

XVI.—THE ENEMIES OF FISH.*

BY BARON DE LA VALETTE ST. GEORGE,

Professor of Anatomy and Director of the Anatomical Institute at Bonn.

Read at a meeting of the German Fishery Association, Berlin, March 31, 1879.

[From Circular No. 3 of the German Fishery Association, Berlin, May 14, 1879.]

[Translated by Herman Jacobsen.]

War is the watch-word of the whole of organic nature; there is a constant war of all organisms against outward unfavorable circumstances, and there is constant war among the different individuals. The seed-grain which falls into the ground, the worm crawling on the earth, the butterfly hovering over the flower, the eagle soaring high among the clouds, they all have their enemies—outward enemies threatening their existence, and inward enemies eating their life and strength.

Even fish, which claim our special attention, are by no means permitted to spend their life in peace. Plants and animals endanger their very life, and when they have been fortunate enough to escape these, man comes and seeks to catch and destroy them with numberless arts and tricks.

Confined to a special sphere of life, the water, they frequently do not find in it the necessary conditions of existence. In their very cradle, so to speak, that is, in the egg, the tender germs, scarcely awakened to life, are threatened by a dangerous enemy belonging to the lowest grades of the vegetable kingdom. This is the much-dreaded *Saprolegnia ferax*; in an incredibly short time its long threads envelop the egg, choke it, and destroy it.

The best preventive is an ample and continuous supply of cold water of a temperature of about zero, a dim light, and the immediate removal of spoiled eggs. Using a brush only destroys the spurs or threads of the *Saprolegnia* and consumes too much time.

These parasitical plants may prove dangerous even to older fish, for I have observed them on full-grown trout. But, as Dr. Wittmark says in his excellent treatise on the enemies of fish, the *propter hoc* and *post hoc* should be well distinguished. I believe that such fungous formations are only found in fish which are worn-out or have been weakened by sickness, and that in such cases it accelerates their death. It is well known to all pisciculturists how important it is to keep all ponds

* *Ueber die Feinde der Fische*, Vortrag des Herrn Freiherrn von la Valette St. George.

or vessels scrupulously clean, and especially keep away all decaying animal matter.

The higher algæ and aquatic plants of every kind may prove hurtful to the fish by limiting the extent of water and hindering the free movement of the fish. This is also the case with the so-called "water plague," *Wasserpest*, *Elodea canadensis*, which, however, does not deserve this name, as it contains much food and develops a great deal of oxygen.

Among the protozoans which form the connecting link between vegetable and animal life we find a small but very dangerous enemy of the fish, namely, the *Psorospermia*. These are round or oval bodies, often possessing a tail, with an internal cellular formation, measuring about 0.005"', which were first discovered in 1841 by *Johannes Müller* in the socket of the eye of the pike and in small pimples on the skin of the perch, the stickle-back, and several fish of the cyprinoid family. They form the contents of small capsules, measuring $\frac{1}{4}$ to $\frac{1}{2}$ "', which are imbedded in the membranes. They have also been found in the bladder of pike and codfish. Recent investigations have thrown some light on the origin of these beings. They are products by separation of the so-called "Gregarines," which develop an amœba without any kernel, which again changes to a gregarine. *Lieberkühn* has observed the development of the psorosperm into an amœba, and *E. van Beneden* the change from the amœba to the "gregarine," the one in the pike and the other in the lobster. So far it has not been ascertained with absolute certainty in what way the fish are affected by them.

It is certain that these parasites occasion the destruction of the tissue which surrounds them by producing festering sores, and that fish infected by them must gradually die.

Certain formations of a higher group—the *infusoria*—have also recently been accused of being enemies of fish; some of them, such as the *Opalina ranarum*, in the intestinal tube of the frog, and the *Trichodina pediculus*, have long been known as internal and external parasites. They can get in under the outer skin and destroy it. *Livingston Stone* recommends the transfer for a short time of fish affected in this way to salt water. It is said that among the mollusks the *Tichagonia polymorpha* does not disdain the spawn of fish.

We must now turn to a group of animals which has a very bad reputation, and which, belonging to the worms, are comprised in the family of intestinal worms or helminths. This group sends a whole army of animals into the field, some only visible through the microscope, others measuring inches and even yards, and often possessing terrible weapons; they live and find their food in the abdominal cavity, the intestines, muscles, gills, and skin of fish.

The eel contains no less than 25 different kinds of these parasites, the perch 23, the pike 21, the salmon 16, the trout 15, and the carp 12.

The intestinal worms are divided into four classes, viz, *Cestodes*, *Trematodes*, *Acanthocephala*, and *Nematodes*.

The fecundity of some of these worms is considerably increased by the so-called "change of generation," that is, the interpolation of generation without sexual connection between the regular generation.

From one of the innumerable eggs of the tape-worm, for instance, there develops an embryo armed with six little hooks, which finds its way through the animal tissues, settles somewhere, and develops into a tape-worm. In the beginning it is inclosed in a bladder, and in this state is known as the "bladder-worm." Generally not until it has reached the stomach or intestinal tube of some other animal, does the head get free and develop the different joints of the tape-worm, in which eggs develop in the regular manner.

In another kind of the helminths, the *Trematodes*, we also find this peculiar manner of propagation. From the embryo worm-like animals are developed *sporocysts* or *redia*, which again develop little worms with tails, the *cercaria*. These very lively little animals, which frequently have bristles on the head, envelop themselves in a capsule and throw off their organs of motion.

If in this condition they enter the stomach of that animal which is to be their definite place of abode, the cyst, as I have shown by experiments years ago, is digested, and its contents becomes a fully-matured animal of the *Trematodes* kind. Before they get so far they may, however, pass through several different animals.

Tapeworms are very frequently found in fish, often in an entirely undeveloped condition, which shows that they were first eaten by some other animal along with the animal in which they lived.

Among these must be counted the *Ligula*, which is frequently found in the abdominal cavity of our fresh-water fish, such as the bleak, blay, crucian, salmon, trout, pike, and perch. In some parts of Italy this worm is called "Macaroni piatti," and is considered a great delicacy. In storks, herons, gulls, and wild ducks it is found in its more developed form. According to *Van Beneden* it only gets into these birds accidentally.

Very similar to the *Ligula* is the *Schistocephalus*, which often fills the abdominal cavity of the stickle-backs to such an extent as almost to make them burst. When 25 years ago I pursued ichthyological studies here in Berlin, under the instruction of my venerable teacher, Professor *Peters*, I often fed crows and ducks with these worms. These experiments were made in my student's quarters in the third story, and were therefore attended with considerable difficulties. *Von Willemoes-Suhm* has pursued his experiments in a reversed manner, and has raised the embryos with six little hooks from the eggs of the *Ligula* taken from a diver, and from those of the *Schistocephalus* taken from a gull. Among these undeveloped forms we must also mention the *Scolex polymorphus*, which is found in many salt-water fish, and comprises different stages of development.

A very simply-formed tapeworm is found in the intestinal tube of nearly

every fish of the genus *Cyprinus*; it is called the *Caryophyllæus mutabilis*. It has only one joint, closely connected with the head, which develops in the same fish, and forms the connecting link with a long and varied series of maritime forms, which in their youth live in osseous fish, and with these migrate into rays and sharks, where they reach maturity. These are the *Tetraphyllidæ* of *Van Beneden*, which have four sucking disks which are either unarmed or have hooks or stings. To the former belong the *Echinobothrium*, *Phyllobothrium* and *Anthobothrium*; to the latter, the *Acanthobothrium*, *Calliobothrium*, and *Onchobothrium*. The *Echinobothrium* found in the ray has only two sucking disks, but two sharp stings on the forehead, and a neck full of long bristles. Next to this comes the *Tetrarhyncus*, which has four hooked trunks. When quite young it is found in plaice, and when fully grown in rays and sharks. Nearly related to this one is the *Triænoporus nodulocus* with two pairs of three-pronged hooks, which in its undeveloped condition is found in the liver of fish of the genus *Cyprinus*, and when fully matured in the intestinal tube of fish-of-prey.

The *Cestodes* found in fresh-water fish are not so numerous and varied as those of the salt-water fish. Of the latter there may still be mentioned the *Bothriocephalus punctatus* of the plaice, and the *Bothriocephalus rugosus* of the codfish; and of the former, the *Bothriocephalus proboscideus* of the salmon, the *Tænia ocellata* of the perch, the *Tænia osculata* of the "Wels," *Silurus glanis*, and the *Tænia torulosa* of the "Orf," the *Tænia longicollis* of the salmonoids, mostly confined in capsules, and the *Tænia macrocephala* of the eel.

The *Trematodes* may be subdivided into a number of families according to the number and position of their sucking disks. In this way we may distinguish the *Monostoma*, *Distoma*, *Tristoma*, *Polystoma*, *Holostoma*, and *Amphistoma*. The sucking disks of the lower extremity are sometimes furnished with hooks as, for example, in the *Gyrodactylus*.

The last of this kind is the *Diporpa*, which in the middle grows together with another individual, and then forms a peculiar twin-animal, the *Diplozoon paradoxum*. The *monostoma* are rarely found in fish. They are found in the intestinal tube of the stickle-back (*M. caryophyllinum*), and the barbel (*M. cochleariforme*), in the gills of the "brachse" (*M. præmorsum*), and in capsules in the small "Maràna" (*M. Maraenulæ*). *Von Nördmann* found an incredible quantity of a youthful formation (*Diplostomum*) of the *Holostoma* living in aquatic birds, in the eye of the perch, the burbot, fish of the genus *Cyprinus*, and in the last mentioned also in the skin. In the lens of the eye of the burbot, 290 such little animals were counted, whilst the vitreous humor contained about half that number. This must of course make the fish more or less blind.

The *Distoma* are very common in fish. Thus the perch has five different kinds, and the eel ten. In our fish the most frequent are the *Distomum globiporum*, the *D. tereticolle* of the burbot, pike, salmon, and trout, the *D. nodulosum* of the perch, the *D. torulosum* of the "Wels,"

the *D. ferruginosum* of the barbel, the *D. macrobothrium* and *tectum* of the smelt, the *D. laureatum* and *varicum* of the "Aesche", the *D. ocreatum* of the herring, salmon, and May-fish, which, when young, lives quite free, and is a parasite on larvæ of worms and small crustaceans.

Of the *Polystoma* I will only mention the *Octobothrium* of the May-fish, which lives in the gills like the *Diplozoon* of the cyprinoids, the *Gyrodactylus* and *Dactylogyrus*.

The *Acanthocephala* are round, tube-formed worms, without mouth and intestinal tube, whilst at the head-end they have a trunk with hooks. Their embryos have smaller hooks, with which they pierce the intestinal tube of the animals in which they live, principally crustaceans, then wrap themselves up in a capsule, and in that state are transferred to other animals, fish, birds, or whales.

We thus find the *Echinorhyncus proteus* when young in small crustaceans, and when more developed in the perch, the "Wels," the carp, the salmonoids, and other fish. It is likewise found in many salt-water fish, as the codfish and the plaice; whilst it does not occur in the rays and sharks.*

Different from the *Acanthocephala* is the family of the *Nematodes*, numbering upwards of 1,200 kinds, distinguished chiefly by a more or less developed organ of digestion. These *Nematodes* are very prolific, and exhibit many peculiar phases of development; a change of generation does not, however, seem to occur with them, at any rate it has so far not been observed. It has been noticed, however, that parasitical hermaphrodites have been produced by free individuals of opposite sexes. There may also possibly be a development of the egg without impregnation.

The *Nematodes* are very frequent in fish, sometimes half developed in capsules, and sometimes fully grown.

We thus find the *Gordius aquaticus*, a very long (1 meter) nematode, living in the water, inclosed in land and water insects and their larvæ, as well as in minnows and loaches; and the *Oucullanus* when young in small crustaceans, and when fully grown in the perch and eel. In the swimming-bladder of the salmonoids we find the *Ancyranthus*; in the stomach of the eel, the *Filaria denticulata*; in fish of the *Cyprinus* kind, the *Trichosoma tomentosum*; and in the plaice, the *Heterakis foveola*. The large genus *Ascaris* has also many representatives in fish, for example, *Ascaris truncatula*, in the perch; *A. gasterostei*, in the stickle-back; *A. clavata*, in the codfish, trout, and salmon; *A. mucronata*, in the burbot and pike; *A. collaris*, in the plaice; *A. siluri*, in the "Wels"; *A. acus*, in the carp, pike, and trout; *A. dentata*, in the barbel; *A. hirsuta*, in the smelt; *A. obtusocauda*, in fish of the *Coregonus* kind; *A. cristata*, in

* As far as can be judged from the very incomplete description, the unusual mortality of the crawfish noticed in several places ("Deutsche Fischerei Zeitung," 1879, p. 62) might be traced to the *Echinorhyncus*, perhaps *E. polymorphus* Br., *E. Milarius*, Zenker, *E. Astaci fluviatis* v. Siebold. When young they live in small crustaceans, and when more developed in aquatic birds. These latter would, therefore, transmit the infection.

the pike; *A. adunca*, in the "May-fish"; *A. labiata*, in the cel; and *A. constricta*, in the sturgeon.

Diesing mentions a *Trichina cyprinorum*, but all attempts to develop *trichina* in fish have so far been unsuccessful. Quite recently I have made experiments with goldfish, feeding them with meat which contained *trichina*, but the *trichina* passed through the intestinal tube. The "fish *trichina*" which are from time to time spoken of in the newspapers are, therefore, probably myths.

A very dangerous and troublesome parasite is the "fish-leech," which lives on the skin and the gills of fish, often in such numbers as to torment the poor fish. We find the *Piscicola geometra* on fish of the genus *Cyprinus*, the salmonoids and the pike, the *P. respirans* on the barbel, and the *P. fasciata* on the "Wels." The *Branchiobdella* lives on crawfish, the *Histriobdella* on lobsters, while others live on salt-water fish and mollusks.

Also among the crustaceans we find a number of parasites which live on the blood of fish, the so-called "fish-louse," remarkable for a peculiar regressive metamorphosis during their development.

The young are very lively and resemble small crustaceans, but when they have reached their permanent place of sojourn, only those organs remain which are necessary for feeding and propagating.

Of the very large number of these parasites, I only mention the *Ergasilus Sieboldii* on the carp and pike, the *Lamprogena pulchella* on the "orpe," the *Lernæocera* on the carp, the pike, and the codfish, the *Achtheres percarum* on the perch, the *Tracheliastes polycopus* on the barbel, and the *Argulus foliaceus* on the carp; the last mentioned of which I had frequent occasion to observe in my goldfish ponds. These parasites seem not to do special harm; still I found it advisable to counteract their spreading by draining the ponds from time to time and by removing the parasites.

I do not believe that more developed crustaceans, which form an excellent food for trout, can hurt the fish-eggs, but there are quite a number, such as the *Anceus*, *Cymothoa*, &c., which live as parasites on fish.

Among the insects the water-beetles and their larvæ, principally the *Dytiscus*, *Acilius*, and *Calymbetes*, are justly considered enemies of fish. I have seen how a *Dytiscus marginalis* killed a Mexican salamander six inches in length, for whom it was to serve as food, by biting it in the neck. The larvæ of the dragon-fly are also said to hurt the fish.

In passing to the *vertebrates*, we find that the fish themselves are dangerous enemies of their own kind. Not only will it happen that a male trout with an utter lack of gallantry will eat the eggs instead of impregnating them, but many fish, which are considered harmless vegetarians, actually turn cannibals, and, especially at a more advanced age, devour the eggs and young fish. This is the reason why there are so frequently no young fish in goldfish-ponds containing strong and healthy male and female fish, whilst those eggs—few in number—which by the water

flowing through the pond are accidentally carried beyond the limits of the pond develop very successfully.

Arrangements may be made accordingly. To take out the old fish after spawning is easier said than done. Although the salmonoids as a general rule, that is, as long as they find a sufficient quantity of insects, crustaceans, worms and snails, are not very dangerous depredators, they love to eat the spawn of fish. Nearly all fish will be guilty of the same offense when tempted by such delicate morsels. Trout which have acquired a taste for such food may prove very dangerous to their younger comrades. The fish-of-prey, properly so called, the pike, the barbel, "Wels," burbot, and eel are well known as such, and they are caught wherever this is possible.

Among the *amphibia*, the water-salamander, the water-toad, "Unke," and the frog should be kept away from the fish-ponds as much as possible, because they may inflict great damage to eggs and young fish.

In order not to pass the *reptiles*, we will also mention among the enemies of fish the crocodile and the water-snake. I do not know whether our common *Coluber natrix* likes fish as well as it does frogs and tritons.

All *aquatic birds* are born enemies of fish. The water-fowl seems to be the most harmless of all, although it cannot be trusted entirely. The stork is decidedly worse than his reputation. But the most dangerous enemies are the herons, which, especially during moonlight nights, do great damage. Among the birds-of-prey the *Circus rufus*, the *Pandion haliaetus*, and the *Haliaetus albicilla* are the most dangerous and powerful enemies of fish. A most dangerous enemy is the kingfisher, *Alcedo ispida*. The crow, *Corvus corona*, also likes fish, and is remarkably skillful in catching them. The wagtail, *Motacilla flava*, and *alba*, and the water-ousel, *Cinclus aquaticus*, are likewise fond of fish-eggs and young fish.

Among the *mammals*, the enemies of fish are not so numerous, but the few are all the more dangerous. Of the *Cetacea*, we must mention the fin-fish, the narwhal, and the dolphin, and of the *Phocidæ*, the seal. The water-rat, *Hypodamus amphibius*, and the brown rat, *Mus decumanus*, should be kept away from fish-ponds as much as possible. Although the first-mentioned lives on reeds, it does damage by undermining the dikes, whilst the last-mentioned most assuredly hurts the fish. *Brehm* has given detailed reports of the great damage done to fish by the *Crossopus fodiens*, which eats the eyes and brains of living fish, even those of considerable size. The domestic cat does not disdain fish-food, and I have often watched cats lying in wait for fish on the banks of ponds. The best known and most dangerous enemies of fish are the otters, the *Vison lutreola* and *americanus*, the *Enhydris lutris*, and the *Lutra vulgaris*. The reputation of the last-mentioned kind is so bad, that I need not say any more about it, but only recommend the excellent methods of catching them introduced by *Von der*

Borne. Their near relatives, the weasel, *Mustela vulgaris*, *M. erminea*, and the polecat, *M. putorius*, cannot be trusted either.

It must also be mentioned that some members of the *bear* family are fond not only of honey, but also of fish.

We have thus quickly passed through the whole animal kingdom, and have arrived at the last and most dangerous, because most intelligent, enemy of fish, namely, *man*.

Ignorance and covetousness have in many parts of the country reduced the number of fish to a minimum, and nothing but efficient fishery-laws and rational pisciculture can remedy the evil. The *German Fishery-Law* and the *German Fishery Association* have opened out a new era for the German fisheries. On this foundation, which has been laid by the best men of our country, we must all build according to our ability. As our revered president has remarked, "there should be a hatching-box near every water-mill." Only united activity will bring us nearer to our object—to raise the general welfare of our nation.*