LARGEST RIVER IN THE WORLD

Natural History of the Amazon.

Piscatorial Wonders of the Stream

Prof. Agassiz's Lecture on the Fishes of the Amazon.

Their Species, Habits, Characteristics, and Commercial Value.

Etc., Etc., Etc., Etc., Etc., Etc.

Prof. Agassiz, the great American naturalist and savan, having recently returned from a journey of scientific exploration in South America, is now engaged in making his discoveries known to the world in a series of lectures at the Cooper Institute, in New York city.

We have already given sketches of several previous lectures, and we now reproduce a *verbatim* report of the most interesting address, that upon the "Fishes of the Amazon"—a subject fraught with vital import in the scientific world, and, as eliminated by Agassiz is full of that popularity and simplicity that charm the million.

STATEMENT OF THE SUBJECT.

Ladies and Gentlemen:—The aquatic population of any extensive fresh water basin has many points of interest. We may, in the first place, view it in reference to the structure of these animals, as compared with that of aerial and terrestrial beings. We may examine them with reference to their geographical distribution as contrasted with those which inhabit the sea or the land. We may also examine them with reference to their variety, or the diversity which exists among them, under apparently identical circumstances. This last point is one of peculiar interest; because you will perceive that, if external circumstances have had a deep influence in bringing about the variety of living beings which we find everywhere on the surface of the earth, we should expect to find great similarity among animals living close together, under identical circumstances, shut out from the influences of the great changes which are constantly taking place in the atmosphere, shut out from the great diversity of the bottoms which are found along the sea-shores, and circumscribed within limits very similar. Now, the Amazon, above all the rivers of the earth, presents a variety of organized beings which is stupendous, which exceeds all conception, and which was a matter of surprise even to me, who had devoted my life chiefly to the study of fishes. I will, therefore, try to give you some idea of this diversity. I regret only that I cannot suddenly impart to you the interest which I have felt for a long time in these animals. Unknown and uninteresting in their ways, they have generally been neglected. Few naturalists have turned their attention to them, and I am afraid you will find my lecture rather monotonous. Yet, if you will for a moment consider that a knowledge of these beings has an important bearing on some of the most important questions which are now under discussion among naturalists, I hope you will follow me in the details which I am about to submit to you.

PISCATORIAL STRUCTURE.

But first allow me to say a few words concerning the structure of aquatic animals. In the infancy of our science, animals were classified, that is, were brought together in groups, according to the conditions under which they are found in nature. If you will turn over the works of the great naturalists of the eleventh century, you will find that their descriptions of the animals then known are arranged under but few heads, one embracing the aquatic animals, another the terrestrial or creeping animals, and the other the aerial or flying animals. But in proportion as our information of the structure of all these beings has been growing, it has been found that these external influences do not so modify organized beings as to bring together in the same habitation those which have the closest resemblance; and we are no longer surprised now to find in the water animals of the most diversified classes, or to find the same diversity among those which either inhabit the land or live in the air. It has been the result of modern investigation to discover that animals, however numerous, however varied, are, after all, built upon four plans of structure only. Those plans are very simple, and may be recognized easily; and these systems may be expressed by formulas so simple that you will permit me for a moment to call your attention to that point.

CURIOUS FORMATIONS.

There are animals which have all parts arranged like rays around a central axis—that is, they are radiated in structure; and a figure like this (draws a star-shaped character on the blackboard) may be considered as a formula expressing those peculiarities of structure. Suppose that we consider any organ, the stomach for instance; it will be found to have five pouches radiating in five different directions. Suppose that we consider the nervous system—it will be found to consist of five rings, five swellings, with the same directions as the five pouches of the stomach; five rays or threads having the same direction, and may be at the ends of the threads there may be eyes. The ovaries will be arranged in the same manner, with a bunch of eggs here, a bunch of eggs here, a bunch of eggs here, and another there. And all those parts are so arranged around a central axis, that they are like spokes of a wheel—rays around a vertical axis; and in that axis we have the mouth at the centre. So these animals, owing to this peculiarity of constitution, are justly called Radiates. Now, of those we do not find any in the Amazon. We do not find any in the fresh waters except one, the simplest kind of polyp, the fresh water polyp, or bush polyp, as it is called; this is the only fresh water specimen of that large family which is innumerable in salt water, such as the jelly-fishes, star-fishes, and sea-urchins—in fact, most of the animals that inhabit the sea, and which have existed not only at all times during geological periods anterior to ours, but which are now common everywhere in the ocean, but which have no representative on land, and but a few very simple ones in the fresh waters of the temperate zone. Another group, which are called mollusks, embrace animals the body of which is symmetrical, the parts of which are arranged around two sides of a longitudinal axis, so that these animals have an anterior and a posterior part—a part that is above and a part that is below—a right and a left, which is not the case with the radiates; for these radiates may move in the direction of either of these rays—they have no right and no left; for if you call *this* the front, *this* may be right and *this* left, but if you call *this* front, *this* is right and this left, so that you have to introduce an arbitrary distinction, when you hear described these radiate animals, with reference to which is the right and which the left side, which is the part that is above, and which is the part that is below.

PECULIARITIES OF THE MOLLUSKS.

Not so with the mollusks. They have internal features, which determine their relations, their symmetry, and fix the position of their parts in a manner which enables us to distinguish the anterior or head end from the posterior or tail end, as well as the right and left, and above and below. To this group of animals belong all the shell-fishes—the clams, oysters, and the like, the snail and the cuttle-fishes also. Part of them are aquatic animals that inhabit the sea, part of them are fresh water fishes, and part of them are terrestrial animals. So you see, here we have animals of one and the same structure inhabiting the different elements, which were made in the infancy of our science, the foundation of the classification of the whole animal kingdom. Of this type there are several classes—three classes—and to them I shall refer presently, as we have a number of representatives of them in the fresh water animals of the Amazon. Let me say that the majority of those which have two valves are either fresh water or marine, the greater part, however, marine, and the less are fresh water. Of those which have only one valve, and are generally wound up in a spiral, we have also a majority in the sea, but some in fresh water, and some on land. Of the cuttle-fish class there are none in fresh water, none are terrestrial, but all of them are marine. And they have been inhabitants of our globe from the very earliest periods of the earth's history during which animals have lived upon it. I may represent the formula of these animals in this way (illustrating on the blackboard), the anterior end marked by some prominent feature which indicates something of a head. Not all, however, have the anterior end very different from the posterior. A longitudinal axis, on the side of which organs are arranged. For instance, in the oyster there is a pair of gills on each side, so that the respiratory organs are placed on the right and on the left; while about the sides of the mouth are those flat appendages, with the aid of which these animals introduce food into their mouths, and the organs, the intestines, the ovaries, the heart, and the organs of respiration are clustered in the centre. Now, the manner in which these several parts are protected by shell are accessory details of their structure, which cause the different families, different generas, and different species.

THE ARTICULATES.

Then we have another group which are called articulates, animals the body of which may be compared to a cylinder, or to a tube, but a tube divided into a number of rings, movable one upon the other, so that, in fact, the body is an articulated cylinder containing a single cavity, in which are arranged all the organs. I represent that in this way (makes a drawing); these transverse rings in this manner; the internal organs arranged in the interior; the alimentary canal in the interior; the respiratory organs in the upper part; the nervous system mainly in the lower part; the respiratory organs upon the sides; and on the rings are frequently locomotive appendages in the shape of limbs, which may be mere hoops, as in the case of the worms, or may be articulated limbs, as in the case of crabs, lobsters, insects, and the like. Now, these articulated animals embrace also several classes of such worms, of which there are marine kinds, and fresh water kinds, and terrestrial kinds. It is one of the class which has the most extraordinary distribution, for worms are found everywhere. They are found even as parasites in the bodies of other animals; in the internal organs of other living beings; they are found in fresh water and salt water, and also in the earth, burrowing under the ground.

IDENTITY OF STRUCTURE.

Then we have the class of crabs, the crustaceans, which is next above, and that of insects which contain animals breathing air and living out of the water. So that we have here again, animals of an aquatic, or terrestrial, or aerial mode of life, all showing one and the same structure. I like to insist upon these facts, which are most brilliant results of modern progress or science, because you see at once what bearing they have upon the question of the origin of these things. If we have identical structures under the most diversified conditions of existence, these external things which act upon living beings cannot have been the cause which has produced such unity of plan. The unity of plan—that ideal common basis of animals—must be derived from something higher than the conditions in which these animals live, when we find that, notwithstanding these diversified conditions, the animals present one and the same plan and structure. (Applause.) The next type is that of vertebrata. It is one which has a special interest for us, for we belong there (laughter), and with us all the animals which have a backbone, all the animals which have an internal solid axis so arranged as to surround two distinct cavities in which the various organs of the body are inclosed, one cavity below that axis in which all these parts or all those systems of the organs are contained by which life is maintained in its normal condition. These are the organs of digestion through which food is assimilated and transformed for the sustenance of the body, the organs of breathing in which this assimilation is fostered, the organs of circulation through which the result of these operations is circulated through the system, and also the organs of reproduction. All these organs by which animal life is simply maintained are contained in the lower cavity of the body, while an upper cavity contains organs which establish the relations between the animals and the surrounding world. In that upper cavity is contained, in the anterior part of the body, the brain, and in the middle and posterior parts of the body the prolongation of the brain which we call the spinal marrow. From it arise the nerves, which are scattered through all parts of the body, and send sensibility and also receive impressions from the outside. To this centre is attached the organs of the senses, and which communicate directly with the central mass of the nervous system. All these parts are contained in the upper cavity of the body, and the whole is surrounded by flesh and inclosed in a skin, and whatever be the type of vertebra which we take for examination, whether man or quadruped, bird, reptile, snake, turtle, or fish, all have the same identical structure, and these structures differ only in the form and complication of the execution, but in no way does the plan differ in the slightest degree. A shark or a perch, a man or a bird, have the same identical plan of structure, and we could make a cut across their body, through the neck, the head, the chest, or the tail, and compare one with the other, and we would find that the sections had the same organs which had the same relations to one another; and if we compared one section in the same body with the other, a cut made through the head, or through the middle, or through the hind part of the part again, we would find the same relations, so wonderful is the idea which is manifested in this innumerable variety. And now let me show you that this is not a fanciful assumption. (The Professor here drew the form of a fish on the blackboard). We have here the backbone, here the upper spine of the skeleton, here also the ribs, here the head, the mouth, the base of the organs of the senses, the eyes, the nostrils, and so on. Suppose we make a section across the body here through the centre of the body, or here through the head, or here through the tail, there will be a difference in form no doubt, there will be a difference in the relative dimensions of the parts, but there will be no difference in the relative position of these parts, and in the nature of these parts. Suppose I commence with the section across the middle of the body. The first thing we find in the centre is the solid axis, above that we have these spires, which are in reality an arch covering a cavity; we have here below the ribs, which are another arch inclosing another cavity; this is the lower cavity, which contains, as I have said, the organs of digestion, the intestines, liver, and the like. In the anterior part of the body we should find the heart, in the middle region we should find the large vessels which run parallel to the backbone, in the upper cavity we should find the spinal marrow, and on the outside of that the masses of flesh which are covered by the skin. And now in the tail we should have exactly the same thing, only that the central backbone is surmounted by a smaller arch. The intestines do not extend here except in the form of vessels and nerves, and here we have a prolongation of the spinal marrow, and we have flesh around here as before. Now, in the head is the difference. This upper portion is largely developed, in comparison with the lower portion. This upper portion becomes the skull. Inside is the extensive mass of the brain. This is the base of the skull. Instead of ribs we have the lower jaw attached. Upon the sides of the skull we have masses of flesh, which keep in motion these parts which are on the side, and the whole is surrounded by skin, as here. So that the whole difference is that the cavity of the intestines is reduced to a cavity of the mouth opening outside, just as the alimentary canal is a continuation of the cavity of the mouth and the spinal marrow of the brain. The brain is only an enlarged portion of the spinal marrow, or, to reverse it, the spinal marrow is a modification of the brain extending through the body. So that you see that my assertion is true, that in whatever region we may make a section to examine the relative positions of the organs of the vertebrata we find the organs identical, bearing the same relation to one another. If time would permit I could readily show you that whatever the form of an animal, whether it be a fish or a serpent, whether a lizard or a a turtle, or a bird, the relation of the parts is again the same, and the differences are chiefly differences in form and development. And it is in consequence of this great similarity that the idea has been started that all these animals may be derived one from the other; that all these animals may be the result of successive modifications of the few. You see on the one hand we have these uniform conditions which sustain the most diversified forms; then again we have this unity of plan, which seems to be in contradiction to the variety of influences under which these animals exist.

DIVERSITY OF FORM.

Then again we have an extraordinary diversity of forms, which seem to indicate the most diversified organs; and yet such is the similarity among these various things that they seem to be only a modification one of the other. No wonder, therefore, that investigators should make it their special object to study these things, and that they should differ in their opinions so much that there should be those who cannot conceive the cause of this diversity, unless it be the immediate manifestation of a special creative act on the part of a Being capable of producing at once perfect beings; while others, more inclined, perhaps, to follow development and progress than to look at first causes of all things, would rather have everything derived from a few primary forms which have undergone extraordinary changes in the course of time. To this subject I shall return in my last lecture. I can only point at present to the bearing which these investigations of structural relations have upon the question of origin, upon the question of diversity, and upon the question of unity in diversity.

EVIDENCES OF ONE SUPREME CREATOR.

For all things that exist in some point of view are alike, chiefly by the unity which prevails throughout nature; while from another point of view everything seems different; and when we come to consider what may be the origin of all things, we are at once led, on the one hand, to the evidences of the workings of one mind, and, on the other hand, to the ever-changing conditions under which everything lives; and in consequence of that these various opinions—some assuming that all things have grown out of the change of a few things, and others assuming that everything must have been made as it is by a Supreme Power. (Applause.)

THE ANIMALS OF THE AMAZON.

Now, with these facts before us, we can turn our attention to the animals of the Amazon, and I may say that they comprise two different types of the same animal. We find in the Amazon, in these fresh waters, mollusks, and they belong to two classes. We find in the Amazon articulates, and they belong to two classes. We find worms and crustacea. We find vertebrates in the Amazon, and they belong to more than one class. We have fishes and we have also reptiles, and among them some that are aquatic while others are terrestrial; we have birds, some of which are aquatic and others aerial and terrestrial, and we have mammalia or quadrupeds, some of which are aquatic. And not the least of the singular features of this immense basin of fresh water is the presence in it of several representatives of the porpoise family. The great family of whales, to which the porpoise belongs, has five representatives in the Amazon in the form of a variety of porpoises, and of that other singular animal which the Brazilians call the beshuyboy, and which we have translated into sea-cow, about which I shall have something more to say hereafter.

Then let us remember this, that in one and the same stream, exhibiting this unity of temperature of which I have treated in a former lecture, we have animals of different types of structure, mollusks, articulates, and vertebrates, while no radiates have ever been found in it; and in these three types we have representatives of several classes. Now let me say what classes they are, so that I may impart a more definite idea upon that point. Classes in the animal kingdom have long been circumscribed by naturalists to suit their fancy, or according to their impressions. It seems desirable to determine the classes according to some principle; and the principle which appears the most natural as the basis of limitation of the classes, is the various modes of execution of these plans of structure. After showing you that vertebrates have one common plan of structure, we will divide that type into classes according to the manner in which the plan is carried out. If the backbone is constructed in the fashion of fishes, if it consists of spines of backbone which are united together by double conical cavities; if the flesh is white, and arranged in large masses on the sides of the backbone; if the organs of respiration are gills instead of lungs; if the organs of inhalation exhibit a heart which has only a single sack from which the blood is propelled to all parts of the body, and another sack to receive the blood which comes from all parts of the body, instead of the complicated circulation which we find in birds and in mammalia—we say that we have here one mode of execution of the plan of structure, which justifies us in considering fishes as a natural class. If, on the contrary, we have animals which have warm blood, which breathe through the lungs, which have a double circulation, the body of which, instead of being covered with scales, is covered with feathers, if these animals, in bringing forth their young, lay eggs upon which they sit, producing young which they rear, we have indications of another mode of execution of that plan of vertebrates; and we consider ourselves justified in calling birds a class in the animal kingdom, and so on. Now, among mollusks, we have three classes, one of which is particularly characterized by the manner in which the parts are arranged on the two sides of the body, in broad flappers, or broad curtains hanging on the sides of the axis, and generally protected by hard shells that are double, that is, one on each side; and that class embraces all the so-called bivalve shells. Of this class, the Amazon contains a considerable variety, and so do all our fresh waters, our rivers and lakes.

VARIETY OF MOLLUSKS.

In the ocean there are numerous forms, but no one of these bivalve shells living upon the land or in the atmosphere, or that can sustain itself outside of water. Then we have another class among these mollusks which embrace all those the body of which has respiratory organs only on one side of the body—namely, the body of which is more or less twisted, frequently coiled up in a spiral, and in which the anterior end of the body is provided with appendages looking something like horns—tentacles frequently, at the end of which are eyes, like our snails. They constitute a second class. Of this class of snails we find quite a variety in the fresh water in the Amazon, and in still greater variety upon land, living upon trees and decaying wood, or upon the soil, burrowing in the earth during the dry season. So that of the three classes of mollusks which exist all over the world, we have representatives of two in the fresh water of the Amazon, and of one of those two we find also representatives on land. There is a curious feature among these fresh-water bivalve shells to which I will here allude—their strange resemblance to marine shells, notwithstanding the difference of their internal structure.

THE AMERICAN BIVALVES.

You all know how numerous fresh-water muscles are in our waters, and how great is the diversity of the fresh-water shells in the Western waters. The Ohio and its tributaries, the Tennessee and the Cumberland rivers, and the rivers that empty into the Gulf of Mexico, and all the Southern rivers, teem with a variety of bivalve shells, all of which have the same internal structure, consisting of this (illustrating by drawing the parts as described); that the middle axis may be protruded in the shape of a fleshy foot, with which the animals creep on the ground or in the wood. At the sides are two flappers, which surround the mouth, to aid in introducing food into the alimentary cavity. Then, there are two gills hanging right and left. Inside here is a sack which contains the organs; and here is a large fleshy mass which extends across the body, and here another; so that upon a transverse section of these animals we would see one valve turning this way and the other that way. And here is one of those bundles extending from one valve to another, so as to bring them together; and here is another. Now these fresh water shells of ours vary in external appearance greatly. Some are smooth and have a thin shell, and have an oviate form. Others are elongated in this way; others are more triangular; others have tubercles on their surface; others have spines projecting from the surface; others have rows of ribs thus, and others rows of ribs in this manner. But while the different species thus differ in their external appearance, their internal structure is everywhere the same.

PECULIARITIES.

The species of the Amazon have another curious feature—that they are not only identical in structure with our own, and identical among themselves in structure, but their external forms are the marine shells, which have a totally different structure. Those among you who know the shell of the razor-fish, called the razor-shell (a very slender and straight shell of this form), will be surprised to hear that there are fresh-water shells of that form in the Amazon, which, far from having anything in their internal structure which resembles the solens (as this is called by naturalists), have all the internal structure of our common fresh-water muscles. There are others which have the external appearance of the mother-of-pearl bivalve shell, exhibiting the external appearance of that group. A third variety exhibits the peculiarities of our arca, having transverse waves alternating with furrows, such as are only known in the family of the marine arca, and yet found in some of these fresh-water shells. What does that mean? It is difficult to say why there should be, as it were, a reminiscence of the sea among animals of the fresh waters, superimposed upon a structure which has no similarity to the structure of these marine shells.

MYSTERIES OF THE CREATIVE POWER.

I can only see in this the working of mind, which combines elements diversified among themselves, and hardly any indication of the transformation of one type into the other. But, without expressing a decided opinion about it, let me tell you that those are the facts upon which naturalists agree, and in consequence of which they present such various opinions, such conflicting views. The naturalist who recognizes only this similarity between the shells of the Amazon and the marine shells, will at once jump at the conclusion that the Amazon Valley was once under the sea, and that when it rose some species remained in the pools that were left, and when those basins were changed into fresh water in the course of time, these marine shells changed to what they are now. But he who remembers that these fresh-water shells have none of the internal structure of the marine shells which they resemble in external appearance, will say:—"But if these external circumstances have so modified the marine shells, what has given them a common character in which they agree so closely with one another?" For not only do they not differ in internal structure in any way among themselves, but they resemble the fresh-water shells found elsewhere in this world, as in North America or in Europe. There must be some other cause at work, not only to produce the change, but there must be some cause to impart unity notwithstanding the change—a unity which extends not to the Amazon only, but to all other parts of the world. The fact is that the world is more mysterious than our philosophy has fathomed thus far, or than man can yet compass in his narrow systems. (Applause.)

THE FISHES PROPER.

In the infancy of our science, all the inhabitants of the fresh water were called fishes, and it is only in proportion as we have become acquainted with these structural differences, that this class of fishes, embracing so much, thus varied in structure and plan, has been gradually referred to different classes. I will now pass on to the fishes proper, to those representatives of the fresh water which instructure resemble man, and which share with us that plan of structure which is common to the birds and reptiles and quadrupeds, as well as to man and the fishes proper. If the time permits I shall close with a few remarks upon the fresh water inhabitants of the type of the vertebrates, worms, and crustacea; but if not, I shall defer my remarks upon those classes to my next lecture. I feel somewhat embarrassed to speak of fishes without saying something of the fundamental differences which exist among them; and that I may better bring before you the differences which characterize the different groups of fishes, let me draw the outlines of some of them, and point out to you the permanent differences which distinguish them. Suppose I take, first, our trout. You perceive here that the head and body run together so that there is hardly a distinct neck. That is a characteristic feature of all fishes. It is only in the class of reptiles that we begin to perceive the first indication of the contraction between the head and body which indicates the position of the neck. What is characteristic of this type of fishes, is the position of the fin upon the back, which is called the dorsal. There is a large fin at the end of the tail, which may be cut square, as in the fresh-water trout; which may be forked as in the sea-trout; or which may have its upper end prolonged greatly, as in some other representatives of the family. This is the caudal, and that fin is the organ with which these fishes impart to themselves an onward motion.

POSITION AND USES OF THE FINS.

Striking right and left with the tail, the body is propelled forward in consequence of this motion, and this motion is aided by the dorsal. This other fin under the tail is called the anal. When the fish strikes violently and raises that fin, the surface with which he strikes the water is enlarged; but when he strikes gently, this fin is bent under the tail, and the surface with which he strikes the water is diminished, and the force with which he strikes being slight, the motion is comparatively feeble. The fin is the ventral. This is on the medial line of the body. There is one above, the dorsal, and one below, the anal, and the caudal at the end of the body. The caudal in this group of fishes is always semicircular; that is, the upper half corresponds with the lower half. If the tail is cut square, then the two parts are about the same; and if it is forked, then the upper part is of about the same dimensions as the lower. It is rarely the case that one of those parts is slightly longer than the other, and it may be either the upper or the lower. For instance, in the flying-fish, which comes very near this, we have the lower lobe somewhat longer than the upper. With this, the moment the fish emerges from the water, it gives its last impulse by striking violently to the right and left several times in rapid succession. We have, also, upon each side of the body one on the right and one on the left; those fins which are near the head, which are, in fact, upon the sides of the chest, and which are known by the name of the pectorals; and these which are here, upon the lower sides of the abdominal cavity, are known as the abdominal fins. In all the fishes of this group we have the abdominal fin, half way between the pectoral and the anal fins. Now let us compare with that a perch, a common yellow perch, as we have them in our fresh water. Here (drawing) we have a very different dorsal; there are two, commonly large. We have the caudal comparatively small and feeble. We have the anal placed in about the same position as in the trout, but it has a strong spine in front of the fin. Then we have the pectorals placed here, and the ventrals, instead of occupying a medial position, are placed just below the pectorals, and the front part of the ventrals sustains a strong spine. You see at once what a difference that makes. This first fin consists of strong spines, while the second fin consists of a number of rays which are divided and subdivided so that the whole fin is soft and tender, while this is very hard and prickly. So are the spines *here*; so are the spines *there*; and on the sides of the head there are other spines connected with the bones of the head. But that is not all. Let us examine the mouth. Here the mouth is very widely cleft, perhaps, but there are also perches in which the mouth is very widely cleft.

THE JAWS AND TEETH.

But the principal difference is that here, in the front, the interior of the upper jaw is made up of one bone, and the posterior part of the upper jaw of another bone, which two bones are placed one in succession to the other, forming one arch, and both have teeth along their lower edge. These two bones are exactly the same as those which form the upper margin of our own mouth. The anterior part of the mouth is occupied by the cutting teeth; then follow the eye teeth, then the grinders. Now there are two cutting teeth, on the right and the left side, which are implanted in a bone which corresponds to this, and is called the intermaxillary. The eye-teeth and grinders are implanted in another bone, which is called the upper maxillary, and the intermaxillary and upper maxillary together, in one arch, form the margin of the mouth. Now in the perch it is very different. We have one bone which extends in this way from the anterior part of the mouth to the end of the cleft, and that one bone is provided with teeth along its margin, and forms alone the upper margin of the mouth; while another bone, placed behind, and forming in no way a part of the mouth, sustaining no teeth whatever, represents the upper maxillary. It is the anterior bone which represents the intermaxillary, so that the proper jaw-bone in the perch has not a tooth. It does not form a part of the anterior margin of the mouth, while the intermaxillary is so large that it alone forms the arch of the upper part of the mouth. These are the most prominent differences that we have here.

THE SHARK AND STURGEON.

And now there are fishes of a very different type from these (draws the outline of a fish on the blackboard). I suppose you may recognize here a shark. (Applause.) It differs from the two types of fishes I have described thus far in having five clefts upon the sides of the head, which are the gill openings. The trout has only one, and so has the perch only one, and that cleft is supported by a bony plate which moves to and fro upon the gills and protects them during respiration. And so has the perch, while the shark has no such bone, and the branchial fissures are open in advance of the large fin, which is placed upon the side, and the ventral has again the same position as in the trout or salmon, while the tail is remarkable for the prolongation of its upper lobe; and that is not only an external prolongation, but the backbone itself extends into this lobe to its very end. So that its backbone does not terminate as in other fish, with a broad blade supporting the tail, or as in the front, salmon and the like, but the backbone extends to the very end. All these fishes, moreover, have their solid frame, that is their skeletons, soft and consisting more of cartilage than bone. (Makes a drawing of the sturgeon on the blackboard.) It differs from the shark, in having the gills protected, like the other fishes, by a bony plate, and so that the gills are covered externally. In having the snout so prolonged, the mouth is far below the head. And then it shares with the shark that singular prolongation in the tail which I have noticed. And it has that very singular feature, that the ventral fins occupy the middle of the abdominal region, half way between the pectorals and the anals. And, finally, there is this last type of fish (makes a drawing of it), which is quite curious for its elongated form; for the truncated termination of the head, which is, as it were, cut square; and for the presence of the simple fin extending all over the body, without any pectorals or ventrals, but with a number of small openings upon the side, as many as seven, and one upon the back. It is called the lamper-eel. To these groups belong all the fishes known on the earth; and to these groups may be referred all the fishes that have lived in all times. (Applause.) But then they assume such extraordinary differences in details that, by a process of changing some part or other, we can at once see how one might have grown out of the other; or we can see that by a difference of execution the same idea may have been expressed in different ways. And here I at once express the different views which are entertained concerning these affinities. They may be the manifestations of the same idea expressed in different ways, or they may be modifications of a few primitive facts.

THE AMAZON HAS FISHES OF ITS OWN.

Now, what are the fishes which inhabit the Amazon?—for I wanted to say all this as preparation to give you some definite idea of the various types of fishes which we find in that mighty basin. Not one of those fishes with which we are familiar in our rivers is to be found there. Not one of those which are in all of the rivers of Europe is to be found there. Not one from any other fresh-water basin is to be found there. The Amazon has fishes of its own, entirely different from those of any other basin. And these fishes are different even from those of other fresh-water rivers of Brazil. And in each part of the Amazon there are fishes of a peculiar character; so that those which inhabit the lower course of the Amazon, say below the mouth of the Tocantins, as far as the contact of the salt with fresh water, differ from those which are found in the river between the Tocantins and the Xingu. At the mouth of the Xingu, we have fishes differing from those which inhabit the Tapajos. As we ascend from the Tapajos and enter the district of the Rio Madeira, we find still other fishes. If we go into the district of the Rio Negro, we find still different ones; and if we go further up on the borders of other rivers which I have explored there are peculiar fishes.

TWO HUNDRED VARIETIES OF FISH IN ONE SMALL LAKE.

And so great is the variety that in small lakes of water we find endless varieties, while in Mainas, at the junction of the Rio Negro with the Amazon, I was led to examine one particular little lake of a very few hundred square yards in extent, with the view of ascertaining how great that diversity among fishes may be which occupy a circumscribed area, and in that pool—for it is hardly anything more; it is only a few hundred square yards at low water, and only a few thousand square yards at high water—in that small lake I have found in the course of two months, during several excursions, over two hundred different kind of fishes (applause)—three times as many as are known from the Mississippi, three times as many as are known from the Nile, or Senegal, or Ganges. And the number found in the whole basin of the Amazon is not less than two thousand different kinds—that is, ten times as many as were known to Linnæus about a century ago, from the whole world. (Applause.) And strange to say, it would appear that in proportion as we became acquainted with a large number of these animals, they should be found to resemble one another more and more; but on the contrary, such are the peculiarities of their features, such is the principle of their differentiation which brings about the differences we notice among them, that in proportion as I found a larger and larger number, I found that the difference between them seemed to grow. And you will understand that. It seems paradoxical, and yet it is strictly so. Concede for a moment that we have here extreme points (illustrating with dots on the board), between which there are certain intermediate forms. Now, suppose that *this* represents the varieties known when I went to the Amazon—the sum total of the fishes described by my predecessors, including all the various expeditions which had gone to that country with a view of studying its natural productions—the total number of fishes then known did not exceed one hundred and fifty, and the number I have brought home exceeds 1500—it approaches 2000. (Applause.) And yet I say that now the difference which we know to exist between them is greater when we take any two than the difference which existed between them when we knew only 150. Every new one has exhibited radiations, modifications in the direction of almost every other, so that the points of contact have, as it were modified not only in point of resemblances, but in point of differences, in consequence of which the sum total of difference which is now known among these 2000 fishes far exceeds the extreme differences which appeared when only the few hundreds were known before. (Applause.)

THE SWORDFISH.

And now I should like to give you some idea of what are those differences, and what is the appearance of some of these fishes, and of the mode in which they differ from the fishes of our own waters. In the first place, the type of sharks has only one representative in the Amazon—that is the swordfish. The swordfish is a shark which differs from ordinary sharks in this, that the skull is prolonged here. You will see how by a modification of the form of some part we obtain widely different forms. The swordfish is a shark, the snout of which is prolonged to a considerable extent, on the two sides of which project large teeth, forming the saw characteristic of that genus. Now the swordfish is the only kind of shark which is known to enter the large rivers. It is not properly an inhabitant of the river. It is found on the seashore, and so is the same species found at the mouth of the Mississippi, and another species found at the mouth of the Senegal, on the other side of the Atlantic. This is the only representative of that group of fishes which we have in the Amazon. The lamper-eel type, of which we have quite a variety throughout our fresh-water streams, has not a single representative in the whole basin of the Amazon. It is entirely foreign to the tropical waters of the Amazon, but it fre-