

(April 7, 1930)

## The Web of Life

BY JOHN ARTHUR THOMSON, M.A., LL.D., F.R.S.

PRESIDENT G. M. SMITH:—We are indebted to the Royal Canadian Institute for this opportunity of hearing the eminent British scientist who is our very welcome guest today. Dr. Arthur Thomson, as you well know, has long been Regius Professor of Natural History in the Aberdeen University. He has recently been lecturing in the University of California and is now returning to Scotland. I cannot give you any just appreciation of his numerous contributions to science and of his biological research work, since my knowledge of his work is limited to his ability to outline scientific subjects. He speaks of the wonders of nature; he reveals not only the disciplined imagination of the scientist but something of the qualities which we more frequently attribute to a great epic poem. On Saturday evening he captivated a large audience by his lecture on the theme of animal life. Here the subject of his address is "The Web of Life." I have very great pleasure in introducing Professor Arthur Thomson.

PROFESSOR THOMSON:—Mr. Chairman, members of the Canadian Club, I first of all want to thank you for your very kindly hospitality and for your invitation to address you. I shall not expand on my gratitude to you, but I just want to say that if there is any Scotsman who is not at home in Toronto, then there is something badly wrong with him.

Shakespeare in one of his dramas, "All's Well That Ends Well," speaks of the web of life. He says "the web of life is of mingled yarn, good and ill together."\* I fancy that Shakespeare was thinking just of our inheritance from

\*Act IV, Sc. iii.

our parents, grandparents and ancestors—of mingled yarn, good and ill together. But the phrase, "the web of life," was used by Darwin in a very different connection. Darwin used the phrase, "the web of life," to express what impressed very, very much the fact that the circle of any animal's life goes into other circles. In other words, throughout the whole of nature there are linkages binding one life to another, often in very subtle ways. This theme, "the web of life," may be illustrated in very many ways and I would begin by reminding you of what you are very well aware, that our whole world of life is based on an endless sequence of incarnations. Like it or dislike as we may, the whole system of animate nature is based upon the conjugation of the verb to eat, based upon the fact that one living creature devours another. It is conceivable there might have been a world in which this did not occur, but the world in which we are privileged to live is based upon endless re-incarnation. Nothing material is ever lost, and the matter of one animal passes into another endlessly till it sinks to the ground and re-enters the circle of life by becoming the food of plants.

We have just had a very pleasant lunch, and I was relieved to see that there was no codfish on the table. My first illustration shall be in regard to that excellent and delectable fish, which is perhaps more appreciated in England than in some other parts of the world. When a hungry man, gentlemen, eats a pound of cod steak for his dinner, what is he really eating? And we can investigate the matter with equanimity since we have had no codfish. Physiologically and biologically the question is: what goes to the making of that pound of codfish. The answer is ten pounds of dog-whelk or sea-snail, that peculiar shell which children hold to their ears to hear the supposed reverberations of the distant ocean. To produce its own flesh each of the ten pounds of dog-whelk eats ten pounds of sea-worms and the sea worm requires ten pounds of microscopic organisms or minute sea-dust. And now we have our analysis completed. A hungry man eats a pound of cod steak, that is to say he eats ten pounds of transmigrated dog-whelk—one hundred pounds of transmigrated sea-worms, or a thousand pounds of sea-dust. Now, of course, that humorous illustration

shows the great fact that one creature depends upon another for its sustenance. All through nature, there is the conjugation of the verb 'to eat', sometimes noisily. "He eats, they eat, I will eat"; the only thing we do not find the echo of, there is no hint of that tense—"I have eaten." Some years ago, there was worked out with great beauty the correlation between the mackerel and the sunshine of spring. The mackerel, as you know, is a sea fish of very great daintiness and has purple flesh. The mackerel feeds chiefly upon crustaceans, copepods or water-fleas—the mackerel feeds upon these little crustaceans. I speak with diffidence on account of Dr. Huntsman's presence. The copepods eat little microscopic plants so that the more of these plants there are in the English Channel the more copepods there are for the mackerel. So that the correlation has been worked out with mathematical accuracy. The more sunshine in the spring, the more microscopic plants there are in British waters and therefore the more copepods, the more food for the mackerel, and the more mackerel the broader the smile on the fish-merchant's face.

The web of life reveals all sorts of illustrations of the dependence of one animal upon another for the continuance of its race. The story that Darwin published in the *Origin of Species* in 1859, which ran round the world, has, I am afraid, become a little trite; and still that should not be, for it was the first great story of its kind, and a very classic one indeed,—the connection between cats and clover, which you will find told at length in the "*Origin of Species*." Darwin with his usual patience and thoroughness took one hundred plants of the red or purple clover and put muslin bags round the flowers so that the air got in and the sunshine got in but no humble bees got in. How many seeds did he get? Of course, he got no seeds. He had another one hundred plants without muslin bags. How many seeds did he get? He got 27,000. So that the first fact you understand is from one hundred plants with muslin bags no seeds came; from one hundred plants without muslin bags, to which the humble or bumble bees had access, 27,000 seeds came, so that Darwin formulated for position No. 1: the more humble bees the better next year's clover crop. And then he noticed with his usual thoroughness

that the field mice, as he called them (we usually call them now field wolves) burrowed the nests of the humble bees, and although vegetarians, departed sometimes from their principles. They devoured the wheat crops and the humble bees. So that Darwin made his second announcement: the more field mice, the fewer humble bees, the worse next year's clover crop. With the assistance of a friend, Mr. Newcombe (he was always so thorough and so patient) he took a census of the field mice in different parts of the country and found there were fewer field mice in the neighborhood of villages and more in the open country. Why? The cats from the villages hunt the field mice. They do not eat them. They hunt them for sport and kill them but they do not devour them. Third proposition: the more cats the fewer field mice, the more humble bees the better next year's clover crop. And when he told this good story to Huxley, who was his champion, Huxley said, "That is a good story Darwin, but you have forgotten one thing." And Darwin said, "What is that?" Huxley said, "Why the more kindly old ladies there are in the villages, the more cats there will be." And so, the more kindly old ladies the more cats, the fewer field mice, the more humble bees, the better next year's clover crop.

The world is just full of these linkages binding one living creature to another. For instance, to give a very modern example of one of the ills that our flesh is heir to, and still unconquered, the black plague that was so terrible in Britain in the fourteenth and seventeenth centuries, the bubonic plague of India. At first, it may seem rather ridiculous to intimate what is the connection between cats and "the black death"? But it is not. The black death in India usually starts in the mills, such as jute mills where the workers are so poor that they do not go home to the midday meal, but eat their frugal repast in the court yard of the mill. Bread and food crumbs fall to the ground and the rats come out and eat the crumbs and the rat is the primary cause of the pestiferous plague. The rat has a flea on its body which becomes infected by puncturing the rat, so that when the rat flea happens to land on one of the workers then the plague is started. So the more rats the more rat fleas and the more likelihood of bubonic plague in

India. But it has been noticed that in those villages and townships where there are cats there are less rats and the less instances of bubonic plague. There we have the connection between the cat and the bubonic plague in India.

One of the most delightful little animals is the Blue Butterfly. It flits about in the meadows like a little piece of rainbow. It is a most beautiful little creature that has been known for a great many years. But in the life history of this Blue, as it is called, there has always been a hiatus. The entomologist never knew what happened to the little Blue Butterfly in the winter time. And, in spite of careful enquiry, and the entomologists are very pertinacious people, they did not discover how the Blue Butterfly survived the winter. But three people, working in partial independence, solved the problem. It is very interesting and, in a way, very beautiful and gives a good illustration of the web of life. The little Blue Butterfly, early in summer, lays its eggs among the flowers of the Wild Thyme, which, you remember, are little purplish blossoms. The eggs hatch, and out come the caterpillars. They are difficult to see because their color is like the color of the Wild Thyme. They eat the blossoms and they grow and moult until they become full grown. They leave the Wild Thyme and go roving. They come into contact with a species of ant and that ant is attracted to the caterpillars of the Little Blue because of a gland on the back of the caterpillar which exudes elixir, a sweet juice which has a very palatable flavor to the ant. And the ant licks it and likes it very much and wishes for more and finally, hoists the caterpillar on its shoulders and makes for home to secure a future supply. And the caterpillars are carried to the ants' nests and there they remain throughout the winter. Periodically the ant goes to these caterpillars and gets a drop of elixir. The ant gets its luxury which is more necessary to it than any necessity; and the caterpillar gets the crops of the ant, and in spring the caterpillar gets restless and leaves the ants' nests and goes roving for a safe place in which to live. They sink into the earth and then the Blue Butterflies emerge and seek for "the bank where on the Wild Thyme grows." So you have an accurate circle blending together two creatures.

I would like to put you a natural history conundrum of

the connection between the handles of penknives or fruit knives and that great fish of North America, the alligator-gar. There is a very magnificent fish over seven feet in length in Chicago. I saw it. What could be the connection between the handles of fruit knives and the alligator-gar? The handles of fruit knives are composed of mother of pearl. It is obtained in North America from the fresh water mussel, called the yellow sand mussel. The handles of fruit knives are composed of mother of pearl from the yellow sand mussel. Step one. But what is the connection between the sand mussels and the alligator-gar. In summer time in fresh water the mussel produces many eggs which are cradled in the hollow basket work of her right gill and there they are kept for weeks and weeks and they develop into pinhead-like larvae called glochidia. In course of weeks the alligator-gar comes swimming leisurely where the freshwater mussel, which has the poorest brain in the world, is stationed. She responds to the alligator-gar and allows her youngsters to come out. They come out in instalments and snap their shells together and they ooze out shreds of sticky stuff called byssus. How do I know? Because I have watched in my laboratory and made experiments in connection with sticklebacks. They snap their shells together and ooze out shreds of glue. They fasten themselves to the fish and sink into the skin and for six weeks or more they remain there. So far as we know, it is quite impossible for the fresh water mussel to continue its race unless its young spend that period as temporary parasites. There is a continental fish called the bitterling—a fish with a very long eggling region. The bitterling lays its eggs in the gill of the fresh water mussel and cannot continue its race unless its young ones spend this time in the fresh water mussel, the alligator-gar or some other fish.

Darwin was merely interested in little things. His whole life work was an eloquent commentary of the great importance of little things. He was greatly interested in the clodlet of the foot of a bird. When a bird flies to another parish it may drop and disseminate little seeds or animals. That was the sort of thing that Darwin lived for—the continued gathering of fauna and flora in birds' feet. The whole idea of the web of life is a commentary on that text

that a sparrow cannot fall to the ground without sending a throb through a very wide circle.

You remember about the Old Country—what is the most striking biological feature? What is the most striking biological feature of Scotland, apart, of course, from the thriftiness of the native? Well, you will all agree that the most striking feature is the way in which the heather flourishes on the hills. That is the most striking biological feature about Scotland, how the heather flourishes on the hills and moorland. How is it that heather flourishes on those hills and moorland where nothing else will grow? The soil is utterly unsuitable for vegetation. It is peaty and is full of humic acid. How is it that heather flourishes? The answer is a significant incident of the web of life. Heather flourishes like many other plants, as has been discovered, because it is not one plant but two. Heather is a dual organism. The heather has a partner the fungus. Everywhere there is the fungus and the fungus is the middleman between the heather and the soil. The fungus does something to the humic soil that enables the heather to flourish. The heather with its partner is able to flourish and thrive. The success of the heather is due to its partner fungus.

We all know that malaria is due to a microscopical organism which invades the red corpuscles of the human blood. We are all well aware that the organism is carried to the human being by the mosquito. Where there is no mosquito there is no malaria. In many parts of the world malaria has been banished by pouring a little quantity of petrol, paraffin or some such stuff on stagnant pools. Petrol or paraffin forms a film over the pools in which young mosquitos' larvae are, and they cannot stick on to the oily, slippery film of paraffin or petrol. Ordinarily they can adhere to the surface, but if the surface film is replaced by a film of oil, they cannot stick so that they sink to the bottom and die of suffocation. In many cases, it is impossible to pour petrol or paraffin on the water because the water is used for drinking purposes and the petrol method cannot be employed. In Indian towns and in Greece also they discovered a method of introducing little fishes about an inch long called Millions, because they multiply so rapidly. These little fishes devour the mosquito larvae. So

that the more Millions there are in water tanks in Indian towns, the less risk of malaria.

To illustrate further: some historians speak a great deal about Greece and the glory of Greece and why did it become dim? And the answer is this. The dimming of the glory that was Greece was due to the effect of malaria which ran rife in Greece. It practically dimmed and destroyed the vitality of the people. Now, do you see what I am working towards? Had it been possible to introduce fish to reservoirs, malaria would have been checked and the glory that was Greece may not have been dimmed. We see a new commentary light on the old saying, "Ye Gods and Little Fishes!"

Well, gentlemen, I am drawing to a close for you see the idea is a very simple one—the idea of merging one life to another all the world over. Let me indicate before I sit down the practical importance of all this. Emerson, who has my highest admiration and is one of my favorite authors, Emerson in his essay, in which he depicts the perfected earth, prophesies what the earth of the future may be like and, in that picture of a perfected, millenarian life, he stumbles for he says that one of the features of that perfect life will be the entire absence of spiders. There will be no more spiders there. Of course, if he had known a little more about natural history he would not have stumbled thus. For a world without spiders would not be a place for a man to live. Spiders occupy a very important role in the work of nature because they keep check on injurious insects so that a world without spiders would not be a world for respectable men to live in. And the moral is just, for man, if he is to continue to be an increasing master of nature, must know more and more about the web of life and respect it increasingly.

What sinister significance followed the thoughtless home-sickness of the man who, in Australia, introduced rabbits? He introduced rabbits because of a latent home-sickness, known as biological home-sickness. Rabbits have been to Australia a most sinister curse, turning vast territories of fertile land into wastes. He had good intentions. They are always present. Man to be master of nature must know more about the web of life, and respect it increasingly.

Wherever man has gone the rat has gone. The rat is man's shadow. In Britain, I am ashamed to say there is one rat for every person. Every man, woman and child—each has got his rat or her rat and this is most discreditably. We are feeding these rats, millions and millions of rats, at a cost which we cannot afford. You know that the rat went to Jamaica—the black rat, which is not a native of Great Britain, thank heaven. It came from the east. It has been introduced to many countries from Britain. There was great tribulation. The rats were doing such damage in Jamaica and the authorities enquired as to a possible cure. They heard about the mongoose; that wiry, sharp-nosed, indefatigable creature, the mongoose, would clear the fields of rats, mice and snakes, so they introduced the mongoose into Jamaica and there was great jubilation. And then it turned its attention to the native rat and there was more jubilation. The mongoose by this time was very much in the plural; and they had to be fed and they turned their attention to the poultry and there was less jubilation,—and the poultry suffered greatly. Then the mongeese turned their attention to birds' nests on the ground and two species of birds became extinct, and they turned their attention to lizards and some innocuous snakes and at least two species of lizards and snakes became extinct. There was still less jubilation. The faces of men lengthened. The mongeese were proving a curse. They began to say the cure is worse than the disease and then came attacks from injurious insects which the birds had kept in check, and there was no jubilation at all. The mongoose had conquered, but at what a cost! If man is to continue to be master of nature, and this is the moral, he must know more and more about the web of life and respect it increasingly.

MR. SMITH:—Gentlemen, on Saturday evening some did not hear that epic poem. Today we have had a scientific folk-song. I have very great pleasure in expressing to Professor Thomson our very hearty thanks for his interesting, graceful and inspiring address.