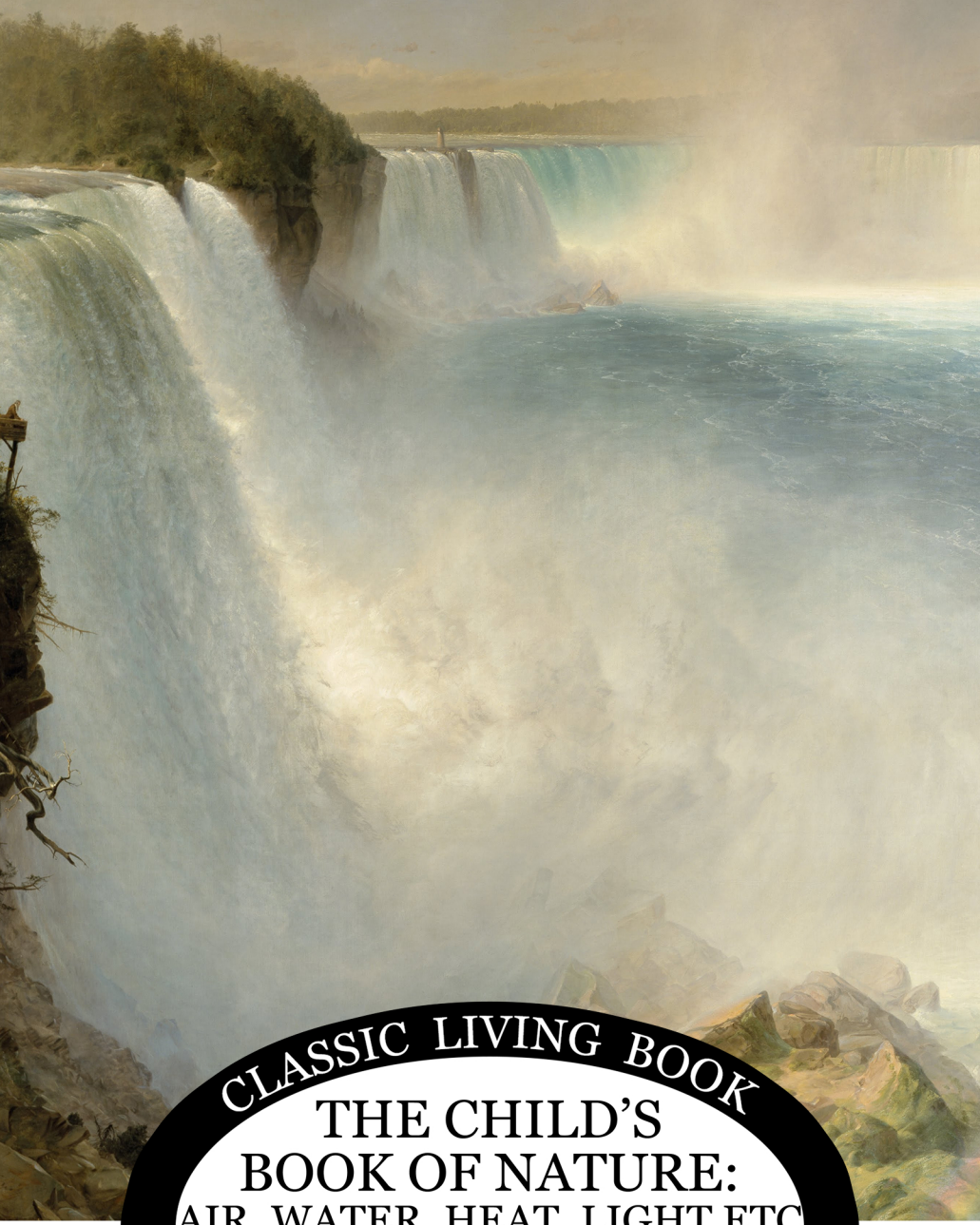

CLASSIC LIVING BOOK

THE CHILD'S BOOK OF NATURE: AIR, WATER, HEAT, LIGHT ETC

Worthington Hooker

COMPLETE AND UNABRIDGED

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WORTHINGTON HOOKER

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PREFACE.

THERE IS no obvious connection between the subjects now to be considered and those which were presented in Parts First and Second. But, after looking at what is of interest in the plants and animals that live in air and water, it seems appropriate to pass to the examination of the phenomena that air and water themselves furnish to us. And then with these subjects are naturally associated the other subjects contained in this Part—light, heat, electricity, etc.

Let me not be understood to say that the subjects treated in this Part are entirely disconnected from those in the other two Parts. There are many points of connection, resulting from the dependence of life upon air, water, heat, etc., and also from the mechanical principles that are brought into operation in the living machinery of both plants and animals. Still, the connection is not of that obvious and intimate character which we see between the subjects of Parts First and Second.

I have placed these subjects last in the Child's Book of Nature because they are not, for the most part, so easily understood as the subjects contained in the other Parts. The mind of the learner needs the training in observation and reasoning which it has in studying the phenomena of plants and animals to enable it to grasp all of the points which are here presented; and as in matter, so in style, I have supposed an advance of mental power in the learner. I have relaxed a little my strictness in simplicity. Indeed, I did so in a small degree in the Second Part. I have been careful, however, not to allow myself too much latitude in this respect, but have endeavored throughout to make

the advance both in style and matter to correspond with the advance of mental capacity in the learner, and not go beyond it.

The subjects of this Part are those which are commonly ranged under the general term Natural Philosophy. They are not presented either formally or fully, but those points are selected which will interest a young beginner and be intelligible to him. I have made it an object to exclude all that are of a different character, for it is very important that the young learner should not be discouraged with difficulties and burdened with uninteresting matters at the outset.

It will be seen, however, that in making the selection alluded to, I have, after all, given quite a full view of the fundamental parts of the different subjects. The simple principles which form the basis of Natural Philosophy are most of them very fully illustrated. And I can not forbear remarking that many older scholars, who have pursued the study in the more formal manner common in our schools, might find their ideas rendered more clear and definite by looking at the simple views here presented.

I would call the attention of the teacher to one feature in my mode of developing scientific subjects to the young, which I deem to be of great importance. I observe a natural gradation in their development, beginning with the simplest views, and leading the learner gradually to those that are more complex and less easily understood. Not only is one thing given at a time, but each thing is put in its right place. I will cite a single example. Take what is said about air. First, the simple and single fact that it is a material thing is illustrated. This is followed by noticing what it does when in motion. Then I show how, by its resistance, birds

and insects rise on the wing. Next I pass to the pressure of the air, first illustrating, in a simple way, the fact of its pressure in all directions, and then passing to show how its pressure operates in the pump and in the barometer. Then come illustrations of its pressure as exhibited in experiments with the air-pump, the immense pressure which the body sustains from it, and the manner in which it does this being especially noticed and explained. Next follows the elasticity of the air when compressed, illustrated by the operation of pop-guns, air-guns, etc. Then is illustrated the pressure of the air in making balloons, bubbles, and other light things rise in it. This leads naturally to the consideration of the rising of smoke and the operation of chimneys. And then, lastly, in the latter part of the book, the action of the attraction of gravitation upon the air is noticed, thus ultimately arriving at the real cause of most of the phenomena of the air's pressure.

Another feature, to which I will barely allude, is a frequent reference to analogies. Thus, for example, in giving the facts about air, I point out the resemblance between flying and swimming, between the action of compressed air and that of compressed steam, and of the gases produced by burning powder, etc. This feature not only adds interest to the various subjects, but makes the points in hand more clear, and gives a wider range to the views of the learner.

It is the author's intention to follow this with other books calculated to carry forward the scholar in his observation of nature. Indeed, I have already published two books, "First Book in Physiology" and "Human Physiology," by which the scholar can proceed with the study of the subjects treated of in Part Second of this book; and as soon as I can do so, I shall write some books for the purpose of

enabling him to go on with the study of the subjects treated of in the other Parts. The whole together will constitute to some extent a series of books on the sciences, adapted to the different degrees of advancement in the pupils.

It will be observed that in this Part there are many experiments spoken of. These the teacher should try before the pupils so far as is practicable. I have also made extensive use of common phenomena as illustrations of the points presented. This will tend to form in the scholar the habit of observing what is just around him—the common things, so much overlooked in education—a habit which is a never-failing source of information and enjoyment. And both teacher and scholar, if they catch the spirit which I have endeavored to infuse into the book, will from their own observation add to the illustrations that I have given, and thus materially increase the interest of the daily recitations.

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CHAPTER I.

AIR.

WE SPEAK of a room having no furniture in it as being empty; but this is not exactly so. There is one thing that it is full of up to its very top. It is a thing that you can not see; but it is as really a thing as the furniture that you can both see and feel. This thing is air.

If you take all your books out of a box in which you keep them, you think of the box as having nothing in it; but it is full of air; and when you shut it up and put it away, you put away a box full of air. When the books were in it, it was full of books and air together; but now it is full of air alone.

You see some boys playing foot-ball. What is it that they are kicking about? It is an India-rubber ball, you will say. But is this all? Is there not something else besides the India-rubber? Suppose that you prick a hole in the ball. It is good for nothing now; but the India-rubber is all there. What makes it good for nothing? It is because the air escapes from the hole. The ball is of no use unless you can keep it full of that thing that we call air; and in playing with it, you kick about air locked up in the India-rubber.

You have heard of life-preservers, and perhaps you have seen them. They are India-rubber bags that you can fill with air by blowing into them. They are made of such a shape that they can be tied around the body. When used in this way, a life-preserver will keep one from sinking in water. But why? It is the air in it that does this. The air is as really a thing as the water is, but it is a lighter thing, and therefore a thing full of air will float on the water. If you

kick a foot-ball into the water, it will float, because it is full of that light thing—air. But if you should prick a hole in it, and press out the air, and then throw it into the water, it would sink. So, too, the life-preserver would do no good if you tie it around you without blowing it up. It is the air that you blow into it that buoys you up in the water.

Why does a boat float on the water? It is not because the boat itself is lighter than the water is. It is commonly heavier, because there is so much iron about it. The reason that it floats is that it is full of air. Even a boat made entirely of iron will float for the same reason. But if there should be a leak, so that the boat can be filled with water, it will sink. So, too, it will sink if you put too much weight in it.

You have heard of life-boats. These are made in such a way that they will not sink, even if they are filled with water. How do you think that they are made to be so much lighter than other boats? It is not because they are built of different materials. They are made of wood, and are fastened together in every part with iron. Sometimes they are made entirely of iron. But they are built in a different way from common boats. They are made double, and in such a way that there are chambers of air between the two parts. These chambers are air-tight. If they were not they would do no good. If there were any opening into these chambers, the water would go in and force out the air. The boat would no longer be a life-boat. It would be of no more use than a life-preserver with no air in it, or with water instead of air.

You can not see air, although it is a thing; but you can sometimes feel it. You can not feel it while it is still, as you can such things as a table or water. You can only feel it when it is in motion. When the wind blows upon you,

it is air in motion that you feel. When there is a gust of wind, as we say, the air comes against you just as a wave of water does. When you fan yourself, you make the air strike upon your face, and you feel it as you feel any thing else that strikes you, as water or a stick.

The air is transparent, or clear, like glass; that is, it lets the light come through it to your eyes. Sometimes glass is not clear, and you can not see things plainly through it. So, also, the air is sometimes not clear, as when there is dust flying in it, or when there is a fog.

Though you can not see air, you can see what it does when it is in motion. You can see it move the trees and other things. This I will tell you about in the next chapter.

The air is a thing which is necessary to our life. If it be shut out in any way from our lungs, great distress is immediately produced; and if it be shut out only for a few minutes, death occurs. I have told you in Part II., in the chapter on breathing, why it is that breathing air is so necessary to life.

Air is as necessary to the life of plants as it is to the life of animals. In animals the air is used by lungs, but in plants it is used by the leaves. This I have told you about in the chapter on the uses of leaves, in Part I.

Air is needed for another thing. Nothing can burn without air. It is the air that makes wood, and coal, and oil, and gas burn when fire is put to them.

The air that is all around the earth does not reach to the sun, and moon, and stars. It extends about forty-five miles above the earth. Beyond this there is no air. You will want to know how this was found out, as no one has ever been so far from the earth. I will not explain this to you now, for you are not old enough to understand it.

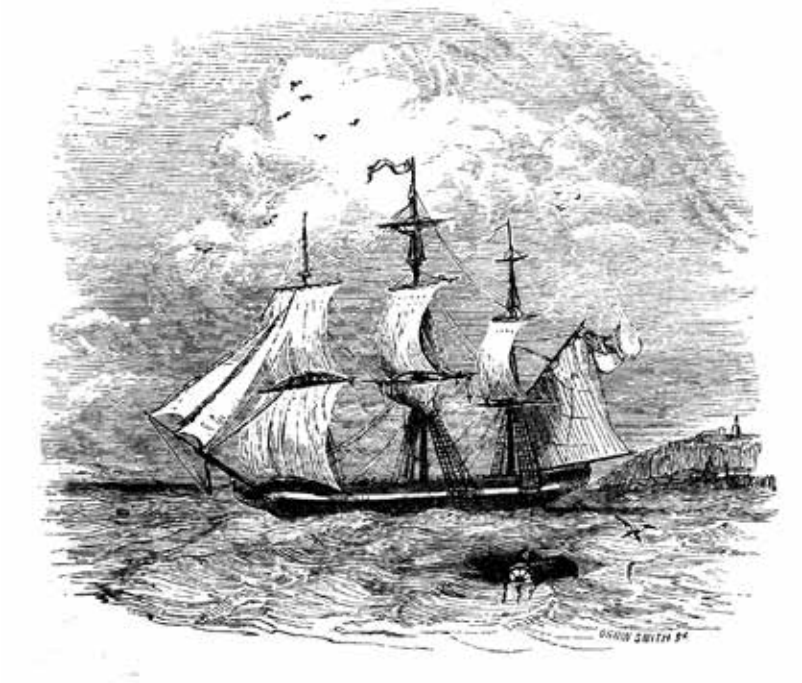
Questions.—*What* is a room full of when the furniture is all taken out? Tell about the box of books and about the foot-ball. What is said about life-preservers? Why does a boat float on the water? How are life-boats made? Can you see air? Can you feel it when it is still? What is wind? What is said about the transparency of air? What is said about its being necessary to the life of animals? What about its being necessary to the life of plants? What else is air needed for? How high does the air extend?

CHAPTER II.

AIR IN MOTION.

THE AIR, when it is in motion, does a great deal of work for us. It pushes along the ships in the water. Perhaps you think that it hardly sounds right to say that the air pushes the ships; but it really does push them. The sails are large, broad handles for the air to press against in pushing the vessels along in the water. On this page is a ship with many sails, and most of them are unfurled, or put out for the breeze to press upon.

The air would push a vessel along to some extent, even if there were no sails, by pressing or blowing against the



body of the vessel; but, unless the wind blew very strong, the air would not push it along very fast in this way. And so sails are put up on masts, that more of the air may get hold, as we may say, so as to press on the vessel.

Sometimes the wind helps you along as you are walking. Now, if you take hold of your coat, and spread it out wide, as you see this boy is doing, it will be like a sail, and the wind will carry you along faster, because there is more for the air to press upon. So, too, if you have an umbrella open when the wind is blowing on your back, it will be to you as the sail is to the ship. But if you are going against the wind, the outspread coat and the open umbrella would prevent your getting along fast.

When a tree is bare, the wind scarcely moves its branches; but how it bends when it is full of leaves and the wind blows strongly upon it! It is then like a ship with its sails all unfurled; there is a great deal for the air to press upon.

Sometimes we say the wind blows very hard or very strong; this is when the air moves very fast. The faster it moves, the more it will do. This is so with other things. When you strike any thing very hard with a stick, you do it by making the stick move fast. When there is only a gentle breeze, that you can just feel, the air is moving very slowly; it is like the gentle touch with the stick. But

when the wind blows so hard that you can scarcely stand up, the air is moving very fast.

If a bullet is tossed to you, it will not hurt you to catch it, because it does not move very fast; but if a bullet shot from a gun should hit your hand, it would wound it, and perhaps go through it. The reason is, that the bullet moves so fast. The faster it moves, the more harm it will do. So the air, when it moves very fast indeed, is apt, like the bullet, to do harm.

You have seen a locomotive backed up against a train of cars to be hitched on. It does no damage, because it is backed up slowly. It only gives a little jerk, you know, to the whole train. Now, if it moved very fast, it would, when it came to the cars, break them to pieces. It is for the same reason that fast-moving air roots up trees, blows down houses, and drives ships on shore, dashing them against the rocks.

When the wind blows hard, the sailor takes in some of his sails. The vessel would go too fast if he left them all out, because there would be so much for the air to press on. If the wind blows very hard indeed, he takes down all the sails, fastening them very tightly, so that the wind may not loosen them. Even with all the sails down the ship will go quite fast enough, perhaps even too fast, pushed along by the wind that strikes right upon it. Here is a ship in a storm. You see how the sailors have tied up most of the sails. One of them has been torn from its fastenings by the violence of the wind, and is in tatters.

The waves that you sometimes see rise so high are made by the striking of the air upon the water; and the faster the air moves over the water, the higher they rise. When the air is very still there is scarcely a ripple, and the water

A coat used as a sail.

looks like smooth glass; and you would hardly think, as you look upon it, that such a light thing as air is could whip it into such waves as you sometimes see.

The waves in the ocean are much higher than they are in a river. This is because the wind blows over so much greater an extent of water in the ocean.

You have heard of whirlwinds. In these the air moves in a whirling way instead of straight forward. You sometimes see little whirlwinds in the street; and as shavings and other light things are whirled about in them, and are carried up in the air, you can imagine what damage large whirlwinds can do, twisting up trees and tearing houses in pieces.

As you can not see the air, and it is a very light thing, you commonly think of it as being almost nothing, and yet it does these great things that I have mentioned. When we see this light thing raise the waves, and move the heavy ships along so swiftly, we see that there is great power in it.

Questions.—*How* does the air make a ship go? What is the need of sails? What is said about the air's helping you along in walking? Why does the wind bend a tree so much that is covered with leaves? What is true about the air when the wind blows hard? Give the comparison about the stick, the bullet, and the locomotive. Why does the sailor take down some of his sails when the wind blows hard? What is said about waves? Why are they higher in an ocean than in a river? What is said about whirlwinds?

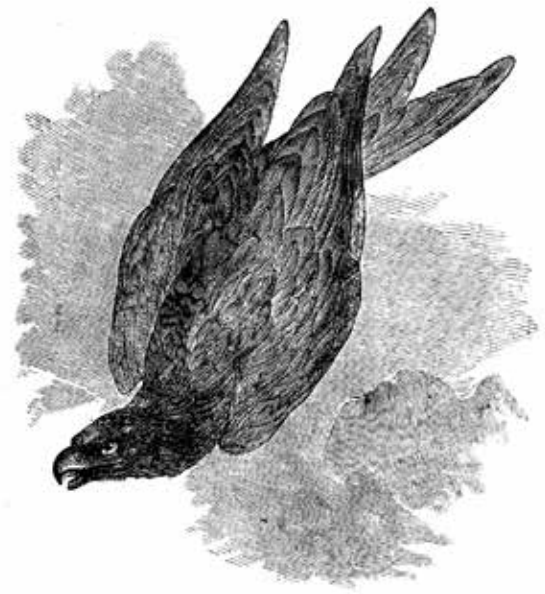
CHAPTER III.

FLYING AND SWIMMING.

YOU CAN jump off from the ground just a little way into the air, but you can not fly into it, as the birds do. It is because you have no wings. But how is it that the birds fly with their wings? They push themselves up with them into the air. But perhaps you will say that they do not have any thing to push against, for there is nothing but air about them. Now it is the air itself that they push against. They press down upon the air with their wings, just as you press with your feet on the ground when you jump up; and as the bird, when it gets once started, keeps working its wings, it goes up and up, pushing down against the air each time that its wings are moved.

It is necessary that birds should have very large wings to raise themselves up thus in the air. If their wings were small, they would do no good, because they would not press upon enough of the air. You can move your hands in the same way that the bird does its wings, but you can not raise yourself off from the ground. Why? Because your hands are so small that they press only upon a little of the air. If your hands were as broad for you as the wings of birds are for them, and you had the proper muscles to work them, you could fly.

You can learn to fly, but it is in the water, and not in the air, that you can do it. Swimming is really flying in water. The hands and feet do for the swimmer what the wings do for the bird. He presses against the water with his hands and feet in the same way that the bird does against



The tail of a fish like a sculling oar.

the air with its wings. Sometimes you see a bird dive down from a great way up in the air, in the same way that the swimmer does in the water. When it does this its wings are very still, and are folded close to its side, as you see here in the kite; but when it goes up again it works its wings up and down, just as the swimmer works his feet and hands when he is rising in the water.

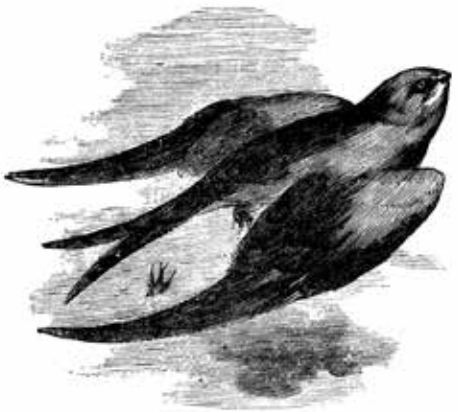
Fishes swim chiefly with their tails. The tail is to a fish in the water what wings are to a bird in the air. It acts like a sculling oar in a boat, as I told you in Part Second, Chapter XXIII. The fins are the balancers, while the tail works the fish forward by its quick movements to one side and the other. You can see this very plainly if you watch gold-fishes as you see them in a glass vessel.

Observe why it is that you can not fly with your hands in the air in the same way that you can swim with them in the water. The water gives way under your hands just as the air does, but the air gives way much more easily than the water, because it is so much lighter. As the air gets out of the way so easily, you can not fly in it unless you have something very broad, so as to press down on a great deal

of it at the same time. To fly, you must have large wings instead of small hands.

You can see what a difference there is between hands and wings by trying a little experiment. Move about your hand in the air. You do it with perfect ease, and the air does not seem to resist the hand at all. Now take a large palm-leaf fan and move that about. You can not do this so easily as you moved your hand, unless you move it edgewise. Why is this? Because it presses upon so much more air than your hand does, and the resistance of so much air to the fan you can feel as you push it out of the way. The fan takes hold, as we may say, of more air than your hand does, and so does also the wing of a bird.

Did you ever think how large wings you would need to fly with? You would have to press upon a great deal of air to carry your body up as the birds do theirs. See how large the wings of a bird are, as they are stretched out. They are both very long and very broad; and, besides, the bird is not so large as he seems to be. You will see this if all the feathers are stripped from its body. If this be done while the wings are left whole, it will seem to you that it takes very large wings to raise a very little body. You can see, then, that it would require very large wings indeed to carry your body up in the air; and still larger ones to carry up a man.



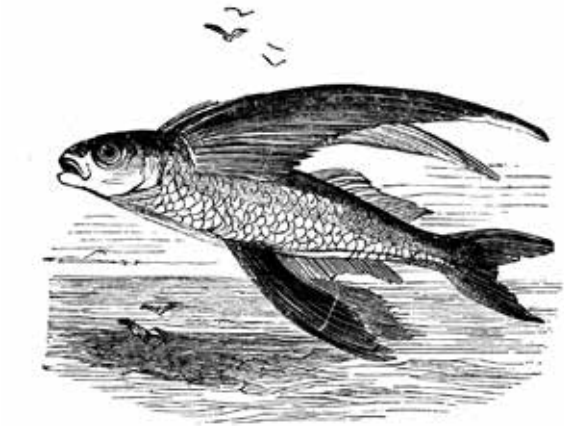
Wings of the swift.

Here is a bird that flies so fast that it is called the swift. Its wings, you

see, are very long. You do not see how broad they are, because they are not fully spread out in the figure.

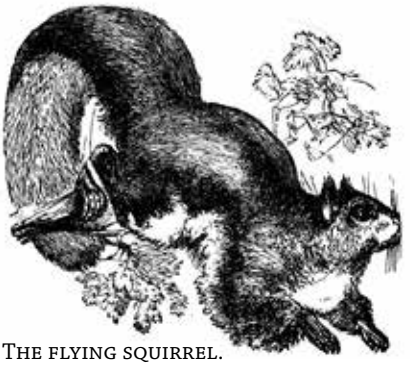
The flying bat

But there is no animal that has a greater extent of wing than the bat, unless it be some of the insects. This is the reason why it flies so swiftly. You can see in this figure of the long-eared bat what a large amount of air its wings press upon as it works them. The wings of insects that fly very swiftly are very large in proportion to their bodies. This you can see in the butterfly that flies so nimbly from flower to flower. Those that fly rather slowly, as the bumble-bee, have not very large wings.



The flying fish.

I believe that there is only one kind of fish that can fly in the air. It is represented here. You can see that the fins with which it flies are not nearly so large as the wings of a bird of the same size would be. It therefore can not fly very high or far. The highest that it was ever known to fly is twenty feet, and usually it skims along only two or three feet above the water. It does not go up into the air in the same way that a bird does. It gets


THE FLYING SQUIRREL.

its upward start from the water, and all that it does with its wing-like fins is to keep itself up, which it sometimes does for perhaps five or six hundred feet. It takes this flight in the air in fleeing from some large fish, and in this way often escapes being devoured.

That beautiful animal, the flying squirrel, which you see here, has a fold of skin extending from the fore leg to the hind leg on each side. These folds answer somewhat as wings when they are stretched out. Very graceful is the movement when the animal takes a long, flying sweep from one tree to another. But he can not go up in the air as a bird does, for the folds are not nearly so large as real wings, and so do not press upon enough air to carry him up. He can only take the sweep that I have mentioned.

Observe the shape of the wings of birds. They are rather rounded on the upper surface, and hollowed out underneath. They are shaped in this way to make the flying easy. This I will explain to you. When raising the wing, the air goes easily off from the rounded surface; but when it is moved downward, the air can not get away easily from the hollowed surface. The wing gets hold, as we may say, of some of the air, and, pressing upon it, raises up the bird.

You can see how this is by moving an open umbrella in the air. You can move it very easily if you push the outer rounded surface straight forward against the air. This is because the air moves off from the round surface of the umbrella as easily as it does from the upper surface of the

bird's wing. But if you move the umbrella with the inner hollowed surface against the air, you find it rather hard work. Why? It is because the air is caught in the hollow of the umbrella as it is in the hollow of the bird's wing.

But this is not all. The bird, in raising its wing, does not move it straight upward. It moves it in such a way that it rather cuts the air with its forward edge. It does this to get it up with little resistance from the air. But when it moves it downward, it wants to get as much resistance from the air as it can, so it moves it straight down, and not edgewise. You can see how this works by moving a palm-leaf fan about in the air. Move it edgewise, and it goes very easily. This is like the upward motion of the bird's wing. But move it broadside against the air, and you feel considerable resistance. That is, the air resists the pressure of the fan, just as it resists the pressure of the wing in the downward stroke.

The swimmer manages his hands in the water in the same way that the bird does its wings in the air. When he raises his hands forward, he does it edgewise; but when he presses them down, he moves them flat against the water, so as to press upon as much water as he can.

Questions.—How is it that birds fly? Why do they have large wings? Why can you not fly? How is swimming like flying? What do fishes swim with? Why can not you fly in the air as well as swim in the water? Tell about the experiment with the fan. What is said about the size of birds' wings? Tell about the bird called the swift. Tell about the bat. What is said about the flying fish? What about the flying squirrel? What is said of the shape of wings of birds? Give the comparison of the umbrella. Tell how the bird moves its wings upward and downward. Give the comparison of the fan. Give the comparison about swimming.