

NOTES ON THE DAILY LIFE AND FOOD OF CAMBARUS BARTONIUS BARTONI¹

FLOYD E. CHIDESTER

IN all animals we find that there are periods of activity and rest. During the active period, we find such interesting phenomena as feeding, copulation, and, in some animals, a very interesting series of movements connected with the care of the young.

My study of the daily life of the crawfish is one of a series of studies instigated by Professor C. F. Hodge in the effort to arrive at some accurate data as to the work performed by various species.

Crawfish were kept in two different aquaria during the winter of 1907-'08, and their actions watched closely.

One tank was an ordinary running water tank with a pile of sand at one end, and containing, in addition to crawfish, at times, trout eggs, young trout, frogs, clams and a turtle. There were also, all the time the crawfish were kept there, several tufts of the common water weed, *Fontinalis*, floating in the water.

The other tank was a heavy glass aquarium, measuring on the inside, $1 \times 1\frac{1}{2} \times 2$ feet 8 in. This aquarium was elevated about an inch at one end, and beginning at the other end, a mud and sand bottom sloped gradually upward to a level bank which was covered with moss and grass and kept moist.

In the aquarium was a clam to assist in clearing the water, a water hyacinth, and some more of the water weed mentioned above.

At different times, as I experimented with the food of the crawfish, there were bits of fresh meat, sprouts, eggs and young of trout, toads, frogs and salamanders; dead frogs and fish, and dead crawfish.

¹ Contributions from the Biological Laboratory, Clark University.

The water was changed daily and oftener at feeding time, during the entire winter, and record kept of the activities of the crawfish. It was not until spring, however, that night and day observations were made.

During the fall and winter, up to February 1, frequent cases of copulation were observed. Contrary to Dearborn's statement, '00, I found that the males do not know the females and that males repeatedly grasp other males, and sometimes, in spite of their frantic struggles, turn them over and attempt to copulate with them. The difference in behavior in the case of the male, when thus grasped, is that he continues to resist violently at intervals, until released, while the female, as soon as grasped firmly, ceases to struggle, and lies passive.

Another interesting thing was noted in connection with the actions of crawfish before moulting. In the case of adult crawfish with hard exo-skeletons, I found that for two or three days before the ecdysis, they would come up partly out of the water, so that the carapace was entirely out of the water, and dried out thoroughly.

Crawfish when transferred from the running water tank to the still water one, would almost immediately seek cover, generally burrowing into the bank, and remaining during the day with their heads toward the entrance, quiet unless disturbed.

In the still water aquarium, there were at one time, six crawfish hibernating in the bank, with their burrows stopped up, for three weeks. The other seven in this tank were in the deep water under plants during the day, but, as darkness fell, they came up into the shallows and on the bank.

Repeatedly, I have come into the building after darkness had set in, and seldom failed to find several crawfish on the bank.

Crawfish are generally supposed to be omnivorous. They are not, however, so fond of decayed matter as has been supposed. Tests made in the laboratory show that, when they refuse to eat stale food, they will eagerly con-

sume fresh. They will eat fish which have been recently killed, in preference to partly decayed ones.

In the spring, after moulting, there seems to be a consuming hunger. I have seen, at about 9 P. M., a crawfish within about six inches of the bank of a small pond, so intent on pulling to pieces and devouring a partly decayed fish, that he did not notice the very strong acetylene light that I held close to him.

Experiments with lights of various intensities, elucidated the fact that crawfish are negatively phototactic to strong light but positively phototactic to weak light.

Raw and cooked meat of all kinds, worms, dead fish, pieces of clam, moulting crawfish, and dead crawfish were eaten by the crawfish in confinement. They are said to eat their own cast-off coats, but although these were left in the aquarium for about a month, they were undisturbed.

Tests were made to determine if the crawfish would eat fish (trout), frog and toad eggs. Very few were eaten, and these few when the crawfish had had nothing to eat for ten days, and had nothing else to eat.

Young frog and toad tadpoles were kept in the aquaria and lived happily for a long time. To determine if crawfish eat toad or frog tadpoles, twenty-five toad and frog tadpoles were placed in a shallow dish, and, with a renewal of water every day, kept for four days with a single, supposedly hungry, crawfish. Of the twenty-five tadpoles, in all, but eight were eaten.

About two weeks later, when the tadpoles had become quite a little larger, a test was made with toad tadpoles. A male crawfish was placed in a shallow aquarium jar with twelve live tadpoles, and kept for three days, with change of water twice a day. It was not until about fifty hours had elapsed that he ate of the tadpoles, and then he ate but one.

A female crawfish was put into an aquarium jar at the same time as the male, with 12 live toad tadpoles. This was at 5 P. M. At 6 P. M., she had eaten all but one of them. At 6 P. M., 17 more were put in, making 18 in all.

At 10:30 P. M., five more tadpoles were gone. At 9 A. M., on Friday, only 5 were left, one of these being dead. This was a record of 22 out of 27 active tadpoles in 16 hours. The female was seen to catch several of the tadpoles, using for this, not her cumbersome chelæ, but her smaller, nimble, first pair of ambulatory appendages.

Evidently *Cambarus bartonius bartoni* is capable of catching toad tadpoles, but it is improbable that many are caught, for I am informed by Mr. Newton Miller that the young tadpoles, although near the shore during the day, go to the deeper water at night. It is at night that the crawfish come into the shallower water near the shore, and even part way out of the water. Here it is that they may catch an occasional fish, frog or toad.

Two young frogs were kept during the greater part of the winter in one of the aquaria on my desk with the crawfish, but none of the dozen seemed able to kill them. Once I forced a frog to swim down to one corner of the tank where several crawfish were collected, and one of the crawfish grasped a hind leg with his right chela, and a moment later secured the front leg on the same side with his left chela. He then forced the frog to the bottom and attempted to pull him limb from limb, all the time holding the animal under water. In just a moment, however, the frog kicked with his free hind leg, and accidentally striking the crawfish on the carapace, was released.

My observations and experiments in the laboratory were supplemented by many evenings spent on the shores of several small ponds near the university, observations being made by means of a strong acetylene light. I believe, in the light of these observations, that the crawfish in the still water aquarium behaved normally.

In the spring, the crawfish is very active, and feeds with much more eagerness than during the winter. It is then, too, that the interesting phase of the mother's care of the eggs may be best seen.

On account of this, I took occasion to watch a pair of crawfish, a male, and a female with eggs just about ready

to hatch, through 24 consecutive hours, beside several observations of lesser duration.

In these observations, I was aided by Dr. C. F. Hodge and Mr. Newton Miller, who kindly gave me occasional resting periods.

The first set of observations which I shall record were made on May 16-17, 1908.

Observation was begun at 6 P. M. on two crawfish, a male and a female with eggs about ready to hatch, and lasted until 6 A. M. the following day. In the aquarium with the crawfish, were the water hyacinth and *Fontinalis* mentioned above, some young sprouts, five young toad tadpoles, and some pieces of fresh meat.

The male was moderately active between 8.10 and 8.45 P. M., most active between 12. and 1.30 A. M., and had a lesser period of activity between 2.05 and 2.30 A. M. The longest period of quietude was from 1.30 to 2.10 A. M. He ascended and descended the bank nine times during the 12 hours. The male did not feed.

The female ascended and descended the bank 84 times during the 12 hours. She ascended and descended 17 times between 1 and 2 A. M. She would climb the bank and aerate her eggs in the open for several moments, then retire to the deep water and almost immediately return to the bank. The greatest activity was from 11 P. M. to 6 A. M. She fed at 6.50 and again at 7.07 P. M. both times on the fresh meat. Her longest rest period was from 10.30 to 11 P. M.

The next series of observations was performed on three crawfish, the two observed on May 16-17, and in addition, a female without eggs. This time observation was kept up for 24 consecutive hours, from 1 P. M. May 19, to 1 P. M. May 20.

The same kind of food was used as before, care being taken to avoid fouling the water with it until about one-half hour before the records were taken.

The male fed a great deal this time on the fresh meat, feeding from 1.35-2.15 P. M., 2.30-2.45 P. M., 3.18-3.40 P.

M., 3.48–5.00 P. M., 4.10–4.30 P. M.

He was most active from 11.35. P. M. to 3.15. A. M. It is interesting to note that each period of feeding, if lengthy, was followed by a correspondingly long period of rest. The longest rest period was from 4.45 to 8.05 A. M. The male did not ascend the bank at all during the 24 hours.

The female with eggs began ascending the bank and aerating her eggs at 4 A. M. and stopped at about 4.25 A. M., then began again at 6.15 A. M. gradually lengthening the stay on the bank until 9 A. M. then shortening the frequency of the visits, and lengthening the stay in the water; this period of less frequent visits lasted until 11 A. M., then from 11 A. M. to 12 M., there was great regularity of aeration, and from 12 M. to 1 P. M., less frequent aeration. Ascent of the bank was made thirty-four times during the 24 hours.

Feeding was done at 1:45 P. M., and again at 2.15 P. M., but in neither case did it last longer than ten minutes.

Number seven, a female without eggs, was very inactive, staying under a stone the greater part of the time. She came out on the bank but three times. Her period of greatest activity was between 3.30 and 4.15 P. M.

From these observations of the crawfish in nature and in the laboratory, we may conclude as follows:

1. Crawfish are most active at night.
2. There is marked activity at nightfall and at daybreak.
3. Feeding is generally done at night, but may occur during the day.
4. In the spring, the crawfish eats much more often than during the winter.
5. *Cambarus bartonius bartoni* prefers fresh animal food to anything else.
6. Feeding is followed by rest, prolonged periods of feeding being followed by equally prolonged periods of rest, the animal not becoming active for several hours.
7. There is apparently no spontaneous play or exercise, movements being purely utilitarian.

8. A female aerates her eggs both on land and in water.

9. Crawfish come up into the shallows and elevate their carapaces partly out of the water.

10. Combing or cleaning movements are executed by means of the first and second ambulatory appendages. These consist in scraping the carapace.

11. Males do not distinguish between the other males and the females, and frequently grasp males and attempt to copulate with them.

LITERATURE

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