

UNITED STATES FISH COMMISSION BUILDING AT WASHINGTON, D. C. (TRINE GROTTO IN THE UNITED STATES FISH COMMISSION BUILDING AT WASHINGTON, D. C. (Taken in July, 1897.)

## EXPERIMENTS IN PHOTOGRAPHY OF LIVE FISHES.

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Up to the present time very few photographs of living fishes have been reproduced and published, and, as compared with the photography of other living forms, attempts or successes in this line are extremely rare. There are a number of methods by means of which fish may be photographed in their natural element, with natural surroundings, as, for example, it is possible to accomplish it beneath the surface of the water by the use of some such contrivance as the subaquatic camera used by Dr. J. E. Romborsts, or that of M. Bonton, or the apparatus of Regnard. By the employment of instantaneous photography some fishes have been taken in the air, in the act of "leaping," as in the case of salmon, or in the act of flight, as in the case of the flying-fish. Such pictures as these latter, however, illustrate peculiar habits rather than topographical characters of the forms thus secured. To obtain these we must resort to the photography of living fishes in suitable aquaria and under proper conditions. In such receptacles the types to be photographed may be taken either through the glass sides of the aquarium (with or without background) or the exposure may be made from above. This, of course, would depend upon the form of the fish and its habits in nature, or, in other words, whether the subject was a bass or a flounder. Again, certain fish in nature have the habit of occasionally resorting to the dry land, and when the opportunity offers species of this kind may be taken upon terra firma in various situations, as in the case of the peculiar gobioid *Periophthalmus*.

The experiments to be described in the present contribution, however, will be restricted to a few the author has made at the aquaria of the U. S. Fish Commission building in Washington in July, 1897, and upon various occasions since. The fish in these cases were all medium-sized teleostean types, and the photographs were first taken through the glass sides of the aquaria in which they are kept in the "Marine Grotto"; and afterwards in a special aquarium placed in the court-yard of the building during the forenoon of a perfectly clear day in July (1898)—two very different conditions. In the first instance the aquaria consist of a series of tanks arranged around a roofless corridor, thus admitting sunlight, when protective awnings are not in use, only from above. Within the grotto, this series of aquaria comes flush by glass-fronts with the wall of the long room, so named. Here they are of glass, 4 or 5 feet above the floor, and as one enters the grotto the impression is given of mural pictures wherein the fish-subjects are alive and moving about. The walls of the grotto

and its entrance are of tin, so modeled, painted, and sanded as to give the appearance of having been built in solid freestone. Practically all the light that gets into the place is through the glass fronts of the series of aquaria and the doorway passage. It is an admirable arrangement and admits of the study of the forms of many kinds of fish and plants, and certain invertebrata as well. To a limited extent it likewise permits the study of some of the habits of the forms exhibited.

To one having but little knowledge of the use of the camera, it would appear to be but a simple matter to photograph under such apparently favorable conditions, but such is by no means the case. In the first place, in most instances the incessant, rapid, and often erratic movements of the fish themselves have to be taken into account; the aquaria being large, we have in the second place the difficulty of prompt focussing to contend with, due to the latitude enjoyed by the smaller and more active forms. Thirdly, there is the question of reflection, and this, taken in connection with the light, is a serious problem. Reflections are especially troublesome, as the glass fronts of the aquaria receive them from all directions, so that, after focussing, a careful study of the image upon the ground-glass will show these reflections not only from some of the other aquaria, but possibly the photographer and his camera besides. All this must be carefully guarded against.

In the early part of July, 1897, I made a number of attempts to photograph the fish contained in these aquaria through the glass-fronts, and in several instances I was successful. Where failure resulted it was due to some of the causes enumerated above, or, as in the case of a catfish, due to the high light upon the fish itself. High lights on the bodies of fish, if present at the time the exposure is made, will in the prints made from such a negative produce areas of white wherein all detail is absent. This is to be especially avoided, and often can only be overcome by shielding the aquarium from the sun above. An umbrella will in nearly all cases serve this purpose.

The camera employed upon this occasion was an old-model Blair tourograph, with a Vöigtlander lens (No. 1) (27,967), an instantaneous shutter of the Low pattern, Seed's gilt-edge plates (5 by 8). I used stops as any special case demanded. A tripod is absolutely essential to success in this kind of work. The instrument was set up in front of one of the more favorable aquaria and focussed upon the part desired and an inch or two beyond the surface of the glass. An armed plate-holder was inserted in place and the "snap" set. Patient waiting for an exposure when the fish swims to the place where you want it is necessary. Care must be taken in drawing or pushing back the slide to the plate-holder, and some of my failures were due to complications of this nature.

The first exposure was made upon a large pike (*Lucius lucius*), some 18 or 20 inches long and in good color and condition. It had a duration of about 2 seconds, at which time the plane of the left side of the fish's body was nearly parallel to the plane of the glass, and about 3 inches from its inner surface. A quarter of an inch diaphragm was used, and the subject remained practically motionless during the time of exposure. Overhead the light was somewhat diffused, and an additional disadvantage presented itself in the fact that the color of the pike closely simulated the shade of the metal-back of the aquarium, thus rendering strong outlines of the resulting negative a matter of doubt. However, the picture (plate 7, lower figure) was fairly good, and on comparing it with the figure of this species in "The Fisheries and Fishery Industries of the United States" (plate 183, upper figure) it is to be observed that in the living fish the pectoral fins are extended almost directly downward; and further, that the

extremities of the forks of the tail are distinctly rounded and not acute, as in the aforesaid drawing. In fact, the caudal fin, or tail, in the latter is incorrect in outline, and there are still other differences to be observed upon comparing the figure of the present paper with the figure given us by Goode, pointing to inaccuracies in the latter. Here is where the great value of the camera comes in. In time, with suitable subjects taken under the most favorable conditions, pictures of fish (as in the case of other animal forms), produced by half-toning processes from faultless photographs, will surely supersede in biological literature the often inaccurate figures that now illustrate it. This is what we strive to accomplish in our efforts to obtain the best possible photographic negatives of fish—live fish in their natural element, with normal surroundings.

On the same day I attempted to photograph the two species of sun-fish then in the aquaria. One of these was the common pumpkin-seed (*Eupomotis gibbosus*) and the other the long-eared sun-fish (*Lepomis auritus*, plate 3, upper figure). In the aquarium at the south end of the grotto there were upward of two dozen specimens of the former, while a handsome male of the latter species, with three or four females, were living in another tank at the side of the room, where the light was much more favorable. By instantaneous exposure I secured two fine negatives of the common sun-fish. One of these had twenty fish in it, all of which were swimming at the time, but the resulting picture shows not the slightest degree of motion in any one of them. There were nearly as many specimens on the second negative, here shown in plate 3, lower figure, and published for the first time in the *Photographic Times*, of New York. These results exemplify what may be expected from a highly colored fish, though rather a dark one, attempted under by no means favorable conditions, and where reliance was mainly placed upon tact, patience, and the best material that the market afforded. It will be observed that those specimens which were deep down in the water took the darkest, while those nearer the surface showed better definition. Nearly all of them, however, give the external characters of the species pretty well, and surely are far more interesting than many illustrations frequently seen in zoological works.

In the case of *Lepomis auritus* the subject selected was the single male fish, and for fully two hours, upon an intensely sultry afternoon, I was obliged to wait before this beautiful specimen came into the proper place to be photographed. The result, however, fully compensated for the delay, and the photograph is an absolutely accurate representation of the male long-eared sun-fish of our American ichthyfauna.

About a week after making these experiments very good results were also obtained with the striped sea-robin (*Prionotus evolans*) and with the naked star-gazer (*Astroscopus guttatus*). The former was taken while resting upon the bottom of the aquarium, while the latter was secured in two positions, the one where it had settled down upon a piece of flat stone, and the other an instantaneous exposure, showing the fish in the act of hiding itself in the sand, a very interesting habit that it constantly exhibits. The reproduction of my photograph of the star-gazer is shown in plate 7, upper figure, and it is a very accurate representation of this species as it appears in life.

This work was not resumed until July of the following year, when the present Commissioner, Hon. George M. Bowers, extended me additional facilities. Mr. Edw. S. Schmid had also had a special aquarium manufactured for my use, and I had the kind assistance in the experiments of Mr. Leighton G. Harron, the superintendent of the Aquaria at Central Station in Washington. I made a number of exposures upon needle-gars, black bass, and crappie. With both the former species I failed for not

having used a shutter of a sufficient degree of rapidity in closing. With the crappie, however, I obtained three serviceable negatives, two of them being very good.

On July 17, 1898, another day was given to this work, at which time the same methods and materials were used; but by the aid of former experience the results were more successful, and excellent negatives of series of three species of fish were obtained. Special good fortune attained the taking of the large-mouthed black bass (*Micropterus salmoides*), of which several negatives were made (see plate 4, upper figure). Views of the common sun-fish (*Eupomotis gibbosus*) were also obtained, far better than those secured during the year previous. These show in great detail the external appearances of this well-known fish (plate 2). The cat-fish (plate 8, upper figure) proved to be another fair result, but this form is a difficult one to photograph on a number of accounts.

Success was attained in the case of the white perch (*Morone americana*) on October 16, 1898. On this date there were two of these fish, with several sea trout (*Cynoscion maculatum*), in the northwest aquarium of the marine grotto. At the time the instantaneous exposure was made the finer of the two perch was swimming slowly over the bottom in search of food, while a broad ray of light lit up the sand just beyond him. Plate 4, lower figure, therefore, not only gives a truthful representation of this well-known species as it appears in nature, but the illustration possesses peculiar artistic merit besides, a piece of good fortune that sometimes befalls the operator. While thus occupied, this fish lowers its anterior dorsal fin and draws up its ventral ones, while the pectoral fins stand out perpendicular to the surface of the body.

A week later (October 23, 1898) a number of very successful exposures were made, and negatives were secured of the sea trout (*Cynoscion maculatum*), the tautog or black-fish (*Tautoga onitis*), and the sea bass (*Centropristes striatus*).

The sea trout, a young specimen, was in slow movement forward at the time of the exposure, and shows the anterior dorsal and ventral fins slightly drooping. The mouth is open, and the fish was doing nothing at the time beyond watching its companions in other parts of the same aquarium. The light marks on the anterior part of the body of this specimen, as well as the emargination of the tail, are due to injury and inflammation, resulting from injuries received during transportation from the seaboard to the Fish Commission building. (See plate 5, upper figure.)

The tautog (plate 5, lower figure) is a medium-sized specimen, photographed while resting in a vertical position upon the side of a little mound of sand and very close to the surface of the glass. It was in one of the west-side aquaria in the marine grotto, which also contained some ten or twelve more specimens of the same species, of various sizes. These fish in confinement exhibit all their natural traits, and in their aquarium some will be seen swimming about not far above the bottom; others will be lying upon their sides, and still others attempting to secrete themselves beneath the rocks, while occasionally exhibiting a peculiar method of combating each other. This consists in two fish (males?) coming at each other face to face, opening their mouths, and, the one bringing his teeth in contact with those of his antagonist, each attempts to force his adversary backward, or if he or the opponent be taken off guard for the instant, the more watchful fish of the two will make the attempt to bite the other. Sometimes there seems to be a certain playfulness about the grotesque maneuvers, while at others an earnest combative nature is quite apparent. Whether the opposite sexes ever engage in this procedure I am unable to say at this writing. At the best the tautog is a peculiar fish in its habits, and their behavior together often

reminds me of that of a litter of little pigs, with some of the movements characterized by a certain kind of cat-like fawning. They feed voraciously and take with avidity their natural food, but in the aquarium they usually receive crushed crabs.

The specimen represented in plate 5, lower figure, shows the handsome vertical markings and mottlings that the tautog frequently assumes. At other times it is of a dull leaden-black all over, while some specimens show every variety of intergradation between these two extremes. These changes, it would appear, are almost wrought at the fish's will, or they may be indicative of the humor it is in, or a color may be assumed that renders the fish less likely to be observed, and this is doubtless of value to it in its native waters, where all fish have enemies of one kind or another.

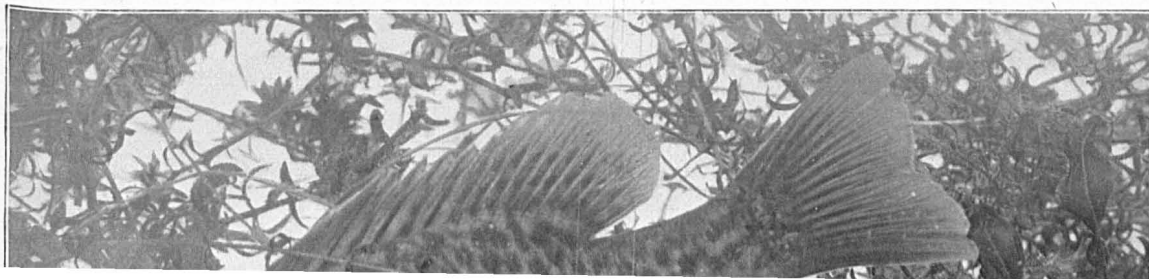
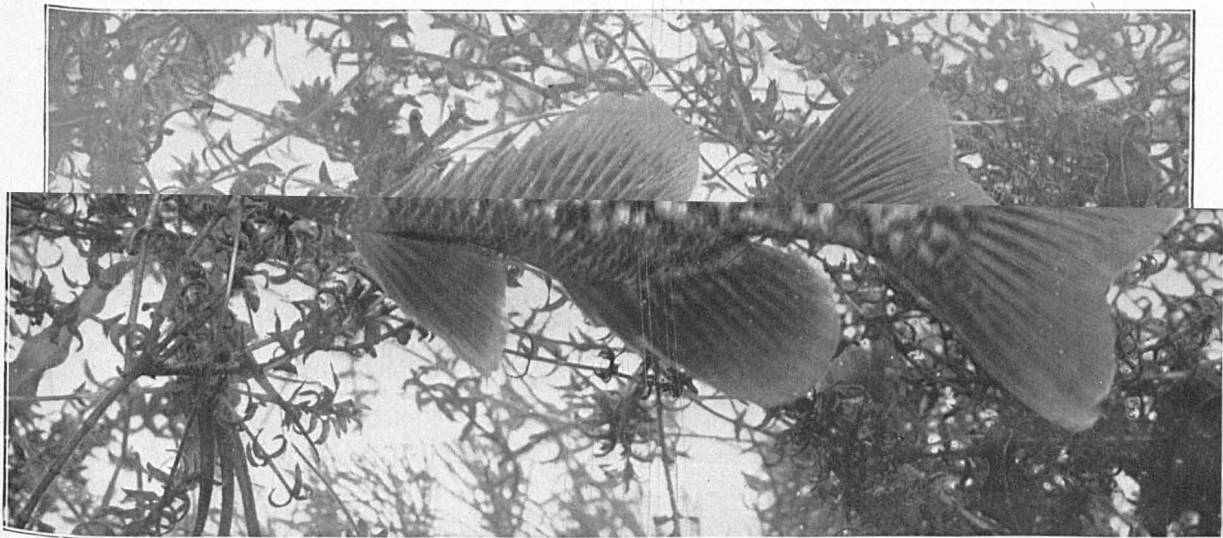
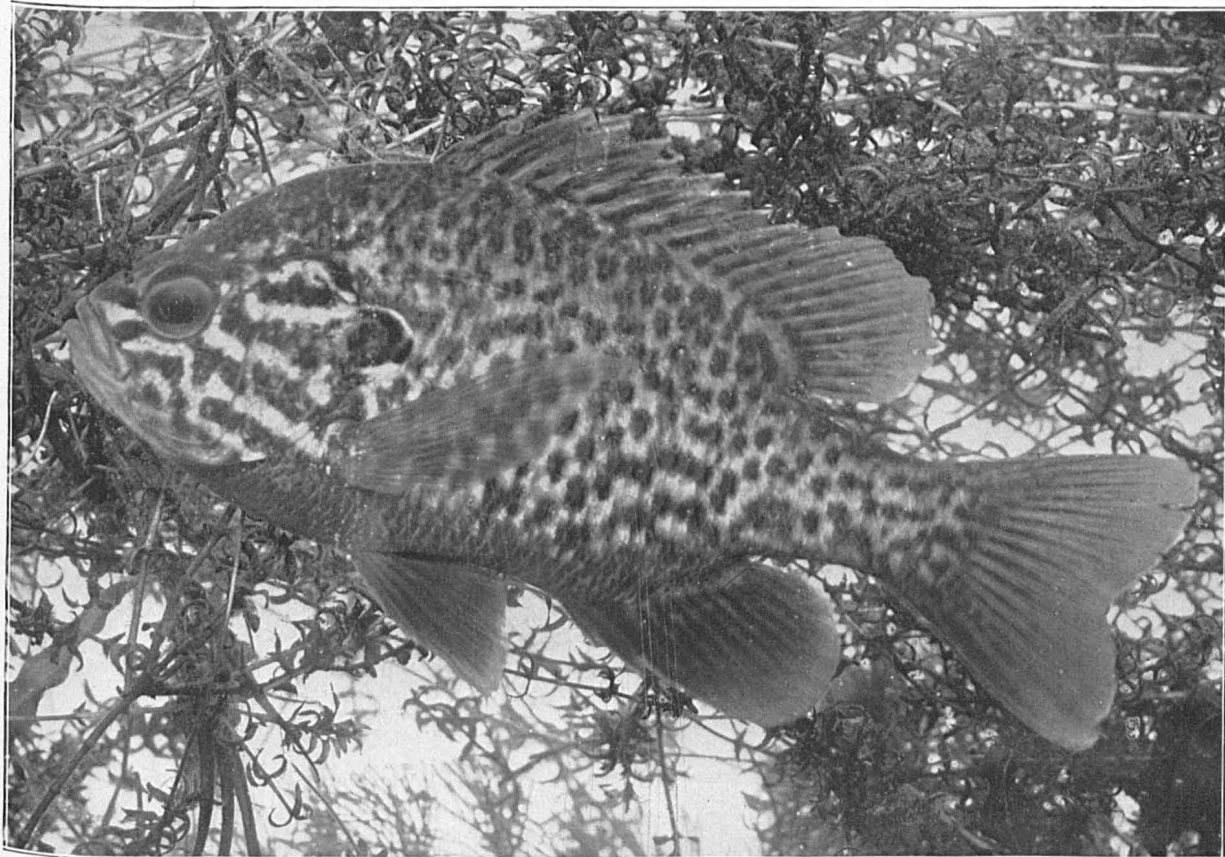
On the same day this tautog was photographed I secured two successful negatives of the young of the sea bass (*Centropristes striatus*). There were a number of these fish of various sizes in one of the aquaria on the west side of the grotto, and the light at the time of taking was excellent. Instantaneous exposures were given, and in one instance the specimen was taken just as it came to rest upon the bottom (plate 6, lower figure), while in the other it had assumed that remarkable attitude of resting upon its pectoral and anal fins that it has in nature (plate 6, upper figure). Both of these results present us with all of the external characters of these fish, and are valuable on that account. This species undoubtedly has the power of changing its color at will, both for the purposes of protection as well as to indicate the play of the humor it may happen to be in. The various shades are assumed very suddenly, quite as much so as I have seen them to be in the American chameleon (*Anolis principalis*) of the Southern States.

Sea bass have beautiful eyes, that change color a little at times, though usually they are of a brilliant emerald green, which unfortunately photographs very dull and pale. Their large and handsome fins are almost constantly in motion, rendering it extremely difficult to catch this species with the camera. The distal extremity of the upper lobe of the tail is seen to project slightly as a blunt point, but is never in the young extended as an elongated ornamental filament. In the adult, however, of a southern species (*Centropristes ocyurus*) both the upper and lower lobes of the caudal fin are thus filamentously produced.

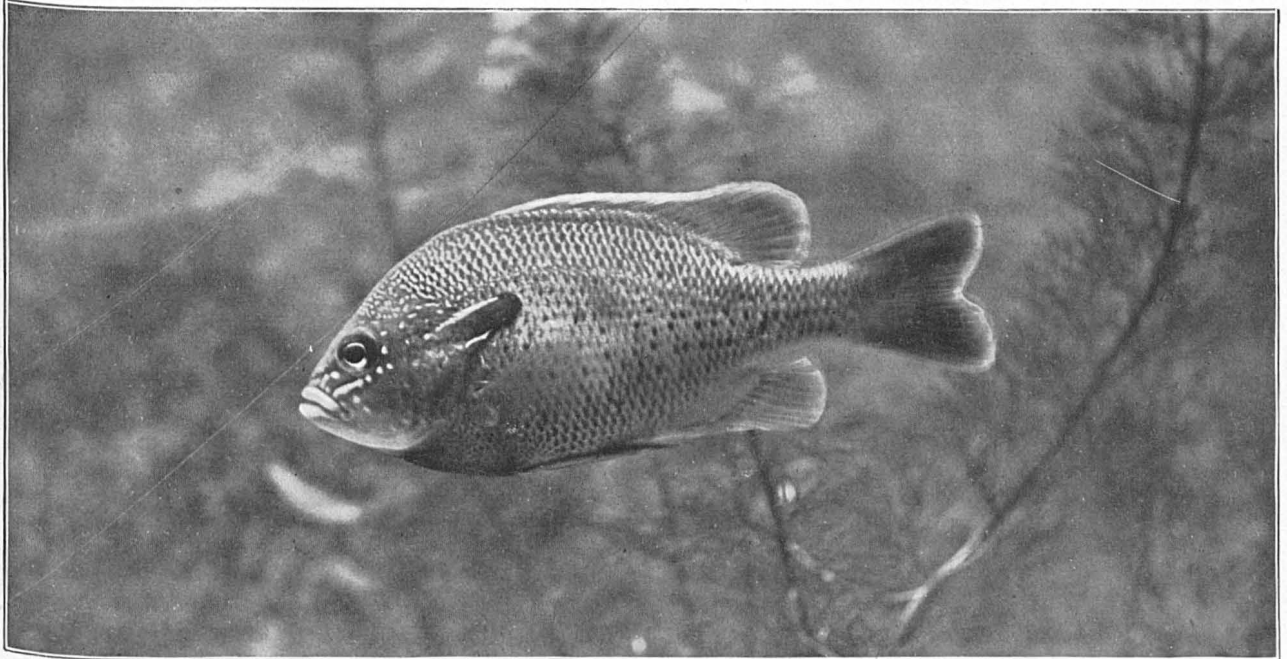
I have also examined specimens of sea bass wherein the middle three rays of the tail were likewise somewhat drawn out in this manner. These examples were in the Washington Center Market (October 26, 1898), and were said to have come from New York. The upper and lower caudal lobes were light-colored, and it was only in the former that any indication of a filament was noticed, and that only in some few of the specimens. These fish were probably *Centropristes ocyurus*, wherein the tails had suffered mutilations due to transportation after capture.

Some of the difficulties which attend the photography of living fish are seen in plate 9, from an instantaneous exposure (made October 23, 1898) upon the north end aquarium of the grotto, when there were swimming in it 450 rainbow trout (*Salmo irideus*). Necessarily some of the number were out of focus. The lower ones show but little detail, owing to being in the shadow caused by the great mass of fish above them, others are indistinct from lateral shadows, and at the best the light at the time of exposure was not of the kind to insure the most perfect success; nevertheless, this result is a very interesting one, and probably not many photographs extant, if any, show so many examples of swimming fish upon the one plate, where not a single individual of them exhibited the least movement in its photograph.

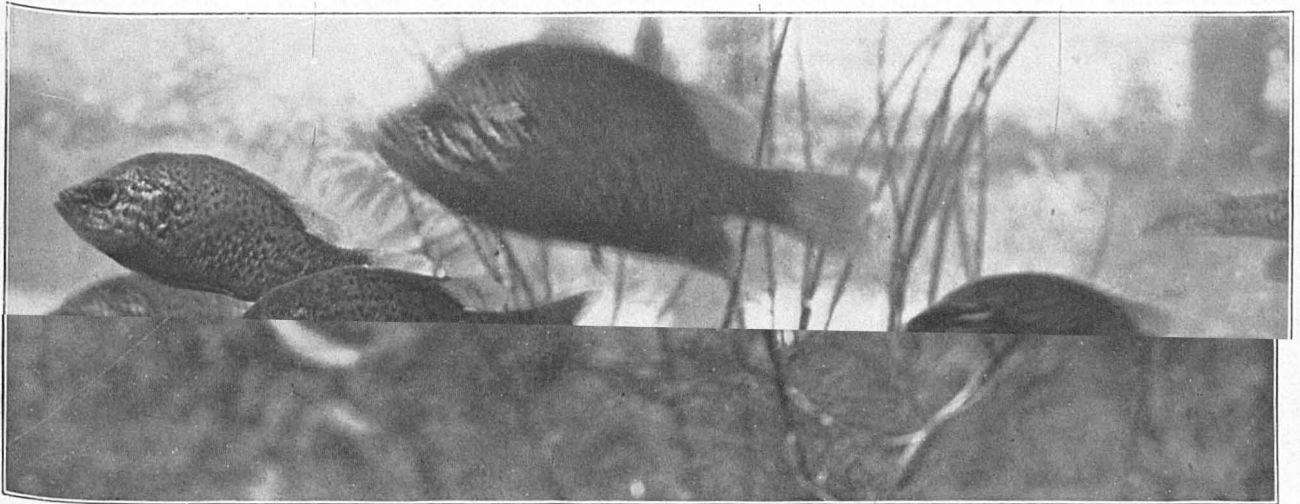




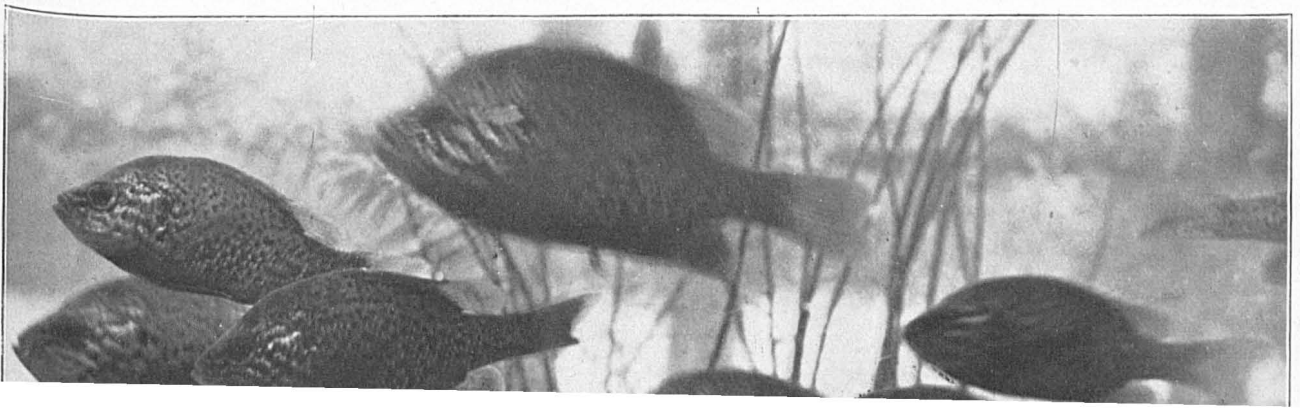


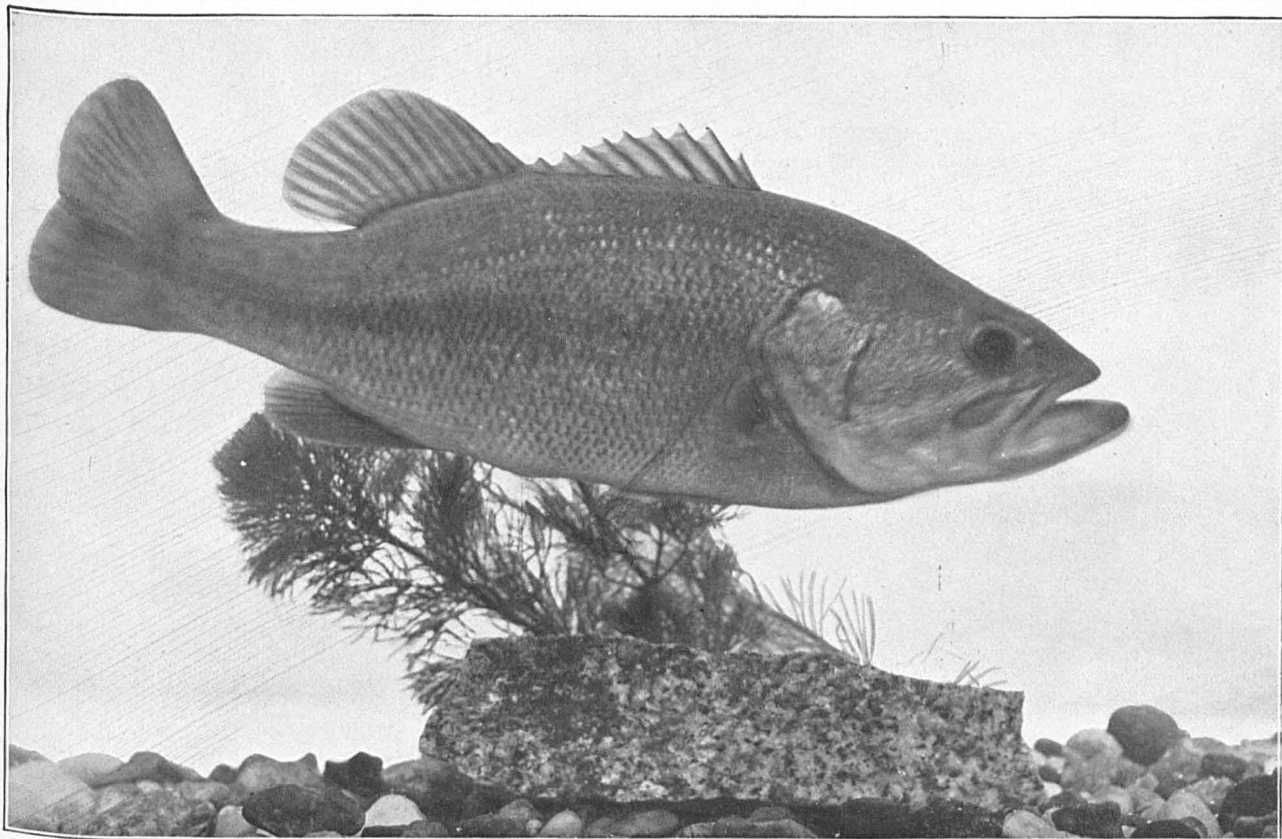


LONG-EARED SUN-FISH (*Lepomis auritus*). Reduced about one-third.

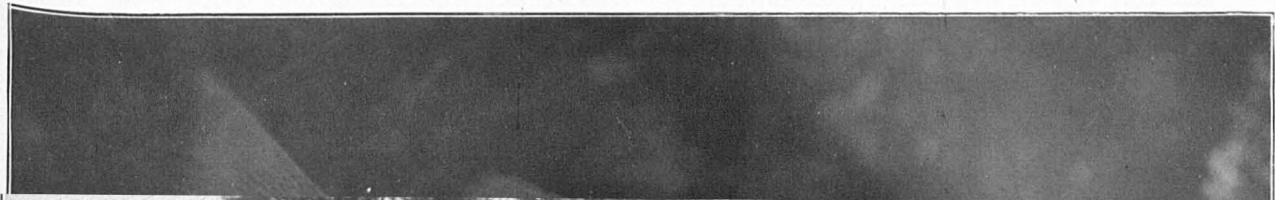


LONG-EARED SUN-FISH (*Lepomis auritus*). Reduced about one-third.



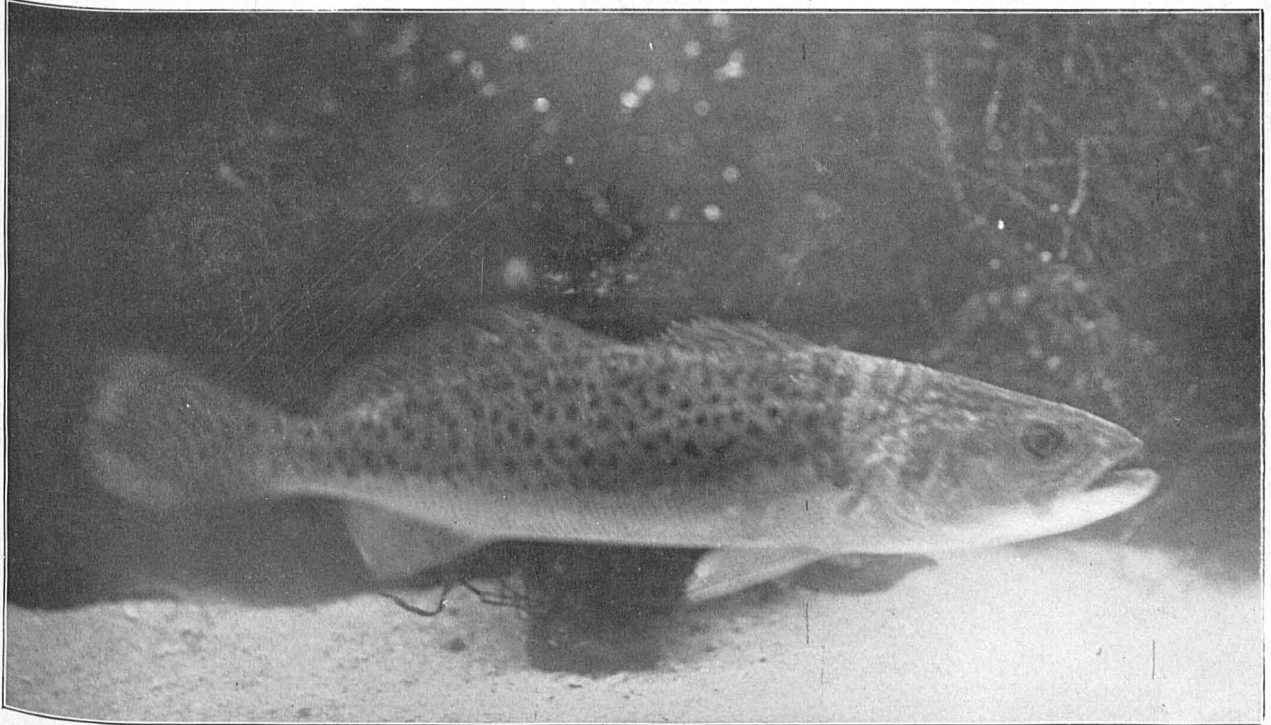


THE LARGE-MOUTHED BLACK BASS (*Micropterus salmoides*). Slightly reduced.

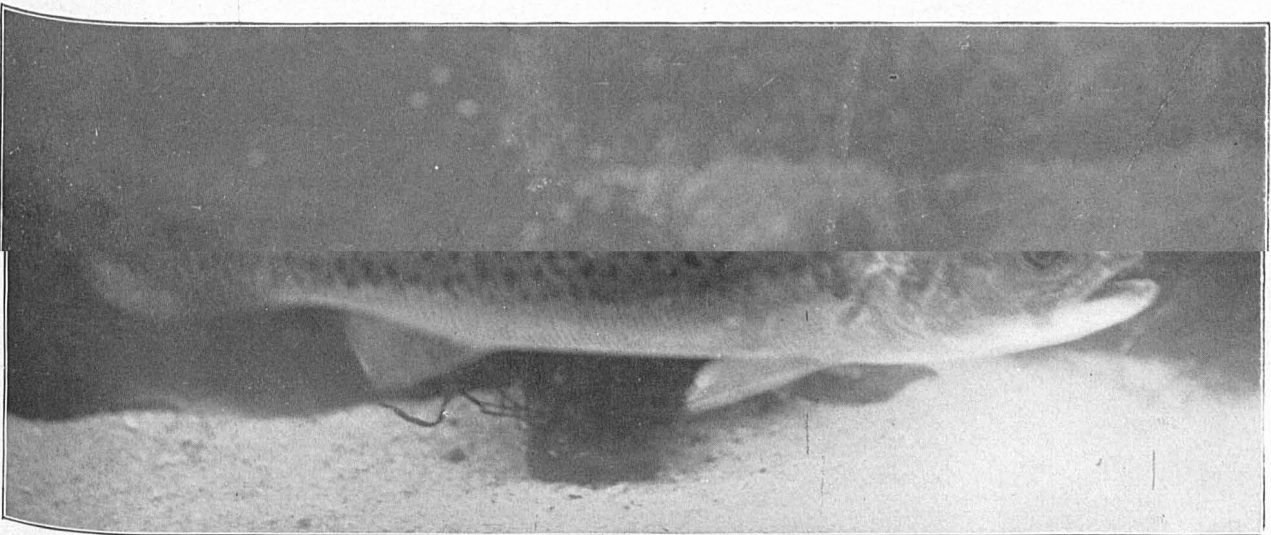


THE LARGE-MOUTHED BLACK BASS (*Micropterus salmoides*). Slightly reduced.



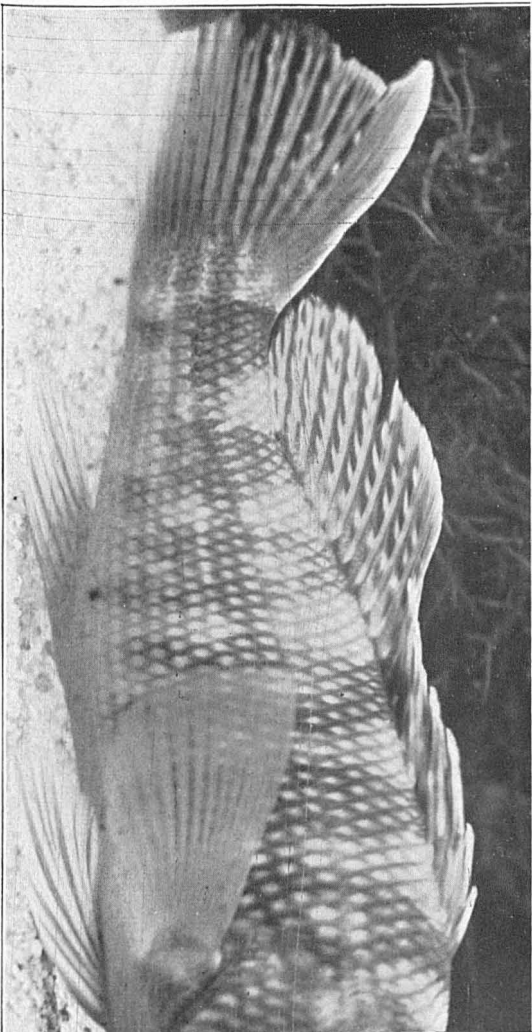


THE SPOTTED SEA TROUT OR SQUETEAGUE (*Cynoscion maculatum*). One-half natural size.

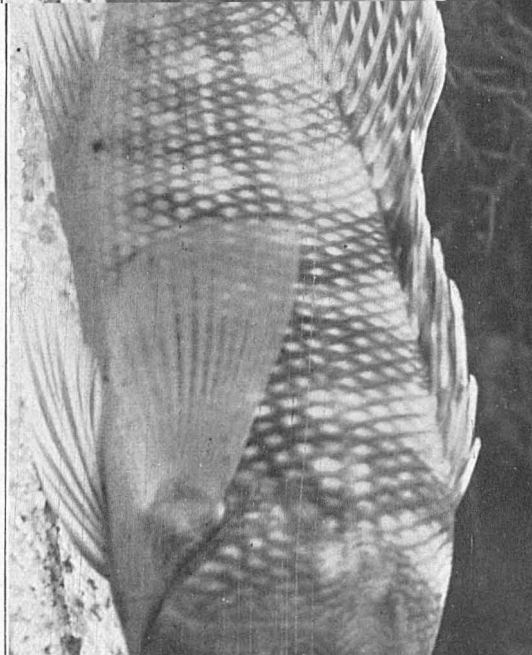
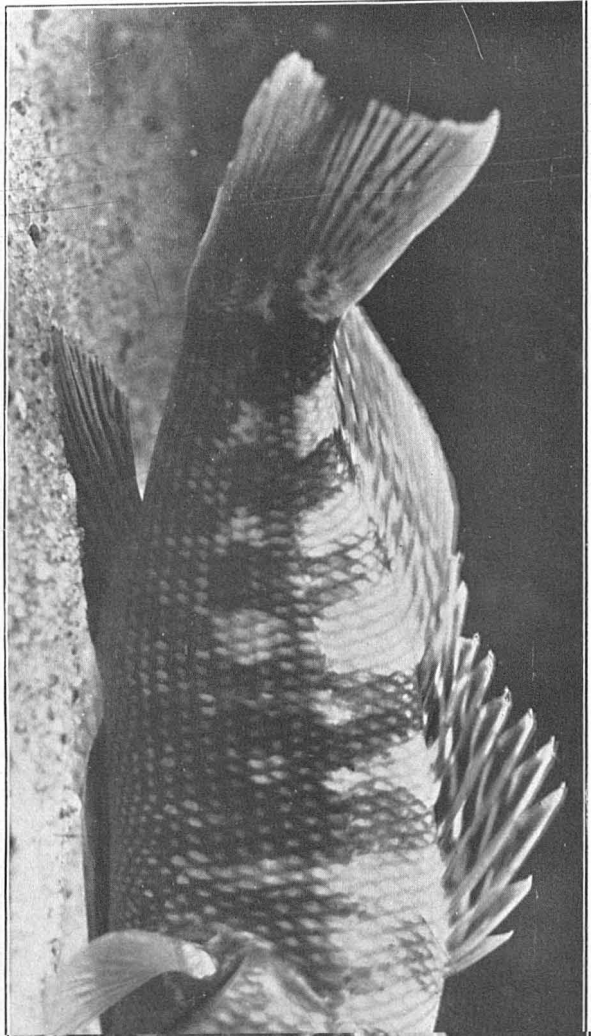


THE SPOTTED SEA TROUT OR SQUETEAGUE (*Cynoscion maculatum*). One-half natural size.

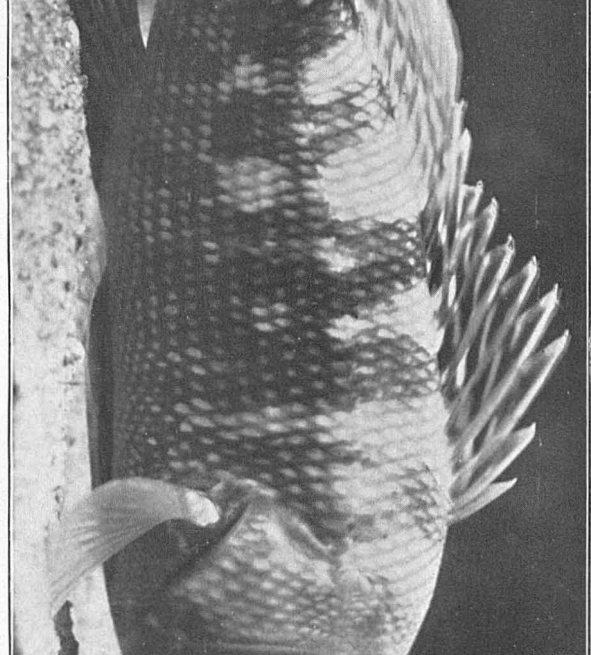


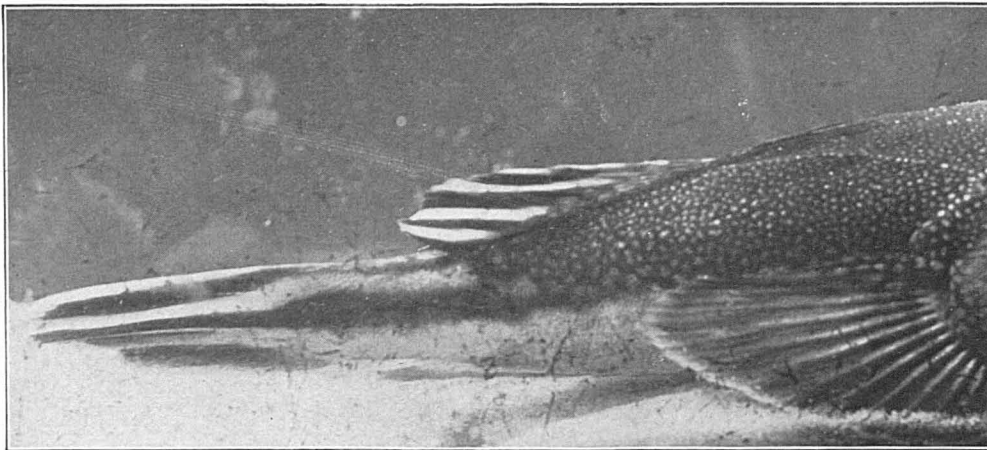


THE SEA BASS (*Centropristis striatus*). Different specimens.

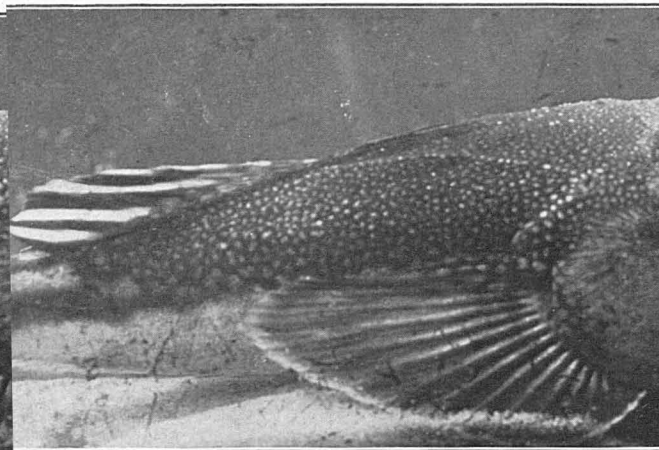


THE SEA BASS (*Centropristis striatus*). Different specimens.

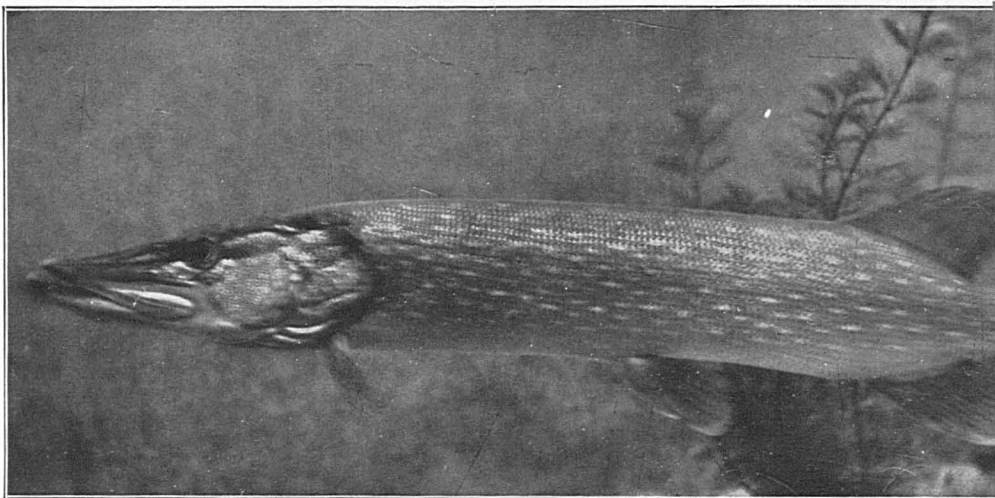




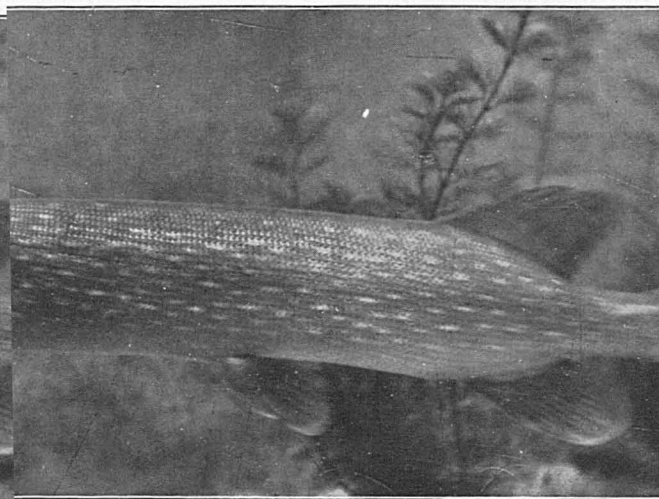
THE NAKED STAR-GAZER (*Astroscopus guttatus*). Slightly reduced.



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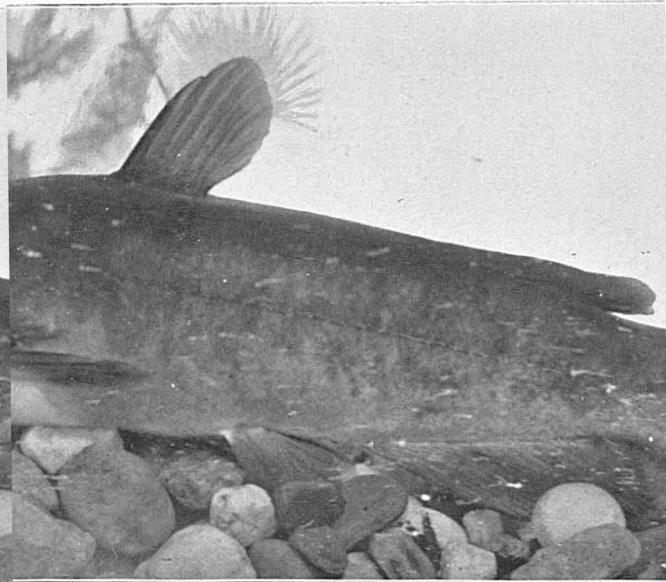
THE PIKE (*Lucius lucius*). Left lateral view.



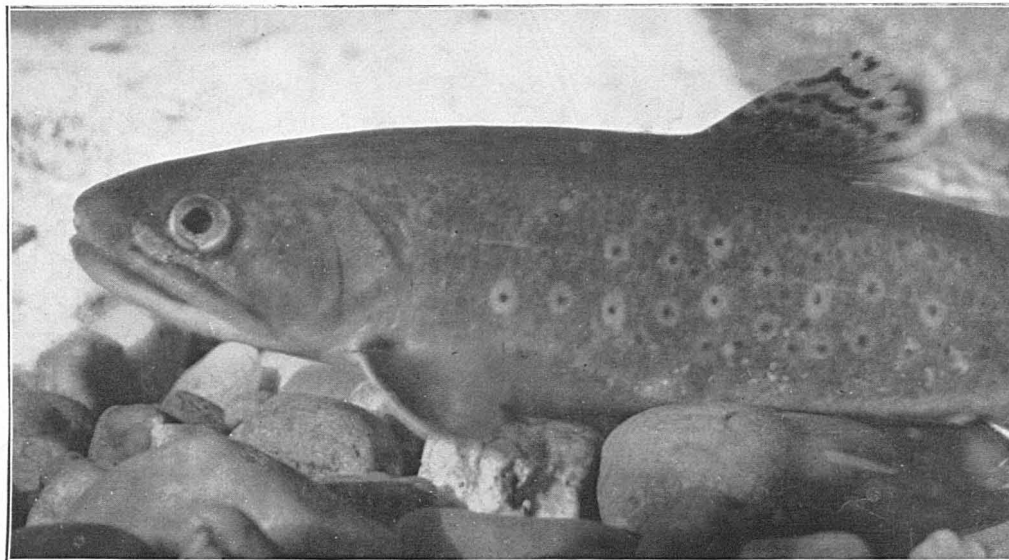
THE PIKE (*Lucius lucius*). Left lateral view.



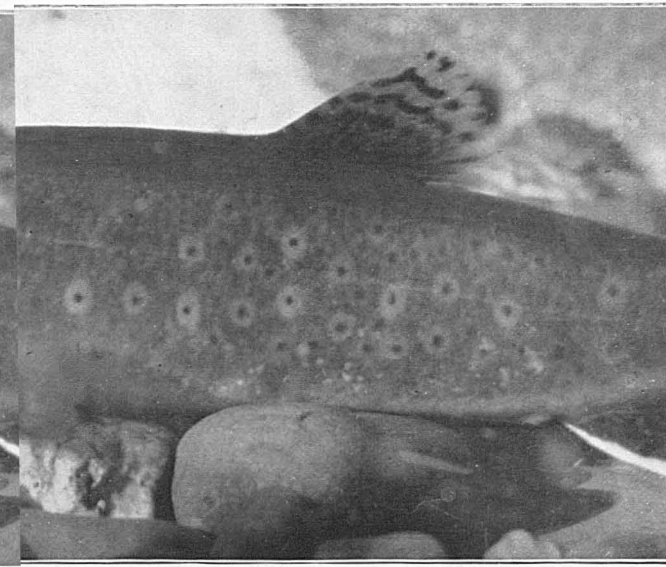
THE CAT-FISH (*Ameiurus nebulosus*). Somewhat reduced.



THE CAT-FISH (*Ameiurus nebulosus*). Somewhat reduced.



THE BROOK TROUT (*Salvelinus fontinalis*). Natural size. Taken July, 1897.



BROOK TROUT (*Salvelinus fontinalis*). Natural size. Taken July, 1897.

YOUNG RAINBOW TROUT (*Salmo tridens*). Four hundred and fifty specimens in the aquarium.

