men gathered about our larger colleges. These colleges have developed, and their libraries have grown more and more valuable; so that the professors no longer find it necessary to go to their academy for books. At the same time the machinery of their long-established organization has grown more effective; and, while many of the members no longer need their society collection of books, the number and value of those added to the shelves each year are constantly increasing. The result is, that in some of our larger cities there are accumulating very considerable libraries of special works which are scarcely used, as they are duplicated at some neighboring college about which those employing such books live.

It is, of course, with regret that one enters such a library, if library it may be called, and sees the new books which are not called for by the former clientage of the collection, but which would eagerly be asked for if the circle of favored outsiders were widened so as to include all properly vouched-for persons who might live within one, two, or three hundred miles, or even more, and who would be willing to pay a small annual fee to defray the expense of sending books to them by mail or express, and for the extra wear, and danger of loss. It is true that such books as could not be readily replaced in case of loss would necessarily be retained from such a wide-spread circulation; but these would be only the older volumes of the various series, and such books as are very generally kept from such extra risks.

The expense of mailing would be considerable; it would average, on volumes of the size of a bound volume of the *American journal of science*, about sixteen cents each way. To this must be added the cost of handling, and some slight charge for the privilege of use. Altogether, the expense of taking out, say, forty books of this class in the course of the year would be in the neighborhood of ten to fifteen dollars, — a charge which could be reduced very materially by sending for the books a number at a time, so that they might be forwarded to advantage by express; the amount named above being the maximum if each book were mailed separately.

That the expense of using a library through the mails would mount up very rapidly is evident; but the facts remain, that there are large libraries of books solely on matters of interest to scientific men, and of vital interest to such men, and that these libraries exist in communities where by duplication they no longer have their former use. It is highly desirable that the books should be put to use; and their owners would probably be glad to arrange some plan by which the scheme of extending the circulation through the mails could be made practicable. It would be of great advantage in perfecting plans, if those who might be benefited would come forward and state their position.

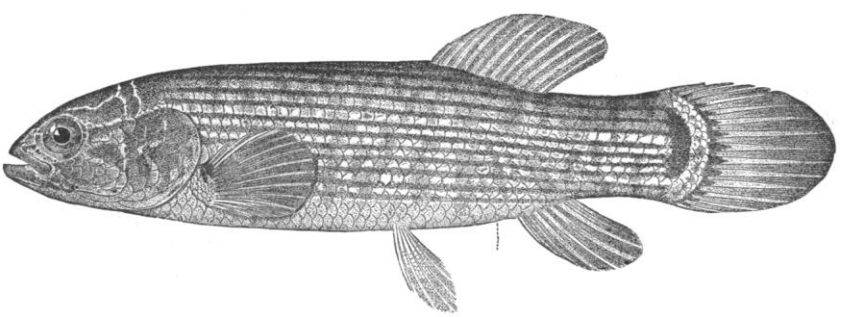
THE COLOR-SENSE IN FISHES.

In his recent volume on 'Mental evolution in animals,'[1] Mr. Romanes remarks, "As further proof that a well-developed sense of color occurs in fish, I may remark, that the elaborate care with which anglers dress their flies, and select this and that combination of tints for this and that locality, time of day, etc., shows that those who are practically acquainted with the habits of trout, salmon, and other fresh-water fish, regard the presence of a color-sense in them as axiomatic." As one 'practically acquainted' with some sixty species of fresh-water fishes, representing a dozen or more distinct groups, I am reminded, by the above quotation, of many occurrences witnessed during my rambles about the Delaware River, or its tributary creeks, that have a bearing upon the subject. Besides recognizing the differences in insects by their colors, have fishes any knowledge of the fact that their own colors may or may not be protective? Are they aware that it depends upon themselves, whether these colors shall be a safeguard, or a source of danger? That we are warranted in giving an affirmative reply, is shown, I think, by their habits, and particularly by the fact that to a certain extent they have the color of their bodies under their control.

Relatively speaking, the fishes of the Delaware River and its tributaries may be classified, in regard to their habits, as diurnal and

[1] Mental evolution in animals, by GEORGE J. ROMANES. New York, *Appleton*, 1884. 411 p. 12°.

nocturnal. It might almost be said that there are no 'fixed' habits. I have found marked variations in every one of the most characteristic habits of our birds; and can see no reason why the same degrees of variability should not likewise obtain among mammals, reptiles, and fishes. In considering fishes as either nocturnal or diurnal, I mean that they are so to about the extent that owls are; i.e., ranging from species as diurnal as hawks to those that are nocturnal, or, properly speaking, crepuscular. How often we hear the phrase, 'as blind as a bat'! yet these mammals are not averse to daylight, and only shun the glare of noonday. In shady woods they are often found insect-hunting by day; and fly just as freely, and range abroad as generally, on cloudy days, as during the gloaming throughout midsummer.



MUD-MINNOW (*Umbra limi*).

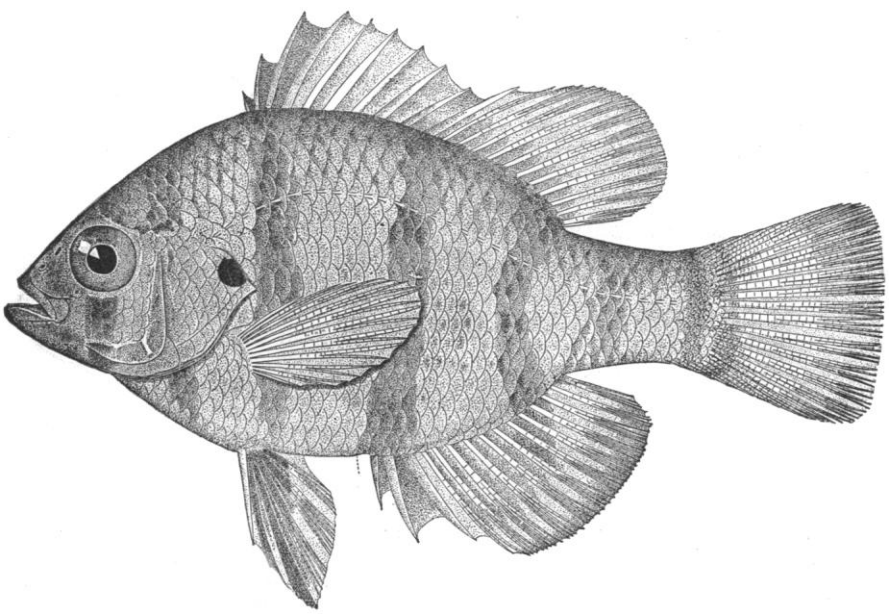
Several years ago, when studying our fishes with reference to detecting supposed traces of voice possessed by them, I concluded that the nocturnal, dull-colored species had the power of uttering certain sounds, especially during the breeding-season; while the diurnal fishes were apparently voiceless, and were dependent upon their gaudy coloration as a sexual attraction. More recent observations have led me a step farther, and I am convinced that the colors of many species continue to play an important part in the struggle for existence throughout the interim from one breeding-season to the next. It must be remembered that fishes, when undisturbed by man's presence, are very different from the frightened animals that rush hither and thither in the most reckless manner when startled by his sudden appearance. We have only to take a favorable position, and, ourselves unseen, to gaze patiently into their accustomed haunts, to realize what animated, cunning, and mentally well-developed creatures fishes really are.

That curious group known as 'darters,' or etheostomoids, is always to be found, when not in motion, resting upon the bottoms of streams; and I have never found these fishes in localities where their color did not closely resemble the sand, mud, or pebbles upon which they rested. I have tested them in this matter in the following manner. Finding a spot in a small stream where many of these fishes congregated, I placed a large number of white-porcelain plates in the stream on a level with the surrounding sand. On disturbing the 'darters,' I found that they invariably settled between these plates, and never on them; and this after the dishes had been several days in position. Finally the currents covered the plates with a thin coating of sand, and then occasionally a 'darter' would come to rest upon one of the plates. The motion of his fins in so doing usually displaced the sand, and exposed the white surface beneath: if so, the fish darted off, and settled between the plates or beyond them. It is evident, I think, that protection through their color must be quite essential to them; more so in the matter of procuring their food, perhaps, than as a safeguard against the attacks of enemies.

The mud-minnow (Umbra limi) depends very largely upon insects and smaller fishes for food, and the question of color is a prominent one in its life history. This fish frequently assumes what we may call an 'inanimate' position, and, with a variety of colors streaking and spotting its sides, has much the appearance of a bit of dead grass, a twig, or a caddis-worm. Often such unnatural positions will be retained for many minutes, or until some object suitable for food comes within reach, when it darts at and seizes it with the rapidity and certainty of a pike. Now, in all such cases, there is great and constant changing of color. Often the tints deepen until the fish appears to be inky-black, then pale until, from above, we can scarcely detect the fish. Such changes, of

course, are very significant, and can only be explained as being serviceable to the fishes in rendering them inconspicuous, both to their enemies and to the wandering animal-life on which they prey. In precisely what way the extreme variations from very dark to pale are serviceable, is not yet known, so far as I am aware; but the fact itself can scarcely be used to the disadvantage of the main proposition, that the color and its changeableness are of benefit to the fish, and are under the animal's control.

I think we have, in the fact that usually they deposit their ova and milt in rapid waters. Waters with a constantly rippling and troubled surface certainly protect them from such enemies as the kingfisher, fish-eating mammals, and probably from frogs and snakes. By drawing a seine through turbulent water at the foot of a mill-dam, I have frequently found scores of splendidly colored cyprinoids; and finally, very soon after spawning, all these extra tints fade out utterly, and the fishes return to their accustomed haunts. These facts



BANDED SUN-FISH (*Mesogonistius chaetodon*).

During the early spring, when the vigor of these fishes is at its maximum, the coloration is more pronounced in every particular; and the continual changing from dark to light, and *vice versa*, as seen in connection with its other habits, shows plainly that it is as much under control as are the folding and spreading of a peacock's tail.

The cyprinoids, or 'shiners,' known collectively as minnows, roach, and dace, so many species of which are conspicuously colored at least at one time of the year, are all essentially diurnal in habit. Their bright colors, as a sexual attraction, are essential to their welfare, but are, at the same time, detrimental to their safety. Have we any reason for believing that these fishes seek to avoid exposure to enemies when thus arrayed in extra-conspicuous dress? certainly seem to indicate that they are aware of the disadvantage of unusually bright colors, which, notwithstanding, are essential to the perpetuation of their kind.

The common banded sunfish (Mesogonistius chaetodon), a silvery-white species, has a remarkable control over the color of the black vertical bands that ordinarily form so conspicuous a feature of the fish. At times when the water is rather clear, and the amount of vegetation not abundant, this sunfish will fade out, and show such ashen, faintly streaked sides, that it might almost pass for a dead leaf; but roused to action by the approach of other fishes, or the finding of food, the dull sides glisten like polished metal, and the faint bands become as black as ebony. Certainly these great and sudden changes are not involuntary. They

cannot be likened to blushing, but are evidently under the fish's control, and are intelligently used to its advantage.

The bony gar (Lepidosteus osseus) is another fish having decided control over the coloration of its scales. When this fish is at rest, the scales are pale blue, with a pink margin; and about the head and gill-covers there is a variety of brilliant hues. At times all these colors will suddenly disappear, and the fish has much more the appearance of a water-soaked stick than of a living animal. Unfortunately I have had too few opportunities for observing this species to determine the reasons for these changes; but it is evident that they are under the control of the fish, and therefore advantageous.

The common pike (Esox reticulatus) also exhibits a variation of coloring, under different circumstances, and suggests the same facts that have already been stated with regard to other species.

When the chief aim of biological science seemed to be the naming and describing of 'species,' it was found that no description of the color of a fish, unless very unusual and marked, was at all satisfactory. Considering the subject of color, as I have in this article, the cause is very evident.

In an early number of *Science*, I offered many reasons for believing that fishes were very far from spending as joyless, machine-like an existence as has been supposed. Those reasons I supplement with the results of studies of their habits, with reference to their brilliant tints and sombre hues, and am in accord with Mr. Romanes when he states that we are justified in regarding 'the presence of a color-sense in them as axiomatic.'

CHARLES C. ABBOTT.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

PROCEEDINGS OF THE SECTION OF BIOLOGY.

A LARGE number of papers (forty-three in all) were presented before the section of biology, but we regret that in our limited space we can give merely the briefest outlines. The first we may mention was a paper by Mr. H. G. Beyer, on the influence of oxygenated and unoxygenated blood, as well as of blood in various degrees of dilution, on the isolated heart of the frog and terrapin. The paper aimed to prove that it is not concentrated mammalian blood which produces the greatest amount of work done in either the heart of the frog or that of the terrapin, but a certain degree of dilution is necessary. There is no exception in the constant, stimulating influence in oxygenated blood, and none in the depressing effect of non-oxygenated blood.

Dr. C. S. Minot read a paper on biological problems. The author opposed the trinomial system, and considered the present mode of determining species entirely unscientific, and thought that the species should be based on a statistical study of all the variations that are known to occur. Individuals are not always homologous. The only fixed units are, 1° cells; 2° the whole series of generations of cells from a single ovum, — a cell-cycle. An individual may be almost any fractional part of a cell-cycle. Roughly speaking, the higher the organism, the fewer the number of individuals it comprises. The author considered the ovum to be homologous with the encysted protozoon, the zona radiator being equivalent to the capsule or cyst of the protozoon, and the contents also homologous.

In a paper by Lillie J. Martin on a botanical study of the mitegall found on the petiole of Juglans nigra, known as Erineum anomalum Schw., a general survey of the gall was given, as to position, number, general appearance, etc. This was followed by a description and comparison of the microscopical appearance of the gall and normal petiole, concluding with the supposition that the mite entered at an early period in the life of the petiole, and the growth of the gall was from within outward.

A paper by Prof. B. G. Wilder, on the relative position of the cerebrum and the cerebellum in anthropoid apes, was illustrated by photographs, and a preparation of a chimpanzee's brain; conclusively settling the much-disputed point, as to whether the cerebrum extended over the cerebellum or not, as the cerebrum was seen to extend at least a millimetre over the cerebellum.

Mr. E. D. Cope, in a paper on the phylogeny of the artiodactyle Mammalia derived from American fossils, considered the derivation of the seledont dentition from the bunodont as established from a mechanical point of view. The oldest American artiodactyl (Pantolestes) is bunodont. The modification proceeded as in other ruminant lines by the co-ossification of the bones of the legs and feet. The peculiar structure of the carpus in the Oreodontidae shows them to be, without doubt, the ancestors of the Tragulina. The following table represents the present views of the author on this subject.