ceeded, and these survive in the existent water-gaps. There can be little doubt that lakes very frequently appeared and disappeared on these stream-courses during the growth of the mountains.

THE INTELLIGENCE OF FISH.

IN Mr. Romanes's recent volume on Animal intelligence,[1] only thirteen pages are devoted to the intelligence of fish. That this class of animals is more 'knowing' than is generally believed, is, I hold, unquestionable. From frequent conversations with old fishermen, I have learned that the exercise of cunning, on the part of fish, is by no means uncommon; and I have also found that certain sayings are common among these people, such as 'cute as an eel,' 'sly as a snippick,' i.e., snipe-pike (Belone truncata), which also show that fish are credited with considerable intelligence by these practical observers, whether rightfully or not. My own impression, based upon long-continued, careful study of our fish, long since fully convinced me that many of them were possessed of nearly as much intelligence as birds, and more than either the snakes or batrachians. This may seem a hasty statement, but I believe it is substantially correct. For this reason, I am surprised that so little has been recorded by observers, with reference to fish, as is evident from the meagre array of facts presented by Mr. Romanes in the work mentioned. The author, in the opening remarks of his chapter on fish, says, "Neither in its instincts nor in general intelligence can any fish be compared with an ant or a bee." This statement I propose to dispute, because there is abundant evidence that the intelligence of fish varies exceedingly, and some fish do possess an amount of cunning which brings them nearer to the ants or bees than Mr. Romanes's remark would imply. Had our author said 'most fish,' perhaps no exception could have been taken to the statement; but, using the words 'any fish,' he is, I think, open to criticism.

But what are the evidences that some fish possess such an amount of intelligence as I have intimated? In reply, I have to offer a case of great cunning shown by a number of pike when in danger of capture. A gilling-net had been placed across the outlet of a small tributary of Popihacka Creek. In this little spring-brook several large pike had wandered in search of minnows. Being disturbed, they rushed with great impetuosity towards the net, and the foremost of them was at once securely entangled in its meshes. Straightway the others stopped as suddenly as they had started, and, recognizing their fellow in trouble, 'took in the situation' at once. Each pike evidently realized the true condition of affairs, and reasoned thus: that pike tried to go through this obstacle in the water, and is in trouble; it is necessary for me to avoid it by some other means. There were five of these fish that paused close to the net; and each acted, I believe, as it *thought* best. One of them came to the surface, and, after a moment's pause, turned upon one side, and leaped over the cork-line. Seeing the success of this effort on the part of one, a second did the same. A third came to the shore near where I stood, and, discovering a narrow space between the brail and the net, passed very slowly through, as though feeling its way, although the water was so shallow that its body was fully one-third out of the water as it did so. The others were either more timid or less cunning. They turned to go up stream; but being met by my companion, who was making a great noise by whipping the water, they rushed again towards the net, but checked their course when their noses touched the fatal net. Prompt action was necessary. They had not confidence in their leaping-powers; and both, as though struck with the same thought at the same moment, sank suddenly to the bottom of the stream, and burrowed into the sand and beneath the lead line, which was in full view. In a moment they reappeared on the other side of the net, and were gone. I could have prevented the escape of all of these fish, but was so much interested in the evidence of thought exhibited by them, that the idea of molesting them did not occur to me. There was something in the manner of these fish, too, which is not readily described, but which gave an importance to those acts, on their parts, that I have mentioned, and which added materially to the strength of the evidence that they were 'thinking' in all that they did.

Evidence of the intelligence of fish is further shown by our common sunfish (Eupomotis aureus), which not only mates early in the spring, and guards its nest and young until the latter are able to shift for themselves, but in many cases remains paired. If it can be said of storks, that marriage occurs among them, the same is true of sunfish. I have known the same pair to occupy for several years the well-protected space bounded by the twisted roots of an enormous maple, that

[1] Animal intelligence. By George J. Romanes. — (*Internat. sc. ser.*, no. xliv.) New York, *Appleton & Co.*

projected into the water. In this case, and I know of many others, these fish plainly showed the existence of strong mutual affection. Indeed, when once the nest is formed, a pair of young sunfish, mated but for the single season, are evidently very fond of each other; and, if one of them is caught, the other is straightway stricken with grief, which it shows by unmistakable signs. Grief is, of necessity, a true mental operation. It cannot be referred to instinct, as defined by Mr. Romanes; and that sunfish are grief-stricken when deprived of their mates is unquestionable. It is only necessary to take one from the nest, and let it nearly die by exposure to the atmosphere; then replace it, and watch the actions of the other. No one will, I think, hesitate to consider as grief the emotion that controls the fish thus deprived of its mate.

The common catfish (Amiurus catus) likewise exhibits great affection for its young, which remain with the parent-fish for several weeks after they are hatched. She does not, indeed, always succeed in keeping her brood together; but, so long as she does, she will defend them from all enemies, without regard to her own safety. I once placed a glass globe containing a brood of young catfish on the bank of the stream from which they were taken, and in full view of the parent-fish, which was greatly excited by being deprived of her charge. This fish at once recognized that her young were not in the creek, although they were swimming in water. After a variety of restless movements, its curiosity overcame its discretion; and it left the creek, and, as best it could, made its way to the base of the globe containing her young, a distance of about two feet. Here she remained for nine minutes, quietly watching her brood, and then returned to the water. In a few moments she returned, having recovered from the effects of exposure to the air. I now liberated the young catfish; and they immediately clustered about their parent, and followed her into deep water. In this case the parent-fish made no effort to escape when I approached, and allowed me to handle her without any resistance. I have since tried similar experiments with these fish, and always with essentially the same results.

Instances, also, might be multiplied indefinitely of actions, on the part of fish, indicative of cunning or forethought, — cunning in their efforts to secure their prey, forethought in their efforts to escape their enemies. I have even seen ingenuity exercised by a roach, notoriously the most stupid of fish. Space, however, will not permit of further details. Let it suffice to mention, that the actions of predatory fish in hunting in schools, and those of comparatively helpless fish (such as the cyprinoids) in keeping together in large companies, that collectively they may lessen individual danger, are cases that exhibit evidence of a realization of the fact that in union there is strength. The predatory fish know, that, by concerted action, their prey can be more readily captured. Those that are exposed to attack know, that, as one in a thousand, the chances of each of escaping its foes are greater than if it wandered solitary and alone.

The very fact that our fish vary greatly in their habits is, of itself, evidence that they differ in their intellectual capacities; those that are solitary being the quicker witted, and the more prompt to adopt some ingenious device to meet the requirements of the moment. Witness, in this regard, the pike, the black bass, the etheostomoids, the mud-minnow (Umbra). In these we have instances of fish that clearly demonstrate the possession of a considerable range of intelligence. On the other hand, watch the distracted schools of cyprinoids chased by rock-fish or perch. It is seldom that they do more than trust to luck; and these fish are never seen except associated in large numbers.

Nor must the fact that many fish, as the mud-sunfish (Acantharcus pomotis), eel, catfish, and chub-sucker (Erymizon sucetta), have well-defined vocal powers be overlooked; for it, too, has a bearing on the subject of the intelligence of fishes, in that the circumstances under which these vocal powers are exercised are such as indicate that they are intended to convey ideas to others of their kind, — an act which necessitates a complicated mental effort.

After years of familiarity with the many species of fish found in the Delaware River and its tributaries, I find that they can only be intelligibly described by using such terms as 'cunning,' 'fear,' 'grief,' 'ingenuity,' and 'anger;' and if their actions unquestionably indicate the possession of such emotions and faculties, — and I claim that they do, — then the great gulf, mentioned by Mr. Romanes, between the intelligence of fish and that of ants and bees, is materially lessened; and future studies of the much-neglected subject of the habits of fish will, I believe, ultimately show that many fish are the intellectual equals of any existing insects.

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