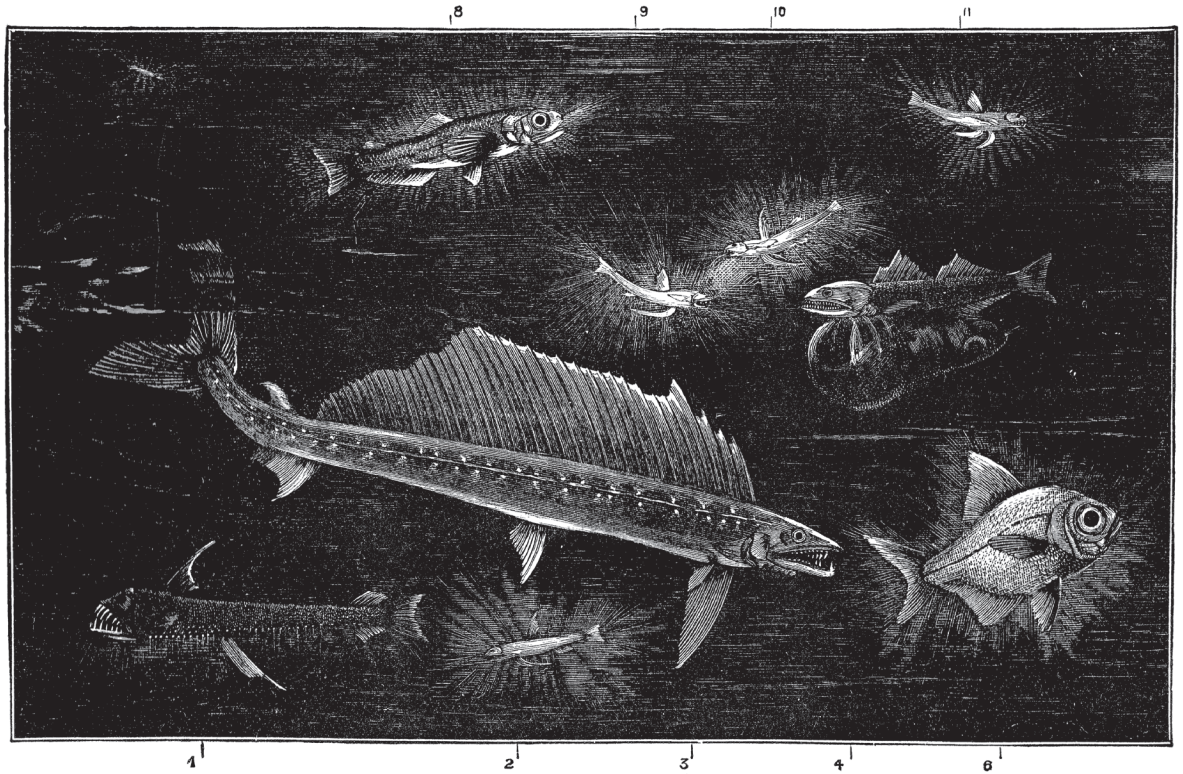
WINNERS
IN LIFE'S RACE



Luminous Fish of the Deep Sea

WINNERS IN LIFE'S RACE

OR THE

GREAT BACKBONED FAMILY

BY

ARABELLA B. BUCKLEY

"Thou gavest me wide nature for my kingdom,
And power to feel it, to enjoy it. Not
Cold gaze of wonder gav'st thou me alone,
But even into her bosom's depth to look,
As it might be the bosom of a friend.
The grand array of living things thou madest
To pass before me, mad'st me know my brothers
In silent bush, in water, and in air."

Blackie's Translation of Faust

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PREFACE

ALTHOUGH the present volume, as giving an account of the *vertebrate* animals, is a natural sequel to, and completion of my former book, *Life and Her Children,* which treated of *invertebrates,* yet it is a more independent work, both in plan and execution, than I had at first contemplated.

This arises from the nature of the subject. The structure and habits of the lower forms of life are sufficiently simple to be treated almost without reference to geological history. When, however, I began to sketch out the lives and structure of the vertebrate animals, which are so closely interlinked one with another and yet so sharply separated into groups, I soon found that I must carry my readers into the past in order to give any intelligible account of the present.

I have therefore endeavoured to describe graphically the early history of the backboned animals, so far as it is yet known to us, keeping strictly to such broad facts as ought in these days to be familiar to every child and ordinarily well-educated person, if they are to have any true conception of Natural History. At the same time I have dwelt as fully as space would allow, upon the lives

of such modern animals as best illustrate the present divisions of the vertebrates upon the earth; my object being rather to follow the tide of life, and sketch in broad outline how structure and habit have gone hand-in-hand in filling every available space with living beings, than to multiply descriptions of the various species. If my younger readers will try and become familiar with the types selected, either alive in zoological gardens or preserved in good museums, they will, I hope, acquire a very fair idea of the main branches of the Backboned Family.[1]

In order to treat so vast a subject simply and within narrow limits, it has often been necessary to pass lightly over new and startling facts. I trust, however, it will not be inferred that such passages have been lightly or carelessly written, for in all cases I have sought, and most gratefully acknowledge, the assistance of some of our best authorities; and I have endeavoured that what little is said upon difficult subjects shall be a true foundation for wider knowledge in the future.

Among the many friends who have rendered me valuable assistance, I cannot sufficiently express my obligations to Professor W. Kitchen Parker for his unwearying kindness in explaining obscure points of anatomical structure, and to my friends Mr. Alfred R. Wallace, Professor A. C. Haddon of Dublin, and Mr. Garnett of the British Museum, for constant suggestion and encouragement.

[1] Almost every animal mentioned in this book is to be found alive in the London Zoological Gardens, or stuffed in the British Museum.

The geological restorations given as picture-headings (some of which are here attempted, I believe, for the first time) have been most carefully considered, though the exact forms of such strange and extinct animals must necessarily be somewhat conjectural. My thanks are due to the artist, Mr. Carreras, for the patience and care with which he has followed my instructions regarding them, and also to Mr. Smit for his masterly execution of the frontispiece.[2]

I have been asked why, in this and the former work, I have not given genealogical tables to help the reader to follow the relations of the various groups. My reason is, that it is impossible to construct tables of this kind without giving a false idea of the fixity of natural divisions and of the extent of our knowledge. To men of science, who know how provisional such tables are, they have a certain value, but they would be positively harmful in a work of this kind, which will have fully accomplished its purpose if it only awakens in young minds a sense of the wonderful interweaving of life upon the earth, and a desire to trace out the ever-continuous action of the great Creator in the development of living beings.

Arabella B. Buckley.

London, *September* 1882.

[2]The Figures in the text, which, with exception of about twenty, have all been drawn expressly for this book, are the work of the above-mentioned artists, together with Mr. Coombe and Miss Suft.

CONTENTS

CHAPTER V

CHAPTER VI

CHAPTER VII

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER I

THE THRESHOLD OF BACKBONED LIFE

Life, life, everywhere life! This was the cry with which we began our history of the lowest forms of Life's children, and although we did not then pass on to the higher animals, is it not true that before we reached

the end we were overwhelmed with the innumerable forms of living beings? The microscopic lime and flint builders, the spreading sponges, the hydras, anemones, corals, and jelly-fish filled the waters; the star-fish, sea-urchins, crabs, and lobsters crowded the shores; the oysters, whelks, and periwinkles, with their hundreds of companions, struggled for their existence between the tides; while in the open sea thousands of crustaceans and molluscs, with cuttle-fish and terribly-armed calamaries, roamed in search of food. Upon the land the snails and slugs devoured the green foliage, while the vast army of insects filled every nook and cranny in the water, on the land, or in the air. Yes! even among these lower forms we found creatures enough to stock the world over and over again with abundant life, so that even if the octopus had remained the monarch of the sea, and the tiny ant the most intelligent ruler on the land, there would have been no barren space, no uninhabited tracts, except those burning deserts and frozen peaks where life can scarcely exist.

Yet though the world might have been full of these creatures, they would not have been able to make the fullest use of it, for all animal life would have been comparatively insignificant and feeble, each creature moving within a very narrow range, and having but small powers of enjoyment or activity. With the exception of the insects, by far the greater number would, during their whole lives, never wander more than a few yards from one spot, while, though the locust and the butterfly make long journeys, yet the bees and

beetles, dragon-flies and ants, would not cross many miles of ground in several generations.

What a curious world that would have been in which the stag-beetle and the atlas-moth could boast of being the largest land animals, except where perhaps some monster land snail might bear them company; while cuttle-fish and calamaries would have been the rulers of the sea, and the crabs and lobsters of the shores! A strangely silent world too. The grasshopper's chirp as he rubbed his wings together, the hum of the bee, the click of the sharp jaws of the grub of the stag-beetle, eating away the trunk of some old oak tree, would have been among the loudest sounds to be heard; and though there would have been plenty of marvellous beauty among the metallic-winged beetles, the butterflies, and the delicate forms of the sea, yet amid all this lovely life we should seek in vain for any intelligent faces,—for what expression could there be in the fixed and many-windowed eye of the ant or beetle, or in the stony face of the crab?

These lower forms, however, were not destined to have all the world to themselves, for in ages, so long ago that we cannot reckon them, another division of Life's children had begun to exist which possessed advantages giving it the power to press forward far beyond the star-fish, the octopus, or the insect. This was the Backboned division, to which belong the fish of our seas and rivers; the frogs and toads, snakes, lizards, crocodiles, and tortoises; the birds of all kinds and sizes; the kangaroos; the rats, pigs, elephants, lions, whales, seals, and monkeys.

Is it possible, then, that all these widely different creatures, which are fitted to live not only in all parts of the land, but also in the air above, and the seas and rivers below, and which are, in fact, all those popularly known as "animals," only form one division out of seven in the real animal kingdom?

Can it be true that while the chalk-builders have one division all to themselves, the sponges forming a transition group, the lasso-throwers another division, the prickly-skinned animals a third, the mollusca a fourth, the worms a fifth, and the insects a sixth, yet the innumerable kinds of birds and beasts, reptiles and fishes, are all sufficiently alike to be included in one single division—the seventh? It seems at first as if this arrangement must be unequal and unnatural; but let us go back for a moment to the beginning, and we shall see that it is not only true, but that quite a new interest attaches to the higher animals when we learn how wonderfully life has built up so many different forms upon one simple plan.

Starting, then, with the first glimmerings of life, we find the minute lime and flint builders, without any parts, making the utmost of their little lives, filling the depths of the sea, and wandering in pools and puddles on the land; acting, in fact, as scavengers for such matter as is left them by other animals. But here their power ends; to take a higher stand in life a more complicated creature is needed, and the sponge-animal, with its two kinds of cells and its numerous eggs, is the next step leading on to the curious division of lasso-throwers. These, in their turn, do their utmost to spread and

vary in a hundred different ways. Possessed of a good stomach, of nerves, muscles, powerful weapons, and means for producing eggs and young ones, they fill the waters as hydras, sea-firs, jelly-fish, anemones, and corals. But here they too find their limit, and, without advancing any farther, continue to flourish in their lowly fashion. Meanwhile the tide of life is flowing on in two other channels, striving ever onwards and upwards. On the one hand, the walking star-fish and sea-urchin push forward into active life under the sea, forming, with their relations, a strange and motley group, but one which could scarcely be moulded into higher and more intelligent beings. On the other hand, the oyster and his comrades, with their curious mantle-working secret protect their soft body within by a shelly covering, and by degrees we arrive at the large army of mollusca, headed by the intelligent cuttle-fish. And here this division too ceases to advance. The soft body in its shelly home does not lend itself to wide and great changes, and it was left for other channels to carry farther the swelling tide of life. These take their rise in the lowly, insignificant division of the worms, which may, perhaps, have had something to do with the earliest forms even of the star-fish and mollusca, but which soon shot upwards, on the one hand along a line of its own, while, on the other, we have seen[1] how, in its many-ringed segments, each bearing its leg-like bristles and its line of nerve-telegraph, the worm foreshadowed the insects and crustacea, or the *jointed-footed* animals of sea and land, forming the sixth division.

[1] *Life and Her Children,* page 135

Here surely at last we must have reached animals which will answer any purposes life can wish to fulfil. We find among them numberless different forms, spreading far and wide through the water and over the land, and it would seem as if the sturdy crab and fighting lobster need fear no rival in the sea, while the intelligent bee and ant were equal to any emergency on dry ground. But here the tide of life met with another check. It must be remembered that the jointed-footed animals, whether belonging to land or water, carry their solid part or skeleton *outside* them; their body itself is soft, and cased in armour which has to be cast off and formed afresh from time to time as they grow. For this reason they are like men in armour, heavily weighted as soon as they grow to any size, while the body within cannot become so firmly and well knit together as if all the parts, hard and soft, were able to grow and enlarge in common. And so we find that large-sized armour-covered animals, such as gigantic crabs and lobsters, are lumbering unwieldy creatures, in spite of their strength, while the nimble intelligent insects, such as the ant and bee, are comparatively small and delicate.

It would be curious to try and guess what might have happened if the ant could have grown as large as man, and built houses and cities, and wandered over wide spaces instead of being restricted to her ant-hills for a home, and few acres for her kingdom; but she too has found the limit of her powers in the impossibility of becoming a large and powerful creature. Thus it remained for Life to find yet another channel to reach its highest point, by devising a plan of structure

in which the solid skeleton should be—not a burden for the soft body to carry, as in the sea-urchins, snails, insects, and crabs—but an actual support to the whole creature, growing with it and forming a framework for all its different parts.

This plan is that of the backboned animals. They alone, of all Life's children, have a *skeleton within their bodies embedded in the muscular flesh, and formed, not of mere hardened, dead matter, but of bones which have blood-vessels and nerves running through them, so that they grow as the body grows, and strengthen with its strength.* This is a very different thing from a mere outer casing round a soft body, for it is clear that an animal with a living growing skeleton can go on increasing in size and strength, and its framework will grow *with* the limbs in any direction most useful to it.

Here, then, we have one of the secrets why the backboned animals have been able to press forward and vary in so many different ways; and especially useful to them has been that gristly cord stretching along the back, which by degrees has become hardened and jointed, so as to form that wonderful piece of mechanism, the *backbone*.

Look at any active fish darting through the water by sharp strokes of its tail,—watch the curved form of a snake as it glides through the grass, or the graceful swan bending his neck as he sails over the lake,—and you will see how easily and smoothly the joints of the backbone must move one upon the other. Then turn to the stag, and note how jauntily he carries his heavy

antlers; look at the powerful frame of the lion, watch an antelope leap, or a tiger bound against the bars of his cage, and you will acknowledge how powerful this bony column must be which forms the chief support of the body, and carries those massive heads and those strong and lusty limbs.

Nor is it only by its flexibility and strength that this jointed column is such an advantage to its possessors; the backbone has a special part to play as the protector of a most valuable and delicate part of the body. We have already learnt in *Life and Her Children* to understand the importance of the nerve-telegraph to animals in the struggle for life. We found its feeble beginnings in the jelly-fish and the star-fish; we saw it spreading out over the body of the snail; we traced it forming a line of knots in the worm, with head-stations round the neck, which became more and more powerful in the intelligent insects. But in all these creatures the stations of nerve-matter from which the nerves run out into the body are merely embedded in the soft flesh, and have no special protection, with the exception of a gristly covering in the cuttle-fish. We ourselves, and other backboned animals, have unprotected nerve-stations like these in the throat, the stomach, and the heart, and cavity of the body. But we have something else besides, for very early in the history of the backboned animals the gristly cord along the back began to form a protecting sheath round the line of nerve-stations stretching from the head to the tail, so that this special nerve-telegraph was safely shut in and protected all along its course.

A careful examination of the backbone of any fish, after the flesh has been cleared off, will show that on the top of each joint (or *vertebra*) of the backbone is a ring or arch of bone; and when all the joints are fastened together, these rings form a hollow tube or canal, in which lies that long line of nervous matter called the *spinal cord,* which thus passes, well protected, all along the body, till, when it reaches the head, it becomes a large mass shut safely in a strong box, the skull, where it forms the brain.

Here, then, besides the unprotected nerve-stations, we have a much more perfect nerve-battery, the spinal cord, carried in a special sheath formed of the arches of the backbone, which is at once strong and yielding, so that the delicate telegraph is safe from all ordinary danger. Now when we remember how important the nerves are,—how they are the very machinery by which intelligence works, so that without them the eye could not see, the ear hear, nor the animal have any knowledge of what is going on around it,—we see at once that here was an additional power which might be most valuable to the backboned division. And so it has proved, for slowly but surely through the different classes of fish, amphibia (frogs and newts), reptiles, birds, and mammalia, this cord, especially that larger portion of it forming the brain, has been increasing in vigour, strength, and activity, till it has become the wonderful instrument of thought in man himself.

We see, then, that our interest in the backboned or *vertebrate* animals will be of a different kind from that which we found in the boneless or *invertebrate*

ones. There we watched Life trying different plans, each successful in its way, but none broad enough or pliable enough to produce animals fitted to take the lead all over the world. Now we are going to trace how, from a more promising starting-point, a number of such different forms as fish, reptile, bird, and four-footed beast, have gradually arisen and taken possession of the land, the water, and the air, pressing forward in the race for life far beyond all other divisions of animal life.

On the one hand, these forms are all linked together by the fact that they have a backbone protecting a nerve-battery, and that they have never more than two pair of limbs; while every new discovery shows how closely they are all related to each other. On the other hand, they have made use of this backbone, and the skeleton it carries, in such very different ways that out of the same bones and the same general plan unlike creatures have been built up, such as we should never think of classing together if we did not study their structure.

What the lives of these creatures are, and what they have been in past time, we must now try to understand. And first we shall naturally ask, Where did the backboned animals begin? Where should they begin but in the water, where we found all the other divisions making their first start, where food is so freely brought by passing currents, where movement from place to place is much easier, and where there are no such rapid changes as there are on the land from dry to damp, from heat to cold, or from bright leafy summer, with plenty of food, to cold cheerless winter, when starvation often stares animals in the face?

It is not easy to be sure exactly how the backboned animals began, but the best clue we have to the mystery is found in a little half-transparent creature about two inches long, which is still to be found living upon our coast. This small insignificant animal is called the "Lancelet," [2] because it is shaped something like the head of a lance, and it is in many ways so imperfect that naturalists believe it to be a degraded form, like the acorn-barnacle; that is to say, that it has probably lost some of the parts which its ancestors once possessed. But in any case it is the most simple backboned animal we have, and shows us how the first feeble forms may have lived.

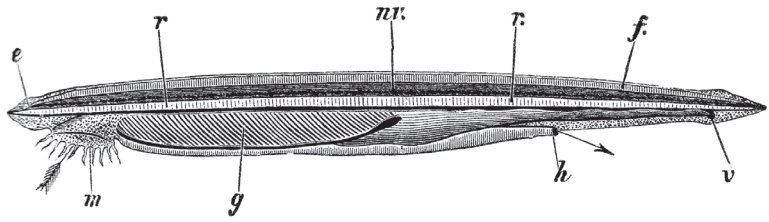

FIGURE 1

The Lancelet, the lowest known fish-like form

m, mouth. *e,* eye-spot. *f,* fin. *r,* rod or notochord, the first faint indication of a backbone. *nv*, nerve cord. *g*, gills. *h*, hole out of which water passes from the gills. *v*, vent for refuse of food.

Flitting about in the water near the shore, eating the minute creatures which come in his way, this small fish-like animal is so colourless, and works his way down in the sand so fast at the slightest alarm, that few people ever see him, and when they do are far more likely to take him, as the naturalist Pallas did, for an imperfect

snail than a vertebrate animal. He has no head, and it is only by his open mouth *(m),* surrounded by lashes with which he drives in the microscopic animals, that you can tell where his head ought to be. Two little spots *(e)* above his mouth are his feeble eyes, and one little pit *(n)* with a nerve running to it is all he has to smell with. He has no pairs of fins such as we find in most fishes, but only a delicate flap *(f)* on his back and round his tail; neither has he any true breathing-gills, but he gulps in water at his mouth, and passes it through slits in his throat into a kind of chamber, and from there out at a hole *(h)* below. Lastly, he has no true heart, and it is only by the throbbing of the veins themselves that his colourless blood is sent along the bars between the slits, so that it takes up air out of the water as it passes.

But where is his backbone? Truly it is only by courtesy that we can call him a backboned animal, for all he has is a cord of gristle, *r r,* pointed at both ends, which stretches all along the middle of his body above his long narrow stomach, while above this again is another cord containing his nerve-telegraph *(nv.)* All other backboned animals that we know of have brains; but, as we have seen, he has no head, and his nerve-cord has only a slight bulge just before it comes to a point above his mouth. Now when the higher backboned animals are only just beginning to form out of the egg, their backbone (which afterwards becomes hard and jointed) is just like this gristly rod or *notochord (r r)* of the lancelet, with the spinal cord *(nv)* lying above it; so that this lowest backboned animal lives all his life in

that simple state out of which the higher animals very soon grow.

This imperfect little lancelet has a great interest for us, because of his extremely simple structure and the slits in his throat through which he breathes. You will remember that when we spoke of the elastic-ringed animals in *Life and Her Children,* we found that the free worms were very active sensitive creatures, whose bodies were made up of segments, each with a double pair of appendages; the whole being strung together, as it were, upon a feeding tube and a line of nerve-telegraph, but without any backbone. Now among these worms we find many curious varieties; some have the nerve-lines at the sides instead of below, and one sea-worm, instead of breathing by outside gills like the others, has slits in its throat through which the water can pass, and so its blood is purified.

You may ask, What this has to do with back-boned animals? Nothing directly, but these odd worms are like fingerposts in a deserted and grass-grown country, showing where roads may once have been. The lancelet, like the worm, has a line of nerve-telegraph and a feeding-tube, only with him the nerve-telegraph lies above instead of below. He has also slits in his throat for breathing, only they are covered by a pouch. Thus he is so different from the worms that we cannot call them relations; but at the same time he is in many ways so like, that we ask ourselves whether his ancestors and those of the worms may not have been relations.

But you will say he is quite different in having a

gristly cord. True—but we shall find that even this does not give us a sharp line of division. By looking carefully upon the seaweed and rocks just beyond low tide, we may often find some curious small creatures upon them, called Sea-Squirts or Ascidians (B, Figure 2).[3] These creatures are shaped very like double-necked bottles, and they stand fixed to the rock with their necks stretching up into the water. Through one neck *(m)* they take water in, and after filtering it through a kind of net so as to catch the microscopic animals in it and taking the air out of it, they send it out through the other neck, thus gaining the name of sea-squirts. So far, they are certainly boneless animals. But they were not always stationary, as you see them fixed to the rock. In their babyhood they were tiny swimming creatures with tails (A and a), and in the tail was a gristly cord *(r),* with a nerve cord *(nv)* above it, like those we find in the lancelet. For this reason we were obliged to pass them by among the lower forms of life, because, having this cord *(r),* they did not truly belong to the animals without backbones; and yet now we can scarcely admit them here, because when they are grown up they are not backboned animals. They belong, in fact, to a kind of "No Man's Land," behaving in many ways like the lancelet when they are young, as if they had once tried to be backboned; and yet they fall back as they grow up into invertebrate animals.

So we begin to see that there may have been a time

[3]For this drawing, and also those of Figures 1 and 4, I am indebted to Professor A.C. Haddon; the larval form A is the young of Clavelina, found at Torquay.

when backbones had not gained quite a firm footing, and our lancelet, with his friends the sea-squirts, seems to lie very near the threshold of backbone life.

And now that we are once started fairly on our road, let us turn aside before beginning the history of the great fish-world and pay a visit to a little creature whose name, at least, we all know well, and which stands half-way between the lancelet and the true fish. This is the Lamprey, represented by two kinds; the large Sea-Lamprey, caught by the fishermen for bait as it wanders

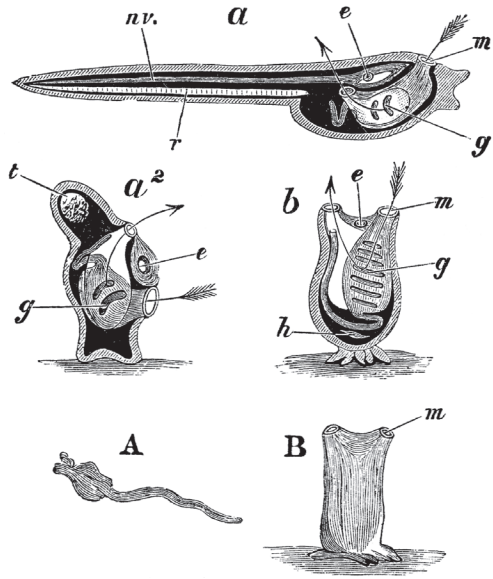

FIGURE 2

Diagram of the growth of a Sea-Squirt or Ascidian

A a, Young, free swimming stage.
a^2, Intermediate stage when first settling down.
B b, Full-grown Sea-Squirt.

m, mouth; *e,* hollow brain with eye; *g,* gill slits; *h,* heart; *r,* rod of gristle in free swimming form; *nv,* nerve cord in same; *t,* tail in process of absorption in intermediate form.

up the rivers to lay its eggs, and the true River-Lamprey or Lampern, which rarely visits the sea.

What country boy is there who has not hunted in the mud of the rivers or streams for these bright-eyed eel-like fish, with no fins, and a fringe on back and tail? If you feel about for them in the mud they will often come up clinging to your hand with their round sucker-mouth, while the water trickles out of the seven little holes on each side of their heads. The small river-lampreys do not hurt in the least as they cling, though the inside of their mouth is filled with small horny teeth. But the larger sea-lamprey uses these teeth as sharp weapons, scraping off the flesh of fish for food as he clings to them.

These Lampreys, together with some strange creatures, the "Hags" or "Borers,"[4] belong to quite a peculiar family, called the Round-mouthed fishes,[5] and, though they stand much higher in the world than the lancelet, yet they are very different from true fish. Like the lancelet they have only a gristly cord for a backbone, but this cord has begun to form arches over the nerve battery, and it swells out at the end into a gristly skull covering a true brain. They have clear bright eyes too, and ears, which if not very sharp, are at least such as they can hear with: they have only one nostril, and their mouth is both curious and useful. When it is shut it looks like a straight slit, but when it is open it forms a round sucker with a border of gristle, and this sucker clings firmly to anything against which it is pressed,

[4] *Myxine*

[5] *Cyclostomata* (*cyclos,* circle; *stoma,* mouth)

so that a stone weighing twelve pounds has been lifted by taking a lamprey by the tail. Inside the mouth the palate and tongue are covered with small horny teeth, and these are the lamprey's weapons.

Salmon have been caught in the rivers with lampreys hanging to them, and where the mouth has been the salmon's flesh is rasped away, though he does not seem much to mind it.

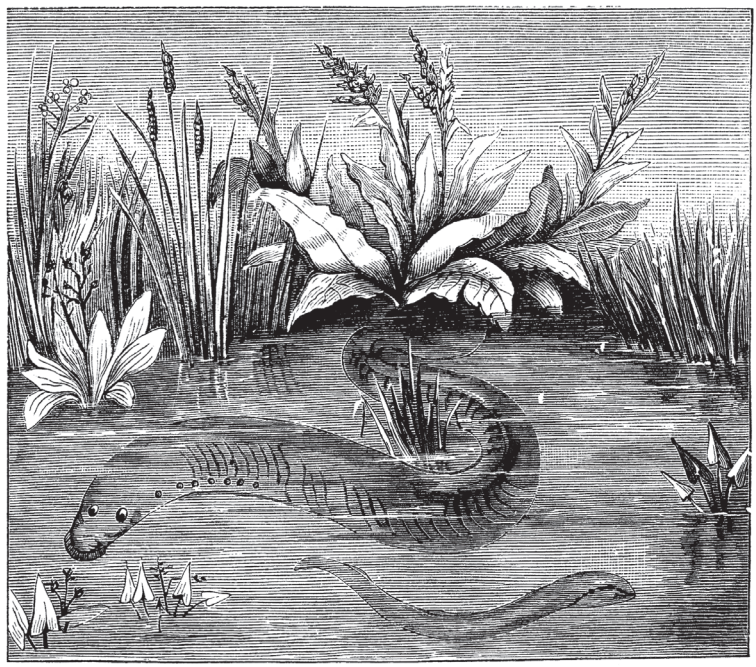

FIGURE 3

Figure of a full-grown Lamprey and of the young Lamprey, formerly called Ammocœtes*

Showing the seven holes through which it takes in water to breathe

**Petromyzon* (*petra*, stone; *myzo*, to suck)

Lastly, the lamprey has a peculiar way of breathing. He has seven little holes on each side of his head, reminding us of the slits in the worm's throat and those hidden under the skin of the lancelet, and behind these holes are seven little pouches lined with blood-vessels, which take up air out of the water. These pouches are all separate, but they open by one tube into his throat. When the lamprey is swimming about it is possible that he may gulp water in at his mouth and send it out at the slits. But when he is clinging to anything he certainly sends water both in and out at the slits, so that he can still breathe, though his mouth is otherwise occupied.

And now, what is the history of his life? For three years he lives as a stupid little creature, with a toothless mouth surrounded by feelers, and tiny eyes covered over with skin, and he is so unlike a lamprey that for a long time naturalists thought he was a different animal and called him *Ammocœtes.* But at the end of the three years he changes his shape, and then he is as bright and intelligent as he was dull and heavy before. His one thought is to find a mate and help her to cover up her eggs. To do this a number of lampreys find their way up the river and set to work. Sometimes one pair go alone, sometimes several together, and they twirl round and round so as to make a hole in the sand, lifting even heavy stones out with their mouths if they come in the way. Then they shed the spawn into the hole, where it is soon covered with sand and mud, to lie till it is safely hatched, and when this is done the marine lampreys swim out to sea to feed on the numberless small creatures in it, or to fasten upon some unfortunate fish.

But there are round-mouthed fishes even more greedy than these. It is not only among the lower forms of life that some creatures, such as worms, which are driven from the outer world, find a refuge inside other animals. But here again we meet with the same thing, for those relations of the lampreys, the hags or borers, which we mentioned above, use their sharp teeth to bore their way into other fish so as to feed upon them. These greedy little creatures actually drill holes in the flesh of the cod or haddock and other fish, and eat out the inside of their bodies, so that a haddock has been found with nothing but the skin and skeleton remaining while six fat hags lay comfortably inside.

So the round-mouthed fishes, feeble though they are, hold their own in the world. How long ago it is since they first began the battle of life we shall probably never know for certain; but if some little horny teeth[6] found in very ancient rocks belong to their ancestors, they were most likely among the first backboned animals on our globe. At any rate they are very interesting to us now, for they have wandered far away from the true fishes, and give us a glimpse of some of the strange by-paths which the backboned animals have followed in order to win for themselves a place in the race for life.

CHAPTER II

HOW THE QUAINT OLD FISHES OF ANCIENT TIMES HAVE LIVED ON INTO OUR DAY

Who is there among my readers who wishes to understand the pleasures, the difficulties, and the secrets of fish life? Whoever he may be he must not be content with merely looking down into the water, as one peeps into a looking-glass, or he may, perchance,

only see there the reflection of his own thoughts and ideas, and learn very little of how the fishes really feel and live. No! if we want really to understand fish-life we must forget for a time that we are land and air-breathing animals, and must plunge in imagination into the cool river or the open sea, and wander about as if the water were our true home. For the fish know no more about our land-world than we do about their beautiful ocean-home. To them the water is the beginning and end of everything, and if they come to the top every now and then for a short air-bath they return very quickly for fear of being suffocated. Their great kingdom is the sea—the deep-sea, where strange phosphorescent fish live, lying in the dark mysterious valleys where even sharks and sword-fish rarely venture;—the open sea, where they roam over wide plains when the ocean-bottom makes a fine feeding-ground, or where they thread their way through forests of seaweed, while others swim nearer the surface and come up to bask in the sun or rest on a bank of floating weed;—and the shallow sea, where they come to lay their eggs and bring up their young ones, and out of which many of them venture up the mouths of rivers, while others have learnt to remain in them and make the fresh water their home.

The tender little minnows that bask in the sunny shallows of the river have never even seen the sea, their ancestors left it so long long ago; yet to them, too, water is life and breath and everything. The green meadow through which the river flows is just the border of their world and nothing more, and the air is boundless space, which they never visit except for a moment to snap at

a tiny fly, or when they jump up to escape the jaws of some bigger fish. Every one knows the minnow, and we cannot do better than take him as our type of a fish in order to understand how they live and move and breathe. Go and lie down quietly some day by the side of the clear pebbly shallows of some swiftly-flowing river where these delicate little fish are to be seen; but keep very still, for the slightest movement is instantly detected. There they lie

> "Staying their wavy bodies 'gainst the streams
> To taste the luxury of sunny beams
> Tempered with coolness. How they ever wrestle
> With their own sweet delight, and ever nestle
> Their silver bellies on the pebbly sand!
> If you but scantily hold out the hand,
> That very instant not one will remain;
> But turn your eye and they are there again."

If you can be motionless and not frighten them you may see a good deal, for while some are dashing to and fro, others, with just a lazy wave of the tail and the tiny fins, will loiter along the sides of the stream, where you may examine their half-transparent bodies. Look first at one of the larger ones, whose parts are easily seen, and notice how every moment he gulps with his mouth, while at the same time a little scaly cover (*g c,* B, Figure 4) on each side of the head, just behind the eye, opens and closes, showing a red streak within. This is how he breathes. He takes in water at his mouth, and instead of swallowing it passes it through some bony toothed slits (*g,* A Figure 4) in his throat into a little chamber under that scaly cover; in that chamber,

fastened to the bony slits, are a number of folds of flesh full of blood-vessels, which take up the air out of the water; and when this is done he closes the toothed slits and so forces the bad water out from under the scaly cover back into the river again. It is the little heart *(h)*, lying just behind the gills, which pumps the blood into the channels in those red folds, and as it keeps sending more and more, that which is freshened is forced on and flows through the rest of the body. It goes on its way slowly, because a fish's heart has only two chambers instead of four as we have, and these are both employed in pumping the blood *into* the gills, so that for the rest of the journey through the body it has no further help. For this reason, and also because taking up air out of the water is a slow matter, fish are *cold-blooded* animals, not much warmer than the water in which they are.

But while our minnow breathes he also swims. He is hardly still for a moment, even though he may give only the tiniest wave with his tail and fins, and he slips through the water with great ease, because his body is narrow and tapers more or less at both ends like a boat. At times, too, if he is frightened, he bounds with one lash of his tail right across the river; and if you look at one of the small transparent minnows you will see that he has power to do this because his real body, composed of his head and gills, heart and stomach, ends at half his length (see Figure 4, A), and all the rest is tail, made of backbone and strong muscles, with which he can strike firmly. This is one great secret of fish strength, that nearly one half of their body is an implement for driving them through the water and guiding them on

their way. Still although the tail is his chief propeller, our minnow could not keep his balance at all if it were not for his arm and leg fins. You will notice that it is the pair of front fins *(af)* which move most, while the under ones *(lf)* are pressed together and almost still. Besides these two pairs he has three single fins *(sf)*, one

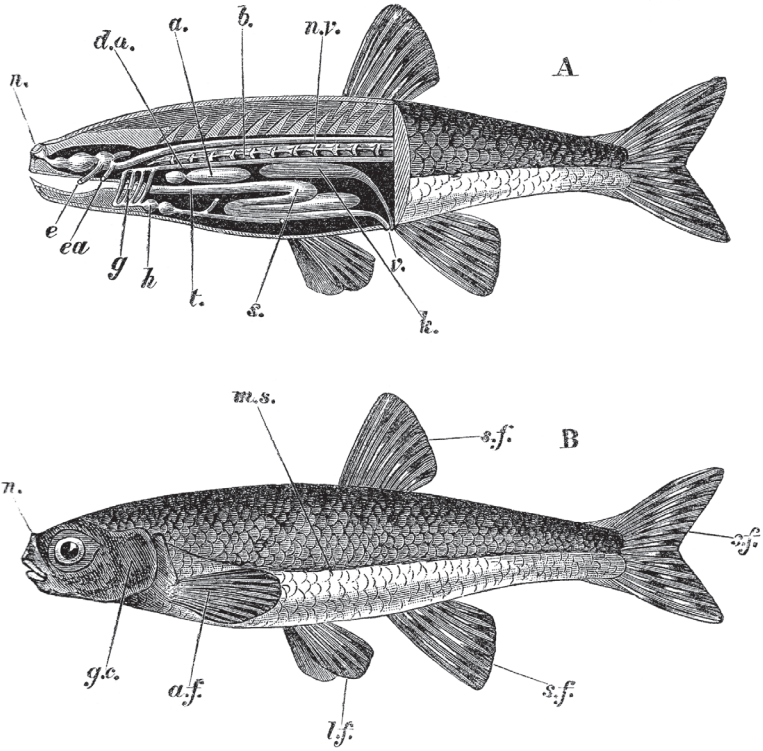

FIGURE 4

The structure of the Minnow and the living fish

A *n,* nose-pit; *e,* eye-nerve; *ea,* ear-nerve; *g,* gills; *h,* heart; *t,* food-tube; *s,* stomach; *k,* kidney; *v,* vent; *da,* dorsal-artery; *a,* air-bladder; *b,* backbone; *nv,* nerve cord or spinal cord.

B *n,* nose; *gc,* gill cover; *af,* arm-fin; *lf,* leg-fins; *sf,* single fins; *ms,* mucous scales.

under his body, one large V-shaped one at the end of his tail, and another single one upon his back. All these different fins help to guide him on his way; but while the single ones are fish-fringes, as it were, like the fringe round the lancelet's body, only split into several parts, the two pair under his body are real limbs, answering to the two pair of limbs we find in all backboned animals, whether they are all four fins, or all four legs, or wings and legs, or arms and legs.

These paired wings are most important to the minnow, for, if his arm-fins were cut off, his head would go down at once, or, if one of them was gone he would fall on one side, while, if he had lost his fins altogether, he would float upside down as a dead fish does, for his back is the heaviest part of his body. It is worth while to watch how cannily he uses them. If you cannot see him in the stream you can do so quite well in a little glass bowl, as I have him before me now. If he wants to go to the left he strikes to the right with his tail and moves his right arm-fin, closing down the left, or if he wants to go to the right he does just the opposite; though often it is enough to strike with his tail and single fin below, and then he uses both the front fins at once to press forward.

But how does he manage to float so quietly in the water, almost without moving his fins? If your minnow is young and transparent you will be able to answer this question by looking at his body just under his backbone, and between it and his stomach. There you will see a long, narrow, silvery tube (*a,* Figure 4) drawn together in the middle so that the front half near his eyes looks

like a large globule of quicksilver, and the hinder half like a tiny silver sausage. This silvery tube is a bladder full of gas, chiefly nitrogen, and is called the *air-bladder.* Its use has long been a great puzzle to naturalists, and even now there is much to be learnt about it. But one thing is certain, and that is, that fish such as sharks, rays, and soles, which have no air-bladders, are always heavier than the water, and must make a swimming effort to prevent sinking. Fish, on the contrary, which have air-bladders, can always find some one depth in the water at which they can remain without falling or rising, and we shall see later on that this has a great deal to do with the different depths at which certain fish live. Our minnow floats naturally not far from the top, and, even if he were forced to live farther down, the gas in his bladder would accommodate itself after a few hours if the change was not too great, and he would float comfortably again.

And now the question remains, What intelligence has the minnow to guide him in all these movements? If you will keep minnows and feed them yourself every day you will soon find out that they see, smell, and feel very quickly, though their hearing and taste are not so acute. They are cunning enough too, and will often steal a march upon heavier and slower fish, snatching delicate morsels from under their very noses. For our little minnow can boast of a real brain, though it is a small one in comparison with his size. All along, above his delicate backbone, the thread of nerve telegraph (*nv,* Figure 4) runs under protecting bony arches, and sends out nerves on all sides to the body and fins; and

when it reaches the head it swells out, under a bony covering, into a small brain, sending out two nerves to the ears *(ea),* in front of which is a second part, with two nerve-stations *(e)* for the eyes, and beyond this a third part, with two more for the nostrils, besides others which go to the face. Look on the top of a minnow's head and you will see two little raised bumps *(n).* These are its nostrils, but remember they have *nothing to do with breathing;* they have not even any connection with the mouth, but are simply little covered cups, each with two openings for water to flow in and out, and they are lined with nerves, which, tickled by good or bad scents in the water, carry to the brain a warning, or a promise of good things.

Such, then, is our little minnow, and the different parts of his body are supported by a slender bony-jointed backbone, with ribs growing from it, supporting a strong mass of flesh on his sides. He is a delicate tender creature, but is protected and buoyed up by the water, out of which he never attempts to go. The thin, rounded, transparent scales which cover his body, growing out of little pockets in his skin, just like our nails on the tips of our fingers, protect this skin from the water and from rough treatment; while they themselves are kept soft by a slimy fluid which oozes out from under them, and especially through the dark line of larger scales (*ms,* Figure 4) running along his body.

Now the minnow is a bony fish, and from it we can learn very fairly what bony or modern fishes are like. But these fish were not the founders of the race; long before they existed there was another very ancient

group of fishes in the world, which were in many ways more like the lancelet and the lamprey; and to find such descendants of this ancient group as are now living we must leave the river and find our way into the open sea.

If we do this, we shall travel not many miles from the shore in summer, wending our way through shrimps and lobsters, gurnards, cod-fish, soles, and turbot, before we may chance to come across a great Blue shark, with his slaty-coloured back and fins, swimming heavily but strongly through the water, and turning sharply from time to time to seize a passing fish, his white belly gleaming like a flash of light as it comes uppermost, and then disappearing again in the dark water.

> "His jaws horrific, armed with threefold fate,
> Here dwells the direful shark."

Or if this formidable monster does not happen to be in the neighbourhood another kind, the Dogfish, may cross our path, perhaps the Smooth hound, crushing the crabs and lobsters in his tooth-lined mouth, or the Rough hound fastening her purse-like egg to the sea-weed by its long string-like tendrils; or, farther out still, we may perhaps see the Thresher shark lashing the water with his long pointed tail, to drive the frightened fish within his reach; or, if we were off the west coast of Ireland, the huge but harmless Basking shark might be floating calmly by in the warm sunshine. For sharks travel all over the ocean, and though they prefer the warm seas, where they sometimes reach a size of forty feet long and more, yet many of the smaller kinds visit our coasts in summer.

Now, at first sight we might imagine that these huge monsters, the terrible tyrants of the sea, must be the last and most finished production of fish-life; but if we look a little closer we shall be undeceived. Examine a shark in any good museum, and you cannot fail to be struck with his strange form. Look first at his tub-like body, so different from the narrow wedge-shape of the minnow, the herring, or the salmon. Then observe his skin, which is either tough, more like that of other animals, or thickly covered with short blunt teeth, which sometimes, especially in front of the fins, become long pointed spines. There is no trace of fish-scales here. Look at his mouth opening under his pointed snout, and you will see that as the skin turns over the lips these blunt teeth line his mouth, so that he has several rows fit for biting, and they are sometimes so formidable that they can cut a man in two at one snap. Then look more especially at the sides of his throat, and there you will see on each side from five to seven slits, reminding you at once of the slits of the lamprey, though they are long instead of round. For the shark has never arrived at having true gills under a horny cover like the minnow, but still breathes by pouches and slits somewhat after the way of the lowly round-mouthed fishes. Lastly, observe his curious tail. In nearly all living fish the tail is even[7] or V-shaped, but in the sharks the top point is usually longer than the lower one,[8] and in some, such as the Thresher, it is very remarkably so.

[7]Homocercal

[8]Heterocercal

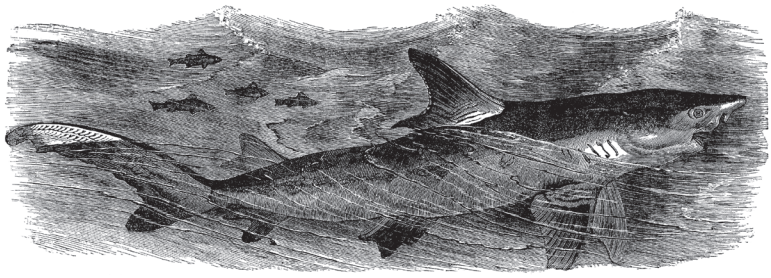

FIGURE 5

The Blue Shark (Carcharias glaucus) (from Brehm)

To show the five slits in the neck, the uneven tail, and the mouth opening under the pointed snout

This uneven tail is the badge of a very ancient race; out of the shark family we scarcely find it anywhere now except among the sturgeons, who, we shall see, are old-fashioned too.

And now when we inquire into the growth of the shark and the kind of backbone he has, we find that he has still more links with the lower fish-like animals. For when he is young he has nothing but a rod of gristle or cartilage running between the long narrow feeding-tube and the spinal cord; but this rod is flattened in front, and as the young shark grows up the flat part enlarges so as to form a boat-like box—the skull, round the swollen end of the nerve telegraph—the brain. Meanwhile the rod becomes divided into rings, and from each ring an arch of gristle growing upwards surrounds the nerve cord so as to protect it from injury, and the whole skeleton becomes firm and strong. But though the shark is one of the strongest of sea-animals

he never loses this gristly state of his backbone or his skeleton; however much he may strengthen it by hard matter it never becomes true bone, but remains quite distinct from the skeleton of the bony or osseous fish.

We see, then, that there is a race of gristly or *cartilaginous* fishes, which, though they have grown strong and powerful, still hold to many primitive habits in forming both their body and skeleton. Nor do the sharks stand alone, for the large sturgeons, which live partly in the sea and partly in fresh water, crowding up the rivers of Russia and America to grope in the river mud for food, and to lay their millions of eggs, are also remnants of the ancient type. It is true that with them the slits in the neck are covered by a horny flap like the bony fish, and like them too they have an air-bladder

FIGURE 6

The Sturgeon (Acipenser sturio) entering a Russian river

under the backbone.[9] But they too have a gristly skeleton, and the gristly rod more or less hardened runs right along their back. In other respects they are perhaps even more peculiar than the sharks; for the sturgeon's head is covered with hard bony shields, and five rows of bony bucklers are arranged along his body. We seem almost to have got back among the armour-covered animals as we look at his shiny plates, reminding us that with a mere gristly skeleton within, it may have been wise for the early types of fish to wear some outward protection. His snout is long and pointed, with four delicate feelers hanging down from it, and his mouth, which is quite under his head, is a soft open tube without teeth, which he can draw up or push out to suck up fish or any animal matter he finds in the mud.

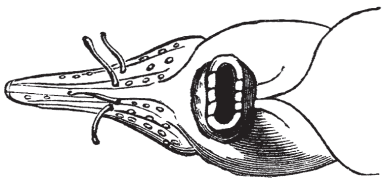

FIGURE 7

The Sturgeon's head seen from below, showing the tube-like mouth and the four barbels or feelers

Clearly the sturgeon is an old-fashioned fellow, as you may see for yourself; when specimens caught at the mouths of our rivers are shown in the fishmongers' shops. I have often wondered, when standing looking at him and at the sharks in the British Museum, whether the people who stroll by have any idea what a strange history these quaint old fishes have, or how they stand there among the scaly and bony fishes lying in the cases around, just as an Egyptian and a Chinaman might

[9]Isinglass is made from the covering of this air-bladder.

stand in an English crowd, descendants of old and noble races of long long ago, whose first ancestors have been lost in the dim darkness of ages, whose day of strength and glory was at a time when the modern races had not yet begun to be, and whose representatives now live in a world which has almost forgotten them.

In the silent depths of the large lakes of North America there is a fish called the Bony pike,[10] a huge fellow often six feet long, with a long beak-shaped mouth, which he snaps as he goes, devouring everything that comes in his way. This fish has his body covered with lozenge-shaped, bony, enamelled scales, like the fish of long ago, and so too has the strange Bichir,[11] which wanders above the cataracts of the Nile, with its row of eight to eighteen fins raised upon its back like tiny sails. Then again there are the curious calf-fish of North America,[12] of the Amazons,[13] of the Nile,[14] and of the rivers of Queensland in Australia.[15] These all have gristly skeletons, and together with the sharks and sturgeons make up all that remains of those strange shadows of the past moving among the bony fishes of to-day.

[10] *Lepidosteus*

[11] *Polypterus*

[12] *Amia*

[13] *Lepidosiren*

[14] *Protopterus*

[15] *Ceratodus*

The mud-fishes are indeed the most curious of all, for they breathe both water and air, and in the Nile and Gambia often coil themselves round in the mud when the water goes down, and, lining their bed with slime, sleep comfortably till the rains refill the pools with water.[16] The fact is they have two quite separate ways of breathing. They have gills with which they can take air out of the water like other fish, and these they always use when they can. But they have a tube in their throat leading into the air-bladder lying under their backbone, and through this they can breathe in air when they cannot get it from the water. In *Amia* especially, which

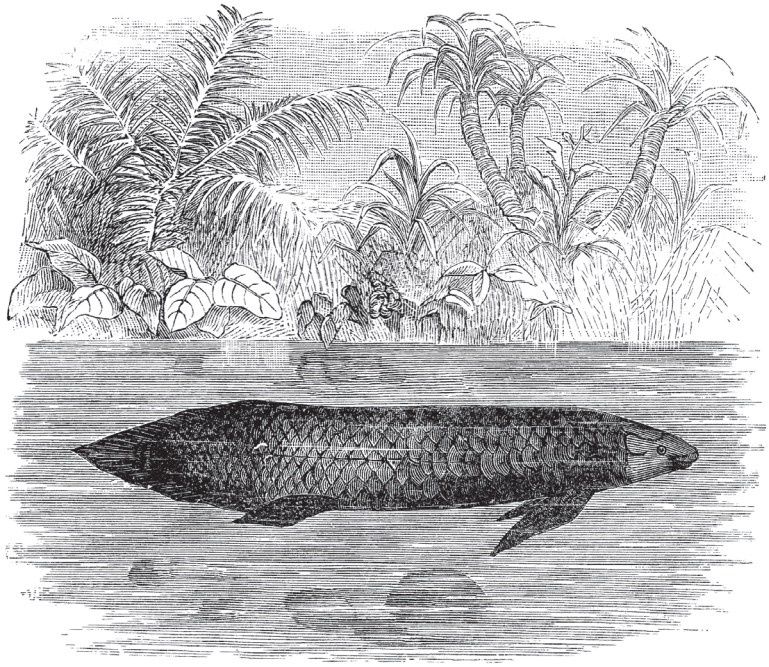

FIGURE 8

The Ceratodus of Queensland, an air-breathing and water-breathing mud-fish of the ancient type, with paddle-fins

is a true enamel-scaled fish, this air-bladder is divided into numerous cells, and it breathes with it just as with a lung.

It was in the year 1870 that the *Ceratodus,* or the "Barramunda," as the Australian natives call him, was discovered in the rivers of Queensland; and since then he has become very famous, for, more than any of the others, he is like the fishes of long ago. He is a lumpy fish, sometimes as much as six feet long, with a gristly cord for a backbone. His body is covered with large rounded scales, and he has a broad fringe round his pointed tail. His fins are more like paddles than fish fins, having several joints, and he uses them, together with his fringed tail, to flap along in the water, or even to wander over the reedy flats at night, chewing the weeds with his broad ridged teeth. And as he flaps along, from time to time, when the water is too muddy for his liking, he comes up to the top, and with a great gulp swallows air into the air-chamber. But before he can do this he must send out the bad air within, and in doing so he gives a grunt which is often heard far away at night in those still Australian wilds. He need not come up for air-breathing, however, if the water is pure, for, strange to say, the whole course of his blood can be altered to suit his wants. When he can get clear water to breathe through his gills the blood flows to them to be freshened, and his air-bladder simply takes in gas from the body as it does in other fishes, and wants feeding with good blood. But when he comes up to breathe then the blood is carried the other way, and comes to the air-bladder to be freshened.

And now if we want to read the history of all these strange forms, you must let me take you by the hand and lead you in imagination back, back through millions of years, to a time so long ago that we cannot even count the ages between. As we recede from our own day we shall leave behind us all the kinds of plants and animals we now know so well, and meet with strange kinds only bearing a general resemblance to them. After a long journey of thousands and thousands of years, in which the plants and animals, and even the very shape of the continents and islands, have gone through many changes, we shall get back to the time when the lime-builders were forming thin layers of chalk at the bottom of the sea, which were afterwards to become our enormous chalk hills. Still backwards we must go through all that long period, and then through three others quite as long, with ever-changing scenes of life and climate and geography, till we find ourselves in those grand old forests whose trees and plants we now dig out as coal.

Even then we must not stop to rest, though we are getting back to the dim ages of the world, for the journey is not yet ended. On, on, backwards through countless years, till we lose sight not only of beasts and birds and reptiles, but even of insects and flowering plants, which, at the time we are reaching, had not yet begun to be. At last we lose almost all life upon the land, so far as we can tell, and after another long period has passed before us we find ourselves in a scene of *water, water everywhere.*

True, there is a line of shore where strange ferns and unknown club-mosses and reed-like plants are growing; but these only border the vast water-world, and we have reason to believe that no living animal wanders over that wild and barren country. But the water itself is full of life, though its inhabitants are of low kinds, as if Nature herself was as yet only half-awake.

Rich and rare seaweeds carpet the floor of the ocean, mingled with delicate flint-sponges and old massive corals; beautiful feather-stars in the form of rooted stone-lilies wave their slender arms; greedy star-fish, grazing sea-urchins, and all their many relations, grope upon the rocks; and sea-snails crawl or float in countless numbers. The Nautilus, too, is there, with curious half-uncoiled companions of forms we have never seen before; and huge sea-woodlice, the Trilobites of olden time with their three-ridged shields, burrow in the sand, or roll themselves up at the bottom of the water. And above all these, among many kinds of armour-covered animals, a huge form, nine feet long, like a lobster, with an imperfect head, rows himself along with his oar-like hind feet, seizing the smaller creatures with his long nipping claws in front. For we have travelled back to a time when the crustaceans were the most powerful animals in the world, and the huge lobster-like Pterygotus was the monarch of the seas.

It was in the midst of a scene such as this that we first find the feeble ancestors of the Sturgeon and the Shark beginning to make their way in the world. It may be that creatures such as the sea-squirts, the lancelet, and the lamprey, were there to bear them company, but

these soft animals could leave no trace behind except the tiny teeth of the lampreys; for they had no enamelled plates like the plated fish, no hard teeth-spines like the sharks, which could become buried in the soft mud when they died, and remain, together with the hard shell of their enemy the Pterygotus, to be dug out now in our day and bear witness to the fight they fought. But the plated-scaled fish had something to leave behind, and from their remains we can picture to ourselves a group of clumsy fish scarcely a foot long, with hind fins like paddles and single-fringe fins on their back, with enamelled lozenge-shaped plates on their bodies and unevenly pointed tails. These fish would keep well out of the way of the Pterygotus, because they were small and weak and he was large and strong. We may imagine them gliding among the seaweeds, and hugging the shore as they chewed the plants with their flat-ridged teeth, for their skeletons were probably feeble and their armour-like shields were heavy, and they would not be so active as the little shark-like animals, not bigger than a half-pound perch, with tough skins and sharp spines, which swam more boldly out to sea. These more active fish were the founders of the shark group, and those sharp spines, together sometimes with the tough skin, remained buried in the mud, and have come down to us as fossils.[17]

We should find it difficult to say exactly to what class all these early fish belonged, for there were very few kinds, and therefore fewer distinctions, between them in those days; and many peculiarities which

[17] *Ichthyodorulites*

afterwards appear in different groups either did not exist or were united in one fish. It is enough for us that they were the ancestors of our sharks and sturgeons and mud-fish of to-day; and though they were but small and weak, yet they were the beginning of a powerful race of creatures, for they had the great advantage of a growing inside skeleton, which could vary and strengthen with their bodies from generation to generation, while their rivals, the Pterygotus and his companions, had only their heavy cumbrous armour with a mass of soft flesh inside, and were but lumbering creatures at best.

And so we find that as thousands and thousands of years rolled by, the descendants of the enamel-shielded fish began to improve, and became larger and more powerful as the generations passed on, till they became masters of the shallow seas, and after awhile of the rivers and lakes. By the time that the first air-breathing creatures, the May-flies and Dragon-flies, had found their way out of the water into the forests of pines and tree-ferns on the land, and left their tender wings in the soft ground of the ponds and lakes, large fishes[18] whose tails were uneven-pointed like the sturgeon,—whose bodies were covered with lozenge-shaped enamelled scales and their heads with shields,—were grazing along the shores and in the rivers and bays, with probably swarms of smaller kinds which have left no traces behind.

These were peaceable fish which fed upon plants, and among them were some curious forms with paddle-like fins and broad-ridged teeth, which, as they swam

[18] *Dipterus*

under the shade of the huge forest trees, would come to the top and take in air through their mouth. These were the distant ancestors of our present mud-fishes, and through all the passing ages, from the time of the coal forests till now, they have kept their fish-like form, so that we have their descendants among us now in the Australian *Ceratodus* and the mud-loving *Protopterus* of the Nile.

But besides these gentle vegetarians there were in the sea huge enamel-scaled monsters, with terrible jaws and gigantic teeth, floundering about and making great havoc among the crab-like animals. One of these, whose head-shield has been found in the ancient rocks of Ohio in America,[19] must have been at least fifteen feet long, with a huge head, three feet long and a foot and a half broad; and no doubt there were many others like him, having a fine time of it now that they were the strongest creatures living. For this was the Golden Age of fishes, just before the time when the coal-forests grew; and the clumsy crab-like animals, and the trilobites, which had had their innings when the fish were small, now began gradually to be exterminated by their powerful enemies. Little by little they gave up the battle of life, and the larger ones died out altogether, leaving only those smaller crustaceans which did not clash with the fish.

So time passed on. The coal-forests grew, and died away and were buried; and as the ages rolled by a still stronger class of animals began to grow up which was to pay back upon the enamel-scaled fish the vengeance

[19] *Dinichthys*

they had wreaked upon the crustaceans. For in the coal forests we first meet with creatures like our newts and salamanders, and after these came the true air-breathing reptiles (see Chapter V), which swarmed over land and sea. There were the fish-lizards, with their strong swimming paddles and sharp teeth, and the swan-like lizards, with their long necks, which enabled them to strike their prey in the water; and these, together with the flying-lizards, and the huge dragon-like reptiles which haunted the shore, made the life of the heavily-moving enamelled fish a burden to them. So they, in their turn, began to give way, and became smaller and rarer as the history went on, till at the time when the chalk-building animals were at work at the bottom of the sea we begin to lose sight of all but those few forms which linger still. It was about this time that the Sturgeon, as we now know him, became the chief representative of these old cartilaginous fishes, and to this day he and his children go on travelling up the rivers of Europe, Asia, and America, or crossing from sea to sea—a living example of those ancient races which ruled the seas of long ago.

The history of the small shark-like animals was rather different. They too grew strong and powerful before the reptiles came, and they did not afterwards lose much of their greatness. With the wide ocean for their home, and not troubled with the heavy enamelled plates of their companions, they kept clear of the monster reptiles, or struggled with them bravely. Some took to the open sea, and from them are descended the giant sharks of to-day which still remain masters of

the ocean. Others still lingered near the shore, where we find quite new forms springing up; some, like the Chimæra or "King of the Herrings," formed a group of their own, half-way between sharks and sturgeons; and some, slightly flattened like the huge Monk-fish, hide themselves in the loose sand when seeking their prey. Others, the Skates and Rays, with flat bodies, and long tails serving as rudders, shoved smoothly along with a wavy flapping motion of their broad arm-fins. These too lie chiefly at the bottom of the sea, where their dusky colour hides them both from the fish they would wish to attack and those that would attack them; for while the sharks trust to their strength, the skates and rays trust to stratagem, and, coming along stealthily in the shadow, flap rapidly over their prey and suck them into their open mouth below. And for further protection we find some of them, such as the Sting-rays, armed with barbed spines; others, such as the Torpedo-fish, with electric batteries in their heads, which they can use to stun and kill their enemies; while others again, such as the Saw-fishes of the Tropics, have the front part of their skull lengthened out in a long bony weapon, armed with teeth, which they use to rip open the bodies of their prey.

All these formidable fish are descendants of the shark family, which, with powerful gristly backbones, strong fins and tails, and highly developed brains, refused to be suppressed as their plated companions were, but found room in the wide ocean to do battle for themselves, and improve in many ways upon their ancestors. They do not, like the sturgeon and the bony

fish, lay their thousands of eggs, but are content with one or two at a time, such as the leathery purse-eggs of the skate and the rough hound shark; or give birth to a dozen or twenty living young ones. Yet they are so well fitted for their life that they flourish and keep their ground, so that while the enamel-scaled fish and the mud-fish are small groups, many of them fading away, the sharks and rays bid fair to be the race which will keep up the traditions of those quaint old Fishes of ancient times, which were once the masters of the world.