THE HABITS OF THE GIANT SALAMANDER.

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[Reprinted from The Popular Science Monthly, April, 1903.]

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CRYPTOBRANCHUS (*Menopoma* of the earlier text-books) *Alleghaniensis* or hellbender, the American representative of the giant salamanders, although only too familiar to the fishermen of the Ohio valley is, to most people, rather a curiosity and its habits therefor are worthy of some attention.

Its distribution, according to most authors, is limited to the tributaries of the Ohio River, but whether or not this is strictly true I am unable to state. I have investigated several cases of the supposed occurrence of *Cryptobranchus* in waters far distant from the Ohio, but in each instance the animal in question proved to be *Necturus*. By the natives of the regions it inhabits, the hellbender is called 'alligator' or, occasionally, 'waterdog': it is easy to imagine how the former name might have originated, but why it should be called a 'dog' is as hard to imagine as the reason for calling *Necturus* a 'mud-*puppy*.' The hellbender is said to reach a length of more than 60 cm., the largest specimen that I obtained, from a considerable number of individuals, was 55 cm. in length. It is a most unprepossessing animal, and, probably on that account, has the reputation, among fisherman, of being poisonous, although it is really a most inoffensive and harmless creature. I have handled many dozen individuals, some of which were just from their native stream and some of which I have had in captivity for more than eight months, but in no instance has any attempt been made to bite. Its jaws are very wide and strong, however, and being armed with numerous small, sharp teeth, are probably capable of inflicting a painful wound. Its repulsive appearance seems to be largely due to the curious flatness of the head, the tiny, almost invisible, lidless eyes and the lateral folds of skin which extend for the greater part of its length.

The tips of the toes, of which there are four on the anterior and five on the posterior feet, are nearly white and are thus in curious contrast to the dark color of the rest of the animal.

The adult hellbender breathes by means of well-developed lungs, but there is a gill opening in each side of the throat, from which bubbles of air occasionally escape. The nostrils are two very small openings situated at the extreme tip of the broad snout, so that when the animal comes to the surface to breathe, it need expose but the tip of its snout above water. The process of inspiration, if it may be so called, is

practically one of swallowing air. When it becomes necessary for the hellbender to take in a fresh supply of air, it swims towards the surface of the water until the tip of the snout is exposed; then, by swelling downward the skin of the floor of the mouth, a huge mouthful of air is drawn in, and the animal, now arching upward its neck and back, slowly sinks to the bottom, the swallowed air passing back to the lungs either by its own buoyancy, the lungs now being higher than the throat, or by a sort of peristaltic action of the throat. As the animal sinks, a considerable portion of the air that was taken into the mouth escapes through the nostrils or through the gill openings. After reaching the bottom, the animal frequently retains, for some time, the strongly arched position, as though the region of the lungs were buoyed up by the air that had just been taken in. The air is gotten rid of partly by a quick expiration when the animal comes to the surface, and partly by an occasional bubble sent up from the bottom. If the animal be alarmed as by a sudden approach to the tank in which it is contained, it frequently sets free one or more large bubbles of air, perhaps by the involuntary relaxation of certain muscles, perhaps by a voluntary expulsion of superfluous air, to enable it better to escape the supposed danger. The length of time that the hellbender remains under water seems, in captivity at least, to be quite variable. I made a series of observations on three individuals, a very large one, a very small one and a medium-sized one, and the average interval between inspirations was about fifteen minutes. The longest time that any individual was actually observed to remain below the surface was forty-three minutes.

In motion the hellbender is usually slow and awkward. On a smooth dry surface, as the top of a table, it is almost helpless, because the slime secreted by the skin soon dries and becomes so sticky as almost to prevent motion. Even in its native element its motions are usually awkward, though when swimming rapidly this is not apparent. In crawling over the bottom, the diagonally opposite legs very nearly 'keep step,' *i. e.*, the left front leg and the right hind leg move forward at the same time. In active swimming the tail is the most effective organ, as in the alligators. If an individual, which is lying quietly on the bottom, be watched carefully it will frequently be noticed that it has a slight rocking or swaying motion, caused by the alternate straightening or relaxing of the legs, similar, perhaps, to the swaying motion of elephants. In captivity they usually congregate in the darkest portions of their tank, crawling under boards or stones if these be present, or under each other if there be no better hiding place. If not lifted above the surface of the water, they may be handled with scarcely a struggle, but if taken from the water they struggle to regain their native element. As a rule the smaller specimens were more active than the larger.

As my chief object in collecting the hellbenders was to obtain eggs for embryological work (my hope being that the animals would spawn in captivity) and as I had at first no idea as to when the spawning season occurred, I started in pursuit of the creatures about the first of February, tramping many weary miles through three feet of snow and chopping numerous holes through the thick ice that covered French Creek in which the hellbenders abound. Hand-lines, night-lines and traps were tried again and again, but, though several specimens of *Necturus* were caught, not a single *Cryptobranchus* was obtained until the twenty-eighth of March, after the ice and snow had all disappeared and several days of warm weather had slightly warmed the water. Fishermen, generally, stated that 'alligators' could not be caught until the ice had melted and the water had had time to warm slightly.

Although the first specimens were caught during the last days of March, it was not until nearly a month later that they could be obtained in any numbers, and it was during May that they were most abundant. About June 7, desiring to obtain a few more specimens, I applied to the boys from whom I had been buying them, but, after fishing for a week or more, they told me that the 'alligators' had stopped biting, and I was unable to obtain the additional specimens that I wanted. Whether they usually cease taking food at this time I am unable to say, but Mr. Chas. H. Townsend, of the New York Aquarium, says* that they were caught by him in August, on hooks baited with pieces of meat or fish heads. Most of the specimens I obtained were caught in traps that had been set for fish, though many were caught with hook and line, the disadvantage in the latter method being that the hook was often caught so far down in the digestive tract that it could not be extracted without seriously injuring the animal.

The color of all the hellbenders, when first caught, was a more or less uniform dirty black or greenish-brown with numerous irregular dark spots on the dorsal side. Fishermen were occasionally heard to speak of 'red alligators' but I never saw a hellbender that could, in truth, be called red, though after they had been in captivity for a couple of months many of them changed color very perceptibly, becoming a more decided brown, sometimes with a decided greenish tinge and sometimes with the dark spots, mentioned above, very pronounced. It is possible that this change in color, in a state of nature, may be very much more marked and that when the breeding season arrives it may become an actual red, and serve as a sexual character. Judging from analogy, it would be supposed that these more brilliantly colored individuals would be males, but such was not the case. Of the specimens that I had under observation, nearly all were females; if this were true in a state of nature, it might be possible

* *American Naturalist*, February, 1882.

that the females had acquired this brighter coloring, as a secondary sexual character, for the attraction of the males.

The hellbender has the reputation of being an exceeding voracious animal, and in his native stream this is probably true, though in captivity his appetite is very moderate. The contents of the stomach of a number of individuals were examined, and it was found that the most common article of food was apparently crayfish, though earthworms, small fish and, in one case, the mandibles and a foot of a small mammal, probably a mouse, were found. Fish as much as 8 cm. in length were sometimes found in the stomachs of large individuals. As it seemed impossible to catch the hellbenders until comparatively late in the spring, it is probable that they lie dormant through the winter, and hence do not take any food until they renew their activity at the appearance of warm weather.

A number of animals that I obtained one morning in a fish-trap seemed very much distended, as with eggs; on being put into a tub of water they disgorged a great mass of material consisting chiefly of a number of small fish that had been caught in the same trap and had thus fallen easy prey to the appetite of the hellbenders. It almost always happened that when hellbenders were put into an ordinary vessel of water they disgorged, within a few hours, the contents of their stomachs, while if put into a tank of *running* water they seldom, if ever, disgorged.

Although it seems certain that they catch and eat living fish and crayfish, under natural conditions, they never ate these animals alive in captivity nor, as far as I could see, ever attempted to catch them when they were put into the tank and left there for days. The fact, however, that the crayfish were frequently found on top of a floating piece of board that was in the tank would seem to indicate either that the hellbenders had attempted to catch them or that they had an instinctive fear of the salamanders, founded on racial experience. A couple of small hellbenders were kept for a short time in a glass aquarium jar for close study These two individuals were the only ones that were actually *seen* in the act of taking food. If earthworms were lowered into the water just in front of them, they would seize them by a quick, lateral jerk of the head and then swallow them by a series of quick forward jerks, the tongue being, apparently, of very little use in drawing food into the mouth. The quickness of this seizing motion was quite surprising in so sluggish an animal, and showed how a fish or crayfish that ventured within reach might easily be captured. From the beginning of their captivity the hellbenders were fed on raw liver, chopped into pieces as large as the end of a man's thumb. During the first few weeks they ate very little and were fed about once a week, but

towards the last of July their appetites seemed to increase, and they were fed every two days. They would never eat, as has been said, while they were watched, but if the liver were left in the tank over night, most of it would be eaten before morning.

The extreme slowness of their digestion is shown by the fact that liver eaten seventy hours before, on being disgorged showed very little change, the pieces being of about the same size and consistency as when swallowed.

After about the middle of September, the hellbenders refused to eat during a period of more than two months, though pieces of liver were put into their tank at intervals. One morning at the end of this period, on looking into the tank, something black was seen projecting from the mouth of one of the largest hellbenders, which on close examination proved to be the end of the tail of the smallest of the hellbenders, which had been swallowed head-first. By means of a pair of forceps the smaller individual was withdrawn from within the larger, and both immediately swam away, none the worse apparently for their remarkable experience. The smaller hellbender was a little more than half as long as the one by which it was swallowed. In spite of this apparent return of appetite, the hellbenders ate but little of the fresh supply of liver that was immediately given them.

The remarkable vitality of the hellbender is well known by those who have had any opportunity of studying the living animal. Mr. Townsend in the article mentioned above says: "They are remarkably tenacious of life. I carried my specimens six miles in a bag behind me on horseback, under a blazing hot sun, and kept them five weeks in a tub of water without a morsel to eat, and when I came to put them in alcohol they seemed almost as fresh as ever."

I had several illustrations of their tenacity of life. One of the first specimens I obtained, a large one, more than 50 cm. in length, escaped from the tank into which it had been placed and hid itself under a lot of lumber and rubbish that was piled near by. After a long search it was given up for lost, but one morning, just a week later, on going into the cellar where the tank was kept, there lay the escaped hellbender, dry and dusty but as well as ever, and the same animal is living at the present time. Some months later, while they were living in a tank of running water in the back yard of a city house, another hellbender escaped and could not be found. Exactly three weeks later it was found lying on the pavement outside of the yard. It was still living, though extremely thin and weak, but it died a few hours after being put back into the tank, possibly because it was too weak to swim to the surface for air. During the three weeks it was lost it changed color very decidedly, becoming a reddish-brown, with the dark spots showing a sharp contrast. During the latter part of June sixteen hellbenders,

nearly all of large size, were put into a wooden box (12 in.× 9 in.× 6 in. in size) in which numerous small holes had been bored and were taken from western Pennsylvania to Baltimore, Maryland. Although confined in such small space for a continuous period of nineteen hours, they reached the end of their journey in perfect condition. On another occasion fifteen of these same animals were put into the same box and taken by rail to a distant city; on this occasion they were in the box continuously for twenty-five hours, and one individual died on the journey, apparently suffocated by the mass of disgorged liver that filled its mouth. I had purposely refrained from feeding them for several days previous to the journey, but their fast had not been sufficiently long and the undigested liver was all disgorged, apparently causing, as has been said, the death of one individual.

Although possessed of such tenacity of life their recovery from wounds is apparently slow, a wound in the head of one large specimen remaining raw and open for several months. Possibly in its natural environment recovery would have been more rapid.

My chief aim, as I have said, in working with *Cryptobranchus,* being to obtain embryological material, I enquired of every fisherman and countryman I met, and of many other people as well, concerning the breeding habits of this little-studied animal. The only facts of any sort that I could learn were obtained from Mr. C. H. Townsend, whom I shall again quote. He says in the article mentioned above: "During their confinement in the tub two of the females deposited a large amount of spawn. This spawn was something similar to frog spawn in its general appearance, but the mass had not the dark colors of the latter. The ova were exuded in strings and were much farther apart than frog eggs. They were of a yellow color, while the glutinous mass which connected them had a grayish appearance." This deposition of spawn, he says, took place in August. Had I had this information earlier in the season it would have saved me many fruitless attempts to capture the hellbenders, and possibly my efforts to obtain their eggs might have been successful. As it was I did not get a single egg, the animals refusing to spawn in captivity, though they were kept in a large tank of running water under conditions as near like their natural habitat as I could make them.

Ovaries examined during the first two months showed a gradual development, but those examined during the early part of September showed evident signs of degeneration. All of the individuals killed, except one or two, were females. It would seem that hellbenders, like some other amphibia, will not spawn in captivity if removed from their natural environment too long before their natural breeding season.*

* The author has in preparation a paper on the anatomy and histology of *Cryptobranchus,* which he hopes to have ready for publication in a few months.

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CONTRIBUTIONS

FROM THE

ZOOLOGICAL LABORATORY

VOL. I.

1903

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