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[D.]

## BELOSTOMIDÆ AND SOME OTHER FISH-DESTROYING BUGS.

BY GEORGE DIMMOCK.

Insects are generally considered to be beneficial to fishes by furnishing them one of the most unfailing sources of food. There are, however, a few insects which are injurious to fishes, thus making an exception to the rule. DeGeer<sup>1</sup> published a statement, in 1774, that the larvæ of dragon-flies, or as they are sometimes called, Devil's-darning-needles (the *Libellulidæ* of naturalists), would seize and kill fishes, a statement confirmed by Dale<sup>2</sup> in 1832. Von Muetzschefahl,<sup>3</sup> in 1778-79, mentioned several aquatic insects which attacked the perch, among them two species of water-beetles (*Dytiscidæ*) and two species of water-bugs (*Notonecta glauca*, and *Nepa linearis*—now called *Ranatra linearis*). The destruction of young fishes by water-beetles has since been noted by Elles<sup>4</sup> in 1830, by Dale<sup>5</sup> in 1832, and by Riley<sup>6</sup> in 1885. In regard to the water-bugs, observations published within the past few years have not only confirmed the above-mentioned earlier statements, but other bugs have been discovered to attack fishes. Leidy,<sup>7</sup> as early as 1847, writes that species of *Belostoma* and *Perthostoma* (*Zaita*) prey upon fishes. Glover,<sup>8</sup> in 1875, states that *Ranatra quadridenticulata* and *Belostoma americanum* feed on small fishes, and that *Nepa apiculata* probably, and *Notonecta insularis* possibly, do the same. Milner,<sup>9</sup> in 1876, writes that *Belostoma grande* captures and eats fishes. Miss Ormerod,<sup>10</sup> in 1878, describes how *Ranatra linearis* attacks fishes; the same year Peck<sup>11</sup> called attention to the destruction of the eggs of carp by the same insect. Turner,<sup>12, 13</sup> the next year, mentions the killing of young sticklebacks in an aquarium by *Belostoma*. Leonard<sup>14</sup> notices the showing at the Edinburgh Fisheries Exhibition in 1882 of a preparation by Hugh D. McGovern, of Brooklyn, N. Y., of a year-old trout "surmounted by the fish-eating bug, *Belostoma grandis*,"

<sup>1</sup> Superior figures in the text refer to the citations of literature at the end of this article.



which was in the act of killing the fish by piercing its head; and Todd,<sup>15</sup> the same year, describes how a *Belostoma*, about three-quarters of an inch long, was seen to vanquish a fish three or four times its own length. Uhler,<sup>16</sup> in 1884, states that *Ranatra* destroys the eggs of fishes, and sometimes attacks the young fishes themselves and sucks their blood. Writing of *Belostoma grande*, the giant species of this genus, that is found in tropical America, he states that "It is a formidable monster in the pools of Demerara, where it lurks on the bottom of the muddy pools which match its color, ever ready to grasp the unwary fish in the cruel embrace of its sharp hooked fore-legs, there to remain fixed until life becomes extinct with the outflow of its blood." This author adds, "Scarcely less rapacious are the species inhabiting the United States. One of these, *B. grisea*, is the facile master of the ponds and estuaries of the tidal creeks and rivers of the Atlantic States. Developing in the quiet pools, secreting itself beneath stones or rubbish, it watches the approach of a *Pomotis*, mud-minnow, frog or other small-sized tenant of the water, when it darts with sudden rapidity upon its unprepared victim, grasps the creature with its strong, clasping fore-legs, plunges its deadly beak deep into the flesh, and proceeds with the utmost coolness to leisurely suck its blood. A copious supply of saliva is poured into the wound, and no doubt aids in producing the paralysis which so speedily follows its puncture in small creatures."

Of easily accessible articles in which the habits and fish-eating propensities of aquatic hemiptera are noticed, probably the most interesting, on account of its popular, simple style and because it deals with American insects, is the paper by Glover<sup>8</sup> in the Report of the U. S. Commissioner of Agriculture for the year 1875. This paper is entitled "Heteroptera, or Plant-Bugs," but deals with many bugs that either suck the juices from plants or animals, or that are entirely rapacious, as are most water-bugs, depending for their nutriment entirely on the blood of other animals.

The rapid extension of fish culture has called attention to the attacks made upon fishes by their enemies. It is quite likely that the requirements of fish culture itself, such, for example, as associating together in the same pond of large numbers of fishes of about the same size, has furnished conditions that have permitted the increase of the actual number of the hemiptera that prey upon them. The abundance of food for water-bugs in a pond stocked with small fishes only, and the absence of larger fishes to devour the bugs while the latter are still quite young, may both contribute to the welfare and increase of the bugs.

That the loss of fish due to these insects is considerable seems

quite probable, because, notwithstanding their secluded habits, they are not rarely to be seen about ponds, sometimes even in the act of taking fishes. The following quotation from a letter from Mr. E. A. Brackett, of Winchester, Mass., Chairman of the Commissioners on Inland Fisheries for Massachusetts, under date of Dec. 16, 1886, will illustrate this fact. He writes, "In October last, while drawing off the carp-pond, the water became very roily, and I noticed several young carp moving on the surface, sidewise, evidently propelled by some external force. With a dip-net I took these young fish out, and found that in every case they were firmly held by a water-bug. The fish were dead, and the bugs apparently had been feeding on them. I had no means of determining how many of these bugs were in the pond."

The largest, and without doubt the most dangerous to fishes, of these water-bugs are those which belong to a family called by naturalists *Belostomidæ*. It is especially of these *Belostomidæ* that this paper treats. In the northeastern United States the common forms of these bugs belong to the genera *Zaita*, *Belostoma* and *Benacus*. The accompanying figure of one of the species of *Belostoma*, which genus, in the tropics, contains some veritable giants in the insect line, will give a good general idea of the form and appearance of these insects. The species figured, *B. grande*, is found in temperate and tropical parts of North America. The form of insects belonging to the genus *Belostoma* is elongated oval, and their considerably flattened form and large size serves to distinguish them from all the other before-mentioned water-bugs except those belonging to the genus *Nepa*, and from them they are easily distinguished by the fact that the body of *Nepa* terminates



*Belostoma grande*.—After Riley.

in a long tube formed by the apposition of two grooved appendages; through this tube the insect obtains air for breathing, while the species of *Belostoma* have no such tube. The form in *Zaita* is like that of *Belostoma*, but the species are smaller. In *Benacus*, another closely allied genus, of which the sole species, *B. halde-manum*, is found in the United States, the femur of each fore-leg lacks the groove on its forward side,—a groove which is present in the species of *Belostoma*, and which serves for the partial reception

of the tibia when the fore-leg is folded up. The genera *Zaitha* and *Benacus* formerly were considered to be a part of the genus *Belostoma*.

Insects of the family *Belostomidae* are abundant in nearly all parts of the tropical and temperate zones of both hemispheres, except in Europe, where they are extremely rare; but, as a general rule, these insects are larger the warmer the climate in which they live. Individual specimens of *Belostoma grande* are sometimes found in tropical America which measure four inches in length, and *B. griseum*, which is found in the northern United States, attains a length of three and a half inches. The young of this species when only two days from the egg measured, according to Packard, a third of an inch in length.

The color of the species of *Belostomidae* is brown, of a greater or less depth, or of a yellowish or a greenish shade. Partially covered with mud, they are quite difficult to discover. The sexes are not easy to distinguish from one another, except that females can at times be distinguished by the eggs which they carry.

These large insects are not only provided with powerful fore-legs which they use to seize their prey, and strong, somewhat oar-shaped hind-legs for swimming; but, when full-grown, they have strong wings and are capable of long-sustained flight. By their flights, which, as in most aquatic hemiptera, take place at night, these insects pass from one pond to another. This insures them a wide distribution, and makes their extermination a difficult matter. Living, as they often do, in pools which dry out at certain seasons of the year, this provision for flight is a necessity of their existence. That these flights are often long and high is proved by the fact that the bugs have been found in the midst of large cities, far from any pond or pool, upon the roofs of three and four story blocks. It is probable that they are found in these situations from having been attracted to the reflecting surfaces of sky-lights, for it is well-known that water-beetles, with their imperfect sight, mistake large expanses of glass, such as are presented by green-houses, for sheets of water. Especially attractive, however, to these large water-bugs are electric lights, and notices have appeared in the daily press of the swarming of these, as well as of other insects, about the electric lights of cities. In flight, as Mr. Brackett states in the letter from which I have already quoted, the species of *Belostomidae* which he observed can arise directly from the surface of the water.

These insects differ, according to the species, as to their mode of egg-laying. Some, like the common *Zaitha fluminea* of our northern waters, lay their eggs on their own backs. In my collection I have a

specimen of this species which has her back almost entirely covered by a nicely-arranged layer of elongated-oval, dark-brown eggs, which number over a hundred and seventy-five. These eggs are set nicely upon one end, and placed in transverse rows, by means of a long protrusile tube, or ovipositor, which the insect can extend far over her own back. This mode of oviposition insures the safety of the eggs until the young are hatched. The eggs are fastened to the back of the mother by a very thin layer of a waterproof gum secreted by the insect. The entire layer of eggs is apt to split from the insects when they are dried, and consequently is rarely seen in collections of insects. The young bug hatches from its egg by means of cutting out a round lid from the top of the egg, and at about the time when the young brood begins to hatch the mother sheds the entire layer of eggs from her back, something as she would moult her skin during growth. It is probable that all the species of *Zaitha* carry their eggs about with them, while, on the other hand, some, if not all, the species of *Belostoma* deposit their eggs in masses, under boards and logs, near the margins of the pools which they inhabit.

The young, upon hatching from the eggs, go immediately on their predaceous course, often feeding at first on young snails. As is true of most hemiptera — the bugs properly speaking — the young differ little from the adults except in the absence of wings in the former. In *Belostoma* the young, however, have two claws on the tarsi of the fore-legs, while as adults they have only one tarsal claw in the same place. It is not certainly known, but is likely that these insects reach their full growth in a year.

In seizing upon fishes or other small animals these insects grasp their prey with their fore-feet, holding it firmly in their claws, then piercing it with their beak or proboscis; for they only suck blood, not being able, as is the case with water-beetles, to eat the whole animal. The proboscis consists of stout horny setæ or bristles which fit closely together to form a fine sucking-tube, while the exhaustion is performed by means of a muscular, extensible pharynx, or throat. As is probably the case with all carnivorous hemiptera, only living prey is acceptable to these insects. The predaceous water-bugs are said to destroy the eggs of fishes, although further confirmation of this statement is desirable.

When the water-bugs attack other animals it is noticeable that the prey dies much quicker than it would normally do from simply the loss of blood consequent upon the sucking of the bug, so it is generally supposed that these insects inject a poisonous secretion through their proboscis into the wound they make. Most of these insects inflict quite severe stings, in self-defence, if they are handled

too freely, using the proboscis for this purpose. Leidy<sup>7</sup> describes the salivary glands of *Belostoma*, which are well-developed, and it is undoubtedly the secretion of these glands that poisons the prey when it is pierced by the proboscis.

As will be seen from the preceding part of this paper, the destruction of the bugs that attack fishes is not an easy matter. The water-beetles can be trapped by the use of decaying animal matter, of which they are very fond. I have seen a dead rat in a small pond surrounded by a great number of these beetles (*Dytiscidæ*), and they prefer such food to living food. On the other hand, the water-bugs will take only living food, so that their entrapping by any bait would be difficult.

The use of poison for aquatic hemiptera seems also impracticable. As hemiptera eat only liquid food which they can suck up through the fine tube of their proboscis, poison that would have any effect upon them must be a liquid, a very finely-divided substance held in suspension in a liquid, a corrosive substance that will directly attack the surface of the bug, or some substance that gives off poisonous vapors. The above remark applies to all hemiptera, but the destruction of aquatic hemiptera is still more difficult. In their case no liquid poison can be applied, because the bugs would not eat it, and because its mixture with the water would endanger the fish that it was sought to protect. For like reasons no corrosive substance or poisonous vapor is applicable. Water-bugs are so much hardier than fish that nothing dissolved in the water would injure them that would not prove dangerous for the fish.

Searching for the eggs of the water-bugs might prove useful on a small scale, but would, of course, be useless for the numerous species of *Zaitha*, which lay their eggs on their own backs. If the collection of the eggs of those species which lay their eggs in masses was attempted, it might be possible to cause the insects to lay their eggs under boards placed in favorable localities in shallow water, and the eggs could be taken from beneath the boards every few days and destroyed. This mode of destroying the eggs is offered as a suggestion, not having had, to my knowledge, any trial.

Collecting the adult bugs with nets would somewhat lessen their numbers, but would only prove of value in small ponds, and even these ponds might become restocked with bugs in a single night. Capturing of migratory insects has little value in lessening their depredations, except where the capturing can be done under very favorable circumstances and over large areas of country.

Keeping fish-ponds clean will certainly be of use in restraining the depredations of water-bugs, as they prefer to live in mud and rubbish, rather than in clear water.

The introduction of some insectivorous fish that will not eat the young fishes would be the most feasible way of ridding a pond of these insect pests, but my knowledge of the habits of fishes is not sufficient for me to state whether any such fish is available for use in our fresh-water ponds. A careful study of what is known about the food of our fishes might reveal some species that would keep water-bugs exterminated from any pond into which it was introduced. Ducks are known by insect-collectors to nearly exterminate the insects from some of the ponds which were the best for the collection of water-beetles before the ducks had access to them. Uhler mentions that, in the Harris collection of insects, there is a specimen of a water-bug (*Zaitha fluminea*) bearing the label, "Found in great numbers in the stomach of a duck." But ducks might eat some of the young fishes, thus proving their uselessness for the purpose intended. Among the enemies of the *Belostomidae* may be mentioned little red mites, which are often seen attached to the joints of the bugs; but these parasites probably cause their hosts but little trouble, and could not be used in any way as a means of their destruction.

The mode of destroying the water-bugs that seems to me to be the most feasible is by the employment of the electric light, and even this method, which would only pay on a large scale, might fail to destroy a sufficient number of the bugs to be of practical value. Since the introduction of the electric light as a means of lighting streets, several notices have been published to the effect that, among other insects which are attracted to the light and sometimes swarm about in numbers, are the aquatic hemiptera. Striking against the glass which surrounds the light they fall to the ground. Collectors of insects have taken advantage of this habit of the bugs, and by waiting beneath the electric lights have enriched their collections by capturing the fallen insects. The more brilliant the light the more insects are attracted to it, and on this account the electric light has proved much more favorable for collectors than gas-lights were. If the number of bugs attracted to the electric light were found to be sufficient to make that a valuable medium for destroying them, it would be easy to contrive a trap that would retain the insects after they had fallen beneath the light. Traps constructed on a similar principle have been used by insect-collectors for a long time.

It is quite possible that an illuminated trap beneath the surface of the water would attract many more of the *Belostomidae* than does a light above the surface, for these insects do not often leave the water, apparently, except when they quit it for the purpose of migration.

In conclusion, it may be said that any practical modes of combating such insect-pests as *Belostoma* are as yet undiscovered.

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