not content, moreover, with filling the water and covering the land, this same silent power peoples the atmosphere, where bats, butterflies, bees, and winged insects of all forms, shapes, and colours, fight their way through the ocean of air; while birds, large and small, sail among its invisible waves.

And when by and by we reach the sea, we find there masses of tangled seaweed, the plants of the salt water, while all along the shores myriads of living creatures are left by the receding tide. In the rocky pools we find active life busily at work. Thousands of acorn-shells, many of them scarcely larger than the head of a good-sized pin, cover the rocks and wave their delicate fringes in search of food. Small crabs scramble along, or swim across the pools, sand-skippers dart through the water, feeding on the delicate green seaweed, which in its turn is covered with minute shells not visible to the naked eye, and yet each containing a living being.

Wherever we go, living creatures are to be found, and even if we sail away over the deep silent ocean and seek what is in its depths, there again we find abundance of life, from the large fish and other monsters which glide noiselessly along, lords of the ocean, down to

the jelly-masses floating on the surface, and the banks of rocky coral built by jelly-animals in the midst of the dashing waves. There is no spot on the surface of the earth, in the depths of the ocean, or in the lower currents of the air, which is not filled with life whenever and wherever there is room. The one great law which all living beings obey is to "increase, multiply, and replenish the earth," and there has been no halting in this work from the day when first into our planet from the bosom of the great Creator was breathed the breath of life,—the invisible mother ever taking shape in her children.

No matter whether there is room for more living forms or not, still they are launched into the world. The little seed, which will be stifled by other plants before it can put forth its leaves, nevertheless thrusts its tiny root into the ground and tries to send a feeble shoot upwards. Thousands and millions of insects are born into the world every moment, which can never live because there is not food enough for all. If there were only one single plant in the whole world to-day, and it produced fifty seeds in a year and could multiply unchecked, its descendants would cover the whole globe in nine years.[1] But, since other plants prevent it from spreading, thousands and thousands of its seeds and young plants must be formed only to perish. In the same way one pair of birds having four young ones each year, would, if all their children and descendants lived and multiplied, produce *two thousand million* in

[1]Huxley.

fifteen years,[2] but since there is not room for them, all but a very few must die.

What can be the use of this terrible overcrowding in our little world? Why does this irresistible living breath go on so madly, urging one little being after another into existence? Would it not be better if only enough were born to have plenty of room and to live comfortably?

Wait a while before you decide, and think what every creature needs to keep it alive. Plants, it is true, can live on water and air, but animals cannot; and if there were not myriads of plants to spare in the world, there would not be enough for food. Then consider again how many animals live upon each other; if worms, snails, and insects, were not over-abundant, how would the birds live? upon what would lions, and tigers, and wolves feed if other animals were not plentiful; while, on the other hand, if a great number of larger animals did not die and decay, what would the flesh-feeding snails, and maggots, and other insects find to eat? And so we see that for this reason alone there is some excuse for the over-abundance of creatures which life thrusts into the world.

But there is something deeper than this to consider. If in a large school every boy had a prize at the end of the half-year, whether he had worked or not, do you think all the boys would work as hard as they do or learn as well? If every man had all he required, and could live comfortably, and bring up his children to

[2]Wallace.

enjoy life without working for it, do you think people would take such trouble to learn trades and professions, and to improve themselves so as to be more able than others? Would they work hard day and night to make new inventions, or discover new lands, and found fresh colonies, or be in any way so useful, or learn so much as they do now?

No, it is the struggle for life and the necessity for work which makes people invent, and plan, and improve themselves and things around them. And so it is also with plants and animals. Life has to educate all her children, and she does it by giving the prize of success, health, strength, and enjoyment to those who can best fight the battle of existence, and do their work best in the world.

Every plant and every animal which is born upon the earth has to get its own food and earn its own livelihood, and to protect itself from the attacks of others. Would the spider toil so industriously to spin her web if food came to her without any exertion on her part? Would the caddis worm have learnt to build a tube of sand and shells to protect its soft body, or the oyster to take lime from the sea-water to form a strong shell for its home, if they had no enemies to struggle against, and needed no protection? Would the bird have learnt to build her nest or the beaver his house if there was no need for their industry?

But as it is, since the whole world is teeming with life, and countless numbers of seeds and eggs and young beginnings of creatures are only waiting for the chance

to fill any vacant nook or corner, every living thing must learn to do its best and to find the place where it can succeed best and is least likely to be destroyed by others. And so it comes to pass that the whole planet is used to the best advantage, and life teaches her children to get all the good out of it that they can.

If the ocean and the rivers be full, then some must learn to live on the land, and so we have for example sea-snails and land-snails; and whereas the one kind can only breathe by gills in the water, the other breathes air by means of air-chambers, while between these are some marsh-snails of the tropics, which combine both, and can breathe in both water and air. We have large whales sailing as monarchs of the ocean, and walruses and seals fishing in its depths for their food, while all other animals of the mammalian class live on the land.

Then, again, while many creatures love the bright light, others take advantage of the dark corners where room is left for them to live. You can scarcely lift a stone by the seaside without finding some living thing under it, nor turn up a spadeful of earth without disturbing some little creature which is content to find its home and its food in the dark ground. Nay, many animals for whom there is no chance of life on the earth, in the water, or in the air, find a refuge in the bodies of other animals and feed on them.

But in order that all these creatures may live, each in its different way, they must have their own particular tools to work with, and weapons with which to defend themselves. Now all the tools and weapons of an animal

grow upon its body. It works and fights with its teeth, its claws, its tail, its sting, or its feelers; or it constructs cunning traps by means of material which it gives out from its own body, like the spider. It hides from its enemies by having a shape or colour like the rocks or the leaves, the grass or the water, which surround it. It provides for its young ones either by getting food for them, or by putting them, even before they come out of the egg, into places where their food is ready for them as soon as they are born.

So that the whole life of an animal depends upon the way in which its body is made; and it will lead quite a different existence according to the kind of tools with which life provides it, and the instincts which a long education has been teaching to its ancestors for ages past. It will have its own peculiar struggles, and difficulties, and successes, and enjoyments, according to the kind of bodily powers which it possesses, and the study of these helps us to understand its manner of existence.

And now, since we live in the world with all these numerous companions, which lead, many of them, such curious lives, trying like ourselves to make the best of their short time here, is it not worth while to learn something about them? May we not gain some useful hints by watching their contrivances, sympathising with their difficulties, and studying their history? And above all, shall we not have something more to love and to care for when we have made acquaintance with some of Life's other children besides ourselves?

The one great difficulty, however, in our way, is how to make acquaintance with such a vast multitude. Most of us have read anecdotes about one animal or another, but this does not give us any clue to the history of the whole animal world; and without some such clue, the few observations we can make for ourselves are very unsatisfactory. On the other hand, most people will confess that books on zoology, where accounts are given of the structure of different classes of animals, though very necessary, are rather dull, and do not seem to help us much towards understanding and loving these our fellow-creatures.

What we most want to learn is something of the *lives* of the different classes of animals, so that when we see some creature running away from us in the woods, or swimming in a pond, or darting through the air, or creeping on the ground, we may have an idea what its object is in life—how it is enjoying itself, what food it is seeking, or from what enemy it is flying.

And fortunately for us there is an order and arrangement in this immense multitude, and in the same way as we can read and understand the history of the different nations which form the great human family spread over the earth, and can enter into their feelings and their struggles though we cannot know all the people themselves; so with a little trouble we may learn to picture to ourselves the general life and habits of the different branches of the still greater family of Life; so as to be ready, by and by, to make personal acquaintance with any particular creature if he comes in our way.

This is what we propose to do in the following chapters, and we must first consider what are the chief divisions of our subject, and over what ground we have to travel. It is clear that both plants and animals are the children of Life, and indeed among the simplest living forms it is often difficult to say whether they are plants or animals.

But it is impossible for us to follow out the history of both these great branches or *Kingdoms,* as naturalists call them, so we must reluctantly turn our backs for the present upon the wonderful secrets of plant life, and give ourselves up in this work to the study of animals.

First we meet with those simple forms which manage so cleverly to live without any separate parts with which to do their work. Marvellous little beings these, which live, and move, and multiply in a way quite incomprehensible as yet to us. Next we pass on to the slightly higher forms of the *second* division of life, in which the members have some simple weapons of attack and defence. Here we come first upon the wonderful living sponge, building its numerous canals, which are swept by special scavengers; these form a sort of separate group, hovering between the *first* and *second* division, and from them we go on to the travelling jelly-fish, with their rudiments of eyes and ears, and their benumbing sting, and then to the sea-anemones with their lasso-cells, and to the wondrous coral-builders. Already we are beginning to find that the need of defence causes life to arm her children.

The *third* division is a small, yet most curious one, containing the star-fish with their countless sucker-feet,

the sea-urchins with their delicate sharp spines and curious teeth, and the sea-cucumbers with their power of throwing away the inside of their body and growing it afresh. This division goes off in one direction, while the next, or *fourth,* though starting with creatures almost as simple as the coral-builders, takes quite a different line, having for its members mussels and snails, cuttle-fish and oysters, and dividing into two curious groups: the one of the shell-fish with heads, and the other of those without any.

The *fifth* division, starting also in its own line by the side of the third and fourth, includes the creeping worms provided with quite a different set of weapons, and working in their own peculiar fashion, some living in the water, some on the earth, and some in the flesh of other beings, feeding upon their living tissues. An ugly division this, and yet when we come to study it we shall find it full of curious forms showing strange habits and ways.

The *sixth* division is a vast army in itself, with four chief groups all agreeing in their members having jointed feet, and subdivided into smaller groups almost without number. The first group, including the crabs and their companions, live in the water, and their weapons are so varied and numerous that it will be difficult for us even to gain some general idea of them. The other three groups, the centipedes, spiders, and six-legged insects, breathe only in the air. This sixth or jointed-legged division contains more than four-fifths of the whole of the living beings on our globe, and it forms a world of its own, full of interest and wonders.

In it we have all the strange facts of metamorphosis, the wondrous contrivances and constructions of insect-life, and at the head of it those clever societies of wasps, bees, and ants, with laws sometimes even nearer to perfection than those of man himself.

Lastly we come to the *seventh* and vast division of back-boned animals which will claim a separate volume to itself. This division has struggled side by side with the other six till it has won a position in many respects above them all. Nearly all the animals which we know best belong to it,—the fishes, toads, and newts (amphibia), the reptiles, the birds and the mammalia, including all our four-footed animals, as well as the whales, seals, monkeys, and man himself.

Under these seven divisions then are grouped the whole of the living animals as they are spread over the earth to fight the battle of life. Though in many places the battle is fierce, and each one must fight remorselessly for himself and his little ones, yet the struggle consists chiefly in all the members of the various brigades doing their work in life to the best of their power, so that all, while they live, may lead a healthy, active existence.

The little bird is fighting his battle when he builds his nest and seeks food for his mate and his little ones and though in doing this he must kill the worm, and may perhaps by and by fall a victim himself to the hungry hawk, yet the worm heeds nothing of its danger till its life comes to an end, and the bird trills his merry song after his breakfast and enjoys his life without thinking of perils to come.

"While ravening death of slaughter ne'er grows weary,
Life multiplies the immortal meal as fast.
All are devourers, all in turn devoured,
Yet every unit in the uncounted sum
Of victims has its share of bliss—its pang,
And but a pang of dissolution: each
Is happy till its moment comes, and then
Its first, last suffering, unforeseen, unfear'd,
Ends with one struggle pain and life for ever."

So life sends her children forth, and it remains for us to learn something of their history. If we could but know it all, and the thousands of different ways in which the beings around us struggle and live, we should be overwhelmed with wonder. Even as it is we may perhaps hope to gain such a glimpse of the labours of this great multitude as may lead us to wish to fight our own battle bravely, and to work, and strive, and bear patiently, if only that we may be worthy to stand at the head of the vast family of Life's children.

CHAPTER II

LIFE'S SIMPLEST CHILDREN: HOW THEY LIVE, AND MOVE, AND BUILD

"The very meanest things are made supreme
With innate ecstasy. No grain of sand
But moves a bright and million-peopled land,
And hath its Edens and its Eves, I deem.
For love, though blind himself, a curious eye
Hath lent me, to behold the heart of things,
And touched mine ear with power. Thus, far or nigh,
Minute or mighty, fixed or free with wings,
Delight, from many a nameless covert sly,
Peeps sparkling, and in tones familiar sings."

LAMAN BLANCHARD

HO are Life's simplest children, and where are they to be found? Let us try to answer the second question first, and rubbing the scales from off our eyes, peer into the hidden secrets of nature; and when we have tracked to their home the tiny beginnings of life, we will examine them and try to understand how they live.

How calm, and lovely, and still the sea looks on a warm, sunny, breezeless day of summer, and how happy we can imagine the myriads of creatures to be that float in its waters! We know many of them well, especially those which come close up to the shore. The small fry of the fish, the shrimp and the sand-hopper, the large jelly-fish, and the tiny transparent jelly-bells (see 3′, Figure 22), only to be seen by the keenest eye, as we dip out the water carefully in a glass. Surely these minute jelly-bells with their invisible hanging threads must be some of the simplest and lowest forms of life. Not so, they are really very high up in the world compared with the forms we are seeking.

If, indeed, we come out late some autumn evening when, after the sun has set and the sky is dark, the sea in some sheltered bay appears all covered with a sheet of light, we may see some of the beings of the lowest order of life with the naked eye; for when we dip the liquid fire out in a glass vessel and examine it, we find in it hundreds and thousands of tiny bags of slime giving out the bright specks of light, and these little Noctilucæ, or night-glows (2, Figure 3), are, as we shall presently see, some of Life's simplest children, although not by any means the most simple of the order.

No; to begin at the very beginning and find the first known attempts at a living being, we must search long and carefully, not merely with our own eyes, but with the microscope. Then we may perhaps be fortunate enough to discover some wondrously small creature like that on page 17, which Professor Haeckel took out of the sunny blue waters of the Mediterranean, near Nice, in

1864. The largest specimen to be found will be smaller than the smallest pin's head, yet when seen under the microscope, this tiny speck appears with outstretched threads, a living animal (see *a,* Figure 1), floating in search of food. Examine it how we will, we can find in it no mouth, no stomach, no muscles, no nerves, no parts of any kind. It looks merely like a minute drop of gum with fine grains in it, floating in the water, sometimes with its fine threads outstretched, sometimes as a mere drop; and if we take it out and analyse the matter of which it is made, we find that is much the same as a speck of white-of-egg. Is it possible that it can be alive? How can we be sure? In the first place it breathes. If it be kept in a drop of water, it uses up the oxygen in it, and makes the water bad, by breathing into it carbonic acid; then it moves, and, as we shall see presently, can draw in and throw out its fine threads when and where it chooses; again it eats, feeding on the minute jelly-plants in the water, or even on animals higher in the world than itself; and lastly, it grows and increases, for when it is too large to be comfortable it splits in two, and each half goes its way as a living animal.

Let us see how one behaved which Professor Haeckel took out of the sea and kept in a watch-glass under a microscope. When he first looked at it he found that it was drawn up in a lump with a minute animal and a plant-cell in the middle of its slime, and close by it in the water lay a small living animal called a Ceratium (*c,* Figure 1), which has a hard case or shell. After a while, as he watched, he saw the thread-slime put out its fine threads on all sides (*a,* Figure 1). Soon

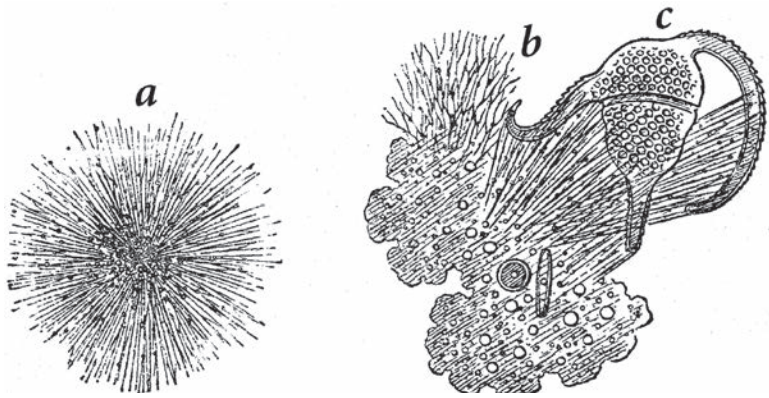


FIGURE 1

The Thread-slime (Protogenes)—Haeckel

a, in its natural round shape, immensely magnified; *b,* spreading itself over a small animal; *c* (*Ceratium*), to suck the soft body out of the shell.

the threads on the right side touched the shell of the Ceratium. Here was food, and the body of the *Thread-slime* evidently became aware of it at once, for all the little grains in the slime began to course to and fro, and the threads touching the Ceratium lengthened out and stretched more and more over it, while all those on the other side which had not found any food were drawn in, (*b,* Figure 1). Six hours later when Dr. Haeckel looked again, to his astonishment the thread-slime had disappeared, but on examining more closely he discovered it completely spread in patches over the shell of the Ceratium. It had drawn its whole body after the pioneering threads and wrapped itself round its prey. Next morning when he looked again, lo! it was back in its original place, and by its side lay the Ceratium shell

quite empty, together with the skeletons of the other two forms which had been inside the Thread-slime!

This little drop of slime without eyes or ears or parts of any kind, knew how to find its food; without muscles or limbs it was able to creep over it; without a mouth it could suck out its living body; without a stomach it could digest the food in the midst of its own slime, and throw out the hard parts which it did not want.

This is the history of one of Life's simplest children.

Here is another (Figure 2), which lives not only in the sea but also in pools and puddles, and in the gutters of our streets and of our house-tops. Anywhere that water lies stagnant these little drops of slime will grow up and make it their home. Sometimes few and far between, sometimes in crowds, so that the whole pond would seem alive if we could see them, they live, and multiply, and die under our very feet. Can anything be less like an animal than this shapeless mass (*a,* Figure 2)? Yet under a strong microscope it may be seen moving lazily along by putting out a thick slimy finger and then letting all the rest of its body flow after it. When it touches food it flows over it just as the Thread-slime did, and dissolving the soft parts sends out the hard refuse anywhere, it

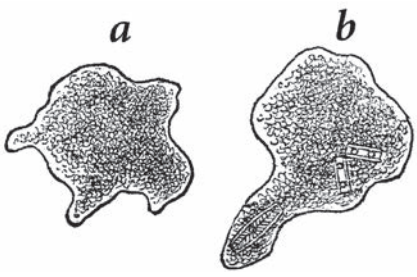


FIGURE 2

The Finger Slime (Protamœba)—Haeckel

a, at rest.
b, feeding on minute slime-plants.

does not matter where, for it has no skin over its body, being merely one general mass of slime.

And now, before we go on to other forms, let me ask you to pause and think what these little slime-specks tell us about the wonderful powers of Life. Can you guess at all how these creatures do their work? *We* are obliged to have eyes to see our food, nerves and muscles to enable us to feel and grasp it, mouths to eat it, stomachs which secrete a juice in order to dissolve it, and a special pump, the heart, to drive it into the different parts of our body. But in these tiny slime-animals life has nothing better to work with than a mere drop of living matter, which is all alike throughout, so that if you broke it into twenty pieces every piece would be as much a living being as the whole drop. And yet by means of the wonderful gift of life, this slime-drop lives, and breathes, and eats, and increases, shrinks away if you touch it, feels for its food, and moves from place to place, changing its shape to form limbs and feeling-threads, which are lost again as soon as it no longer needs them.

Nor have we yet learnt one-half of the marvels which can be wrought in living specks of slime. For, on further inquiry, we find these simple forms developing two quite different modes of life. In the one case the slime is moulded itself into delicate forms, making creatures with mouths, with suckers, and with delicate lashes to drive the body through the water; while in the other case, remaining a simple drop with delicate threads, it has learned to build a solid covering of the most exquisite delicacy.

To the first class belongs our little Noctiluca, and the forms drawn by its side in Figure 3. To the second belong the microscopic shells (Figure 4) which form our chalk. Look at the little wriggling creatures at 1, Figure 3, small as they look here, they are drawn many thousand times larger than they really are in life, and yet they are much more perfectly formed than either the thread-slime or the finger-slime. They have actually a kind of skin, and do not throw out threads here and there, but are provided with a little whip of slime, which they lash to and fro, and so drive themselves through the water. These microscopic forms called *monads* grow

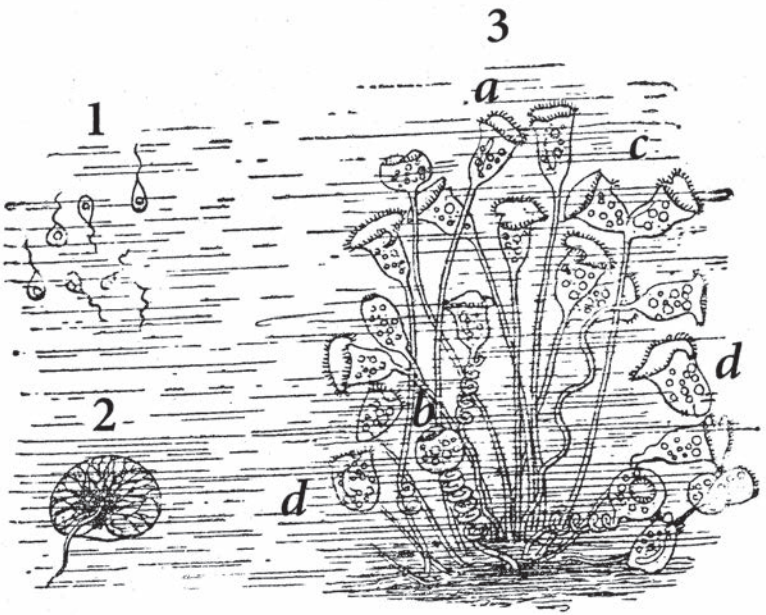


FIGURE 3

Infusoria, all immensely magnified

1, A group of monads *(Monas).*
2, The Night-glow *(Noctiluca).*
3, Bell-flower *(Vorticella).*

up in water in which flowers have stood for many days till their stalks begin to decay, and in *infusions* of hay or straw, made by pouring hot water upon them and letting it stand and for this reason the little beings are called *infusoria*. In such impure water, under a powerful microscope you may see them darting along by thousands. But the whip does not only serve them as an oar, it also sends the food they meet with into a tiny opening, one of life's first attempts at a mouth. With a little jerk, when the creature is still or fixed to the bottom, the whip drives still smaller beings than the monad itself into its wide-opened cavity, and there they are digested in a little watery bubble, which may be clearly seen in its body. The Noctiluca or *night-glow* (2, Figure 3) is much larger, being often as large as the head of a small pin, and just below the outer rim of its slimy bag the sparks of light are given out. It has been reckoned that there are as many as 30,000 Noctilucæ in one cubic inch of phosphorescent water, and it is almost impossible to grasp the idea of the millions upon millions of these tiny forms which must be floating over a sea which is giving out a glow of liquid fire for miles and miles. And it is only because of this light that we realise that they are there. There are just as many other forms in the water on every side of us, while we dream nothing of this teeming life in the midst of which we live.

We cannot stop here to speak of the *tube-sucker (Acineta)* and all his relations, which have a mouth at the end of every tube; nor of the beautiful little *bell-flower (Vorticella nebullifera)* which may be seen in any

pond or in sea-water, with its hanging bells whirling the food in by their little fringe of hairs (*a,* Figure 3); or shutting up with the food inside, and starting back by curling up their slender stem *(b);* or splitting in two *(c)* and sending off buds *(d, d),* which swim away to form new colonies elsewhere. All these wondrous little beings are some of life's simplest children, and one and all are made of nothing but slime, while yet they live, and move, and seek their daily food.

But all these are naked and homeless, and to a great extent unprotected. Gulped down in thousands and millions by each other, and by other animals, they are defenceless and weak against attacks. It would certainly be better for them if they could have solid shells to cover their soft bodies, and to protect them in many dangers. And so we find that even in this lowest stage of life necessity is the "mother of invention"; and drops of slime, no higher than the thread-slime (Figure 1), have learned to build shells around their delicate bodies.

These shell-builders live chiefly in the sea, and there you may find them if you search carefully by the help of a strong magnifying glass in the ooze of oyster-beds, or under the leaves of the delicate green seaweed, or in the muddy sand of the sea-shore. The most common forms will be those shown at *a, e, f,* and *g* in Figure 4; and, though they are so very small, you may if you are fortunate see them clinging by their fine slime-threads to the weeds or the mud.

These animals are, as I have said, simple slime-drops like the *thread-slime,* but they add to the list of

wonderful things that such slime can do, for they take out of the sea-water, particle by particle, the lime which is dissolved in it, and build around their soft bodies the solid shell or skeleton in which they live. Nor is this all; even if they all built the same simple shell, it would be very puzzling to imagine how they do it, but they do much more. They build shells in many different shapes, often with the most beautiful and complicated patterns upon them. All but the simplest shells have several chambers in them, a new one being added as soon as the animal outgrows the last one; and in the partition between each chamber there is a minute hole through which a thin thread of slime passes into the next chamber, so that the whole body is joined together throughout the shell. On account of these holes these lime-builders have been called *Foraminifera* from *foramen* a hole, *fero* I bear.[3]

Let us now take one of these shells (*a,* Figure 4), and see how it was built up. The grown animal as he looks when the shell is taken off him is shown in Figure 5. In the beginning, when he is quite young, he is merely a round drop (1, Figure 5) with a delicate transparent shell and an opening, out of which he puts his threads of slime. Then as he outgrows this first chamber he draws his slime threads together and forms a bud (2) outside the shell, and round this bud he builds a second chamber out of the end of which he again puts his threads. Then he forms the next bud (3), and goes on

[3]This name is now often defined as meaning that the outside of the shell is perforated with holes, but the earlier use of the word as given here is more correct, because it applies equally to the perforated and non-perforated *Foraminifera*.

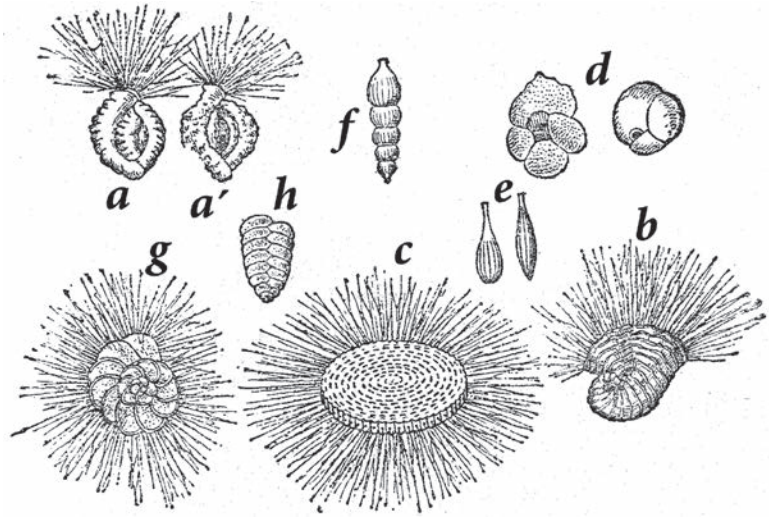


FIGURE 4

a, Miliolite, with a shell of lime.
a′, The same, with a shell of sand.
b, Peneropolis.
c, Orbitolite.
In these shells the animals feed only from the edge of the shell.
d, Globigerina.
e, Lagena.
f, Nodosarina.
g, Rotalia.
h, Textularia.
These shells are full of holes, out of which the animal puts threads to feed.

thus till he has built a complete shell, generally of seven chambers; and as each new compartment is so placed as to overlap the one before it, the whole when finished has the curious form a, Figure 4, altogether not larger than a millet-seed, from which it takes the name of *Miliola.* These miliolite shells may be found by the help of the microscope in the damp sand of almost any sea-shore, and while some of the shells will be empty, others will still be filled with the dark-yellow animal slime.

Think of the constant manufacture of such delicate shells as these going on all over the world, and the makers but a drop of slime! And lest you should be inclined to think little of it as a mere mechanical process, the miliolite himself tells us another story, for from time to time we find miliolites with shells made,—not of lime,—but of grains of sand and tiny broken pieces of shell (*a´*, Figure 4), which the little architect has used to build the walls of his house, when for some reason the ordinary material was deficient. It seems to me that the power of this living drop to choose its own materials is one of the most wonderful facts in the history of life's simplest children.

These miliolites and other Foraminifera when found clinging to sea-weed are easily placed in a saltwater aquarium, and they will then thrust their threads out of the mouth of the shell and crawl on the sides of the glass. Professor Schultze even saw a number of young miliolites born in an aquarium, and this was how it happened. He noticed one day that several of his miliolites had covered the *outside* of their shells with their brown slimy body, and a few days later he could see through the microscope a number of dark-looking specks gradually loosening themselves from this slime.

There were as many as forty of these specks on one shell, and after a time he could distinguish that every speck was a tiny miliolite, having only one chamber (1, Figure 5) to begin life in, the shell of which was so pale and transparent that he could see the slime within it. As soon as each one shook himself free from the rest of the slime, he put out his threads and crawled away on

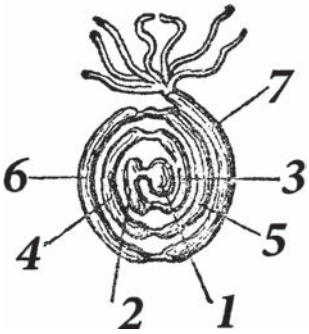


FIGURE 5

The jelly body of the Miliolite, *a,* Figure 4, showing the buds of slime, 1, 2, 3, etc., round which each chamber is built.—*Carpenter.*

the glass to get his own living; and now when Professor Schultze examined the shell of the parent miliolite, he found it almost empty. The mother had broken herself up into her little children!

A miliolite builds generally only six or seven chambers, but other forms, such as *c,* Figure 4, build hundreds of separate apartments. This particular form *c,* which is called an Orbitolite, has often as many as fifteen rings, each with its numerous chambers, even when the whole shell is only as large as the head of a small pin; and in ages long gone by, the larger Orbitolites had a far greater number of rings and thousands of chambers in one single shell. The animal builds these in the same way as we have seen the Miliolite do it, only after he has made one round of chambers with a hole in each, he puts out slime-threads at every hole and joins them into a ring with swellings in it, like beads upon a string, and round these he builds the next row of chambers. So he goes on increasing his home till he reaches his full size, and then Professor Parker tells us that the slime of the outer row often breaks up into myriads of young Orbitolites just as the body of the Miliolite did. At the same time these forms can also multiply by merely

breaking in half as the naked Finger-slime does, and if by accident a piece of an Orbitolite is broken off it can form a new and complete shell of its own.

If you have now understood how the Orbitolite grows, you will see that the only communication it has with the outer world is through the minute threads which stretch out of the holes of the chambers in the *last* ring (see *c,* Figure 4), and that the slime in all the middle chambers can get food in no other way than by its passing from the outside right through all the other rings. This is a tedious way of getting food, and we shall find that some of the forms shown in Figure 4 have escaped from it in a most ingenious way. These forms (*d* to *h,* Figure 4) have hit upon the plan of keeping their thin threads stretched out like the thread-slime (*a,* Figure 1) all the time they are laying down their lime house. The consequence of this is that wherever a thread has been, there a minute hole like a pin-prick is left in the shell, and while the animal can draw itself quite in out of danger, it can also come out all over the shell and take in food. Here, then, we have another stratagem taught by life to these her infant children. The slime which builds the Globigerina *(d)* or the Rotalia *(g)* is exactly the same as far as we can see as the slime which builds the Miliolite, and yet those drops of slime have learnt a new lesson, and each one as it is born stretches out its fine threads before constructing its shell, thus providing a thousand openings for the entrance of its food in a house not bigger than a grain of sand!

And now it only remains for us to ask how long these wondrous lime-builders have been upon the earth.

FIGURE 6

A Nummulite with half the shell broken open, showing the chambers. Life size.

We ask, and ask in vain, for we have no means of counting the vast ages during which they have lived and built. One of the largest and most complicated forms called the *Nummulite* (from *nummus* a coin, which it resembles), lived and died in such millions before the Alps or the Carpathians had any existence, that whole beds of limestone thousands of feet thick and stretching over hundreds of miles are made entirely of its shells; while the little Globigerina (*d,* Figure 4) and its friends were living and multiplying in still more dim and distant periods till their shells accumulated into vast beds of chalk.

When the ancient Egyptians raised the pyramids of Egypt, they little dreamed that every inch of the stone they used was made of the shelly palaces of the Nummulite, constructed by little drops of slime with a skill and ingenuity far surpassing their own. As little do most Parisians think now that the limestone of which their houses are built is almost entirely made up of Orbitolite shells. And still less does the country boy as he strolls over the chalk downs of Sussex or Hampshire suspect that the chalk under his feet is largely composed of shells of the Globigerina and the other minute forms shown in Figure 4; yet so it is. These minute slime-builders have been patiently living and building for untold ages, and are doing so still, at the bottom of

the Atlantic, where the Globigerina lives in such great numbers that the falling of the shells through the water down to the bottom must be like a constant shower of snow, as is proved by the freshness of those brought up in the dredge.

When a little of the chalky mud was taken up from the bottom at the time when the Atlantic telegraph was laid down, it was found to be almost entirely composed of Globigerina shells, and this led naturalists, who had long known that chalk was formed of shelly matter, to rub down some ordinary chalk and examine it under the microscope, and there again was our little Globigerina, often crushed and worn, but still plainly recognisable. So that, astounding as it may seem, it is nevertheless true that the vast beds of chalk stretching from Ireland to the Crimea, from Sweden to Bordeaux, are in great part formed of the dead shells of these little drops of slime.

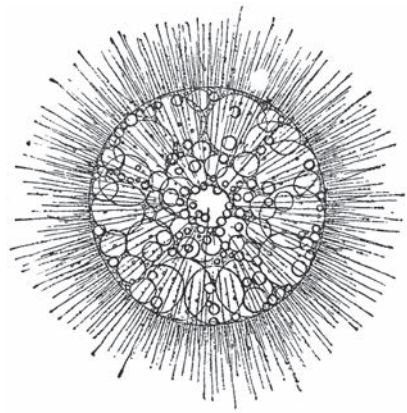


FIGURE 7

The Sun-Slime (Physematium)—Haeckel

Immensely magnified, its real size being not larger than a mustard seed.

We have paused so long over the lime-builders that we can only glance at those minute specks of slime which build their skeletons of flint instead of lime. These animals are a little higher in the world than the lime-builders, for their body has within

it a small bag or capsule, buried in the middle of the slime (see Figure 7), and in this bag the solid grains lie very thickly, and have sometimes small crystals among them, while in the slime round it there are often little oil-globules floating. If you dip a glass into the quiet bays of Nice or Messina you may be fortunate enough to bring up one or more of these little sun-slimes, but they are so tiny and transparent that even when the light falls upon them you will only distinguish them as bright specks in the water. Their threads stick out stiff and straight, and for this reason they are all classed under the name *Radiolaria*, or ray-like animals.

Let us look for a moment at Figure 8, and study the solid skeletons which these Radiolaria build with the flint (or silex) which they find in minute quantities in the water. We saw that the lime-builders construct shells into which they can draw back entirely if they are attacked, but the flint-builders seem very careless in this respect, for they have large holes all over their flinty skeletons. But then, on the other hand, notice how they send out sharp spikes, which must be uncomfortable for any animal trying to snap at them, although as we have seen (p. 16) the soft thread-slime manages to suck their bodies out of the shells. Still these hard spiky outside skeletons must be a great protection to them, and we find every kind of shape devised by these wonderful architects in the construction of their tiny houses, though these are so small as to look like a grain of sand when seen by the naked eye. Perhaps the most wonderful of all is the one shown at *f,* Figure 8. It is broken open to show the three balls one within another,

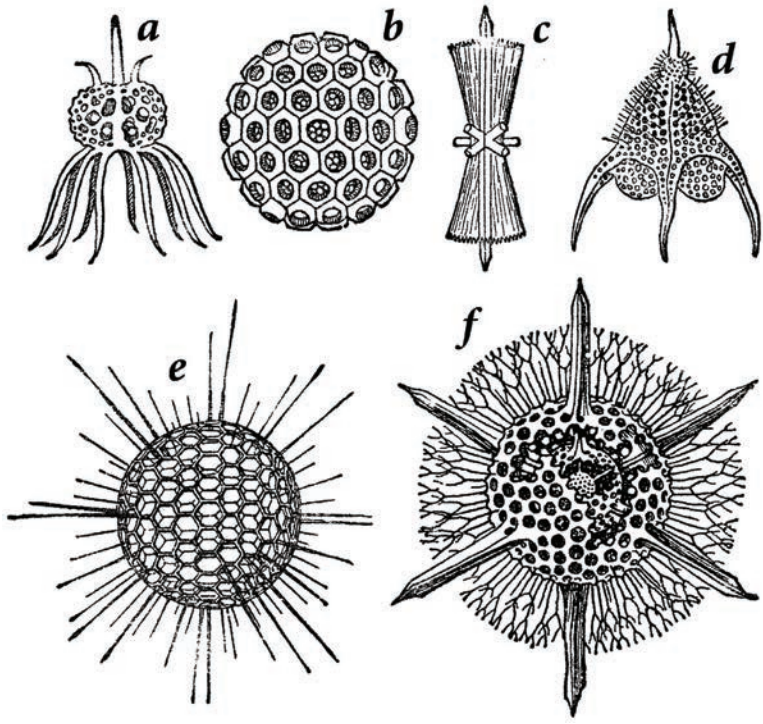


FIGURE 8

Flint Shells built by slime animals

(Radiolariæ or Polycistinæ)

a, Petalospyris; *b,* Ethmosphæra; *c,* Diploconus; *d,* Dictyopodium; *e,* Heliosphæra; *f,* Actinonima.

Immensely magnified: the real sizes are from a mere speck to that of one of these letters.

each kept in its place by rods of flint passing through the whole. This beautiful little shell looks just like the carved balls of the Chinese, yet, instead of being the work of intelligent man, it is built by a mere mass of slime.

We have now learned to know the simplest of all animals; how they live, and move, and the homes they build. All the forms are not quite equally simple, for some of the higher ones have a solid spot or *nucleus* in the middle of the slime, and sometimes a small watery bubble, as in the Monad or the Bell-flower, which contracts and expands at intervals: and in these forms the outside of the slime is rather thicker than the inside, so that we might say that they are on the road to having a skin, while the shell-builders have a uniform slimy body. But both classes alike belong to that first and lowest branch of the children of life, called by scientific men the *Protozoa* (*protos* first, *zoon* animal) or first animals. The still water everywhere is swarming with them, though we may see and know nothing of them. Yet we owe them something; for not only do the dead shells of many of them form our solid ground, but those now living purify our waters by feeding upon the living and dead matter in them. These tiny slime animals are the invisible scavengers of the ocean and the pools, and in earning their own living they also work for others. When you look upon a still pond in some quiet country lane, the insects you see swimming about in it, and the plants which cover it, are not the only inhabitants, but on its surface and in its silent depths minute specks of slime are living and working though no eye can see them. Beautiful and wonderful, however, as these forms are, they are yet very low in the scale of life; they live and increase in multitudes, but in multitudes also they die and are devoured. Delicate, and frail, and helpless, they are, as it were, but first attempts at the results which

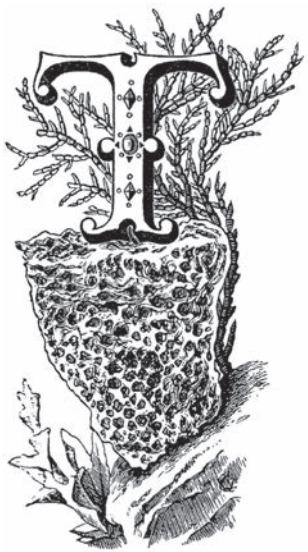
life can accomplish. Let us pass on and see the next step towards higher and, in many ways, more ambitious creatures.

CHAPTER III

HOW SPONGES LIVE

And here were coral bowers,
And grots of madrepores,
And banks of sponge, as soft and fair to eye
As e'er was mossy bed,
Whereon the wood-nymphs lie,
With languid limbs in summer's sultry hours.

SOUTHEY



THERE are certainly very few people, from the little child in the nursery to the artist in his studio, or from the lady in her bedroom to the groom in the stables, who do not handle a sponge almost every day of their lives; and yet, probably, not one in a hundred of these people has ever really looked at the sponge he or she is using, or considered what a curious and beautiful thing it is.

Yet there are at least two things in even the commonest sponges which ought at once to attract attention.

If you take a piece of ordinary honey-comb sponge in your hand and look at it, you cannot help being struck by the large holes, few and far between, upon its surface, and the numberless small holes scattered about between them; and on looking carefully down one of the large holes, you will see that it leads to a long tube, into which a number of small tubes open; while, on the other hand, if you try to follow out any of the smaller holes in the same way, you will find that they soon come to an end, and branch out sideways into each other, so as to form an irregular network of short tubes. Lastly, if you cut the sponge open and follow out this network, you will discover that it always ends by leading, sooner or later, into one of the large tubes. What is the reason of this complicated arrangement of holes, all opening into each other, and by whom has it been planned and carried out?

FIGURE 9

A thin fragment of a bath-sponge seen under the microscope.

Again, an examination of the material of the sponge will show that it is not a mere structureless mass, but is made up of delicate silk-fibres, woven together into a kind of fine fluffy gauze. By putting a thin slice of the sponge under a microscope, it is possible to distinguish this gossamer tissue very clearly, and to see that it is quite loosely woven; and that it is only because the texture is so fine, and the layers fit so closely one above the other, that, when looked at from above, it appears a solid substance. There is scarcely a more curious object

under the microscope than a thin slice of fine sponge, though it is almost impossible in a picture to show its curious nest-like appearance. How has this web been woven so delicately? What architect has laid the fibres so skilfully, and formed such a wonderful and intricate structure?

The architect is one of Life's children, whose history we must next consider; for though the sponge was long thought to be a plant, we now know that it is the skeleton or framework of a slime-animal, a little higher than those spoken of in the last chapter. When the sponge which you hold in your hand was alive, growing on the rocks in the warm deep waters of the Grecian Archipelago or the Red Sea, it did not consist merely of the soft fibre you now see, but was covered all over the outside and lined throughout, even along the smallest of its tubes, with a film of slime. This slime, though it appears to be all one mass with specks of solid matter here and there, is really made up of Amœbæ or finger-slime beings (see Figure 2), and if any little piece is torn off it floats in the water and puts out fingers, exactly as the Amœba does. Nevertheless, in the sponge all these separate cells are not independent creatures, but form the flesh of one single sponge-animal, which lives, breathes, feeds, grows, and gives forth young ones in its ocean home.

At the bottom of the warm seas on the Mediterranean coast or in the Gulf of Mexico these sponge-animals live in wild profusion, sometimes hiding in submarine caverns, sometimes standing boldly on the top of a slab of rock, or often hanging under ledges. Some are

round like cups, some branched like trees, some thin and spread out like a fan; while there is scarcely a colour from a brilliant orange to a dull dingy brown, which is not to be seen among them.

The floor on which they grow is often as beautiful as they are themselves, with its covering of tangled seaweeds, among which live the many shelled creatures of the sea, while fish swim hither and thither, and the whole region is teeming with life.—

> "Of sea-born kinds, ten thousand thousand tribes,
> Find endless range for pasture and for sport."

Such is the Sponge-kingdom, and the whole colony of sponges of every shape and size flourish like monarchs in their domain. So long as they are alive few can attack them and fewer conquer or destroy them. Only the sponge-fisher diving down into the rich colony disturbs its peace, and tearing the living sponge ruthlessly from its rocky bed, wrings out the living slime, and destroys the animal for the sake of its skeleton.

Every three years this destroyer visits the sponge-colony, for he knows that in spite of his having carried off all the best and richest specimens, this interval is enough for new sponge-animals to have grown up so as to weave large and perfect skeletons.

What secret then has Life taught to the sponge-animal, that while it is still only slime it can grow into such large masses and protect itself so well against the other inhabitants of the sea? We will answer this question by tracing the growth of a sponge from its birth, and reading its history.

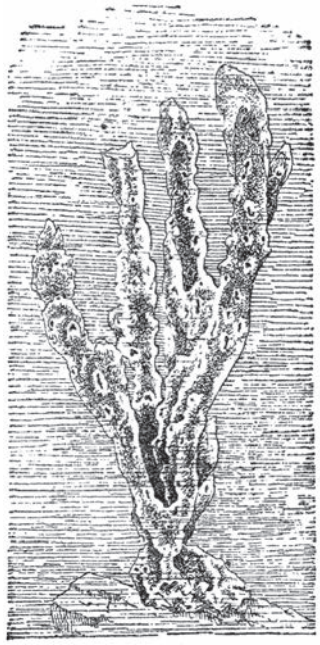


FIGURE 10

A British sponge found at Brighton—life-size.

If you wish to watch a living sponge yourself you have only to keep one in a salt-water aquarium, for small sponges are easily found alive on our English coast, though they will not look like those we use. In this description, however, we will imagine that we can visit one of the sponge-colonies in the Mediterranean Sea or the Gulf of Mexico, where the rocks from fifty to a hundred and fifty feet below the surface of the clear blue water are covered with sponges of every size, and shape, and texture.

If we could visit these sponge-beds during the summer or autumn months, and examine carefully the slimy lining of one of the big tubes of a living sponge, we should find that minute bags of slime (1, *a,* Figure 11) are beginning to appear in it, either scattered through the sponge or collected in heaps. These are sponge-eggs, out of which young sponges are to grow, and in many ways they are very like a hen's egg. Within, as may be seen through their transparent covering, is something which answers to the yelk of an egg, with a solid spot or nucleus in it. This yelk begins soon to divide into two cells, or separate masses of slime, and these again divide into four, these four into eight, and so on till the egg is

a globe of small round cells, the beginning of the young sponge. And now a change may be seen to take place in those cells which lie all round the outside of the rest; each one of them puts forth a minute whip-like lash called a cilium (from *cilium,* an eyelash), so as to form a fringe round the whole body, and then the young sponge, being ready to make its own way in the world, bursts through the skin of the bag, and waving its lashes, swims out an oval-shaped body (2, Figure 11) into the sea.

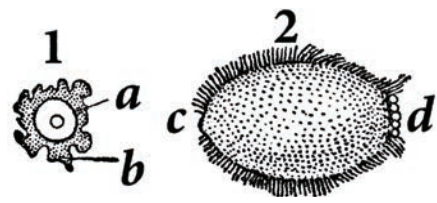


FIGURE 11

The birth of the Sponge (Adapted from Carter)

1, Sponge-egg. *a,* The yelk within the envelope, *b.*

2, Young sponge swimming.

c, Nipple projecting, where a large hole will afterwards form.

d, Root-cells by which the young sponge afterwards fixes itself to the rock.

Here, you will notice, we have a body, not made as in the simplest slime-animals of a mere piece of slime, but composed of a number of cells, the inner ones round and without lashes, like a group of *Amœba,* while the outer ones, each with his little whip, are like a colony of *monads* (see Figure 3), surrounding the animal.

By means of these it swims along and feeds; and as it grows, a small nipple, *c,* afterwards to become a hole, appears at the tip, while a group of larger cells *(d)* collect at the hinder end. By means of these cells the little animal attaches itself to the spot where it is to spend the rest of its life, sometimes to a pebble, but generally

to the solid rock. Small sponges often fix themselves to living shells, and Dr. Johnstone tells us that he met with a sponge on the back of a crab, which walked about quite unconcerned with its light burden, though it was many times larger than itself.

Having settled, the young sponge now spreads Itself out upon the rock, and grows and builds up its fibrous skeleton, while its surface becomes irregular and full of large and small holes, and the true sponge appears.

And now comes the curious part of the story. As the sponge grows larger it is clear that the cells in the middle of its body must be more and more shut out

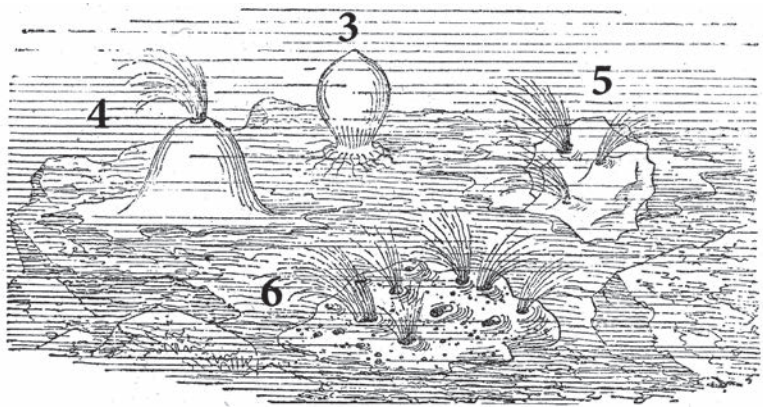


FIGURE 12

Development of a young English sponge (Halichondria simulans)—Adapted from Carter

3, The swimming sponge of Figure 11, which has now fixed itself.
4, The same with water squirting from the hole now formed.
5, The same further developed.
6, The perfect sponge with small holes, where the water enters, and large holes out of which it is squirted.

from the surrounding water out of which food can be taken, and yet these cells want feeding as much as those outside. In order to bring this about, the sponge-animal, instead of growing up as a solid mass of slime-cells, arranges the silky fibres of its skeleton in such a manner as to leave a number of small canals or passages throughout its body, and these open, as we have seen, sooner or later, into large canals or main thoroughfares, while the slimy sponge-body is spread out as a thin film along them all. In this way it is possible for the sea-water to reach right throughout the whole body of the sponge along the various canals. But if this water only lay still from day to day, no fresh food could be brought, and the whole would become stagnant and bad. The animal cannot feed or even breathe unless a constant fresh supply of water, full of oxygen and living beings, is driven through the canals.

How is this to be done?

At first sight it seems as if the young sponge were behaving very foolishly in this matter, for no sooner has it settled down than it draws in all the whip-like hairs outside its body which we should have thought would be useful for driving in food, and becomes a mass of smooth slime-cells with large and small holes scattered here and there. Still, as the water goes on pouring out at the big holes (see Figure 12), it is clear that it must be going in somewhere; and on cutting open the living sponge and watching it at work the secret appears. Here and there throughout the narrow canals of the skeleton are to be found little chambers, like two saucers face to face (1, Figure 13), and in these are arranged in rows

a number of whip-like cells, exactly like those which were before outside the sponge. It is the whips in these cells which do the work required. Waving ceaselessly to and fro, they drive the water before them always in one direction, so that it is drawn in at the small holes (*a a,* Figure 13) and driven out at the large ones *(b b).* By means of this wonderful contrivance fresh sea-water

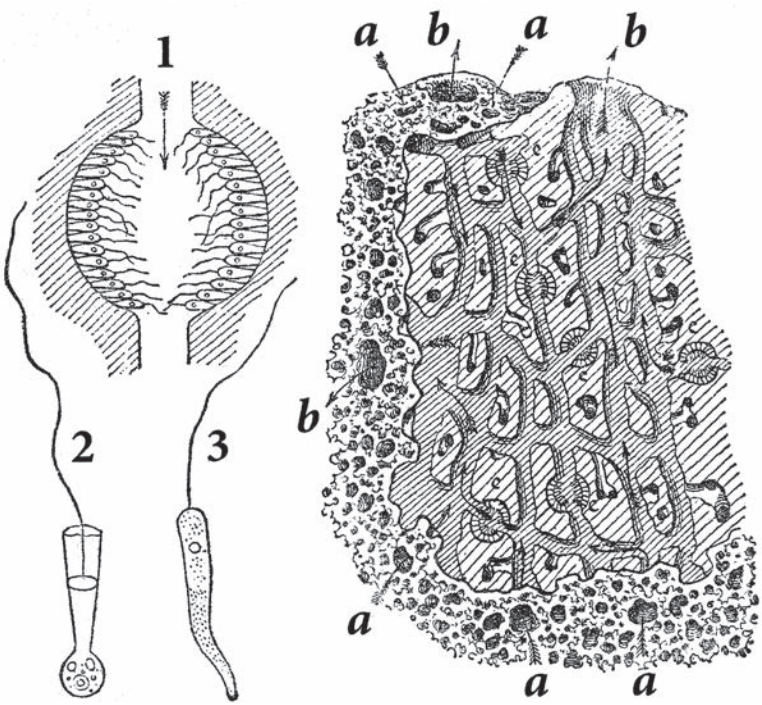


FIGURE 13

Section of an ordinary bath sponge—Murie

a a a, Small holes where the water enters.
b b, Large holes where it flows out.
c c, Chambers with whip-cells which drive the water on.
1, A chamber enlarged showing the cells.
2, 3, Different forms of whip-cells.

full of oxygen and living plants and animals is always pouring along the small canals, bringing air and food to each cell along the road, while the bad water out of which the slime has taken all the oxygen, and into which it has thrown the hard parts and refuse of its food, is driven out at the large holes, carrying away with it all that is hurtful and useless.

And now we can understand why the sponge, though a mere slime-animal, is classed as the pioneer of the second division of living animals; because in it quite a new plan of structure has begun. Starting from one egg, the whole sponge is one single individual; yet, when grown up it is not a mere mass all doing the same work, as in the simplest animals, for it has learnt the secret of division of labour; and while one set of cells, those forming the smooth slime, are busy taking in food, the other and whip-like cells are foraging for this same food and sweeping away the refuse; and, between these two, a special layer of smooth cells is employed in building up the skeleton which supports the whole body.

If we knew only the grown-up sponge, we might look upon it as a society of two kinds of slime-animals living together and building a common house. But when we consider that each whole sponge comes from a single egg, growing and dividing like one of the eggs of the higher animals, and that any piece of a sponge-animal is able to settle and grow up into a perfect sponge with the two kinds of cells, we see that these animals have made a great step never again to be forgotten by the children of Life. They have learned to form in one body

two kinds of cells with different duties, which, by their mutual labour, carry on in one being the work of life.

We are now, I hope, able to picture to ourselves the sponge growing upon the rocks in deep water, or sometimes in shallow pools, or between the tidemarks, looking like a smooth mass of slime of different shapes, with holes invariably open as long as it is under water, but closed (as we shall find on the English shores) if the sponge is by chance left high and dry by the tide. We can imagine to ourselves the small fountains of water spouting from the larger openings, and carrying off the refuse from the inside of the sponge, and we can fancy we see the small chambers buried in the canals with their active inmates lashing the water onwards in its course through the whole mass.

But we have yet to consider the *skeleton* of the living animal, and why so much time and labour should be spent in forming it. There are two reasons why a solid framework is useful to the sponge-animal. First, it supports the large mass of soft slime, and enables it to spread itself out in thin layers, so as to touch the water in the canals; and, secondly, it protects it from enemies.

There are a few sponges made entirely of slime, the canals and thoroughfares being in the slime itself; and in these, when the animal dies and decays, nothing solid is left behind. But such sponges have probably become degraded and have lost their skeleton, and they are clearly under a disadvantage, for the walls of slime are forced to be much thicker, and food cannot reach them so easily; and besides this, when we remember

how many sea-animals feed on living slime, we cannot but see that these sponges offer a very tempting feast. Comparatively large animals, such as shrimps and fish, will take big mouthfuls out of them, while the water-fleas and smaller sea-worms which are carried through their canals, are quite as ready to eat the slime as the slime is to eat them. But if the sponge can offer a very tough and unpalatable mouthful, or can prick its enemies' mouths with a sharp point, they will not be so ready to take a second bite; and so it comes to pass that we find in sponges some of the most curious weapons imaginable.

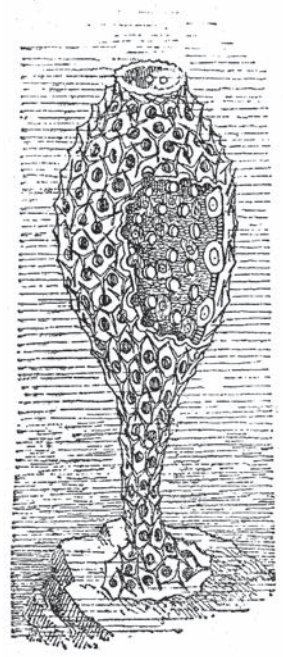


FIGURE 14

Sponge (Ascetta primordialis) with lime spicules forming the skeleton over the living flesh. —*Haeckel.*

The sponges we use are by no means the first attempts at sponge-skeletons; on the contrary, they represent the highest art in sponge-building. The simplest kind of sponges build their skeletons of lime and flint, as did the earlier slime-animals. Figure 14 is a picture of a lime-sponge. Here the outer layer of sponge-flesh has taken in lime and built up with it a number of little pointed spikes or *spicules*, which lie buried in the slime. The rest of the sponge is composed entirely of the sponge-animal, the outer cells being smooth

and the inner ones whip-like, so that water and food are drawn in at the small holes in the sides, while the refuse is driven out at the large hole in the top.

Now suppose that a fish attacks this sponge, instead of a mouthful of soft slime he will bite upon a number of minute sharp points which he will carry away sticking to the soft lining of his mouth, and the next time he sees such a sponge growing he will hesitate before touching it. In some sponges these lime-thorns are so arranged that they lie flat against the sponge when it is still, but form a complete hedge of spikes round the holes when it is taking in water, showing that it is not only against the fish that it is protecting itself but against the smaller but dangerous animals, which might be washed into it. In another sponge the spicules point towards the mouth at the top, so that any creature which has got in can be easily thrown out but one trying to get in would be spiked directly.

Lime-sponges are to be found in most parts of the world, and some of them are very beautiful from the arrangement of their spicules. But these look, after all, like mere rough attempts at spike-building when compared with the wonderful spicules which are made by the flint-building sponges.

Figure 15 shows only a very few of the forms of flint spicules which are known. They look, under the microscope, as if the sponge-animal were an artist trying how many curious patterns he could invent; and yet Dr. Bowerbank has shown that each of these shapes has some special use, either in keeping out enemies, in

supporting the sponge, or in spiking and entangling the smaller animals which form the food of the sponge-animal. Often as many as from three to seven different shapes may be found in one single sponge, forming by their combinations intricate and beautiful patterns. Yet each one of these spicules, perfect and complete in form as it is, is so small as to be barely visible as a speck to the naked eye, and so transparent that when mounted on glass for the microscope it is impossible to detect even a group of them without a lens.

FIGURE 15

Spicules of flint found in the flesh of flint-sponges. Real size a mere speck, almost invisible to the naked eye.

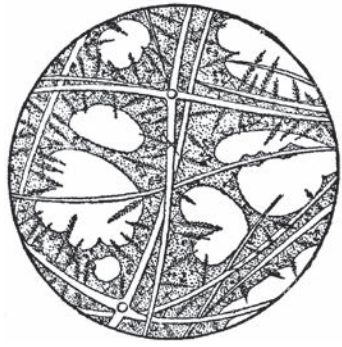


FIGURE 16

A piece of a flint-sponge with the sarcode or flesh, magnified 100 times.

In Figure 16 may be seen three kinds in their natural position in the flesh of the sponge, the large ones binding the sponge together, and the small feathery and anchor-shaped spicules protecting the flesh; and small as these last appear, yet they are even now magnified 100 times. Lastly, in the higher

flint-building sponges the architect gets beyond mere separate spicules, or binds them together so skilfully with fine, transparent flint threads that they form a network of wondrous beauty. Looking at the marvellously delicate Venus' basket (Figure 17) which grows in the seas near the Philippine Islands, it is almost impossible to persuade ourselves that the flint-lace of which it is made has been constructed by an animal with no eyes to see the beautiful pattern it was weaving, and no machinery in its body with which to direct the web; and that out of mere slime cells has arisen a fairy structure such as the most skilled human artist might try in vain to rival! These sponges live chiefly in very deep water. In one of them, called the glass-rope sponge, the animal is anchored to the bottom by long flint threads, often several feet long, looking like the finest spun glass.

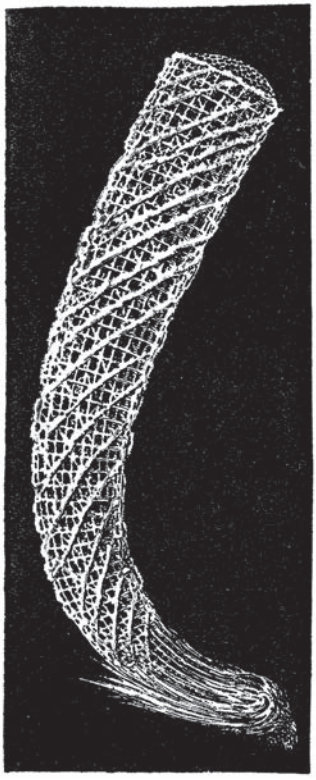


FIGURE 17

Venus' Basket
(Euplectella speciosa)

The skeleton of a flint-sponge.

And now we find the sponge-animal advancing yet a step farther, and beginning no longer to build entirely with lime and flint taken from the water, but to manufacture its own material. We all know that

the spider spins its web of threads of gum formed in its body; and that the silk of the silkworm is made in the same manner, and now we have to learn that the sponge-animal with its simple slime cells can do this too! For all the sponges which we use are made of fine fibres, which prove, when examined, to differ very little chemically from the silk of the silkworm. These fibres have been secreted by the slime-animal out of its food, and by crossing and re-crossing them in all directions it forms the soft elastic skeleton of the toilet sponge. Yet they are not woven carelessly or without purpose, for we have seen that they are so arranged as to build up the small canals and the large tubes in their right positions; and though all may look confused to us, yet there is no part which the water cannot reach in its passage through the sponge.

At first in the coarser sponges the fibre is thick and loosely woven, and though it is tough and almost impossible to bite or digest, yet it leaves such large openings as to afford but a poor protection. In these sponges flint spicules are still built in with the fibre, scattered about in all directions: and, because of the sharpness of the spicules, their skeletons are of very little use to us. But little by little, in sponges of a finer web, in which the tough silky fibres are so closely matted together as to repel all intruders, we find the sponge-animal beginning to neglect the formation of spicules, and contenting itself with building in fragments of sand, making those gritty sponges so disagreeable to handle. And by and by it ceases even to do this, and in the fine soft Turkey sponge we find the holes so small that no enemy

large enough to do harm could enter, while the densely woven fibres offer a most unpalatable and indigestible morsel to any creature which might have the strength to tear it away; and these, needing no further protection, are made entirely of soft fibre.

FIGURE 18

Cup-sponge growing in the sea. Real size about a foot high.—*From Figuier.*

Here we must leave the history of sponges and their lives. We have left much unsaid, for to tell how sponges may increase by dividing or by budding, as well as by eggs, would have taken us too far into detail; neither could we give space to trace the wonderful way in which the various spicules are used as weapons of defence; and for special examples of the different kinds of sponges you must consult works on natural history. We have had one chief object in view, namely, to see how Life in this new form has advanced beyond the earliest slime-animals. The sponge, with its two forms of cells and its division of labour, stands already far above the microscopic beings of our last chapter. Rooted to the rocks, and large enough to invite the attacks of enemies, it has yet learnt to protect itself by wonderful structures, to distribute its food throughout a large body, and last, but not least, no longer to form

its skeleton merely of flint or lime, but to manufacture in its own body the material with which it builds.

It has indeed succeeded so well that Dr. Bowerbank, one of the best authorities on sponge life, came to the conclusion that sponges are able to escape almost entirely, during their lifetime, from becoming the food of other animals. It is only after their death that their slime serves to nourish myriads of minute creatures, and then the wonderful rapidity with which the living matter is devoured, is quite enough to prove to us how well the living sponge must have used its weapons to protect itself, while still it was one of Life's living children.