

XIX.—NOTES ON THE FUNGUS DISEASE AFFECTING SALMON.*

BY A. B. STIRLING.

It is widely known that a destructive epidemic has this spring appeared among the salmon of the rivers Eden, Esk, and Nith. The mortality among the fish has been so great as to cause considerable alarm among proprietors, salmon-commissioners, tax-men, anglers, and the general public.

The newspapers inform us that within three days the watchmen have taken out of the Esk as many as 350 dead salmon. All who have examined the fish carefully agree in referring the disease to the presence of a fungoid growth.

The other fish in those rivers, as the smolts, trout, eels, lampreys, minnows, pike, and flounders, are also said to be attacked in a similar way to the salmon, and fears are entertained that the disease may become thoroughly established in the district.

In these circumstances I have thought it might be interesting to describe the condition of some of the fish which have come under my observation. In March last, my friend, Dr. Philip Hair, of Carlisle, sent me the fin of a salmon which had been affected by the disease, and requested me to state, if possible, its nature. Unfortunately, the fin was in a putrid condition when it reached me, and, as a result of the examination, I could only state to Dr. Hair that the disease was probably a fungoid one. A few days later I received from Dr. Hair a fine specimen of a trout, but it was not stated whether the fish was taken alive or picked up dead. It was, however, quite fresh, and the effects of the disease were painfully exhibited on the carcass. A hurried examination of this specimen enabled me to inform Dr. Hair that the disease was due to what I had previously suspected, namely, a fungoid growth.

While examining this specimen I observed, entangled among the fronds of the fungus, foreign matter of various kinds, namely, torulæ or yeast-fungus, triple phosphates, fecula, human hairs, hairs of the cat and mouse; also desmids, diatoms, shreds of dyed wool and cotton, with other fragments of matter unknown to me. Respecting the torulæ, I, in my letter to Dr. Hair, asked if their presence could be accounted for

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by bakeries or breweries in Carlisle, whose refuse might have got into the river.

My letter was published by Dr. Hair in the Carlisle Journal of March 29 and in the Field newspaper of March 30, and as worded it might have been inferred that I regarded the presence of bakeries and breweries as the cause of the disease. This was of course not intended. On April 12th I received two salmon and a trout from J. Dunne, esq., chief constable of Cumberland and Westmoreland, all of them in a diseased condition. Mr. Dunne requested me to make an examination of those fish, and hoped, on public grounds, that I might be able to discover the true nature and cause of the disease.

As a result of my examination of those fish, I sent a preliminary report to Mr. Dunne. This report was forwarded to the fishery-inspectors, and was considered of so much importance that it was published in the Times and many of the provincial and local newspapers. Sir Robert Christison had also very kindly supplied me with a number of specimens from the river Nith, all of them affected with this disease. An examination of these has confirmed me in the opinion expressed in the report above referred to. All these fish had the disease in an advanced stage, being more or less affected about the head, chin, branchiostegal rays, and fins in every instance. One salmon had rubbed the chin till the lower jaw had nearly separated at the symphysis, the skin was rubbed off the branchiostegal rays, and the rays broken. A trout had the upper left jaw bare of skin, the bone worn and hanging loosely attached to the cheek, the pectoral fin of the left side in rags, and the rays worn to stumps.

Another salmon had the skin rubbed off the nose and crown, and the matted fungus covered the bare parts; the dorsal fin was quite destroyed, the strong anterior rays being reduced to stumps of half an inch in length, and the remains of the fin bare, bleached, and without membrane. Beneath the dorsal fin on each side were spaces extending 3 inches forward toward the head, and $2\frac{1}{2}$ inches backwards toward the tail, thickly covered with the fungus. Besides these there were other spaces on the sides of the fish from 1 inch to 2 inches in diameter, all covered by the fungus, which gave the fish a spotted appearance.

This fish appears to have been alive when taken, as the skull and brain had been punctured by the fisherman. The greater part of this fish was cooked; it was very firm and fat, and the three persons who made a meal of it pronounced it capital. I tasted a portion of the flesh from a part where the fungus covered the skin, and could not detect anything different in the flavor from an ordinary fishmonger's salmon.

The fungus appears, in the first instance, to attack those parts of the fish that are not covered with scales, as the crown, nose, sides of the head, chin, throat, and the membranous parts of the fins. From those parts the fungus extends by vegetative growth (which seems very vigorous) to those portions of the surface of the body which are covered

with scales. On the sides of the fish, where small patches of the fungus were situated on the scales (and no rubbing had taken place), no sore could be detected, and the fungus was easily wiped off with the finger.

I may also mention that all the fish which I received from the Eden River, both trout and salmon, were infested with tape-worms of a large size, the worms being about two yards in length and three-sixteenths of an inch in breadth. One of the salmon had from 60 to 80 yards of those worms in the pyloric portion of the gut. Another salmon had three varieties of worms in various parts of its alimentary canal—first, in the stomach were many round worms, about 4 inches in length, tapering to each end, and as thick as ordinary whip-cord in the thickest part of the body; many of those worms were entangled among the gill-rays, it being their habit to crawl there when the fish dies, and from their presence in this situation they are called gill-worms by the fishermen; second, a small spiral worm, which attaches itself by burrowing in the outer walls of the intestine, in the fat and pyloric appendages; third, tape-worms seated within the pylorus and intestine.

On May 30th I received from Sir Robert Christison a large salmon from the Nith. This fish was believed to have been to the sea after being attacked with fungus, and was captured on its return. The specimen was a female, and had the roe about one-fourth grown; the viscera were very healthy, and no entozoa were found in it. The head of this female is peculiar in having a kip on the under jaw, and a cavity in the upper jaw to receive it, as in the male fish of the species. The right side of the head, including the eyes and nose, was very deeply rubbed and the bones injured, but no fungus adhered to the injured part. The pectoral fin on the same side had no membrane, the rays being bare, broken, and separate from the muscles at their roots. There were several patches on both sides of the fish, from which the scales were rubbed off, but no fungus adhered to the rubbed parts. In several of those rubbed parts, although the skin was unbroken, a portion of the muscle, corresponding in breadth to the external injury, and half an inch in depth, was in a pulpy condition; beneath other rubbed spots the muscle was quite sound. The dorsal, ventral, caudal, and anal fins were all more or less injured by rubbing. No fungus adhered to any of the fins except the anal, the rays here being reduced to stumps of an inch or half an inch in length, on which a thickly matted covering of fungus is seated. The branchiostegal rays are very slightly rubbed, and are the only other part of the fish on which the fungus remains. In my report to the fishery commissioners in April last I stated that the fish did not die of the fungus, but of the injuries they inflict by rubbing, in trying to rid themselves of the pest. As some objection was taken in regard to this statement, I quote, in corroboration of my views, from a letter published in the Field of May 25th last. The letter was written by Commander Duncan Stewart, R. N. He says:

“In regard to the disease from which salmon are suffering in some of

our rivers, it may be of advantage that I should mention what I observed in a small river at the head of Castric's Bay, in Siberia. I found the river rather low, but with plenty of clear running water. But what astonished me was to see thousands of salmon in all stages of disease and death, some darting away, but soon stopping to rub the side on the bottom or on a rock; others were constantly rubbing, others unable to rub. In those last cases large sores, from the size of a shilling to that of a half-crown, of a most filthy appearance, were always present. Fish in which the scales had been rubbed off would try to get out of my way, but I could kill them with a stick; those with the skin gone would rub themselves against my trousers."

Supposing this salmon from the Nith had been to sea, and had while there got rid of the greater part of the fungus with which it was affected, it had returned to the river in such a mutilated condition, and with unhealed sores of such a nature as in all likelihood would have ultimately proved fatal. Besides, the fact that the fungus was not killed by the salt water, but was found in a highly vigorous condition on the parts to which it still adhered, gives but small hope of any permanent benefit to diseased fish from a visit to the sea.

The fungus belongs to *Saprolegnia*, a natural order of doubtful affinity, said to have the habits of molds and fructification algæ. This order consists of the genera *Saprolegnia* and *Achlya*, which are great enemies of fish and other animals preserved in aquaria.

The filaments of the fungus arise free from the outer surface of the epidermic layers of the fish, having neither branches nor articulations. They are tubes, the walls of which are perfectly translucent, and in their interior, at irregular intervals, are small groups of fine granular matter.

The majority of the filaments are spear-shaped at their upper terminations, and appear to be barren.

The prolific filaments, on the contrary, enlarge at their upper extremities, and form elongated club-shaped chambers, in which granular matter gathers. In the midst of this granular matter small round bodies appear, and, those enlarging, gradually develop into spores. The prolific filaments apparently contain more granular matter, and are of greater caliber than the other filaments. They are evidently destined from the first to be the propagating media.

The spores escape by an opening in the summit of the chamber. This aperture is not an original opening; it is produced in a somewhat remarkable manner. So long as the spores are unripe and unfit for expulsion, a slender continuation of the filament projects from the apex of the chamber in a manner similar to the neck of a bottle. At the point at which this joins the spore sac there is a slight contraction, which goes on gradually increasing in depth. Ultimately, when the spores are fully matured, it drops off, and the aperture is formed. The filaments forming the mycelium of the plant are tortuous and branched; they

ramify in the mucous and epidermic layers of the fish; they do not penetrate the corium where there are no scales. In other situations they never reach a greater depth than the outer surface of the scales; they are tubular. The whole plant, being without septa, forms a single individual of apparently indefinite extent. The spores are variously shaped at different stages, ovate and kidney being the commonest forms. They are very minute, and require a power of 450 diameters to observe them well. The cilia are two in number, a longer and a shorter one, and are situated at the long axis of the spore. They are difficult to observe, and always disappear in permanently-mounted preparations, although the spores themselves remain unaltered in all other respects. When the fungus is stained with logwood or picric acid, excellent permanent preparations can be got. It has been stated that the fungus dies with the fish. I have not found this to be the case; on the contrary, all my observations have been made from dead fish. Some of the specimens sent me from Carlisle by Mr. Dunne were missent to Aberdeen, and returned to me on the seventh day after the death of the fish, and yet I have scores of permanent preparations from these specimens which show distinctly the characteristic form of *Saprolegnia ferax*.

I have also found the fungus perfectly identical in all the specimens I have examined, which consist of salmon, sea-trout, and river-trout from the Eden, and salmon and grayling from the Nith.

It has also been said that a salt solution destroys the fungus, "*which melts in the solution like sugar in water.*" On the contrary, salt and water is an excellent preservative of *Saprolegnia*; masses of it before me as I write have been in a salt solution for two months, and it remains unaltered. Further, the salmon captured in the Nith, which is believed to have gone to the sea in order to get rid of the fungus, had the fungus growing vigorously on several parts of its body. The fungus must either have instantly attacked the fish on its return to the river, or not have been destroyed during its stay in the salt water.

Regarding the cause of the disease, I can offer no opinion further than that some functional condition of the fish seems necessary for the propagation of the fungus. The germs of *Saprolegnia ferax* must exist at all times and in many places; and, if so, there must be a reason why fish are not constantly affected with the fungus and in every river. I am persuaded that the condition of the fish is in some way either suitable or unsuitable for the propagation and growth of the fungus. Whether this arises from too high or too low condition, I am quite unable to say; but I may remark that while some of the fish examined were in the kelt stage, others were in a condition perfectly fit for food.

