Young Folks' Library:
A Book of Natural History

by

David Starr Jordan, Editor

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Animals, Birds, And Fishes

BY
DAVID STARR JORDAN, LL.D.

This volume is made up from the writings of naturalists who have told us of the behavior of animals as they have seen it at first hand and of the beginnings and the growth of life so far as they know about it. In selecting these from the wealth of available material the editor has been guided by this rule: The subject matter must be interesting to young people; it must be told in a clear and attractive style; and most important of all, it must deal with actualities. We have seen in the last few years a marked revival of nature studies. This has led to a wider range of interest in natural phenomena and in the growth and ways of animals and plants. If this movement is not to be merely a passing fad, the element of truthfulness must be constantly insisted upon. If a clever imagination, or worse, sentimental symbolism, be substituted for the truth of nature, the value of such studies is altogether lost.

The essence of character-building lies in action. The chief value of nature study in character-building is that, like life itself, it deals with realities. One must in life make his own observations, frame his own inductions, and apply them in action as he goes along. The habit of finding out the best thing to do next and then doing it is the basis of character. Nature-study, if it be genuine, is essentially doing. To deal with truth is necessary, if we are to know truth when we see it in action. The rocks and shells, the frogs and lilies, always tell the absolute truth. Every leaf on the tree is an original document in botany. When a thousand are used or used up, the archives of Nature are just as full as ever. By the study of realities wisdom is built up. In the relations of objects he can touch and move, the child finds the limitations of his powers, the laws that govern phenomena, which his own actions must obey. So long as he deals with realities, these laws stand in their proper relation. "So simple, so natural, so true," says Agassiz. "This is the charm of dealing with nature herself. She brings us back to absolute truth so often as we wander."

So long as a child is led from one reality to another, never lost in words or abstractions,—so long this natural relation remains. "What can I do with it?" is the beginning of wisdom. "What is it to me?" is the beginning of personal virtue.

By adding near things to near, the child grows in Knowledge. Knowledge, tested and set in order, is Science. Nature-study is the beginning of science. It is the science of the child. The "world as it is" is the province of science. In proportion as our actions conform to the conditions of the world as it is, do we find the world beautiful, glorious, divine. The truth of the world as it is must be the final inspiration of art, poetry, and religion. The world, as men have agreed to say that it is, is quite another matter. The less our children hear of this, the less they may have to unlearn. Nature studies have long been valued as "a means of grace," because they arouse the enthusiasm, the love of work, which belongs to open-eyed youth. The child blasé with moral precepts and irregular conjugations turns with fresh delight to the unrolling of ferns or the song of birds.

Nature must be questioned in earnest, or she will not reply. But to every serious question she will return a serious answer. "Simple, natural, and true," she tends to create simplicity and truth. Truth and virtue are but opposite sides of the same shield. As leaves pass over into flowers, and flowers into fruit, so are wisdom, virtue, and happiness inseparably related.

This little volume is a contribution to the subject matter of Nature Study. It is the work of students of nature, and their work is "simple, natural, and true," in so far as it is represented here.

Leland Stanford Jr. University,
California, *April* 22, 1902.

The Wonder of Life

(From His Science Primer, Introduction.)

By
PROFESSOR, T. H. HUXLEY

Every one has seen a cornfield. If you pluck up one of the innumerable wheat plants which are fixed in the soil of the field, about harvest time, you will find that it consists of a stem which ends in a root at one end and an ear at the other, and that blades or leaves are attached to the sides of the stem. The ear contains a multitude of oval grains which are the seeds of the wheat plant. You know that when these seeds are cleared from the husk or bran in which they are enveloped, they are ground into fine powder in mills, and that this powder is the flour of which bread is made. If a handful of flour mixed with a little cold water is tied up in a coarse cloth bag, and the bag is then put into a large vessel of water and well kneaded with the hands, it will become pasty, while the water will become white. If this water is poured away into another vessel, and the kneading process continued with some fresh water, the same thing will happen. But if the operation is repeated the paste will become more and more sticky, while the water will be rendered less and less white, and at last will remain colorless. The sticky substance which is thus obtained by itself is called gluten; in commerce it is the substance known as maccaroni.

If the water in which the flour has thus been washed is allowed to stand for a few hours, a white sediment will be found at the bottom of the vessel, while the fluid above will be clear and may be poured off. This white sediment consists of minute grains of starch, each of which, examined with the microscope, will be found to have a concentrically laminated structure. If the fluid from which the starch was deposited is now boiled it will become turbid, just as white of egg diluted with water does when it is boiled, and eventually a whitish lumpy substance will collect at the bottom of the vessel. This substance is called vegetable albumin.

Besides the albumin, the gluten, and the starch, other substances about which this rough method of analysis gives us no information, are contained in the wheat grain. For example, there is woody matter or cellulose, and a certain quantity of sugar and fat. It would be possible to obtain a substance similar to albumin, starch, saccharine, and fatty matters, and cellulose, by treating the stem, leaves, and root in a similar fashion, but the cellulose would be in far larger proportion. Straw, in fact, which consists of the dry stem and leaves of the wheat plant, is almost wholly made up of cellulose. Besides this, however, it contains a certain proportion of mineral bodies, among them, pure flint or silica; and, if you should ever see a wheat rick burnt, you will find more or less of this silica, in a glassy condition, in the embers. In the living plant, all these bodies are combined with a large proportion of water, or are dissolved, or suspended in that fluid. The relative quantity of water is much greater in the stem and leaves than in the seed.

Everybody has seen a common fowl. It is an active creature which runs about and sometimes flies. It has a body covered with feathers, provided with two wings and two legs, and ending at one end in a neck terminated by a head with a beak, between the two parts of which the mouth is placed. The hen lays eggs, each of which is inclosed in a hard shell. If you break an egg the contents flow out and are seen to consist of the colorless glairy "white" and the yellow "yolk." If the white is collected by itself in water and then heated it becomes turbid, forming a white solid, very similar to the vegetable albumin, which is called animal albumin.

If the yolk is beaten up with water, no starch nor cellulose is obtained from it, but there will be plenty of fatty and some saccharine matter, besides substances more or less similar to albumin and gluten.

The feathers of the fowl are chiefly composed of horn; if they are stripped off and the body is boiled for a long time, the water will be found to contain a quantity of gelatin, which sets into a jelly as it cools; and the body will fall to pieces, the bones and the flesh separating from one another. The bones consist almost entirely of a substance which yields gelatin when it is boiled in water, impregnated with a large quantity of salts of lime, just as the wood of the wheat stem is impregnated with silica. The flesh, on the other hand, will contain albumin, and some other substances which are very similar to albumin, termed fibrin and syntonin.

In the living bird, all these bodies are united with a great quantity of water, or dissolved, or suspended in water; and it must be remembered that there are sundry other constituents of the fowl’s body and of the egg, which are left unmentioned, as of no present importance.

The wheat plant contains neither horn, nor gelatin, and the fowl contains neither starch, nor cellulose; but the albumin of the plant is very similar to that of the animal, and the fibrin and syntonin of the animal are bodies closely allied to both albumin and gluten.

That there is a close likeness between all these bodies is obvious from the fact that when any of them is strongly heated, or allowed to putrefy, it gives off the same sort of disagreeable smell; and careful chemical analysis has shown that they are, in fact, all composed of the elements carbon, hydrogen, oxygen, and nitrogen, combined in very nearly the same proportions. Indeed, charcoal, which is impure carbon, might be obtained by strongly heating either a handful of corn, or a piece of fowl’s flesh, in a vessel from which the air is excluded so as to keep the corn or the flesh from burning. And if the vessel were a still, so that the products of this destructive distillation, as it is called, could be condensed and collected, we should find water and ammonia, in some shape or other, in the receiver. Now ammonia is a compound of the elementary bodies, nitrogen and hydrogen; therefore both nitrogen and hydrogen must have been contained in the bodies from which it is derived.

It is certain, then, that very similar nitrogenous compounds form a very large part of the bodies of both the wheat plant and the fowl, and these bodies are called proteids.

It is a very remarkable fact that not only are such substances as albumin, gluten, fibrin, and syntonin, known exclusively as products of animal and vegetable bodies, but that every animal and every plant, at all periods of its existence, contains one or other of them, though, in other respects, the composition of living bodies may vary indefinitely. Thus, some plants contain neither starch nor cellulose, while these substances are found in some animals; while many animals contain no horny matter and no gelatin-yielding substance. So that the matter which appears to be the essential foundation of both the animal and the plant is the proteid united with water; though it is probable that, in all animals and plants, these are associated with more or less fatty and amyloid (or starchy and saccharine) substances, and with very small quantities of certain mineral bodies, of which the most important appear to be phosphorus, iron, lime, and potash.

Thus there is a substance composed of water + proteids + fat + amyloids + mineral matters which is found in all animals and plants; and, when these are alive, this substance is termed protoplasm.

The wheat plant in the field is said to be a living thing; the fowl running about the farmyard is also said to be a living thing. If the plant is plucked up, and if the fowl is knocked on the head, they soon die and become dead things. Both the fowl and the wheat plant, as we have seen, are composed of the same elements as those which enter into the composition of mineral matter, though united into compounds which do not exist in the mineral world. Why, then, do we distinguish this matter when it takes the shape of a wheat plant or a fowl, as living matter?

In the spring a wheat-field is covered with small green plants. These grow taller and taller until they attain many times the size which they had when they first appeared; and they produce the heads of flowers which eventually change into ears of corn.

In so far as this is a process of growth, accompanied by the assumption of a definite form, it might be compared with the growth of a crystal of salt in brine: but, on closer examination, it turns out to be something very different. For the crystal of salt grows by taking to itself the salt contained in the brine, which is added to its exterior; whereas the plant grows by addition to its interior: and there is not a trace of the characteristic compounds of the plant's body, albumin, gluten, starch, or cellulose, or fat, in the soil, or in the water, or in the air.

Yet the plant creates nothing; and, therefore, the matter of the proteins and amyloids and fats which it contains must be supplied to it, and simply manufactured, or combined in new fashions, in the body of the plant.

It is easy to see, in a general way, what the raw materials are which the plant works up, for the plant get nothing but the materials supplied to it by the atmosphere and by the soil. The atmosphere contains oxygen and nitrogen, a little carbonic acid gas, a minute quantity of ammoniacal salts, and a variable proportion of water. The soil contains clay and sand (silica), lime, iron, potash, phosphorus, sulphur, ammoniacal salts, and other matters which are of no importance. Thus, between them, the soil and the atmosphere contain all the elementary bodies which we find in the plant; but the plant has to separate them and join them together afresh.

Moreover, the new matter, by the addition of which the plant grows, is not applied to its outer surface, but is manufactured in its interior; and the new molecules are diffused among the old ones.

The grain of wheat is a part of the flower of the wheat plant, which, when it becomes ripe, is easily separated. It contains a minute and rudimentary plant; and, when it is sown, this gradually grows, or becomes developed into, the perfect plant, with its stem, roots, leaves, and flowers, which again give rise to similar seeds. No mineral body runs through a regular series of changes of form and size, and then gives off parts of its substance which take the same course. Mineral bodies present no such development, and give off no seeds or germs. They do not reproduce their kind.

The fowl in the farmyard is incessantly pecking about and swallowing now a grain of corn, and now a fly or a worm. In fact, it is feeding, and, as every one knows, would soon die if not supplied with food. It is also a matter of every-day knowledge that it would not be of much use to give a fowl the soil of a cornfield, with plenty of air and water, to eat.

In this respect, the fowl is like all other animals; it cannot manufacture the proteid materials of its body, but it has to take them ready made, or in a condition which requires but very slight modification by devouring the bodies either of other animals or of plants. The animal or vegetable substances devoured are taken into the animal’s stomach; they are there digested or dissolved; and thus they are fitted to be distributed to all parts of the fowl’s own body, and applied to its maintenance and growth.

The fowl’s egg is formed in the body of the hen, and is, in fact, part of her body inclosed in a shell and detached. It contains a minute rudiment of a fowl; and when it is kept at a proper temperature by the hen’s sitting upon it, or otherwise for three weeks, this rudiment grows, or develops, at the expense of the materials contained in the yolk and the white, into a small bird, the chick, which is then hatched and grows into a fowl. The animal, therefore, is produced by the development of a germ in the same way as the plant; and, in this respect, all plants and all animals agree with one another, and differ from all mineral matter.

Thus there is a very broad distinction between mineral matter and living matter. The elements of living matter are identical with those of mineral bodies; and the fundamental laws of matter and motion apply as much to living matter as to mineral matter; but every living body is, as it were, a complicated piece of mechanism which "goes," or lives, only under certain conditions. The germ contained in the fowl’s egg requires nothing but a supply of warmth, within certain narrow limits of temperature, to build the molecules of the egg into the body of the chick. And the process of development of the egg, like that of the seed, is neither more nor less mysterious than that, in virtue of which, the molecules of water, when it is cooled down to the freezing-point, build themselves up into regular crystals.

The further study of living bodies leads to the province of biology, of which there are two great divisions—botany, which deals with plants, and zoölogy, which treats of animals.

Each of these divisions has its subdivisions—such as morphology, which treats of the form, structure, and development of living beings, and physiology, which explains their actions or functions, besides others.

Life Growth;—Frogs

From A Song of Life.)
By
MARGARET WARNER MORLEY

Somewhat higher than the fish in the scale of life is the frog. Although he begins life as a fish, and in the tadpole state breathes by gills, he soon discards the water-diluted air of the pond, and with perfect lungs boldly inhales the pure air of the upper world. His life as a tadpole, although so fish-like, is much inferior to true fish life: for though the fish has not the perfect lung, he has a modification of it which he fills with air, not for breathing purposes, but as an air-sac to make him float like a bubble in the water. Will he rise to the surface? he inflates the air-bladder. Will he sink to the bottom? he compresses the air-bladder. But in the frog the air-bladder changes into the lungs, and is never the delicate balloon which floats the fish in aqueous space. When the frog's lungs are perfected, his gills close, and he forever abandons fish-life, though being a cold-blooded creature he needs comparatively little air, and delights to return to his childhood's home in the bottom of the pond. But although he can stay under water for a long time, he is obliged to hold his breath while there, and when he would breathe must come to the surface to do so. It is possible to drown him by holding him under water.

As a feeder the frog relies upon animal life, which he expertly seizes with a tongue fastened by the wrong end, as compared with our tongues. He is a certain marksman, and when he aims at an insect the chances are that the insect will enter his stomach and be there speedily changed into a new form of animal life.

Although from the moment the gills disappear the frog is a true land animal, he is obliged, on account of the fish-like character of his young, to lay his eggs in the water. For this purpose the frogs enter the pools in early spring. The surface of every country pond swarms with the bright-eyed little creatures. They have awakened from a long, cold, winter sleep, to find the spring about them and within them. Life has suddenly become abundant and joyous. Their sluggish blood flows faster, their hearts beat quicker; they leap, they swim, they swell out their throats and call to each other in various keys. The toads are with them, and the pretty tree-frogs that change their color to suit their emotions. And all are rapturously screaming. Their voices are not musical, according to man's standard, but seem to afford great satisfaction to the performers in the shrill orchestra of the swamps, who thus give vent to the flood of life that sweeps through them after the still, icy winter.

As though the new spring-life were too plentiful to find room in the frogs and toads already existing, it calls for more frogs and toads; and new creatures are born to share the extra vitality. Like the flowers and the fish, the frogs, too, give forth new life. Within them, too, the miracle is performed. The tiny eggs of the one wake up and begin to grow. The tiny living bodies in the fertilizing principle of the other also wake up and begin to grow. But higher life is better guarded, because less prolific. The frog and the toad lay but few eggs as compared with the fish. Fish eggs may drop under the stones or float