

Buckland, F. and others.

Disease among salmon in England and Scotland.

1880

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REPORT

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DISEASE WHICH HAS RECENTLY PREVAILED

GAMBRIDGE, MASS

AMONG THE

SALMON

IN THE

TWEED, EDEN, AND OTHER RIVERS

IN

ENGLAND AND SCOTLAND.

BY

FRANK BUCKLAND AND SPENCER WALPOLE, ESQRS.,
INSPECTORS OF FISHERIES FOR ENGLAND AND WALES;

AND

ARCHIBALD YOUNG, ESQR., ADVOCATE,
COMMISSIONER OF SCOTCH SALMON FISHERIES.

Presented to both Houses of Parliament by Command of Her Majesty.



LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

FOR HER MAJESTY'S STATIONERY OFFICE.

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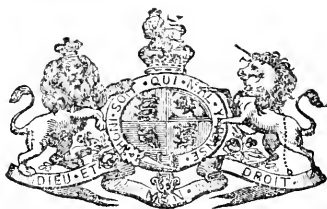
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COMMISSION.

WHEREAS it has been represented to me that a destructive disease has extensively prevailed during the years 1877, 1878, and 1879 among the salmon of the Tweed, Eden, and other rivers in England and Scotland. And whereas it is expedient that inquiries should be made into the causes of such disease, and the steps which it may be expedient to take to prevent its propagation in the rivers in which it has already appeared, and its extension to other rivers.

I, the Right Honourable Richard Assheton Cross, one of Her Majesty's Principal Secretaries of State, do hereby nominate and appoint Francis Trevelyan Buckland, Esquire, Spencer Walpole, Esquire, and Archibald Young, Esquire, to be Commissioners to make such inquiries as are aforesaid, and to report fully to me the result thereof.

(Signed) RICHARD ASSHETON CROSS.

Whitehall, 23rd August 1879.



PHOTOGRAPH OF DISEASED SALMON.

SALMON DISEASE COMMISSION.

REPORT

ON THE

RECENT OUTBREAK OF DISEASE AMONG
SALMON

IN

CERTAIN RIVERS OF ENGLAND AND SCOTLAND.

Home Office, Whitehall,
2nd August 1880.

SIR,

WE, the undersigned Commissioners appointed to inquire into the causes of the disease which has recently appeared among the salmon of the Tweed, Eden, and other rivers of England and Scotland, and into the steps which it may be expedient to take to prevent its propagation in the rivers in which it has already appeared, and its extension to other rivers, have the honour to inform you that we have held public inquiries at—

Dumfries on the Nith.

Annan on the Annan.

Kirkcudbright on the Dee.

Ayr on the Ayr.

Keswick on the Derwent (Cumberland).

Carlisle on the Eden.

Melrose, Kelso, Cornhill, and Berwick, on the Tweed.

Girvan on the Girvan.

Colmonell on the Stinchar.

Newton Stewart on the Cree.

Lancaster on the Lune.

And also at Edinburgh.

We have collected, in other ways, a variety of information on the subject, and we are now enabled to make the following report.

A salmon affected by the disease bears a very different aspect from a fish unaffected by it. The scales are covered more or less by patches of a fungus resembling, when dry, moist brown paper. If the fish is placed in water the fibres of the fungus will separate one from the other and the appearance presented will be that of very delicate cotton wool. Hence in some parts of the country

fish when attacked on the head are called "salmon with white night-caps." There is hardly any part of the body of the fish which is not liable to be attacked by this fungus; but the parts first affected are the softer portions of the body which have no scales. Thus, for instance, the nose and the back of the head are generally first attacked. The next part attacked is usually the tail. It is, however, on the tail, the dorsal fin, and the pectoral fins that the fungus is found, to a greater or less extent, according to the virulence of the disease. In bad cases, masses of fungus are also found on the inside of the palate.* It is noticeable that as the disease advances it attacks the delicate structure of the gills, and, forming upon them a deposit not unlike glue, affects the respiration, if it does not entirely put an end to the life of the fish by suffocation.

The internal viscera of diseased fish do not, in general, materially differ from the internal viscera of undiseased fish in a similar stage of existence, though in some cases the livers of diseased fish are pale and break down easily under the finger.

The brains of diseased fish have been occasionally found in a state of inflammation, but this probably arises from the irritation caused by the fungus eating through the skin into the bone of the skull.

The symptoms affecting live fish do not seem to have been observed so carefully as the appearances on the dead fish; it is certain that the presence of the fungus causes a very great amount of irritation and probably pain to the fish, as they are seen throwing themselves about as though in great agony, and when exhausted swimming about in a helpless manner on the surface of the water. Thus Mr. Stoddart (Appendix, p. 43) informed us there was a sort of rabies among the fish. "They were rushing about as if distracted with pain, skimming along the surface of the water."

As regards the external appearance of the disease we select the following passages out of the evidence:—

"The fungus had eaten into the flesh, beginning generally at the head."

"The fish were covered with fungus from head to tail. The intestines were in perfect order, and the flesh was firm and rich."

"The first stage in old fish is a white spot on the frontal bone."

"The fish had spots generally above the dorsal fin, on the head, and near the side. The spots were as large as a half-crown on the back of the head. The sores were covered with fungus."

"The fish had white spots about the head, fins, and tail. The fungus grows on the white spots, and rubs off like scurf."

"The whole head of the fish is covered, like a white night-cap."

"Noticed a quantity of fungus near the nose; and the head, the back fins, and tail had almost rotted away."

"The disease begins at the head and near the eyes, top of tail, and back fin. Has seen fish with the eyes almost out of them."

* A plate, taken from a photograph of two diseased fish, forms the frontispiece of this Report.

“ It had a soft fungus on the gills. The gills were covered with a slimy matter ; the fish might have died of suffocation.”

We might easily multiply similar descriptive extracts from the evidence which is printed in the Appendix.*

The fungus adhering to various parts of the body being at all events the outward and visible sign of the salmon disease, whether it really be so from a scientific point of view or not, we shall now examine the evidence : first, as to the nature of the fungus ; and secondly, as to the way in which it affects the fish.

Fungi chiefly grow on dead and decaying substances, and may be called the scavengers of nature. They help to dissolve and remove the exuvie of one generation, and convert it into vegetable mould.

Good examples of terrestrial forms of parasitic fungi are the dry-rot fungus, so fatal to timber under certain circumstances ; puff-balls ; and several fungi, sometimes of bright colours, that are found among the decaying branches and leaves in damp woods. In wine cellars, also, vegetable fungi are common, especially a fungus which attacks and completely destroys the bark of a tree which we know under the form of cork.

We also find fungoid disease in the following cases :—

Smut of wheat.

Potato fungus.

Grape fungus.

Coffee leaf disease.

Blue mould of cheese.

Fungi, however, also attack animals. The silkworm, for instance, is liable to a disease known as muscardine. The fungus in this case resembles common mould, and rapidly spreads. Fungus on fish is not uncommon. Fungi on fish have been observed in America, China, France, Germany, and other countries. The particular fungus which is observed on fish affected with the “ salmon disease ” is known as the *Saprolegnia ferax*.

In the opinion of Sir Robert Christison “ it takes root apparently in the cutaneous tissues of the fish and grows there. It is like muscardine on the silkworm, and like fungoid diseases affecting the human race, or vegetable fungi on trees.”

Sir R. Christison thinks it is “ a purely cutaneous disease, because in the slighter forms he has seen the fungus removed and no sign of disease underneath except a slight discoloration.”

Mr. Erasmus Wilson, to whom some specimens of diseased salmon were submitted by Mr. Buckland, is of a similar opinion. “ The appearance of the disease,” he writes, “ very closely resembles ringworm in the human subject, in which also there is a fungiform growth, and I have no hesitation in referring the cutaneous disease of the salmon to a similar cause. The parts most affected were those most distant from the centre of circulation, namely, the fins and tail, and of these the whole surface was coated

* A plate showing the appearance of the *Saprolegnia ferax* under the microscope, which we owe to the courtesy of the Editor of the “ *Gardener's Chronicle*,” in which the drawing originally appeared, is published on the opposite page.

“ over; whereas on the fleshy parts the disease was developed in circular discs, each about the size of a shilling, while here and there a cluster of discs had become blended into a broad irregular patch. Again, where the fungiform growth was scraped away, the scales were imperfect or lost, and the growth had taken the place of the scaly covering. The parallel with ringworm is very striking.”

Mr. A. B. Stirling, Assistant Curator of the Anatomical Museum, Edinburgh, stated in evidence that he first heard of the salmon disease in March 1878 from Carlisle. He ascertained that the fungus was *Saprolegnia ferax*, and examined specimens from the Eden, Nith, Caldew, and Tweed. The disease was identical in each case.

The fungus, he told us, has been well known since 1836. Its mode of reproduction is described by German authors, and by Dr. Burdon Sanderson. Mr. Stirling's observations agree with their descriptions. To quote the notes of his evidence:—“ The fungus is both a-sexual and bi-sexual. First, there are zoöspores which are very plentiful, hundreds in a spore case. They are produced in the filaments of the fungus. The zoöspore produces a plant which produces another spore called oöspore. These are found in a globular cell called *ogonium* by botanists. These are different from the zoöspores. Has only seen four cases in which there were from four to eight spores in each ogonium. These are called ‘resting spores’ because they do not die for some time.

“ The fungus absorbs the mucus and eats through the skin; it continues to grow until a counteracting influence appears. It grows on dead fish. It kills by hiding the light and preventing endosmose and exosmose at the skin and by suffocation. Thinks the fungus is the same on both clean and unclean fish. The action of fungus is mechanical and purely cutaneous. The *Saprolegnia ferax* has been known many years; it is present, he thinks, in all waters, at all times. It is equally present in both pure and impure water. Botanists say there is a climatic influence of which they are ignorant. Cannot say why the disease is confined to the Border rivers. A climatic influence might have existed specially there.”

Dr. John Ogle gives his opinion that whatever tends to lower the tone of the fish tends to invite the disease, the sporules of which are probably always present in the water, but which require special conditions which cause them to spring into life.

Mr. Werthington Smith also says the disease of fish is caused by the attack of a fungus no other than the common *Saprolegnia ferax*.

“ With a low power of the microscope the fungus will be seen to consist of a dense mass of matted threads without joints, and in a thick forest of minute transparent clubs both zoöspores and resting spores appear to be most eager to germinate.”

The disease is well known in North America.

Mr. Byers, who was formerly Government surveyor in British Columbia, stated in evidence that thousands of diseased salmon may

be seen in the Harrison River, 60 miles from the mouth of the Fraser. The greater proportion of the larger fish are diseased. A great number of fish die after the spawning season. He agrees with Mr. J. Keast Lord's description, which is as follows: "You will often find salmon with their noses quite worn off, their heads bruised and battered, fins and tail ragged and torn, bodies emaciated, thin, and flabby, the bright silvery tints dull and leaden in hue"—in fact with all the symptoms of the salmon disease.

Since Mr. Byers gave his evidence at Kelso, the following information has been received by us relative to the salmon disease in the rivers of San Francisco in 1880. The Hon. B. B. Redding, United States Government Fish Commissioner in California, states that the same or a similar disease exists there, and has, as far as could be learned, always existed. The Indians are familiar with it, their ancestors were equally so. Mr. Redding is of opinion that none but kelts, or spent fish, and injured fish are attacked by the disease; that those who return to the ocean recover from it; and that when they do not return it is because the disease attacks the sight, blinding the fish.

On this subject a paper was read a short time ago before an Academy of Sciences in America by Mr. Justin P. Moore, an authority on fungoid diseases. He says, "The disease is caused by a fungus which first begins in the form of a delicate web-like mass of semi-transparent, very fine threads, resembling a mould. It may begin either upon the head, gills, or scales; an examination with the microscope shows this mass to be made up of simple threads. These in a few days, from eight to ten, increase in length and send out branches. These are club-shaped and are filled with protoplasm. Soon the protoplasm seems to break up, and zoospores are formed within the club-shaped tube. At the base of these club-shaped filaments may often be seen shorter septate filaments, bearing on their summits a globular mass containing spores. These latter are what we call resting spores. Either zoospores or resting spores may germinate, though the latter are undoubtedly intended to play the principal part, and serve to carry over the species from one season to another, as their name indicates. The disease is known as *Saprolegnia ferax*. Whenever there are wounds, or whenever the circulation is weak from any cause, and the nutrition consequently slow, the attack is most likely to begin. For instance, the skin of fishes placed in water not well aerated, in which the mucus is changed, becomes a fit point of attack. In such water the bronchial respiration not being well accomplished, the gills may be the first point of attack. The secretions from wounds present very favourable conditions to the development of the disease; it can be readily transplanted from one animal or fish to another and there develop itself. This can be accounted for by the fact that it takes along with itself enough of its own substance to form a nidus and serve as aliment until the presence of the disease itself can cause an alteration in the normal mucus.

“ Warm sluggish water, shallow pools, badly aerated reservoirs
 “ or tanks, containing much nitrogeous substance, make a
 “ fitting breeding-place for this disease. Fish are more subject to
 “ it at certain seasons of the year than at others; salmon at the
 “ end of the spawning season are especially subject to its attack,
 “ and a great mortality prevails among them. Mr. Livingston
 “ Stone, in his report of the salmon-hatching establishment on the
 “ McCloud river, says: ‘ A marked change takes place in the
 “ salmon a little before the middle of August. The males grow
 “ deep and thin, and the dog-teeth begin to show themselves.
 “ The females are now big with spawn. They become foul and
 “ diseased, and very much emaciated. Blotches of fungus appear
 “ on their heads and bodies, and in various places are long white
 “ patches, where the skin is partly worn off. Their fins and tails
 “ become badly mutilated, and in a short time they die exhausted.
 “ By the 1st of October most of the fish that were in the river in
 “ August are dead.’ ” Mr Moore adds, “ The fact remains that
 “ ninety-nine hundredths, if not all, of the salmon in the upper
 “ tributaries of the Sacramento river appear to die immediately
 “ after their first spawning.”

From these various opinions, as well as from those expressed
 in other able papers printed in the Appendix,* we infer that the
 disease which we have been appointed to investigate is a fungus
 known to naturalists as the *Saprolegnia ferax*, which multiplies
 both a-sexually and bi-sexually with extraordinary rapidity. We
 have now to consider (1) whether this fungus has recently been
 introduced into this country, or (2) whether it has existed for any
 lengthened period and has been only recently stimulated into
 unusual reproductive energy.

The scientific evidence chiefly points to the latter of these con-
 clusions. The sporules of the *Saprolegnia ferax* are said to be
 commonly present in running water; and assuming, as we are
 bound to assume, that facts stated with such confidence and on
 such high authority are correct, we conclude that the *Saprolegnia*
 is no new disease, but that it has existed in what may be called
 a sporadic form for a long series of years. The practical
 evidence to a certain extent corroborates this conclusion. Fishermen
 of many years' experience told us on the Tweed, the Lune, and elsewhere
 that fish with fungus upon them had been constantly taken in past
 years. We do not, indeed, attach much importance to this evidence,
 because the very interesting account, which we print in the Appendix,†
 from the Honorary Consulting Naturalist of Southport Aquarium,
 seems to show that there are two distinct fungi by which fish are
 attacked which may easily be mistaken by non-scientific observers.
 The same thing was clearly stated to us by Mr. Stirling. It is possible
 that some of the fish, affected with fungus in previous years, may
 have been attacked by another fungus than the *Saprolegnia*. But

* Appendix II., p. 103.

† Appendix II., p. 109.

whether that is so or not, we assume, with the scientific witnesses who have come before us, that the seeds of *Saprolegnia* are generally present, and that the disease therefore is not a new one.

If this be so, it seems to follow that, for some reason yet to be explained, the *Saprolegnia* which has existed in a sporadic form has—to use a technically inaccurate but expressive word—become “epidemic” of late years. On a small scale, this seems certainly to have occurred at Ightham in Kent. An epidemic of *Saprolegnia*, the cause of which is unexplained, broke out among the coarse fish in the moat surrounding an old house in 1850 and 1874. We reprint in the Appendix the full account of this epidemic.* It is sufficient for us to add that what occurred at Ightham may occur and has occurred at other places, and that just as sporadic cases of typhus, cholera, or ringworm may be stimulated into epidemics by various exciting causes, so sporadic cases of *Saprolegnia* may become stimulated into a salmon disease.

What then are the circumstances which have made the *Saprolegnia* epidemic? We print as an addendum to this report an analysis, drawn up by one of us, Mr. Buckland,† which expresses his opinion of the causes of the disease which have been brought forward by various persons. It is sufficient here to say that no one hypothesis which has yet been suggested stands the test of careful criticism.

All the different circumstances and conditions which were stated by different witnesses to be the causes of the disease are to be found existing in rivers where the disease has never been heard of. We have found the disease existing in polluted and in pure rivers; in rivers obstructed by weirs and in rivers where there are no obstructions; in understocked and in fully-stocked rivers; in rivers flowing from or through lakes and in rivers with no lakes belonging to their catchment basins; in short, in rivers with the most opposite physical features: and we have been unable to detect in the Tweed, Nith, Annan, Doon, Esk, Eden, and other rivers attacked by the disease any special conditions to which the disease can be attributed, which are not likewise to be found in some of the rivers which have escaped its ravages. Those who are acquainted with only one or two salmon rivers are rather apt to imagine that in the pollution, obstruction, or overstocking of the rivers with which they are familiar they have discovered the true cause of the disease. But to those who have an extensive acquaintance with the salmon rivers of Great Britain, the most perplexing thing connected with the present inquiry is that every cause, without exception, which has been assigned as the true origin of the salmon disease in infected rivers, is to be found in rivers where no disease exists, or has ever been known to exist.

We have thus been unable to ascertain for certain any one cause which would satisfactorily account for the epidemic character of the recent outbreak of *Saprolegnia*. Such a cause, however, must undoubtedly have arisen from one of two circumstances. Either (1) the fungus itself must have recently been stimulated into

* Appendix III., p. 117.

† See p. xiv.

exceptional activity, or (2) the fish must have been rendered exceptionally susceptible to its attacks. The first of these causes is admirably illustrated by Professor Rolleston—the second by Dr. Cooke—in the valuable papers which we have inserted in the Appendix.* We can only say here that we do not consider either of these theories quite established, and we pass on to the question whether any remedies are applicable to the disease.

On this point, however, a very material question arises which we have not hitherto examined. The evidence which we received during our inquiry pointed to the conclusion that the disease was a freshwater disease or a disease which attacked the fish during their sojourn in fresh water. Isolated cases indeed came before us of fish taken in salt water with disease upon them. But in all these cases the fish were taken in the estuaries or near the estuaries of rivers, and there was reason to believe that they had dropped down to the sea after they had contracted the disease, and had not recovered. This conclusion was strengthened by an experiment undertaken by the Tweed Commissioners. They confined diseased fish in the brackish waters of the estuary of the Tweed, and kept them till they recovered from the disease. For all these reasons we were disposed to infer that the disease was a purely freshwater disease. The remarkable outbreak of the disease, however, which undoubtedly occurred in the Aquarium at Southport, seems to shake this conclusion. There can be no doubt whatever that an outbreak of *Saprolegnia* occurred in the freshwater tanks of the Aquarium. There can also be no doubt that a sea-trout in salt water, which had been continuously in salt water for months, and had never come into contact with fresh water, showed symptoms which in the judgment of the Honorary Consulting Naturalist, Mr. C. L. Jackson, and the Curator, Mr. Long, were precisely similar to those which were displayed by the diseased fish in fresh water. We made arrangements for ascertaining whether the fish thus affected was affected with *Saprolegnia*. But, in the hot weather of June, the disease gradually disappeared from the freshwater tanks, and, at the same time, the sea-trout also recovered. Two of us visited Southport. The sea-trout then bore traces of the fungus. Its tail was partly eaten away, and scars were visible on its head and on its body. But the fungus had entirely disappeared and we were unable to obtain any for microscopic examination. We cannot, therefore, say that the fish in question actually had the *Saprolegnia*. But there are *primâ facie* grounds for suspecting that it had the disease, and at any rate, with this doubtful case on record, we hesitate to pronounce the *Saprolegnia* a purely freshwater disease†.

If the *Saprolegnia* can, under any circumstances, live in salt water, the difficulty of curing the disease is obviously increased. But, even in that event, the efforts towards eradicating it must

* Appendix II., pp. 103, 113.

† In this view Mr. Buckland does not concur. His individual opinion on this particular point is separately expressed at the end of his Addendum to this Report. See p. xxiii.

be mainly directed to the fresh water. In this case the cure must proceed on one of two hypotheses. We must either endeavour to eradicate the disease, or we must try to render the fish less susceptible to its attacks. On the first hypothesis we own we see little hope of successfully coping with the disease. It will be difficult to eradicate the seeds of a fungus which multiplies with such rapidity as the *Saprolegnia*. But, if the other view is right, it is obvious that a good deal may be done to improve the condition of the fish by improving the condition of the rivers—(1) by facilitating the passage of salmon up and down the rivers, over weirs and natural obstructions; (2) by the prevention of pollutions; and (3) if rivers should in any case be overstocked, which we do not think proved, by sanctioning the destruction of kelts, or possibly by sanctioning in a salmon river the capture for a certain time of the less valuable salmonidæ, such as bull-trout, after the commencement of the close season. But in every case we feel satisfied that all dead fish should, wherever it is possible, be removed from the rivers and buried beyond high-water mark or burned.

These conclusions are we fear, inadequate; they are, however, the only conclusions, which seem to us warranted by the present state of our knowledge. Increased observation by naturalists, microscopists, and other scientific persons, prolonged over many seasons, may possibly be necessary in order to enable us to arrive at a complete knowledge of the cause of the recent outbreak of *Saprolegnia*, and of the remedies which are applicable to this disease.

We have the honour to be,

Sir,

Your obedient Servants,

FRANK BUCKLAND.

S. WALPOLE.

ARCHD. YOUNG.

The Under Secretary of State,
Home Office.

ADDENDUM

TO THE

REPORT ON THE SALMON DISEASE.

BY
FRANK BUCKLAND, Esq.

The causes to which the salmon disease and its spread have been attributed may be put under one or other of the following heads:—

1. Pollutions.
2. Lowness of water caused by excessive land drainage.
3. Effects of frost and snow on the water.
4. Overstocking or overcrowding of fish.
5. Obstruction by weirs.
6. Dead fish left in the rivers.
7. Wounds from fish fighting on the spawning beds and injuries by anglers.
8. Transport of fungus by birds.

1. POLLUTIONS.

Before the official inquiry into this question was ordered the proprietors on the Tweed seemed to have almost universally made up their minds that the cause of the disease in the Tweed was pollutions.

Various witnesses stated in evidence that the Tweed is much polluted. "Much pollution comes from Kelso. All the refuse from Galashiels and Hawick comes down the river. The water is also affected by the pollution of the Gala and Ettrick. It is offensive to the smell in summer."

Again, a witness stated that the pollutions in the Tweed last season were much worse, owing to the hard winter. By "pollutions" he meant water from the factories at Galashiels. "On Sunday and Monday," he said, "the water is quite clean and pure. On Monday after 5 and all the week it is like ink—it is a bluish black."

"The water is not at all pure now. The pollution is both chemical and vegetable—chiefly indigo."

"Wool scouring sends turpentine, sulphur, arsenic, spirits of tar, and black soap into the river. This comes from the wool in the wool-works. The fish get unhealthy through pollutions. The pollution is double what it was in 1874."

"Innerleithen has turned its town sewage into the Tweed within the last two years."

Under the head of pollution sheep dipping has been mentioned. I am not, however, inclined to attribute much importance to this cause as the origin of, or the means of keeping up, the salmon disease, though no doubt sheep dipping does much injury in the spring of the year to fry, &c.

A person who had only seen the Tweed in its polluted condition might readily be pardoned for coming to the conclusion that in this instance the salmon disease was to be attributed to pollutions. In the course of our inquiry, however, evidence was given that the salmon disease had occurred in many places where no pollutions whatever existed. Thus in the Nith at Dumfries there are no pollutions in the waters where the salmon disease occurred. A witness stated that "the Nith is quite pure where he observed the disease. It is one of the cleanest rivers there is." It is polluted at Dumfries, but below where the disease was first observed. The Annan is also pure.

The Kirkcudbright Dee is also pure. The Doon used formerly to be polluted from the Carnochan coal mines, but a witness told us that the pollutions were cured, and the stones in the river which were discoloured were now getting clean. When the pollutions were bad there was no disease; for several years the pollutions had not been at all bad, and yet there was disease.

The Cumberland Derwent is a little polluted by collieries and débris of lead mines and tin-plate works, but is a comparatively pure river on the whole.

The Eden is not polluted very much in its upper waters. The sewage of Carlisle in the lower waters is, however, very bad, and on the Calder, a tributary joining the Eden near its estuary, there are dye, tan, print, and brewing works. These, however, do not much affect the main Eden.

The Girvan cannot be said to be polluted, nor yet the Dee or Bladenoch. The upper waters of the Lune are entirely free from pollution.

The cause of salmon disease would appear from the above to be unconnected with pollution, yet we must pause awhile and take into consideration other facts of the case. Although the rivers may be unpolluted by the consequence of human industries, yet the very fact of so many dead fish being accumulated in the river may be considered in itself as the worst possible form of pollution. (*See* p. xxi.)

2. LOWNESS OF WATER AND LAND DRAINAGE.

I now come to the second cause on my list, viz., lowness of water. On this point the following evidence was offered:—

"The water was low. The river was about half or two-thirds full." (Nith.)

"The river was very low in the spring." (Nith.)

"The fish cannot get away after spawning owing to deficiency of water, and if they are kept too long in fresh water they might contract the disease." (Annan.)

"The river was very low in 1878 and 1879, in the spring months." (Annan.)

"When the diseased fish were first noticed, the water was low." (Annan.)

"There was very low water. 1877 was followed by an exceptionally dry year." (Doon.)

“ The dry weather had something to do with it. 1878 was exceptionally dry. The frost came after December, and after the disease. The weather was very dry all the summer of 1878.” (Doon.)

“ There has been more water this year than the year before, which was very dry. The river was exceptionally low two years ago. Not so low last year as the year before.” (Derwent.)

“ The river was very low when the disease appeared.

“ The latter part of 1877 was exceptionally dry. The early part was not particularly wet. The spawning season was dry and there was no trace of disease.

“ The winter of 1878-9 was cold.

“ The water early in 1878 was low.

“ There was a deficiency of water, and the fish did not get away freely.” (Tweed.)

“ When the water is low there are too many kelts.”

“ The river was low and icebound last season, and this was the cause of the disease.”

“ The water was very low. When it is low pollution has a bad effect on the fish.”

“ It would have been better if there had been more water for the fish.”

Connected immediately with lowness of water in rivers comes the question of land drainage, upon which point the following evidence was given:—

“ The quantity of water in a river is altered by drainage. The river has changed, and is not so big as formerly. The drainage is the cause. The marshy ground is drained which used to keep the river up.” (Tweed.)

“ The floods do not last long now. Formerly, before there was so much drainage, they continued twice as long.”

“ Land drainage has done much to alter the river. If the water rose faster the floods would be higher, but they are not.”

“ Drainage is for bottom water, not for surface water. The water formerly got away in thousands of small streams, instead of as now in a few large ones.”

It will therefore be observed that, in the rivers where the salmon disease has broken out, it has been at the time when the water was low. Salmon are fish that above all things require a plentiful supply of water. Lowness of water at the time they are enfeebled by spawning or after spawning must necessarily have great influence in debilitating the fish, or as it has been ably put, “ the river was too little for the fish.”

† It must also be recollected that where sewage from towns, refuse from factories, &c. exist, their quantity and effect must be greatly enhanced at times of low water.

At Edinburgh evidence was given that there had been no disease in the Tay, nor yet in the Forth.

It immediately struck me that the reason of this was the presence, in the head waters of both these rivers, of large deep lakes, which collect water in its purest possible form direct from the mountains.

Thus, at the head of Loch Tay, there are large lakes, viz., Loch Tay, Loch Tummel, Loch Rannoch, &c. These act as compensation reservoirs, and, by pouring out their superfluous water, afford to the fish a larger or smaller stream constantly flowing all the year round.

Again, when Mr. Napier, head-water bailiff of the Forth district, was under examination it forcibly struck me that the city of Glasgow was supplied from Loch Katrine, and that the water from this lake was considered the purest in the world. I also recollected that beside Loch Katrine there were Loch Achray and Loch Ven-nachar, intervening between the head waters of Loch Katrine and the Teith. At the bottom of Loch Vennachar there is a compensation or overflow weir. Thus, then, from the above-mentioned three lakes, and also from two others, Loch Voil and Loch Lubriaig, there is a constant stream of water—the compensation water for the mills being settled by Act of Parliament—flowing down the river at all times of the year.

These fine lakes in fact act as big reservoirs, and keep the head of the river always up to a certain point, so that there is always a certain amount of water moving downwards, thus tending much to keep up the general health of the fish. The question, therefore, of making compensation reservoirs at the head of salmon rivers deserves more attention than it has hitherto received.

The above-mentioned idea of the influence of lakes on salmon disease I am bound to say does not hold good in all cases. The Cumberland Derwent, for instance, has lakes in its upper waters; the Doon runs out of a large lake, Loch Doon; the Dee (Kirk-cudbright) runs out of Loch Dee, and its tributary the Ken through Loch Ken; and on the Cree there is Loch Trool. All these rivers have suffered from disease.

3. FROST AND SNOW.

The next cause to which the salmon disease has been attributed is frost and snow.

Relative to this point the following evidence was given us:—

At Melrose we were informed by Mr. Donaldson, the superintendent of water police, that the Tweed and tributaries were frozen close over from the 13th to the 30th of December, 1878. There were a few fish up before then, and they were driven down to the pools by the frost while in the middle of spawning.

“A frost came on the 30th of December, and lasted a week, but all through January the river was frozen over again. The fish got on the ridds in February, two months behind time. The fish became unhealthy.”

“The River Tweed was ice-bound in January and February, 1879, and the water was very low.”

At Kelso the Duke of Roxburghe stated: “The fish were kept off their beds for many weeks last winter. The spawning was consequently very late.”

“The reason why they were unable to spawn was, that the river in the spawning districts was for a long time a solid mass of ice.”

The superintendent of the Tweed reported that during the greater part of January the rivers were frozen at many places, which prevented the fish getting on to spawning ground, and many had to spawn in deep holes.

“As the fish could not spawn, the retention of the ova and milt was likely to cause inflammation of the ovaries, and the fish being unhealthy, were more susceptible to disease.”

“The frost broke twice, and there were a number of salmon, and no eddies for them, and they could not make their nests.”

“The winter began in November, and lasted till the beginning of February.”

“More severe frosts have been known, but it was the continuance.”

“The river was covered with ice in the winter. The frost began end of November, and lasted till April.” (Ayr.)

“Thinks the disease due to the long spells of frost, and the confining the fish in little pools.” (Ayr.)

“Owing to the frost the river was very low in December 1878, and spring of 1879, and there was less disease afterwards.” (Derwent.)

“The frost reduced the quantity of water in the river.” (Derwent.)

As regards the effect of frost, the following experiment is most interesting:—Sergeant Nicholson reports that on the 16th of January 1878, five fish, one of which had a small spot on the end of its nose, were put into a pool in the Caldew. On the 19th two others were put in, making seven in all. A hard frost set in, and on the 4th of February four were found to be affected by the disease.

The effect of frost is more especially noticeable in the case of female salmon. Generally speaking, the proportion of male fish to females found dead is very large.

Mr. Donaldson states: “In former years chiefly kippers were affected. This year the female fish were most affected. There were 22 females to one male among the fish buried.”

By the returns from the Tweed given in by Mr. List, it will be seen that there were found dead between Berwick-on-Tweed and Carham 548 females against 208 males.

An angler well acquainted with the Tweed writes that, of the fish which he examined, “not one had spawned. They were all female fish, and full of ripe eggs. I attribute this to the frozen state for many weeks of the spawning beds, which prevented their getting on them.”

Among the salmonidæ at my own fish-breeding establishment at South Kensington, I find that the females will hold their ova—even though quite ripe—for a very long time; in fact it frequently occurs that I am obliged to spawn them artificially, even though I have no mate for them, knowing quite well that if I did not they would die.

It must be recollected that when the frost comes, not only salmon, but other fish, are driven into the deep holes in the river, thus tending to aggravate the effects of the next cause to be mentioned, viz, overcrowding.

When a frost comes it nips up the small tributaries among the hills the water in the river below in consequence becomes more or less stagnant.

This fact may account for the presence of the disease in rivers which, though flowing towards the sea in different directions, derive their water from high lands at and about the same district.

4. OVERSTOCKING AND OVERCROWDING.

The next point to be considered is overstocking.

On this subject the following evidence was given:—

“ The spawning grounds were crowded in the spring of 1879.”
(Nith.)

“ The river is overstocked, so is every river where there is a fungus. It is a symptom of overstocking. Rivers will only carry a certain amount of fish. When you get beyond this, the disease appears. By overstocking means there is neither room nor food for the fish.” (Annan.)

“ Overstocking is the cause. A river can only produce a certain amount of fish.” (Annan.)

“ The fish became diseased because they had no food and were overcrowded. The great run of fish to be overcrowded as there was no fishing.

“ The cause of the disease is overstocking. There are more than twice as many fish as usual. They were crowded on the spawning beds, and that was the cause of the disease. Thinks there is a close connexion between the great run of fish and the appearance of the disease.

“ The river will only bear a certain number of fish, as land will only bear a certain number of cattle.” (Kirkeudbright Dec.)

“ It was due to the large quantity of fish and deficiency of food; it is due in fact to overstocking.”

“ The Esk is overstocked as a salmon river.”

“ There are too many fish in the water and on the spawning beds.”

“ There are too many breeding fish in the river.”

“ Too many fish go up the Tweed. They get overstocked.

“ There are too many fish in the breeding season, but two few in the fishing season.”

“ Overcrowding and the long stay of the fish in the river have helped to cause disease.”

“ The last two years there were no fish in the river in the summer but two many in the spring; the river was overstocked.”

“ The Tweed being a late river, the fish consequently had more severe weather to contend with. The pools were overstocked, and had three times as many fish as usual.”

In considering this matter we must be careful to draw a distinction between overstocking and overcrowding.

All fish in a river breathe alike by means of gills, therefore whatever kind of fish may happen to be in a river, their numbers all tend to absorb the oxygen from the water, and thus render it less capable of sustaining animal life. This point may be well

illustrated by the following evidence:—A witness at Dumfries stated, “the river is filled with vermin, *i.e.* grayling. In 1877 the “river was fuller of fish than ever, and overstocking increased the “disease.”

“This river is overstocked and polluted with small fish.”

“He fished about 60 yards with a small net and landed three “washing-pails full of grayling.

“There are many pike, trout, and eels and roach in the Nith.

“They are all affected. Eels are not caught as an industry.”

In the Eden we were told there are large numbers of scullies or chub. “They are a great nuisance, and power should be given “to remove them. The water is overcrowded with scullies. “Formerly people took 100 stone of scullies in the week, 14 lbs. “to the stone. Many scullies are diseased and die. The disease “is on the head, on the back of the tail, and on the fins.”

In confirmation of the fact that overcrowding of fish will produce fungus growth, it is important to note that (as all breeders of salmon by artificial means know only too well), when the young of salmonidæ have attained a certain growth, if they are too crowded in the hatching troughs, they at first breathe with great difficulty, and ultimately die with the gills propped widely open by a growth of fungus. If the fish are allowed to remain in the water, in a few hours the fungus will spread completely over the whole of the body, growing equally from all parts of the body, so that finally it assumes the appearance of thisledown.

There is no cure for the disease except immediately removing all the dead and dying fish, and greatly reducing the numbers of the survivors by removing them to fresh homes.

5. OBSTRUCTION BY WEIRS.

The next point for consideration is the connexion of weirs with the existence and furtherance of the salmon disease.

Many of the fish get blocked at Armathwaite, on the Eden; they fight at this weir in hundreds, and knock themselves to pieces.

“There were a great many at Christmas 1877. There were hun- “dreds and thousands of them. The water was low all the winter.

“The first good flood was in April. The fish were in the pool all “that time. There was no water over the weir during the frost.”

“In 1878 there might be a thousand fish attempting to jump, “and only 50 in previous years.”

“The kelts are overcrowded in March and April. There are a “great many kelts which ought to go to the sea in the river. They “collect above and not below the weirs.”

“There is overcrowding above the weir at Melrose. There is no “pass. Coming up to spawn the fish collect to a certain extent “below the caulds, but generally get over.”

“Owing to drainage there is often at the mill caulds a collection “of fish in the middle of April; 12 or 14 fish in a body may “be seen going down.

“The male fish got up easily, and the females were left behind “at Walkerburn. Hundreds lay there because the water fell, and “they could not get up.”

The obvious remedy for this is to make all the weirs harmless as regards the fisheries of the river by making a pass through, over, or round, each weir, and by closing the hatch at the head of every mill leat on Sundays, and whenever the mill is not at work, so that the water shall flow down the fish pass, if there be one, or else over the dam.

6. DEAD FISH.

Under the head of overstocking many details are given in the evidence relative to the number of dead fish allowed to stay in the river and the injurious effects which follow.

The following evidence will prove that it is at present illegal to remove dead kelts from the rivers in Scotland.

A witness stated that "if a dead salmon was found in the river covered with fungus, he would throw it back into the river, because he might get sixty days for lifting an unclean salmon. The proprietor of a pool in the Esk netted his pool and took out the diseased fish. This was justifiable, though illegal."

Another witness stated "that when fishing on the Tweed the 14th of August 1877, he saw salmon lying in the water covered with fungus, looking like a sheep's back covered with wool. The fish were rotting in the water. Thought they were logs of wood. They must have been a source of infection. He could not examine them, because he was afraid of the law."

Mr. Dunne, chief constable of Cumberland and Westmorland, thought it would be advantageous if authority were given to remove fish even suspected of disease; legally there is no power to do so. He adds that the steps taken by the Eden Board were really in defiance of the law. He stated that between March and October 1878 he had buried 1,700 fish, and from October 1878 to 29th September 1879, 398 fish, making a total of 2,098.

In addition to the above number a great many diseased fish were taken out and buried between Warwick and Rockcliffe.

Captain Yorston stated that he had seen numbers of dead fish in shallow water, and it would be imprudent for a farmer to bury such fish, as he might have the water-bailiffs after him; but there should be power to enable the fish to be buried.

"At one time anglers were allowed to kill kelts, now they may not do so. Many people have been severely fined for taking kelts.

"The Tweed Commissioners transgressed the law by taking out dead fish, but thought this so necessary that they ran the risk."

Mr. List, chief constable of Berwickshire, informed us at Berwick that after he had got the authority of the Commissioners to remove the fish from the pools, no less than 756 fish were taken out in the lower district up to Carham in the months of May and June 1879.

Mr. George Rooper, who has very great experience as an angler on the Tweed, says: "It is not alone to the rotting carcasses of the numberless fish which, instead of furnishing wholesome food, are allowed to float down the river until

“ anchored in some quiet nook they fill the air with stench and pestilence, that the disease is due. The fish are themselves “ deteriorated in constitution and less able to resist the attacks.”

Through the kindness of Captain Jones, chief constable of Dumfriesshire, I am enabled to give the following returns showing the number of fish taken by constables from rivers in Dumfriesshire from December 1, 1879, to March 8, 1880:

Nith	- Found dead and buried -	-	113
	- Found diseased and killed	-	33
			<hr/> 146
Annan	- Found dead and buried -	-	86
	Diseased and killed	-	10
			<hr/> 96
Esk	- Found dead and buried -	-	486
	Diseased and killed	-	242
			<hr/> 728
			<hr/> <hr/> 970
	Total	- - -	<u>970</u>

7. INJURIES INFLICTED BY FISH FIGHTING, OR BY ANGLERS.

All those acquainted with the habits of salmon at spawning time are well aware that the males fight very severely, and often inflict formidable wounds on each other.

Scattered up and down among the evidence will be found opinions expressed that wounds received in fighting added very much to the prevalence of the disease, though they were not the principal cause of the disease.

It will be also noticed that on the Solway the disease is attributed to excoriations and wounds received by whammel *alias* hang-nets. In both these assertions there is in my opinion a great amount of truth: that is, the fungus more readily attaches itself to that portion of the fish's body from which the scale or the cuticle has been rubbed off and excoriations made. It is the experience of those connected with aquaria that fish which have been bruised and injured in the nets are much more liable to the fungus than those whose scales have been comparatively uninjured.

It has been frequently alleged that when in the spring of the year salmon kelts have been hooked and run, especially by the minnow, the fish generally die from exhaustion, or the effects of the hook wounds, after they have been returned to the water.

To obviate this difficulty, it has been recommended that kelts caught fairly by angling should not be required to be returned to the water after a certain date, such date to be fixed by the Local Board of Conservators, subject to the approval of the Secretary of State.

On this point the following suggestions have been made:--

- “ A kelt should not be considered a kelt after the 1st of May.
- “ Many suggest the 15th of April.”
- “ After certain date kelts should be kept. The end of April or beginning of May would do.”
- “ Kelts should be kept after 15th of April by anglers.”

- “ All fish should be legally caught say, about April.”
 “ Kelts should be taken by rod after 15th May.”
 “ After March all kippers and baggits coming up Tweed
 “ should be taken.”

8. BIRDS.

A curious suggestion will be observed in the evidence, namely, that the infection might have been carried from river to river by birds. It has been observed that the rivers mostly affected by the salmon disease are near each other at the points where they rise, and the idea seems to be that the sporules of the disease might have been carried from one watershed to the other by birds.

Thus, at Carlisle it was suggested that predaceous birds might have carried the disease. A bird feeding on diseased fish might get his claws entangled in the disease and carry it from river to river.

At Melrose : “ The disease may possibly but not probably have
 “ been carried from water to water.

“ The seeds might be carried by birds; ducks in the spring
 “ wading among the fungus might carry it away. It is no
 “ objection that the birds have carried it to certain rivers only.
 “ It is possible that the disease being stimulated in one place
 “ might be carried to others by birds.”

I am of opinion that even though we admit the occasional dissemination of the seeds of plants or even the germs of animal life by birds, yet the great diffusion of the salmon disease cannot be attributable to the agency of birds.

THE CURATIVE EFFECT OF SALT.

With reference to the alleged case of *Saprolegnia ferax* occurring in salt water, referred to at page xii of this Report, I beg to add the following remarks on the effect of salt as a curative agent in cases of salmon disease :—

That salt has a direct curative effect upon the fungus which causes the salmon disease I have no doubt whatever.

For many years past I have been in the habit of treating my fish, such as young salmon, full-grown trout, adult American salmo fontinalis, &c. affected with fungus, with salt water, and, if the disease has not gone too far, a cure has generally been effected.

Mr. Carrington, of the Aquarium, Westminster, tells me that he received a pike from the Duke of Edinburgh, which, after a while, became fungousy : the fish was well doused with a stream of salt water, and the fungus disappeared. Whenever the fungus has re-appeared on the pike, which it has three or four times, a bath of salt water caused it to disappear.

It is clear, therefore, why it is so desirable to get the salmon kelts down to the salt water of the ocean as quickly as possible, for not only will the disease itself be destroyed, but also the general health of the fish will immediately begin to recover, and thus throw off the remains of any fungus, and the prejudicial effect of the disease from which it has been suffering. With this view of the matter my

friends, Mr. Erasmus Wilson, Dr. Ogle, and other medical men to whom I have submitted the case entirely agree.

LIST OF DISEASED SALMON EXAMINED BY MR. BUCKLAND.

I now give a list from my books of the various diseased salmon, &c., of which I have made post-mortem examinations during 1879-80. I have notes of each case, and have made preparations and casts of the diseased appearances presented by the fish.

1879.—April	11.—Kelt.
„	13.—Ditto, Eden.
„	18.—Salmon, Lune.
May	7.—Salmon, Tweed.
„	28.—Trout, Cumberland.
Oct.	24.—Salmon, Tweed.
„	30.—Salmon, Lune.
Nov.	11.—1 salmon. 2 small sea trout.
1880.—Jan.	8.—2 trout and 1 salmon.
„	13.—1 35 lb. kelt, Lune.
„	19.—15 lb. salmon, Irthing. 1 grilse, 3 lb. 1 salmon, 19 lbs. Eden. 19 lb. salmon, Eden.
„	26.—28 lb. kelt. Small bull-trout.
„	28.—2 salmon, Dee.
Feb.	3.—4 salmon, Lune. 1 sea trout, ditto.
„	4.—1 salmon, Eden.
„	5.—2 salmon, Tweed.
„	1 bull-trout, ditto.
„	11.—4 salmon, Lune.
„	18.—2 salmon, Girvan.
„	27.—21½ lb. salmon, Tweed.
March	8.—12½ lb. fresh run salmon, Tweed.
„	16.—4 salmon, Lune. 1 sea trout.
„	27.—25½ lb. kelt.
„	29.—Tail of a kelt.
April	22.—16 lb. kelt, Tweed.

The following is a total of the fish thus submitted to the scalpel and the microscope :

Salmon -	-	-	-	38
Sea trout	-	-	-	6
Common trout	-	-	-	3
				—
Total	-	-	-	47
				—

FRANK BUCKLAND.

APPENDICES

TO THE

REPORT BY THE COMMISSIONERS APPOINTED TO INQUIRE INTO THE SALMON DISEASE, 1879-80.

APPENDIX No. I.

MINUTES OF EVIDENCE.

Town Hall, Dumfries, Tuesday, September 23rd, 1879.

PRESENT :

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

W. FRANCIS HUNTER ARUNDELL, Barjarg, Dumfries.—Is a proprietor of fishings in the Nith. Has observed disease among the salmon since last year. Saw something similar to the present disease 12 years ago. It was on two salmon 12 miles above Dumfries, *i.e.*, in non-tidal water. Observed it on kelts last year early in the spring, but had heard of it before then. The fish were covered with fungus. They were kelts. The fungus had eaten into the flesh, beginning generally at the head.

DUMFRIES.

Opened one or two fish, but not having sufficient knowledge failed to detect anything amiss internally.

The fish showed great discomfort as they were throwing themselves out of the water, or lying on the top, or near the side, dying. Picked up several from a boat.

The disease began, and was observed principally, among the kelts. Cannot say whether males or females were mostly attacked.

River trout and grayling were also affected. The grayling were clean fish.

Has not seen the disease since the spring of this year. It lasted last year till the end of June and beginning of July. As the summer advanced the disease vanished. It died away very early this year. Has not seen it since April.

The stock of fish has not been reduced. There are more fish this year than ever.

The Nith is quite pure where he observed the disease. It is polluted at Dumfries, but is altogether one of the cleanest rivers there is. The disease cannot be attributed to pollution. Polluted rivers exist where there is no disease.

Cannot say whether the disease first appeared above or below his property. Heard of it from all quarters, and in the Annan as well as the Nith.

[*Specimens produced of salmon affected with Saprolegnia Ferax, prepared and lent by Mr. Stirling, of Edinburgh University Museum.*]

Cannot say how soon the disease proves fatal. Has formed no opinion on the point, and the more he hears the less he understands. Is satisfied it is not caused by pollution. Cannot say, except from hearsay, if it has been

DUMFRIES. observed in the tideway, but has been told of fish with sea-lice being affected by the disease.

It cannot arise from overstocking. There were many more fish when he was a boy than now.

The exceptionally severe winter and spring cannot have caused the disease, though it appears to be from the severity of the winter that the disease is worse.

The disease occurred above Cluden Rocks. His water is above the pollutions. Has no records of the temperature of the water. The water was low. The river was about half or two thirds full. The low water enabled him to see the fish better. It was in the spring and summer that he saw them, and the fish were not injured by frost.

The use of guano manure cannot have had anything to do with the disease.

Lives close to the spawning grounds. The spawning grounds were crowded in the spring of 1879. Cannot say if there were more fish than usual. Perhaps the fish were a little later coming up. The male fish were perhaps most affected. Every year many kelts die, but there were more than usual this year. Saw an immense quantity.

The dead fish were sometimes taken out. No orders were given to remove dead fish as was done on the Esk.

The specimens produced, taken in the Nith, must have been dead a long time.

MACALPIN LENY, Dalswinton.—Is well acquainted with the Nith. Lives seven miles from tidal water. Has taken much interest in the disease since March 1878. Has observed and opened many fish. Observed no peculiar symptoms. The intestines were in perfect order. The flesh was perfectly firm and rich. The fish were covered with fungus from tail to head. Sir Robert Christison measured the fungus and found that it grew on the fish between Saturday and Monday.

In the first week in April he put the net in the Tweed and took 10 female fish—some with fungus: two were affected on the dorsal fin.

Heard of disease in the Drumlanrig water among the sea trout. Wrote to Mr. Fenton, Procurator Fiscal of Dumfries, to get a diseased fish in tidal water. Got sea trout with sea lice on it and with the disease. The fish was seen by many, and was sent to Mr. Stirling at the Anatomical Museum, Edinburgh. The skin was marked like the scar of a burn. This was the only diseased fish he knew of taken out of the sea. The gills were closed: attributes its death to suffocation.

[*Produces a specimen taken eight miles from tidal water.*]

This fish had not been four days out of the sea.

The river was very low in the spring. Does not attribute the disease to the fish being confined in shallow water. If there is a big flood in April the kelts will not always go down. Has pulled out 32 fish in April. Kelts will only go down when it suits them. They will not invariably go down in floods in April and March.

After the breaking up of the ice this spring the fish were all in the river.

Has formed no idea as to the causes of the disease. Is inclined to agree with Sir Robert Christison that the fungus arises from disease, but it is not the disease itself. Six minnows were confined in the water supplying Edinburgh, and they ate the fungus and throve on it. The fungus is an after-consequence of disease.

The first stage in old fish is a white spot on the frontal bone. In clean fish it comes out more at the tail.

Injuries do not predispose the fish to disease. Sores are not a cause of it. Female fish are not torn, and yet they are diseased. Took 10 females, all of which were affected: some were very bad with fungus, others with white spots.

His observation of the Nith extends to 1878.

It is a new disease.

The only thing to do is for Government to give power to bury every fish. It is at present illegal to do so under the Solway Act.

It is a disease which requires no half measures. The whole fish in the river should be buried in March whether diseased or not. Would stamp it out like the cattle plague.

The fish have spawned in March and so the kelts would all be cleared out.

The minnows he refers to ate living fungus in which pulsations could be observed under the microscope.

Has seen the white spots on the frontal bone in kelts. Has only seen two clean fish diseased: they had the fungus on the tail. The white spot grows in different stages and gets deeper the more the fungus is growing. Has never cut away the spot.

Agrees with Mr. Arundell that the intestines are healthy. Mr. Stirling's opinion is that they have worms; but clean healthy fish also have worms.

The disease never appeared before 1878. It first appeared more decidedly in the river above his residence. In the Eden he heard rumours of it in 1877. It has appeared in the Annan. The lessee says it has not appeared in the Dee.

The disease may have been carried from watershed to watershed by birds. A heron might eat a fish in the Nith and hop across to the Tweed carrying the disease as it carries pike spawn. It is possible that birds might do so.

The new sheep drains have more to do with it than anything else. The fish do not get pure water. The disease cannot have been caused by drainage because drains have been in use 30 years, but the drainage might predispose to disease by creating artificial conditions. An artificial state of water is created by draining and liming the land.

The experiment of killing all the fish should be tried in one river. The disease began in one river in 1877 and has extended.

It is more likely the fish get rid of it in the sea. Only one fish has been brought to him from the sea and it was recovering. The fish may have dropped down to the sea to get rid of the disease. The fish hang about the tidal water and acquire the sea-lice without being actually in the sea. The disease came certainly from above.

The pollution is all below the Cauld at Dumfries. Artificial manures are used but not to any excessive extent. The country is pastoral.

The Tweed, Clyde, and Annan rise close to each other. The Clyde is not affected. The Clyde rises near the Nith. Has seen the disease on an eel in the Nith.

The close season ends on the 11th February. The 31st October is the end of the rod-fishing season.

The stock of fish in the river has increased. In his father's lifetime only one fish a year was killed by the rod for 40 years. Has caught more than that himself this year. The Nith was an open river, being fished all the year round, and practically there were no salmon in it.

JAMES MARSHALL—Is tenant of the estuary fishings under Mr. Witham and Lord Harris and two others. Has held them for 35 years. The fisheries have improved materially. The fisheries are more flourishing than ever.

Has known the disease for upwards of 30 years.

The disease he observed formerly was similar to the specimen produced. In 1877 and 1878 it has been more virulent.

In previous years the salmon were affected before spawning. The unspawned fish are first affected now.

It breaks out about November among the fish going to spawn. There is generally a good stock of fish.

Has a theory to account for its increased virulence. The river is filled with vermin, *i.e.* grayling. In 1877 the river was fuller of fish than ever, and overstocking increased the disease.

Has seen it eight miles below Dumfries in the tideway among the fish going down. Has seen fish coming up from the sea. They had the disease before they went down, and had remained there two months perhaps. The disease was all but cured. The sea has a medicinal and curative effect. The worst fish, if it reaches the sea, will be cured.

The disease is not propagated in the sea, but essentially in fresh water. It has been always present there, but overcrowding has caused it to increase. Refers to other fish besides salmon.

Would ask the proprietors of the Nith to give encouragement to anglers to kill small fish. This river is overstocked and polluted with small fish. A gentleman asked him to get some fish for a pond, and he fished about 60 yards with a small net and landed three washing-pails full of grayling. The river cannot support such a stock.

DUMFRIES.

If there were no fishing operations in an uninhabited country, the fish would increase more rapidly, but there would not be any impurities. There are some impurities in the Nith. Has seen the Nith polluted below Dumfries. The river is not polluted above Dumfries. Has seen 13 dead fish killed by pollutions.

It would not be a good plan to kill all the fish.

Has seen fish which were eaten into the inside with the disease, and came back clean from the sea. The disease can be cured by fish going to the sea. Some one should be empowered to bury all the dead fish, and leave the living fish alone.

There are pike, trout, and eels in the Nith. Many pike and eels. They are all affected. Eels are not caught as an industry. Has seen roach affected.

The disease kills the fish slowly. Does not think they die in eight and a half days. It must take a long time to kill them. It acts like inflammation. Has opened fish and traced the disease through the flesh by a black mark. The whole organs are interfered with. The flesh is red except where blackened by disease. The disease is external, and internal in the intestines. All the fish coming from the sea have had inflammation. The blood is pure and healthy.

The disease is contracted in spawning. The fish are worried, and the stock of fish in the river in a dry season is, in his opinion, a cause of the malady.

ROBERT W. MILLAR, Tweed-warehouseman, Dumfries.—Has known the Nith for 20 years. Observed the disease in the spawning season of 1877. Has seen what he now thinks was disease before then, and has heard others say so. Has noticed many fish with their tails above water. Examined a good many in 1877, but never opened any. They had spots, generally above the dorsal fin, on the head, and near the side. The spots were as large as a half-crown on the back of the head. The cancers were flabby and soft. The sores were covered with fungus.

Many years ago observed sores under the throat of salmon. Thinks now it was the same disease. Saw the fish from Thornhill Bridge to the tidal water. They were healing when in the tidal water, having come down from the river. The affected spot was covered with a scab.

The disease cannot be contracted in the sea. Has never seen the fish come out of the sea affected.

It is not easy to recommend any remedy. Pure water is a great thing. Pollution must have something to do with it. The river is polluted much more than formerly with artificial manure. Vitriol is thrown in below the Cauld. There are some small pollutions above Thornhill. Sewage is thrown into the river below the Cauld. The sewage of Maxwelltown comes in above the Cauld, where the water is stagnant in the summer.

Has seen all kinds of fish diseased. Saw an eel with five spots. The fungus seemed to get longer. The symptoms were the same as in the salmon. Saw spots like blisters on a trout.

Little attention is paid to the trout, and the disease may have appeared in the trout first without being noticed.

Sheep drains may have much to do with it in summer time. The water rises very fast in floods, but falls equally rapidly. Formerly it would not fall in a week. The river runs very low in the summer, when the fish are going up.

A disease has been observed for 10 years. Used to see fish marked under the head in the spring. The recent disease has not been noticed before. The disease may have been but in existence, and the pollution may have increased it. It could not have existed without being noticed by tacksmen and others.

It has existed since the spawning season of 1877. In 1877-78 there was the greatest run of fish known for many years. The river was not overstocked with salmon, but perhaps with other fish. More fish were taken out before 1877 than since.

No grayling were formerly in the Nith. The grayling alluded to by Mr. Marshall were taken by him.

Agrees with Mr. Leny as to the white spots on the frontal bone. Has seen fish lying in the river with white spots; the fungus covers the spots. This was before they reached the fish water at the head of the tideway.

Has never examined fish internally. A dead fish was examined, but found nothing unusual. Is not, however, competent to judge. Has seen perfect fish with worms inside.

The grayling accidentally escaped in 1856 out of a pond belonging to Mr. Shaw, of Drumlanrig.

THOMAS BARKER STEWART, of Sanquhar.—Has heard that the disease has been observed at Sanquhar on salmon and sea trout.

R. W. MILLAR (*recalled*).—Fish have never been known to be diseased in lochs. Branksome loch contains trout, which were supplied to it from the Teviot, but there is no disease in it. 500 dead fish have been found in the Nith in a season. The fish may possibly contract the disease on their heads by poking about on the ridds. Has seen smolts, on which the fungus grew longer. Salt is a remedy. As soon as a fish gets to the sea the sore becomes well. Salt might be tipped into the river to be carried down among the fish.

MCA. LENY (*recalled*).—Can corroborate Mr. Millar's statement. A friend of his put in a pair of brown trout from the river Ae into his pond at Carmichael. The pond was netted 18 months after, and no trace of the disease was observed.

J. MAXWELL-WITHAM, Kirkconnel.—No disease has been seen among the salmon in Loch Kinder, which communicates with the Nith. It is a large loch, a mile long, and 20 feet deep.

Mechanics' Hall, Annan, Wednesday, September 24th, 1879.

PRESENT :

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG, Esquires.

JAMES BONNER, general dealer, Annan.—Has owned fisheries in the river Annan for five years. They are partly in tidal water. The fisheries are greatly on the increase, and have been increasing at the back end of the year ever since he has been here. They have also increased in the spring, but during the summer there is low water.

The close season begins on 27th August. The chief run of salmon is about two months after that date.

First saw disease in the river in the fishing season of 1877—in the spring—when he began netting. This was above Annan, in non-tidal water. The diseased fish were kelts. The fish had white spots about the head, fins, and tail.

The fungus grows on the white spots, like scurf, and rubs off like scurf.

Has never cut into the flesh. Threw the fish back into the river, as it would be illegal to kill an "unclean" fish, or even to bury it, under the Solway Act.

The first fish he saw were kelts, but has seen one or two clean fish diseased that had been in the river some time. Never saw fish come up the river with the disease. The disease comes from above—say, two miles above Annan, and it has been known above there. It was worse in 1878 than in 1877. In 1877, when he first saw it, it was cold weather, and it has been the same each year. The disease died away about May. It never died away from the fish that were coming down, but the fish were cured in the sea. Is quite sure of this. The fish kept their heads out of the water as if to get rid of the smarting. The salt killed the disease.

Some of the fish had only the white spots, which is the first stage of the disease.

Salmon-trout have also been affected. Has not noticed other fish. Only fishes for salmon.

Where he fishes, the water is pure. There is no pollution to account for the unhealthy fish.

The land is not more drained than formerly.

The river is overstocked, and so is every river where there is fungus. It is a symptom of overstocking. Rivers will only carry a certain amount of fish. When you get beyond this the disease comes.

Recollects no previous cases of disease, and never heard of it before 1877.

By overstocking means there is neither room nor food for the fish.

When fish are hard pressed they spawn below the fresh water. They did not come down to the salt water to get rid of the disease. They have spawned in tidal water, when they had no room above.

Cannot say if the tributaries are full. Knows the river as far as Moffat. The fish get above Moffat. There is a tributary near there. Cannot say if they go up it. Cannot say whether the disease is caused purely by overcrowding.

The cure is to allow fishing up to the 25th September. Under the old Annan Act the close time used to end on the 10th March. A little more time to kill the fish should be given now. The large rivers abroad can bear larger numbers of fish than the small Scotch streams.

All rivers with streams should be fished later. All the Solway rivers should open and close at the same time, both Scotch and English. The open season is now from 10th February to 27th August. Would prefer from 10th March to 26th September.

The Annan is a late river. The close time has been altered, and the river placed among the early rivers. It should be as late as the Nith, or as late as the close time under the old Annan Act.

The fish are finest from 26th August to 26th September. They spawn at different times. Those that go up early do not spawn till late. They are not ready to spawn till after 26th September, and would be perfectly fit for market.

Cannot say if some Scotch rivers exist which have a larger stock of fish than the Annan. Cannot say if they would have disease also if this is the case.

Cannot say if the North Esk is much more stocked, or if it also should have disease from overcrowding.

Never saw a fish with the gills covered with slime.

The diseased fish die gradually. The disease is a fresh-water disease.

There has never been a fungus on the kelts here. They might die through the frost. Never saw kelts with fungus till a year or two ago.

Smolts are never diseased. Cannot say if the diseased fish are mostly male or female. Thinks they are mostly males. The males fight a great deal, and a fish wounded would be more likely to die than one not wounded.

Cannot say if the nets cause wounds.

Never took the temperature of the water.

Never saw a seal here, but has seen many porpoises. There were plenty in former years, and whales too.

Herrings are sometimes caught here.

Cannot say if the disease spreads up or down the river.

Never saw the fungus except on the fish. The fungus is perfectly white at first. The whole head of the fish is covered like a "white night-cap."

The inside of the fish is not affected.

It is infectious, and diseased fish should all be lifted out of the water.

If a dead salmon was found in the river covered with fungus, he would throw it back into the river, because he might get 60 days for lifting an "unclean fish." They should all be lifted out. A law should be made to this effect, and the fish should be buried.

The fish have increased in size lately. They run to 20, 30, 40 lbs. The largest this year were a cock fish of 42 lbs., and a hen of 37 lbs. They average 12 to 20 lbs.

There are others in the river. Never gets the chance to kill them.

Never saw birds eating salmon; gulls eat them. Does not think birds carry the disease. Cannot say for certain.

Never counted how many kelts he has lost. Many a gross—not a thousand. There are no lakes connected with the Annan.

WALTER THORBURN, Inspector of Fisheries for the Annan District Fishery Board.—Has had charge of the Annan for seven years. Has paid some attention to the disease. First heard of it in 1877. Examined one or two fish and cut them open. Found nothing amiss internally. There were sores on the head and fins.

Noticed the fungus, but no sores without fungus.

The disease was worse in 1877 and 1878 than in 1879.

There are not so many fish in the river this year as before.

Never saw the disease in the sea. It is always in the fresh water.

Cannot say if the sores caused by fighting predispose to the disease.

The Annan is a late river. Cannot say about extending the close time. It is much about the same as the Nith and might go on to the same date (10th September).

Has no idea as to the cause of the disease. Cannot say if it is overstocking. Never heard of it before 1876-7. Has formed no idea as to the cause except that the fish cannot get away after spawning, owing to deficiency of water, and if they are kept too long in fresh water they might contract the disease. The kelts are generally away before May. This year they were kept up till June, and this might cause the disease.

Never saw any slimy coating on the gills.

The river was very low in 1878 and 1879 in the spring months—about half full.

There are no grayling in the Annan, but yellow trout; no roach or dace; some pike. Burn trout are affected. There are not too many burn trout.

There are a few herons.

The diseased fish should be taken out of the river altogether.

The fish are better after the 15th September than any time of the year. They are red, but not affected inside. Cannot say if they get red by lying on the sand.

Recollects a great destruction of salmon in the Solway 10 years ago. Was not on the Solway then.

Knows the Annan as far as Moffat. Saw the disease first in 1877 five or six miles above Annan. Cannot say where it first appeared, but it was on kelts coming down. Thinks it broke out here before it was in the Nith. The Nith and Annan headwaters are close together. The disease may have occurred through the fish being kept too long in the river after spawning. Saw the disease first in the spring, probably caused by the fish which went up in August. The sooner they get away the better.

Never saw fish coming from the sea with the disease; it is a river disease.

No extra drainage has taken place in the country lately. There are no pollutions and no factories. Cannot say if Annan and Moffat drain into the river.

CAPT. MORDEN YORSTON, Irvine House, Canobie.—Has come here to give evidence about the Esk. Has paid much attention to the disease, and is interested in a large portion of the Esk and Liddle above Longtown.

In the spring of 1878 had his attention drawn to diseased fish. Saw 13 dead fish above his house. Saw them also in the river in March. Noticed spots on the fish. Is speaking of the Esk. Saw spots from the size of a sixpence to the size of a man's hand. Some fish were slightly affected, others so languid from disease that they could scarcely move. Noticed a quantity of fungus near the nose and head. The back fins and tail had almost rotted away.

The fungus is the cause of the disease. One gentleman, a naturalist, told him he had made ponds which had no connection with the river, and had put parr and trout in it, and in a short time they most, if not all, of them had fungus. Thinks it is a spontaneous growth.

Is not sure whether the fungus in the case he refers to is the same as this salmon disease. Cannot say if the fungus observed in aquaria is the same as the fungus on diseased salmon.

Cannot say if the white spot is the first symptom. The spots are irregular. Most of the diseased fish had the disease about the nose and head. Cannot say if it arose from rubbing in the sand. This has been their habit in all ages. Old fishermen have noticed spotted fish in February and March for 40 years. It only attracted general attention last year. The disease has probably always existed, and lately special circumstances have caused it to become more virulent.

Never cut down into the sores to examine the fish.

Saw the disease first in March 1878 in the Esk. The highest spot he has seen it is Langholm, but has heard of it all the way up. A few clean fish have

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been taken with it. A collier at Canobie killed a fish so diseased in July that he left it on the bank.

The Duke of Buccleuch's keeper told him of two fish diseased within the last few days.

The kelts are principally affected.

Mr. Ormerod, a fishmonger in Carlisle, told him of diseased fish taken in the tideway. A fish attacked by the fungus might go down to the sea to get rid of it. A naturalist examined some fish eight or ten years ago from the Tweed.

In the teeth of the law he got a kelt or two, and tried a solution to see what would wash away the fungus. He found 25 per cent. of common salt the best remedy, and formed the theory that it was a provision of nature to force the fish into the sea to get rid of it, just as they go into the fresh water to get rid of the sea lice.

It is a river disease, in his opinion. Diseased fish have been seen 15 miles above Langholm, as far as fish are seen.

Has not killed one by the introduction of the disease, but believes it has been known in the Esk for as long as memory goes back. Knows of no special circumstances to favour its propagation. The winter of 1877-8 was a winter of heavy floods, with an average amount of frost. The winter of 1878-9 was exceptional, and the disease has been less since.

There has been a much smaller stock of fish in the river lately. Seven hundred fish were buried between the sea and Langholm, and the stock must have been diminished. This is the opinion of everybody he knows.

Has not killed one fifth of the fish he used to.

Sporadic cases of disease are observed all through the summer.

Fish of all kinds have been spotted with disease, including eels, and large numbers of sea trout (herlings). Cannot say if they had fungus.

The valley of the Esk is chiefly pastoral. The construction of sheep drains cannot have affected the river. There are no artificial manures used.

The disease has been known for many years. Like the grouse disease, it has been more virulent one year than another. Last year was not an exceptional year as regards the weather.

It is not possible for interbreeding to affect the fish. In a state of nature interbreeding would exist. The stock of fish in the Esk has largely increased for several years past in consequence of the watching by the Esk and Liddle Fishery Association. Cannot say if there are more fish in those rivers than there would be in a state of nature. Nature would take care to keep down overstocking. Knows rivers as largely stocked as the Esk, without the disease.

Does not know much of the Tweed. Older men have known the disease there, but have not paid much attention because it has not been so virulent. Kelts are always liable to die, but this disease is quite distinct from the kelts dying. Has not examined kelts closely to see if they have fungus.

Overstocking might be a cause of the spreading of the disease, because the spores would be spread among more fish. Cannot account for the fact that there is no disease in the rivers north of the Forth, and south of the Eden.

Suggests that if it is true that the disease spreads from the large number of fish, it would be an advantage to be able to reduce the fish. The proprietor of a pool in the Esk netted his pool and took out the diseased fish. Thinks this was justifiable, although illegal; would like a law enabling Boards and Associations to kill diseased fish in the close time.

Hundreds of fish were taken out by the gentleman alluded to. Above 700 fish were buried from the Esk alone.

Has not seen the fungus floating in the water, but thinks fish rubbing in sand would catch it.

Has heard that the flesh below the spots is brown or rotten. Thinks it is possible the fungus is a symptom and not a cause of disease, but has not examined the fish sufficiently carefully to speak positively.

Has seen a fresh fish in a fishmonger's shop with the fungous spot. The fish was put aside as unfit to sell. It had a rotten place on the nose.

When the diseased fish were first noticed the water was low. It cannot be seen in high water on account of the floods.

Has never taken the temperature. It is not taken by anyone on the Esk. In 1877-8 there was nothing apparent to an ordinary observer to account for the disease.

Sea trout are largely affected. More of them were noticed than of salmon. The fish affected lie in shallow places moving sluggishly. Cannot say if their brains are affected. Cannot say if the disease kills rapidly. It was noticed in February, March, and April, but cannot say when the fish began to suffer. Kelts are in the river till May.

The river Esk is very late. The clean fish come up in small numbers in March. There is a "Candlemas" run, like that on the Nith. Cannot say if there is a Candlemas run in the Annan. The river is small, and no fish come in numbers till June, and there is no run of any magnitude till August.

The fish are not in condition in September. They are very poor eating. The fish are barely fit for the table in the early part of September. This applies to the Nith also. Four out of five fish are gravid. The rivers on the Solway ought all to have the same close time. An alteration of the season in the Annan will cause opposition in the Eden and Esk. The size of the mouth of the Annan shows that the close time should not commence later.

The kelts are generally out of the river in May. They stay in the tidal water. The water of Esk is peaty. The Esk is the best river in this part of Scotland for sea trout.

Sea trout and herlings, *i.e.* young sea trout, are also affected by the disease.

ROBERT C. McQUEEN.—Resides with his father, tacksman of salmon fishings, in the Annan district. Has seen a good deal of the disease. First saw it in the spring of 1878. This was the first appearance of it. In the Forth there was a similar disease 30 or 40 years ago. Cut up and ate the fish. They were red fleshed and firm, and very good. The intestines were not affected. It was purely a scab, and the fungus is an after-effect. The fungus preys on the decaying flesh. It is purely a fresh-water disease. Fish are descending when affected. They heal directly they reach salt water. Overstocking is the cause. Later fishing would remedy it. A river can only produce a certain amount of fish.

In the end of September 1877, there was the largest run of salmon ever seen. The next spring the disease appeared. The stock is diminishing. Does not impute this to the disease.

It is foolish to bury the fish. In the Annan the people went into the pools and drove the fish to sea.

The disease is contagious. The fish affect one another, but all the fish would soon descend to sea and be healed. The sea cures the fish as it mends kelts. Kelts when ulcered are over-cured. The disease does not drive the fish down. They will descend according to the water. They principally descend in March. Has not had any opportunity of observing if smolts are diseased.

Sea trout are diseased. Does not get burn trout in his fishery.

The fish are undoubtedly in good condition in September. Can show a 20 lb. fish got to-day lying on the sand here. Would extend the fishing season to the 25th September. The full supply of fish cannot be caught unless this is done. The Nith should be the same as the Annan. Different close times facilitate poaching. The Cree is an early river; it is not important to open it later. The run of fish is on till July. The Luce is very late, like the Esk and Annan.

The Esk should be under a special Act; it is now under both the English and the Scotch law. The close time in Scotland should be fixed by the Scotch without reference to English rivers.

Stake nets are not legal and never were legal in England. The disease is dying out. The fish became diseased because they had no food and were overcrowded.

No cure is practicable. It will die out like a plague, in his opinion.

Never lived on the Tweed. Has heard they have the disease there. The yield of the Tweed has fallen off for 15 years, and the season goes on till 14th September. The great run here in 1877 came in on 20th September, and there was a similar run in the Tweed and Spey. The catches of salmon go in periods; two or three years are good, and two or three bad. The weather has a great effect on the take.

The great run of fish caused the fish to be overcrowded, as there was no fishing, and they became emaciated.

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The disease is contagious, and fish touching each other become infected. The fungus is an effect of the disease, and the fungus will not convey the disease to fish. Has eaten diseased fish and found them very good. The flesh near the white spot is not affected. Has seen no black mark under the scab. The head is generally cut off. The disease begins at the head, and near the eyes, and on the top of the tail and back fin. Has seen fish with the eyes almost out of them.

CAPTAIN YORSTON (*recalled*).—Any person found in possession of unclean fish is liable to all sorts of pains and penalties. Has seen numbers of dead fish in the shallow water, and it would be imprudent for a farmer to bury such fish, as he might have the water-bailiffs after him, but there should be a power to enable the fish to be buried.

R. C. McQUEEN (*recalled*).—The fish can be picked up and buried under the "scientific purposes" clause, and people are entitled to do it under the Sanitary Laws. In the Eden the living fish were killed and buried, and they were not entitled to do this.

The disease is confined to the fresh water. Has seen the clean fish with new skin forming under the scab, and the sea perfectly heals them.

DAVID AITCHISON, fisherman.—Fishes the Burgh of Annan stake nets. Has heard the evidence. The cause of the disease is overstocking. Came to this opinion from the quantity of fish that came up in 1877, about this time of the year. There are more than twice as many fish as usual. Cannot say where they came from. They were crowded on the spawning beds, and that was the cause of the disease. Saw an old kelt very bad, and he cut it up and found the liver very rotten. Believes the disease comes from the inside of the fish.

It would be a good thing in one sense to extend the open season, as the fish do not spawn this time of year—not for two or three months.

Has seen fish marked with wounds, but always thought it was due to fighting. Took no notice till 1877. Thinks there is a close connection between the great run of fish and the appearance of the disease. The fish are not fit for market when they are diseased. They are in good condition in September if not diseased. Every fish now (September) is worth 1*l.*, and they are not had at any other season of the year. They are very large and heavy in the autumn.

The dead fish are better out of the way, on sanitary grounds as well as for the sake of the fish.

Remembers the great death of fish ten years ago. But there was no sign of disease. The fish were dying up as far as Rockcliffe in the Eden. Saw them then wobbling about with a slight motion, but apparently quite healthy. Many people thought the heat of the sands and water must have caused it. Saw no marks on the fish. They died with their mouths wide open.

County Buildings, Kirkcudbright, Thursday, 25th September 1879.

PRESENT :

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

WILLIAM MARTIN, Kirkcudbright, tacksman of the Dee fishings.—Has known the Dee for 50 years, and has never seen anything like the fungus disease [*specimen produced*].

Eighteen or 20 years ago there was a disease with a brown spot, chiefly behind the head. This caused very great mortality. The stock of fish was much decreased. The fish were very uneasy. Went one day to Tongueland, and in a cavity he found a fish, weighing 6 lbs., with its head down and tail up, quite dead. It was a well-grown fish. It had a brown spot on its head, no spot on its fins or tail.

It was kippeded, and ate perfectly well. It was an external disease. The fish was being twisted round. It was above the old bridge. Has not seen kelts affected so. This was a clean fish.

Had formed no opinion then. Has not observed any diseased fish since. This year he had one instance of a fish with a brown spot near the tail. It may have been fungus. Observed no filaments. It corresponded with the spot 18 years ago. The fish have been healthy in the interval. There was no disease in 1877-8-9. The disease is often ascribed to scabs on kelts in the spring, which arise from fighting. This scab is often produced in this way, but it is not disease. The sores so caused are different from the specimens produced of *Saprolegnia ferax*. Never saw anything fleecy or flocky on the fish. Much so-called disease arises from biting and fighting, and injuries on rocks.

There has been an average stock of fish this season in the river, but never fewer killed, owing to floods.

The disease might exist in salt water. The fish referred to was a clean-run fish. It would not have got the disease in the fresh water. It was a fat, plump, bright fish.

Knows of no disease in the Cree, Bladenoch, Urr, &c. There has been scarcely any disease in the Dee since 18 years ago.

A purer stream cannot be found. Kirkcudbright discharges its sewage into the Dee, but it makes no difference. Knows of only one polluted tributary of the Dee.

Has no idea what is the cause of the disease. It is like cholera among men or rinderpest in cattle.

Does not think it can be carried by birds from one river to another.

The Dee has neither improved nor got worse the last few years. It is well stocked in the upper waters. The upper waters were full this season.

Does not think the disease is due to overcrowding. Fifty years ago there were five or six fish to one now, and no disease then. The Dee was better stocked then than the Nith now.

The fish he refers to was dead when he found it. It was 200 yards above high water mark. It was lying with its head on the bottom and the tail out of water. This was an odd fact, but was due to a sort of whirlpool. It would have lain flat in still water.

It had a brown spot on the frontal bone. Does not know anything about a white spot except on kelts wounded from fighting. The white spots can be seen on any kelts. The brown spot was a disease and was fatal; the white spot is temporary. Did not cut into the fish that had the brown spot this year. The flesh was soft. Never saw a fish that had been killed by dynamite, but the brown spot could not, he thinks, have been caused by an explosion.

The close time is from 11th February to 26th August. Many fish run up after 26th August. The preservation in the upper beds has been very good, and poaching is nearly abolished. Has watched fish on the spawning beds.

Has heard that there were fewer fish up last year. It is reported that there are more fish this season than for 20 years, on account of the floods. In March and April this year the river was occasionally high; it was not particularly low, except in July, when it was very low.

Loch Ken is about 14 miles by river from the sea. It is four miles long, and in some parts a half to three-quarters of a mile wide. Does not know the depth. The salmon spawn a long way above it, and also spawn below it.

Loch Ken acts as a reservoir. Without it the Dee would be worthless. The fish below always feel the influence of the water from the lake. The Ken has one fourth of the whole of the fish in the river, another fourth spawn about Heinsol in the Blackwater of the Dee. Does not think the disease is prevented by the abundance of water in the Ken. Above Loch Ken the river runs very rapidly. It is rocky and gravelly with pools. The water is peaty.

There are a good many sea trout, but not one-tenth of what there used to be. Has not seen them diseased. The sea trout have fallen off because the Dill-dawn Burn is grown over with grass, and it was the best spawning ground. The stream was diverted by the late Dr. Cowen.

The fry were eaten by jackdaws and gulls when left dry by the diversion of the water. This was 10 years ago.

KIRKCUDBRIGHT.

The Nith and Dee resemble one another very much. Cannot say which has most water. The Dee has an advantage in Loch Ken.

There are no grayling in the Dee, but plenty of minnows. There are pike and perch in Loch Ken, and they are injurious to the salmon. Has had a pike upwards of 60 lbs. in weight. Angling is prohibited by the proprietors. Has never seen pike diseased.

Deep draining has seriously affected the river. When he first came here a heavy flood would last for a month; now the river will run down in three or four days. The river is either empty or full.

Knows nothing about the temperature.

The fish have increased in size the last 10 or 12 years. The average size of grilse is 12 or 14 lbs. The biggest salmon killed for many years was caught last year, weighing 48 lbs.

Many kelts die naturally and float down the river dead. They are washed ashore and eaten by pigs. There is no regular system here of collecting dead fish. It would be well if it were so. Most dead fish come ashore. It would be well if authority were given to officers and watchers to collect and bury dead fish. Thinks that nobody would be interfered with who did this here.

Has heard of very many dead kelts being found, particularly on the Tarfe, but has not seen many.

The Dee is a rather late river. Approves of the present close time. Condemns rod fishing so late as the end of October. Would allow it up to 15th October. This is quite late enough. It is a pity to kill spawning fish on the ridds by the fly. Adheres to his opinion expressed in his letter published in the Report on Scotch Salmon Fisheries, 1870 (p. 72). Would perhaps allow fishing up to the end of September with rods.

There was no remarkable run of fish in the autumn of 1877 here, such as that stated to have occurred in the Nith and Annan.

JAMES GILLONE, tacksman of the fishings in the Dee two miles above Kirkeudbright.—Fishes with a shoulder net. Has had the fishery four years. The numbers of fish have a little improved. His father had the fishings before him. The Dee is well stocked this year. Knows the Nith. The stock in the Dee is better than that in the Nith; therefore the disease should have appeared here if overcrowding were the cause. There was no particular run in 1877. The spawning tributaries are well filled this year. It was a very bad season last year. The previous year was very good.

Has seen very little disease. Saw a kelt this year with white scurf on the fins. His men have seen no others. They would have seen them if they had been there. The fish was caught by a fly. The fish was affected with fungus on the fins and head. He was quite lively. It was a pretty good kelt of 9 lbs. weight. Has never seen diseased fish in the Annan.

Has formed no theory as to the cause of the disease.

Sees no difference between the Nith and Dee to account for it. About equal numbers of fish spawn above and below Loch Ken.

In 1877 there was a fair number of spawning fish. There were very few in 1878. Is speaking of the spring of the year. This spring there was a fair number. The beds were not overcrowded.

The Nith runs quicker than the Dee in the upper waters.

Would approve of the burial of dead kelts.

The fish are earlier in the Nith than the Dee, and earlier still in the Eden.

Thinks the fish feed on the shrimps in the sea.

Regularly gets fish marked with the whammel nets; the marks are sometimes a little fungous. The fish were not freshly marked, but were getting well. This was in fresh water.

There are eels in the Dee; they are not fished.

JAMES PENNY, manager for Mr. Anderson, tacksman of the Mid-Dee fishings, which extend from half a mile above Kirkeudbright to one mile below.—The water is tidal. Mr. Anderson has held the fishery since 1876. The fishing is rather falling off. The two first years were good. The season has been bad, owing to the whether. There is nothing wrong with the river.

Saw a supposed diseased salmon with a small white spot on the cheeks. Saw two clean grilse in July—one this year and one last year, taken in tidal water. Does not think the fish had been long in the river. They were

clean-run healthy fish. There was nothing but a clean white spot the size of a farthing. The fish were perfectly healthy, and weighed 8 lbs. each. Thinks the spot came from salt water. The white spot had no filaments of fungus. The water of his fishery is almost always salt. This year it has been fresher owing to floods. Never heard of any other cases here.

Knows nothing of salmon from other different rivers.

Heard Mr. Martin's evidence. Has often seen the brown spot on their heads, and also on their sides. Always thought it came from a wound, and that it was a wound healing up. The fish Mr. Martin saw may have been killed by a wound. Has seen many dead fish, but very few in the river. The brown spot is like a wound healing up and a little puffy. Thinks it was an injury. Thinks the fish would have been injured passing through the yairs.

Saw more fish in the autumn of 1877 than in the four years he has been here. Was fishing for smelts, and often got salmon in his nets. Did not see a quarter of the fish in 1876, 1878-9, that he saw in 1877.

Does not know the upper waters. Has fished for 35 years in other rivers. This river is not so well stocked with fish as the Tay, which he formerly fished. Believes the Tay produces 105,000 fish a year. The Dee is a far later river than other southern rivers. The fish are not ready till May.

Can give no idea of the number of fish caught in the Dee.

Thinks the disease is caused partly by dirty water from factories and towns, but cannot give any satisfactory idea. The word "Dee" means "Black."

JOSEPH DUNCAN, water bailiff to the Fleet District Board.—The Fleet is a small late river. Has known it for 20 years. Saw a diseased fish, like the specimen produced, on the 8th August last year. It was a clean fish of 2½ lbs., and was caught with the fly. It had a soft spongy fungus on the gills. There was no mark on the fins. The gills were covered with a slimy matter. The fish was in good condition. It might have died of suffocation.

Saw some fish similarly attacked on the Usk five or six years before. Saw kelts there repeatedly so affected. There was a white spot, with a cancerous appearance, and fungus. The fungus itself is subsequent to the disease.

Has no correct idea as to the cause. It cannot be overstocking in the Fleet. The Fleet occasionally falls very low. The retention of the fish by ice in the pools could not account for the disease.

It arises in both salt and fresh water, if it is in the fish. The diseased fish found in salt water may have come down, but is inclined to think the disease is in the fish, and not in the water. Knows nothing of other rivers here.

The Fleet fishery has not fallen off lately. It is chiefly a sea trout and herling river. The fish he has referred to as diseased was a sea trout.

The fish run up first in the latter end of June. The sea trout have not fallen off, but increased.

The Fleet is one of the latest rivers flowing into the Solway.

An attempt to introduce grayling failed; was not here then.

Has not observed the disease on any other fish. Did not observe it in the Fleet before 1878, but in the Usk.

Would approve of dead fish being buried.

Had charge of the Usk for eight years, and was well acquainted with the upper waters. The kelts are diseased with a fungus growth every year. Has not seen this in any other rivers. It is found in the Usk every year: not so much the first year he was there, but latterly the fungus and dead fish increased. Never saw smolts affected in the Usk. Knows the whole of the Usk. The disease among the kelts there is the same as the disease in the Solway. Cannot say why clear fish are affected here, and not in the Usk.

There is little pollution in the Fleet. The Usk is polluted at Newport. The Usk has the larger number of spawning salmon, but the Fleet has more fish than the Usk, because it has more herling and sea trout.

If there had been any serious disease in the Usk, he must have observed it. Was there five years. The fish, crowded in the pools, would not produce the disease; it is very contagious, but it is in the fish, and not in the water.

The first run of fish in the Fleet is far on in June. Has been there five years.

There were more spawning fish, salmon and grilse, in 1877, than in any other year in the Fleet. There was very low water in the spring of 1878, but

KIRKCUDBRIGHT.

there was no disease. There were many kelts. The Fleet rises in granite, gravel, and peat. The water is very clear, but not so clear as the Usk above Brecon, because of the peat.

Does not think sheep-washing has anything to do with the disease.

WILLIAM DAVIDSON, occupier of fisheries in the estuary of the Fleet.—They have been in a backward condition for two or three years, especially this year, owing to the weather. Has heard Mr. Duncan's evidence. Got two grilse last year with a kind of white spot on the fins—the tail, and the ventral fin. The spot was merely a mouldy-looking spot. They were clean grilse taken in salt water. Thinks they had come down from fresh water and run back to the sea. Has caught several this year, which had decidedly come from fresh water. They had spots about the "lugs." There were no long filaments like the specimen produced. It was like scurf. Often saw the same thing on the Tweed at Berwick 12 years ago. Was bailiff there under Mr. List. It was the same white spot on the kelts which they buried. There were no hair-like appendages. It was in fresh water. It was at Scotch New Water and in the tidal part of the river as well. Never saw clean fish so affected in the Tweed. Here the clean fish were affected.

Attributes the disease to overcrowding. The Tweed is overcrowded according to the season. The Tweed is going back. Many fish go up after the close of the fishing.

Has had experience of the North Esk, which is very crowded. Knows no river anything like so productive as the North Esk. It is the fullest stocked river for its size he knows.

Has seen the white scurf on the kippers chiefly. Believes it was on wounds caused by fighting. Never heard of its extending to clean fish. If the North Esk was overcrowded, it ought to be diseased. The condition of the fish depends on the food. The natural food of the fish in the North Esk is more abundant. The upper part of the North Esk is boggy.

Suggests that overcrowding should be prevented by more fishing, to clean out the river before the breeding fish come. The upper heritors would object to this.

The disease is produced by overcrowding, because the river will only bear a certain number of fish, as land will only bear a certain number of cattle. The males are more plentiful than the females. Most of the kelts he buried were males—say two to one.

Never saw a fungous fish on the spawning beds. Last year saw them on the coast near the Fleet.

Many fish run up the Tweed in October after the nets are off. If there are too many spawning fish, they may root up each other's beds. Has seen this done. A limited quantity of spawners is better than too many.

The netting should be prolonged. Has seen female fish in the North Esk up to Craigo without males, which run up later in the year.

Cannot explain why one overcrowded river has disease and another none unless there are pollutions. There are pollutions in the lower reaches of the North Esk, but none above Craigo Dyke. There is one bleach-field.

More fish spawn between the Gorge and Craigo Dyke than in all the river. There is a bleach mill here, pouring pollutions into the river.

In the Tweed where the fish spawn in large numbers the water is sometimes clean and sometimes dirty. There are many factories on the Tweed at Jedburgh. Was stationed below the polluted parts of the river. Where there is dirty water the pollutions will predispose to disease.

Does not know the Nith.

The fishings in the North Esk have fallen off this year owing to the weather, but up to this they continued increasing. Before he left, eight years ago, it was thought better to extend the fishing at the back end of the year.

A great deal depends on the feeding grounds, and the mouth of the river. Adheres to the theory that overcrowding is the cause.

The rivers should be fished in the upper waters when the fish might be taken which have escaped the lower nets. Enough fish are not killed in the upper waters. Nets should be used in the upper pools.

The disease breaks out among the kelts. There are plenty of people ready to kill kelts. In the North Esk the trout kelts are killed because it is thought

they feed on salmon spawn. It would be well to kill all kelts, because they eat young salmon. Trout will eat young salmon.

Would have the whole river opened up later to kill the fish till they begin to spawn. Only 10 are killed by rod for every 100 left in the upper pools.

County Buildings, Ayr, Friday, September 26th, 1879.

PRESENT :

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

THE MARQUIS OF AILSA, Cassilis House, Ayr.—Is the principal proprietor of fishings in the Doon. Has fishings both in the upper and lower waters. The nets have been off the river for some years. Has artificially bred fish for two years. In 1877 put in 60,000 young fish, and from 150,000 to 200,000 fish in the following season. Has reared the *Salmo fontinalis*.

Has noticed these fish (cocks) affected with disease when wounded by fighting. Has tried to cure it, and last year cured three or four. Only one died that he knows of. Mixed two table-spoonfuls of salt in $1\frac{1}{2}$ pints of water, and put the fish in till they became sickly, and then took them out. One dose was generally sufficient to cure them. Gave them a second bath in a fortnight, if necessary.

Was abroad when the disease first appeared. Never saw river fish affected. Directed the Provost of Ayr in June to send any affected fish to Mr. Buckland. Understands this was done. Has lived on the Doon this year since 5th August. Has fished occasionally. Has found that the disease has entirely disappeared. Has killed fish with ova. Even with fish discoloured there was no disease. Has formed no theory on the subject.

The *S. fontinalis* were in his private breeding ponds. The fungus generally began on the shoulder, and spread to the gills, appearing first on wounds. The fish looked much the same after immersion in the salt water. The fish referred to were like the specimens produced. The fish that died was nearly covered with fungus. Thinks it began with a scurfy mark. The ponds are a long way from the river, eight miles away. There is no disease in the river near them.

Thinks any fish pent will get fungous. Cannot say if wounded fish are always so affected. Heard of bad cases in the Doon.

The Doon is polluted. It rises above Loch Doon. The fish go above the Loch. The Loch keeps the supply of water equable in the river.

The fish did not communicate the disease to other fish in the pond. It was only wounded fish that were affected. Knows that fish in captivity are liable to fungus. His fish were similar to fish generally so affected.

Has had fungus among his young fish before. White globules appear on them and they die. The umbilical bag gets covered. It looks like a cottony growth in course of time. The eggs when dead are also affected. Has never observed any other disease. When they have absorbed the umbilicus the fish are not affected.

His fishery has been crowded, and he has never had fungus disease. The water is partly from a spring and partly from surface drainage. The flow of water is through a 2-inch pipe not running full.

There are not too many fish in the Doon. The water has been low and few fish have been caught. Once thought the pollutions had caused the disease, but does not now think so.

When the fish are found dead in a river, it is a bad plan to leave them. Would bury any that he saw. There is nothing against doing this in the Scotch law.

There are lots of fish up the Doon now, but they will not take the fly. They did not run till the nets were off.

The spring fishing was better last year than the later fishing.

AYR.

The Doon has peaty ground in the upper waters.

A great number of spawning fish were up last year.

Loch Doon is used, to a certain extent, as an artificial reservoir to keep up the supply of water.

Only caught 30 fish this year in a net 12 yards long. The average is 100. Has always thought the fish would be cured by getting down to the sea.

No law is required to enable watchers to bury the dead fish.

Has not tried crossing the breed of fish.

Cannot say how the fish referred to contracted the disease. It appears to be contagious. Never heard of the disease in the Doon before.

WILLIAM MACRORIE, solicitor, Ayr.—Has acted as factor to Lord Ailsa. Knows the Doon, but little of the Ayr. In 1867 complaints were made of pollution from the Carnochan coal pits. Lord Ailsa had an analysis made, which is published in the Report on Scotch Salmon Fisheries, 1870. It was mine water pumped up. This is not a statutory offence. In 1867 the Dalmellington Iron Company formed settling ponds with chalk to purify the water.

The effect of the pollution at that time was to kill the fish, but none of them showed fungus. The ponds were discharged by a pipe from the bottom when the river was in flood. In August 1878 the man in charge let in the water during a rise, but the rain ceased, and the river fell, and all fish below were cleared out. Salmon, grilse, sea trout, yellow trout, and eels, from Patna down to the sea—12 miles—were all killed. A few fish in the tributaries escaped. The fish were found lying about. Nothing similar has since occurred. No discharge from the pits takes place.

In October 1878 Lord Ailsa got two dead fish, and found that, from another pit, more than a mile further up, on a different side of the river, polluted water was entering the river. A portion of the discharge was taken, and analysed. The following is the report of the analyst:—

“ Messrs. Hunter, Blair, and Cowan,
 “ DEAR SIRS,
 “ Analytical Laboratory,
 “ Surgeons Hall, Edinburgh,
 “ 26th October 1878.
 “ WHEN I had the pleasure of seeing you on the 10th instant I mentioned that I had examined the dead salmon and sample of water forwarded by Lord Ailsa on the 2nd instant, and had not been able to detect any poisonous or deleterious material in the waters, or any appearance on the fish themselves of injury through chemical agencies. The water was of fair quality for river water, and the analysis gave as follows:—

“ In Imperial gallon :

“ Saline matter	-	-	8.68 grains.
“ Organic and volatile matter	-	-	0.86 ”
“ Iron salt	-	-	Practically none.
“ Acidity	-	-	None.

“ Whilst these results were negative, I mentioned the desirability of an inspection being made of the discharge from the ironstone pits and of the immediate neighbourhood, in order to determine how far ferruginous water of a poisonous and deleterious character was allowed to flow or was discharged from these pits into the River Doon. It was this kind of water which gave rise to all the mischief from No. 2 Carnochan pit, and which, on the shutting up of that pit in 1873, I mentioned in my report at the time, might in course of time come to be included in the discharges from the pits on the northern side of the Doon, where the Jellieston pit is situated. These ferruginous discharges are destructive whilst they last, but when they pass down the river there is little left in the succeeding water to indicate that the impurity has passed, and even the examination of the injured or dead fish may fail to indicate that the ferruginous poison has been affecting them. I was therefore anxious to make a thorough inspection of the district, in the hope that in the runs or drains from the pits I might have been able to collect sufficient evidence of poisonous discharges having been sent from the pits, and likewise that in the bed of the river where the discharges enter the stream I might have observed the ferruginous deposit on the stones, &c.

“ The River Doon being in flood, it was considered desirable by Mr. Macrorie that the inspection should be postponed, and in the meantime he

" brought to my rooms here four samples of water connected with the discharges from the Jellieston pit, and marked 1, 2, 3, and 4. These waters I have carefully analysed with the following results :—

	No. 1.	No. 2.	No. 3.	No. 4.
" In Imperial gallon.				
" Persulphate of iron -	34·38 grs.	6·82 grs.	7·48 grs.	7·52 grs.
" Persulphate of alumina	7·16 "	2·16 "	2·34 "	2·41 "
" Sulphate of lime -	56·84 "	11·23 "	13·68 "	13·26 "
" Sulphate of magnesia -	6·42 "	1·96 "	2·56 "	2·62 "
" Free sulphuric acid and " other saline com- " pounds -	30·24 "	6·69 "	8·36 "	8·75 "
" Total matter in Imp. gal.	135·04 "	28·86 "	34·42 "	34·56 "

" These results prove the waters are more or less impregnated with the noxious ferruginous matters, and especially No. 1 sample must be injurious to fish. It is manifest, therefore, that the discharges from the Jellieston pit are of the same nature as the discharges which previously flowed from No. 2 Carnochan pit. I further examined two fish which were received from Mr. Macrorie, and can find no trace of the fungi which are characteristic of the disease prevalent in several rivers last year. The disease in question is well known in rivers polluted by sewage, dreg, and refuse dye stuffs, &c. from manufacturing, and I have investigated the matter in several rivers during the last six years.

" (Signed) STEVENSON MACADAM."

The discharge has now been effectually cured. The works to carry this out have been in operation since April. The Doon is now practically unpolluted.

The fish have not been so numerous since the discharge in 1878. The Doon is considerably understocked.

Traces of disease were first seen in October 1878, but his own attention was not drawn to it till the spring of 1879. Only saw very few diseased fish.

Instructed the bailiff to bury all dead fish. Sent a specimen to Mr. Buckland in May 1879.

The last fish was caught on the first Saturday in July this year. According to his observation, the diseased fish were mainly clean run.

The Doon is an early river, the fish running in February, March, and April.

Was fishing in June, and saw a fish floating about alive in a pool. He secured it; it was a spring fish, 12 lbs., with disease on the head, gills, and tail. It was one mile below Carnochan pits. It was apparently quite healthy in other respects. He showed the fish to two other men, and they cut the fish in two, and the flesh was perfectly red. It was eaten, and they reported that it was as good a fish as they ever ate. Does not think the fish was internally affected.

It was a skin disease. It was floating alive near the top of the water. One of its eyes was affected. Never before heard of any such disease. It is a new disease. The suggestion has been made that it may arise from decomposition of vegetable matter, owing to the peculiar season of 1877.

At Ayr there was 50·12 inches of rainfall in 1877, the average being about 36 inches. In 1878 it was 30·92. The River Doon is rapid in the upper parts. A considerable portion of the upper part is a mossy bog. The burns here run from pasture land.

In the wet seasons hay, &c. is washed into the water. This has always happened, but especially in very wet seasons. 1877 was the second wettest season for the last 30 years. The rainfall in 1872 was 51·69 inches. In 1862 it was 50·12 inches. 1877 was followed by an exceptionally dry year.

Below Loch Doon the river is pure. The upper portion is grassy and boggy. There is almost no arable land till you come to Patna; after that both crops and pasture, mainly pasture.

Loch Doon has not saved the Doon from disease.

Does not think it possible that the disease can have been carried by birds from the head waters of one river to those of another.

AYR.

The disease has not, he thinks, been seen above Loch Doon. Last year many dead fish, supposed to have been frozen up, were found in the upper waters. The main breeding tributaries of the Doon are Carrick Lane and Whitespout Lane, and other lanes above Loch Doon. Fish were reported by shepherds to be found frozen up till April. Thinks the fish could not get away. These were not, he thinks, diseased fish.

Diseased fish were found near the sea. Does not know if any were seen in the tideway. Thinks the fish got weak and floated down to sea. Does not think the disease is in the sea. The disease is a river disease, and not a sea disease. In July the water-bailiff was instructed to experiment by throwing rock salt into a burn, but he could not obtain a diseased fish before the disease disappeared.

As to remedy, does not think anything can be done besides introducing rock salt into the burns. This would not be practicable in large rivers, but the introduction of rock salt might prevent the disease breaking out. The Doon has only one tributary.

The bailiff got 18 large diseased fish, and others were taken by other people.

Is in favour of burying dead fish. Would kill diseased fish if they were not near the sea. If near the sea they should be taken to the sea. They should be watched in the small burns. Would not approve of killing all kelts. Clean fish are as liable to disease as kelts.

The stay of the kelts in the river depends on the weather. This year the kelts were detained till May and June, owing to the long frost.

Does not think that after a certain date kelts should be considered as fit to be kept. In April 1858 three anglers landed 27 kelts in three pools. Does not think kelts should be destroyed unless there is clear evidence that they are injurious.

Does not think the existence of a lake, or bog land, can prevent the disease. The disease is a river and not a sea disease.

Sea-trout were first affected. Carrick Lane falls into Loch Doon.

The fungus disease was not seen in the Carrick Lane or in the Whitespout Lane. The fish that were seen were on the edge of Loch Riecaur after the disease had appeared. The disease was first seen in October or November 1878. The dead fish referred to were seen in April and May 1879.

Gratings have been placed at all mill leats, and fish cannot have been wounded by mill-wheels.

All the nets in the river are bag nets. If fish were caught and hung up in the leaders, they would be killed outright. If kelts fighting were the cause of the disease, it ought to have been prevalent before. But it is quite a new thing.

The pollutions are cured. The stones in the river which were discoloured are now getting clean. When the pollutions were bad there was no disease, and for several years the pollutions have not been at all bad.

ROBERT ARMOUR.—Has been river bailiff on the Doon for five years. First observed the disease on 18th October last year. Never saw it before. It was on some sea-trout. It was white fungus growing on the fins—all the fins—and on the head. The fish were dead. This was about six miles from the sea. Most of these fish were seen within two or three miles of the sea.

Cut them open; the intestines were in good condition. The flesh was not firm. They appeared to have spawned. This was in October 1878. Never saw anything before like it. The sores were quite distinct from sores caused by fighting. The fins were being eaten away, and only the bones left.

Sea-trout generally spawn about November. If the fish had spawned they must have been early. Is not sure if they had spawned; they had nothing in them. The fish he found were males. Has seen fresh-run fish affected. Saw nothing more till 12th April 1879, when he saw the same thing on some spring salmon.

Thinks the fungus grows on decayed flesh. Cannot say if it originates in fresh water. Has got diseased salmon in tidal water. The first one he got was taken there. It had come down the river.

Overstocking does not exist in the Doon.

Does not think pollution is the cause.

Buries all dead fish. Has always done this. Has always seen dead fish, not diseased, with the beak growing through the head, so that they cannot feed.

Has seen diseased fish at the mouth of the Glen.

Has never been so high up as Loch Doon.

The sluices at the outlet of Loch Doon have not been used for two years to let down an artificial flood. They were made to be used in this way.

Cannot suggest any remedy. Has seen no diseased fish since July. Thinks it may be periodical, and may disappear after a time. Found 18 dead diseased salmon altogether from 19th May 1879 up to 19th June 1879. Did not count the sea-trout. There was a spring fish caught in tidal waters at Doon Foot.

Could not say how many were picked up dead by other persons—perhaps as many more. Did not notice if they were males or females.

Has no idea of the cause.

Has not taken the temperature of the water.

There are a few fish in the river. They did not get diseased. Saw several eels, 15 inches long, in the tidal water in May and June touched with disease behind the head. Saw two smolts diseased in May and June 1879 in tidal water.

BENJAMIN TAYLOR, gamekeeper to Mr. Dunlop, Doonside.—Knows the river three miles above the tideway. Mr. Dunlop fishes with the rod. Saw a little disease at the end of September 1878. Paid little attention then, but saw several sea-trout, and at the end of October some dead salmon, from 14 to 25 lbs. weight. They were covered with blotches on the head and over the nose and in the mouth. The autumn was dry. There was no pollution. There was a very small run of fish. Very few fish were caught with the rod; none so taken were diseased. Diseased fish will not take the fly.

Has known the Doon all his life. Nothing of this kind has ever happened before. The disease is new. There was nothing exceptional in the water.

Saw three parrs a fortnight ago. They were diseased on the tail, head, and ventral fin.

The fish have died in his water. Has found diseased sea-trout going down the river and coming to the surface, 2 lbs. each, which were perfectly clean, and straight from the sea. The fish were clean from the sea, and were dropping down to sea again. At the same time got clean fish without disease. Has seen 20 or 30 salmon, sea-trout, and parrs since September 1878.

Last year the herlings came up in August.

Got some large fish as early as November, and cut them open; the flesh was quite good and red. Fed his hens on them. Did not examine the intestines.

The dry weather has had something to do with it. 1878 was exceptionally dry. The frost came after September, and after the disease.

The weather was very dry all the summer of 1878. There were a great many decayed leaves in the river; large quantities come down every year in October, and stop the fishing. Has not noticed more mud in the river than usual. The Doon is not very broad, but there was plenty of water for all the fish in it.

Has killed nearly 20 fish since July, and has seen no disease; they were particularly good. The catch was an average one, but there was too much water. The grilse are better than before. Has had them weighing 12 lbs. this year. The floods will wash the diseased fish to the sea.

GEORGE MCCREADE, fish merchant, Ayr.—Has known the Doon and the Ayr all his life. Has had no diseased fish sent for sale. Thinks the disease is due to the long spells of frost and to the confining of the fish in the little pools.

Has never seen a diseased salmon. Has fisheries on the Stinchar. Never got so many kelts—thin, bad kelts—as lately. There is no disease in the river. There are dams and pollutions.

Has only the sea fisheries. The salmon were the best he has seen this year. His fishery extends from Troon to Loch Ryan. The quantity was small, but the size and quality better than ever.

The river was covered with ice in the winter. The frost began in the end of November and lasted till April. There has been a wet season since. 1878 was a dry season.

AYR.

THOMAS ALEXANDER, tacksman of sea fishings at Girvan.—Has noticed no disease in the Girvan; it is quite clear of disease. Has no theory as to its cause elsewhere. Fish are often damaged by nets in the Girvan, but there is no disease. The fish not getting down to the sea is probably the cause, but they formerly had as much difficulty, and there ought to have been disease then, but there was none. Fish in a weak state are more likely to get disease than healthy fish. Ice is a great protection to fish. After hard frosts always finds better fish, and more of them. The fish should have been more healthy after two hard winters. Has found for three or four years, after a hard frost, that the fish have been more numerous as well as better in quality.

GEORGE MCCREADE (*recalled*).—The kelts he refers to had a white sort of hoar frost on them. Has found two or three dead kelts on the river side.

When a spate comes down the river, instead of being dark as formerly, the water is now a white nasty colour. This he attributes to surface drainage.

W. MACRORIE (*recalled*).—Has heard that the disease has broken out in the Stinchar about three weeks ago.

WILLIAM SHAW, miner, Waterside, Dalmellington.—Knows Loch Doon, and has been fishing for 16 or 17 years. Has seen sea-trout and salmon six weeks or two months ago affected with disease, in the river below the sluices. Saw a salmon with tail and head and ventral fins affected with white splashes and white sores; saw a male and a female; the female was marked on the head. The fish were pretty well made up. This was at the opening of the Loch. This is the only instance he has observed. It is something quite new. It was a mystery to him. Has heard of Mr. Hill, of Waterside, sending away a diseased fish taken three or four miles further down.

Has seen no diseased fish in the tributaries. Saw kelts in the end of February or in April quite clean and bright in Loch Doon. A kelt of 3½ lbs. which, if mended, would have been 9 or 10 lbs., was taken without disease. Found a dead kelt quite free from disease in a burn near Loch Riecaur. Thought the disease was from want of water.

The people at Dalmellington thought it was owing to the fish being too long in salt water, as he never saw a fish with it in fresh water, except when the fish were coming from the sea.

A "lane" is equivalent to a "burn."

County Buildings, Keswick, Saturday, September 27th, 1879.

PRESENT:

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

W. FLETCHER, M.P.—Has no personal knowledge of the disease, but lives near the river, and has heard of it from experienced fishermen. Two years ago the number of salmon diseased was enormous. From half to three-quarters of the stock of fish were diseased. Last year it was much less severe, being confined to perhaps one tenth of the fish. This year the fishermen tell him that not a single fish has been diseased.

The water of the Derwent is pure, except as regards pollutions from collieries (iron pyrites). Is himself concerned in collieries. Some years ago the water was examined by analysts, who reported that the pyrites were not soluble, and that they did no harm to the fish.

The first diseased fish caught in the river in the year referred to were caught close to the collieries.

There are lead explorations in the neighbourhood of the Cocker, but it is not affected thereby. The water has been tested and proved perfectly free from lead.

Has no theory as to the disease. The lessee of Salmon Hall fishery (Mr. Dalzell) attributes it to overstocking.

Has seen the diseased fish, which were quite similar to the specimens produced.

Cannot suggest any remedy. Has no doubt the dead fish should be removed; but advocate diseased fish being taken out as well, even if alive, and buried.

The Derwent is a very late river. The fish seldom run up till July and August; and if the river is low they do not come till September. They then lie below the coops at Workington. There has been more water this year than the year before, which was very dry. The river was exceptionally low two years ago. It was not so low last year as the year before. It has been exceptionally high this year. It was supposed that the reason of the river being so much lower than the Eden was the temperature, but his brother, the late Mr. J. Fletcher, M.P., and Mr. Hodgson, of Carlisle, kept records of the temperature, and they found that there was no difference between the two rivers.

JOHN BENSON, Cockermouth.—Has known the Derwent for 24 years, and has taken much trouble with the protection of it. The fish have increased, and more fish have been killed by the rod than formerly. The fish are chiefly killed between Cockermouth and Bassenthwaite. There are more fish than there used to be.

Has fished the Eden. The fish in the Derwent are not so much spread about as in the Eden.

Does not know if Mr. Dalzell has any opinion as to the produce of the river.

Has received a letter from Mr. Dalzell, stating that he believes the disease was caused by overstocking; that the river is late, and no large salmon come up till after the netting season, and suggesting that the open season should be prolonged.

The disease was first seen two years ago in the autumn of 1877, about September or October. Some fish were caught by rod, and others were seen with white marks. The fish were not ready for spawning. Only a few were noticed here and there. The disease showed more as the fish increased. The fish were in about the usual quantity. The fish were seen because the river was low. They lived some time, but died eventually. Others got to the sea and were washed up by the tide. The disease in the spring was more apparent, because there were more fish.

When they came up the next year there were not so many fish. Has only heard of one diseased fish up to this time. It was a temporary disease, and the cause was temporary. Never noticed anything of the kind before, but has heard of it before. This was the worst outbreak he ever heard of. Has heard old men say they had seen diseased fish.

It extended below Bassenthwaite. The Derwent has the two great lakes of Bassenthwaite and Derwentwater. The Cocker has three lakes. The river nevertheless falls very low. Last year it was almost dry.

The disease was not caused by cold, as the weather was not cold when it first appeared.

The trout were diseased. Does not know about parr.

Thought at first it was from weeds, &c. in the river decaying. There was not more than usual in the autumn of 1877. Thought the fish required more oxygen.

Does not agree with the overstocking theory. The river is sufficiently stocked if it is not high, but it would hold more spawning fish this year.

The kelts get well mended in the lake but not in the river, and come out as silvery as they get in the sea.

The overstocking theory is only a bid for altering the close season. Thinks the nets at the mouth of the river take all the fish. The adjustment between upper and lower proprietors is correct as it is.

Cannot say if the disease originated in the river or elsewhere. The specimens produced are like the fish he has seen. Has seen a scurfy mark, as if the males had been fighting. Could see nothing but the scales rubbed off. Cannot say if the fungus had been rubbed off. Never cut into a fish to examine it.

The river is fairly clean. It is polluted by coal works, and very badly near the mouth of the river by a tin plate works. The fish are killed by the vitriol. Does not attribute the disease to the pollution. Does not know of any steps taken to stop the pollution. The works are going now.

The disease, he thinks, appeared at the same time in the Eden and the Derwent. Has not heard of it in the Ehen, Irt, Mite, Calder, &c.

KESWICK.

Has no recommendation to make. Thinks the watchers should be authorised to bury dead fish, and also to take out living diseased fish. A fish diseased will recover if only just starting. It would be a pity to kill such fish. Cannot say if a line should be drawn in the river, above which fish should be killed.

Thinks salt will kill the disease. Cases have occurred of fish just out of the sea. The fish may possibly have been up the river, contracted the disease, and dropped back. Has heard of fish coming direct out of the sea with the disease.

Male kelts die in most years. They are usually unspawned. There is some froth in the gills, which, some people think, is the milt of the fish. But this cannot be. They die because they have not spawned.

The river is late because of stake nets, &c. preventing the fish coming up. The tide runs up the Eden a long way, but in the Derwent the fresh water falls direct into the sea.

Wishes to call attention to the Fitz stakes. Mr. Paterson and others held an inquiry. The stakes were proved to be an obstruction. They are just below Cockermouth. They have been altered since 1865.

Cannot say if the fungus is a disease, or an effect of disease. Has only seen old kelts with slimy matter. The river was very low when the disease appeared. The disease was owing, he thought, to want of oxygen and the presence of too many plants. With the amount of decayed matter and the fish in the water, there were too many fish. The vegetable matter is of all kinds. Bassenthwaite was as full of weeds as it could be. Saw more diseased fish in October and November and at Christmas. First saw them in September and October, and they increased. Saw some also in January, February, and March. The fish had left before May.

Does not know if the fish in the artificial ponds at Troutdale have been diseased. There was a year of hard frost, and he thought it would prevent the disease, but it did not. The frost reduced the quantity of water in the river.

WILLIAM IRVINE, watcher to the Keswick and Derwentwater Angling Association.—Has known the river for two years. First observed the disease in November 1876. Took out several salmon and buried them. They were diseased either at the head or the tail first, and it spread over the body. It was a white spot, and it seemed to grow on the fish, and was always followed by a fungoid growth. The fish got into the shallow water. It was a new disease; it was external. Did not cut any fish open. It was a growth on the skin of the fish. The place was quite soft, and he might push his finger in the place.

This was in the spring of 1877.

Does not know the tideway. The lowest point at which he saw such fish was in Bassenthwaite.

Saw the kelts in the spring of 1877 in the Solway with the same disease as the disease here. Has heard of diseased trout taking the fly.

Has seen eels and minnows so affected, but not char, or grayling.

Has not seen sore fish without fungus. Does not know the cause. Salmon in the river get diseased where there are no pollutions.

There is good spawning ground in the Greta. It would carry a good number of salmon. The disease has reduced the stock of fish. The disease is dying out. Only saw one case this year, and there was a middling run of fish. Saw a great many in 1877, but fewer in 1878. In the winter of 1878-9 the water was all frozen. Few places were unfrozen. In 1877, when the disease first appeared, there was good water, little frost, and many floods.

Has seen fish spawning here in February. Has seen kelts at the end of May. Clean fish come in June. The first fish he saw was on June 26th.

Has observed no peculiar smell or bubbles in the water from decaying vegetation. There are a good many weeds. Does not know Bassenthwaite.

The minnows were affected just like the salmon. They did not stay in deep water when affected by disease. Has buried dead fish.

There are a few otters in the river. Also a good few herons and sea gulls.

Never saw fungus floating in the river by itself. Never saw it before, and has watched a good many rivers. One fish was like a white rag through the disease.

Has seen both kelts and clean fish diseased.

Has watched the Derwent, the Annan, the Eden, the Tweed, the Teviot, and the Nith.

The stock of fish in the river is very short. Does not agree with the overcrowding theory. The Derwent is less stocked than the Annan, a great deal less than the Tweed, and less than the Nith. The river would hold a good many more fish, indeed, than it does. Never saw anything the least like the present disease. Has seen dead kelts with wounds, but never with fungus.

Watches the Greta and St. John's Beck. They are neither full of spawning fish. There is plenty of room for fish.

Has seen fish with disease spots the size of half-a-crown, and they got bigger. Cannot say if the fish have ever come up with it from the sea. Thinks the disease is a river disease.

There is plenty of food in the lakes.

The spawning beds are sometimes short of water. The river is sometimes low. It was very low in December 1878, and in the spring of 1879, owing to the frost, and there was less disease afterwards.

The water was middling low in 1878, but not so low as in 1879. The disease was worse when the water was higher. The fish can be seen better in low water.

CAPTAIN WLADIMIR B. J. JACKSON, Keswick.—Knows the Derwent. Fishes the Greta, Derwent, and St. John's Beck. Fishes from Derwentwater to Bassenthwaite. The fish vary in quantity according to the year. Heard of diseased fish after February 1878. Saw a trout of 1 lb. diseased. Examined it and thought it had been under a mill wheel, being wounded. The watcher took it home and found it was diseased. Saw also kelts, both of salmon and trout. Tried to catch some fish. One was a trout of $\frac{1}{2}$ lb.; from the head to halfway down the body it was like a white kid glove. It was quite blind. The matter was like a floating stuff, like fur, similar to the specimens produced. The fungus was white. The fish was in 9 inches of water, and was dying. The fish could see him, as one eye was not quite blinded. Never heard of anything like it before.

Has heard of a case where a man got some minnows which were kept in a separate vessel, and they had the disease. Is pretty sure it was the same disease. They were caught with a small poke net. They were not injured. Never heard of minnows being diseased before last year.

Thinks it is like the grouse disease, but cannot say what is its cause.

There have been more fish in previous years, when there was no disease, than there are now. There were not so many when it first appeared. The water must get stagnated in the pools at low water. The river has not been lower than usual.

It would be well to give permission to bury dead kelts, and to allow all kelts to be killed with the rod after March.

In 1877 got two well-mended kelts. The fish called the hardhead is caught here—the great lake trout. Believes there are char.

WILLIAM HODSON.—Lives by Ulleswater. Has been an angler for many years. For 25 years fished in the Ellen, and has fished there lately. Fishes the Eamont: not the Eden. Saw two or three cases of trout in Ulleswater with disease in the spring of 1879. Other cases may have occurred without being noticed. This was near the centre of the lake, where the water is perfectly clean.

The mining pollution comes in at the head of the lake. It might affect the water in the middle. Has been absent 28 years. 40 or 50 years ago there was no such thing.

There is disease in the Eamont among the trout—clean trout. The Eamont is blocked at Penrith by a weir, which is occasionally passed by salmon. It is possible, but not probable, that diseased salmon have reached the lake. No parr are found there. Thinks the disease must have been propagated in the lake.

Would destroy all dead and dying fish. It would be difficult to do this in Ulleswater.

The stock in the last 40 years has fallen off, but believes it is now improving. It is much less than it was 48 years ago. Overstocking is not the cause of the disease.

Has fished the Ellen for 35 years.

KESWICK.

It is a very polluted river.

Has heard the foregoing evidence. All the cases of disease he has seen were internal—with a large fungoid growth inside the mouth, growing from the mouth, and spreading out like a large hen's egg beyond the mouth, and affecting the gills also; only the bones were left. The flesh was eaten away.

Has studied botany, but has not studied parasitic fungi. Fungi attack decaying wood. Cannot say if *Saprolegnia ferax* is always present in the water.

Has never seen any fish diseased on the outside. The tongue of one was eaten away. Has no reason to doubt that it is *Saprolegnia ferax*.

Has seen fungus on gold fish. Cannot say if this is *Saprolegnia ferax*. Has seen fungus on dead animal matter. Fungi grow specially on decaying matter, both animal and vegetable.

The trout he saw had fungus in the mouth, and the gills were choked up.

The fish were 12 inches long, and weighed only about 6 oz. each.

Believes the majority of fish in Ulleswater are free from disease, but has heard of fish being rejected for food, and supposes these may have been diseased.

The pollution of the lake is from lead. It is not so bad as formerly.

The fungoid growth inside the mouth was the same in character as the specimens of external fungus produced.

Indictment Office, Crown Court, Carlisle,

Monday, September 29th, 1879.

PRESENT:

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

JOHN DUNNE, Chief Constable of Cumberland and Westmoreland.—Has had charge of the watching of the Eden during the last nine years. Employs "additional constables" to watch the river. The fisheries of the river have very much improved. Since the formation of the Board of Conservators the fisheries have increased in productiveness, and fish have considerably increased through the district. The takes vary according to the weather, floods, condition of water, &c. Generally the increase has been very material. 1877 was an exceptionally good year. Cannot give the greatest number of fish taken, as he has never had returns from proprietors. The take was counted by tens of thousands.

The river is largely stocked as far as Armathwaite. The catchment basin of the Eden is not all available for salmon. The Caldew is cut off. The main take of fish is between Carlisle and the estuary. The take of 1877 was much greater than that of 1876, which was estimated at 10,000.

The sewage of Carlisle falls into the river below the city, and complaints have been made about it. Does not think the river is perfectly pure above Carlisle. Many villages empty their sewage into it. The population between Carlisle and Penrith is not very dense. No steps are taken to purify the river.

The high spring tides come up to the point where the sewage falls in. This is a mile below Carlisle, at Willow Holme.

Since the large increase of fish the spawning grounds have been thought insufficient. They might be increased by opening up Armathwaite Bay, beyond which are some of the finest spawning grounds in the country. The fish would get into Ulleswater, &c. Armathwaite is 15 miles above Carlisle. The fish get above Armathwaite in high floods. The pass at Eamont Bridge is inoperative. The Eamont should be opened up at Penrith. There are no tributaries below the Irthing. The Petterill is not visited by salmon. It is purely a trout river. The Caldew is blocked, but possesses good spawning grounds. It is not polluted till you get to Skiddaw, when it is somewhat polluted. The

Irthing, a fine spawning river, comes in at Warwick Hall. It is not so much frequented by fish as the main river, except at certain seasons.

The latter part of 1877 was exceptionally dry: the early part was a favourable season for agriculture—not particularly wet. The spawning season was dry, and there were no traces of disease. In March 1878 various persons stated they had seen diseased fish, and the water bailiffs saw them jumping up and rushing across the river. The fish seemed in great pain, and tried to relieve themselves. The bailiffs had never seen anything similar before. It must have been observed if it had occurred during the previous nine or ten years of watching. The majority were clean fish. A few were kelts. (*Hands in a report from Inspector Nicholson on the number of dead salmon buried.*)

“ SIR, “ Constabulary Station, Eden Town,
27th September 1879.
“ I HAVE the honour to report to you that the numbers of diseased
“ fish buried by the water-bailiffs since the appearance of the fungoid disease
“ are:—

“ Between March 1878	October 1878	-	-	-	1,700
“ Since October 1878, and up to this date		-	-	-	398
				Total	<u>2,098</u>

“ The greater part were heavy salmon, and were taken out of the river by
“ means of drags which you directed the bailiffs should be supplied with for
“ the purpose.

“ In addition to the above number, a great many diseased fish were taken
“ from the river by the fishermen at the fisheries between Warwick and
“ Rockcliffe, which were also carefully buried. The disease has now almost
“ entirely disappeared; neither I nor any of my men have been able to find
“ more than four since the beginning of July last, which were fresh-water
“ trout, and were found in the Eden near Irthing Foot.

“ *Close Season, 1877-8.*

“ The spawning season of 1877-8 was an open season; no frost in the
“ winter or in the spring; and the largest number of breeding fish were seen
“ on the spawning beds during the last eight years (with the exception of
“ 1874). It was also discovered at the beginning of the fishing season that
“ large numbers of clean salmon had also ascended, and were in the river
“ between Carlisle and Armathwaite; and early in March it was discovered
“ that a destructive disease had broken out among the fish in the district
“ between Armathwaite and the tidal waters of the Solway; and before the
“ beginning of October the water-bailiffs had taken from the river and buried
“ a total of 1,700 fish, over 1,000 of them being clean fish. The disease was
“ most virulent during the month of March and up to the 20th of April, and
“ between these dates scarcely a salmon was to be seen in the river between
“ Carlisle and Armathwaite free from the disease, but a flood being at that time
“ in the river large numbers of salmon were carried down to the sea. A good
“ many were caught in the nets at the lower fisheries, and also in the tidal
“ waters of the Solway, badly diseased. From the beginning of May to the
“ end of September the disease gradually disappeared, but a few sea trout,
“ brandlings, grey trout, eels, flounders, and other coarse fresh-water fish were
“ seen affected with the disease, and dead ones occasionally got out of the
“ river, which were also carefully buried by the bailiffs. The largest numbers
“ of diseased and dead fish were seen and found in the river between Cargo
“ and Corby Castle, a distance of about 14 miles by the river. The tributaries
“ were free from the disease throughout the whole district.

“ *Close Season, 1878-9.*

“ Early in September 1878, in consequence of high floods, a large number
“ of fish ascended the river and passed over Armathwaite Bay, to the upper
“ district, and commenced spawning in the latter end of November in the
“ rivers Eden, Eamont, and Lowther, and the spawning beds being regularly
“ examined, only an odd fish was seen to be affected with the disease, and

CARLISLE.

“ which possibly might have been affected before passing the weir at Armathwaite. A hard frost set in about the beginning of the spawning season in the lower district, and the few fish on the spawning beds below Armathwaite in December were compelled, through ground ice, to leave the spawning streams and fall back into the pools, where odd ones were seen to be affected by the disease. The frost continued until the 14th of January 1879, when a thaw set in, which removed the ground ice from the streams, and numbers of salmon took the spawning beds between Carlisle and Warwick, and several of the fish were again seen affected with the disease. A hard frost again set in on the 20th of the same month, which continued until the 5th of February, the river being entirely frozen over during the time. Between the 6th and 10th of February the Eden and tributaries ran in high flood; the ice was cleared away, and large numbers of salmon ascended the river, and the spawning beds between Carlisle and Armathwaite, and also in the rivers Irthing and Gelt, were well stocked with large breeding salmon, and odd ones were seen to be affected with the disease when spawning. Odd ones were also seen on the spawning beds of the rivers Irthing and Gelt, and which had no doubt been affected before leaving the river Eden. The greatest number of diseased and dead fish were seen in the months of March and April, and as the summer advanced the disease gradually disappeared, only four having been found dead in the Eden below Warwick since July last, and none in the upper district. The total number of fish buried from October 1878 up to this date is 398, about 40 of which were clean salmon. Only five were found in the river Caldew and in the Eden above Armathwaite about 30 diseased fish.

“ JOHN NICHOLSON,
“ Inspector.”

The Board authorised him to take steps to check disease, and he instructed the bailiffs to remove all diseased fish. They did so in the spring and autumn of 1878, and also this year.

The numbers quoted do not include the fish buried by owners of private fisheries and others, whom he asked to take similar steps.

The disease was much less destructive in 1879 than in 1878. There were fewer fish in the river. The proportion of diseased fish might be the same. The kelts were chiefly affected in 1879, and the clean fish in 1878. Explains this by the fact that the spawning fish were injured this year by the floating ice, and the injured fish had a tendency to contract the disease. The disease is on the decrease, and, like most epidemics, has run its course, for the time at least.

The specimens produced are the same as the disease in the Eden.

Communicated with Mr. Stirling, curator of the Anatomical Museum of Edinburgh University, in order to endeavour to discover some means of curing the disease. Mr. Nicholson saw some fish in a pool in Holme Head Bay in the Caldew in February last, and caught seven fish in the pool, which were sent to Mr. Stirling. (*Hands in specimens of the fungus prepared by Mr. Stirling.*)

There is a theory that the disease is traceable to the absence of frost in 1877, and to the warm winter. The fish referred to were under the ice for many weeks, and frost, therefore, has no effect in curing the disease.

(*Hands in a letter from Mr. Nicholson and two from Mr. Stirling on the fish referred to.*)

“ Constabulary Station, Eden Town,

“ SIR, 5th February 1879.

“ I BEG most respectfully to report that on the 16th of January 1878 five fish were seen in a pool at Holme Head in the river Caldew, one of which had a small white spot on the end of its nose. On the 19th other two fish were put into the same pond, making a total of seven. On the 20th two diseased fish were seen in the pool, and, a hard frost setting in, they were not seen again until the 4th of February, and four of them were then affected by the disease. They were caught on the following day, and forwarded to Mr. A. B. Stirling, Edinburgh.

“ I have, &c.

“ J. Dunne, Esq.

J. NICHOLSON.”

“ Anatomical Museum, University, Edinburgh,
6th February 1879.

CARLISLE.

“ SIR,
“ I AM in receipt of your note and Inspector's report, also of four
“ salmon which came safe and in fine condition.
“ I have examined the disease carefully, and find it to be the same as that of
“ last spring and summer, namely, *Saprolegnia ferax*, and I am sorry to say
“ as vigorous and virulent in form as at that time.
“ The Inspector's report is very important, as showing the rapid growth of
“ the pest, on which we had no previous information.
“ I will send you next week specimens for the microscope of both last and
“ this year's fungus, so that you may compare them.
“ With thanks for the specimens,

“ I am, &c.

“ J. Dunne, Esq.

A. B. STIRLING.

“ I will report further when I have examined the viscera, &c.—A. B. S.”

“ College, Edinburgh,

5th June 1879.

“ DEAR SIR,
“ IN reply to your favour I am sorry to say that I cannot give you any
“ account, satisfactory or otherwise, of the cause of the so-called salmon
“ disease.
“ I can only say that the disease is purely parasitic. How, when, and
“ whence the fungus comes is the whole mystery. I have utterly failed to
“ propagate the fungus, by the method said by eminent botanists to be a sure
“ one, namely, from dead flies and spiders, immersed in rain water for a time
“ ‘when a crop of *Saprolegnia ferax* can be got at any season.’
“ After 10 or 12 days' immersion there is generally a fungus, or mould,
“ upon the flies, but it has no affinity to the *S. ferax*. Further, I have tried
“ to propagate the fungus upon minnows, by direct contact with the fungus
“ obtained from salmon and other fish, care being taken, if possible, to keep
“ the fungus alive till put into the water with the minnows, as follows: the
“ skin with the fungus adhering to it is cut from the salmon or trout, as the
“ case may be, never allowing it to dry; it is put in a wide-mouthed bottle
“ filled with river water and sent on to me, when both skin, fungus, and
“ water are emptied into the vessel among the fish. *The result is nil*, the
“ minnows eat the fungus, nibble the skin, and make a cover of it to hide
“ under, and remain healthy and fat. This experiment has been tried since
“ 15th May, and is still continued without result.
“ Until some one discovers the mystery of what the *Sap. ferax* originates
“ from, I despair of any knowledge regarding it further than what it does not
“ originate from.

“ I am, &c.

“ John Dunne, Esq.

A. B. STIRLING.”

The disease in its early stages begins with the small white spot described by Mr. Nicholson. The white spot appears distinct from the fungus. The fungus may be a separate growth on diseased flesh. The fish injured may contract the fungus more easily than sound fish, but he will not venture to give an opinion on this point. The fact, as far as he knows, is that no fungus is found in the first stages of disease. The first symptom is a small white spot on the nose. All the fish were cut up and examined, and all were found internally perfectly healthy. Nearly 2,000 of them were examined.

In the Eden many of the cock keltts die as a usual occurrence after spawning. Has not heard of fungus growing on these fish; they become putrid. His attention has not hitherto been called to any fungus on ordinary dead keltts.

The winter of 1877-8 was a mild winter, and the fish could not have been injured by the ice. The theory was that they had been injured by fighting. The clean fish had not fought. It is thought that the disease having got a footing had spread to these fish; but this theory is contradicted by Mr. Stirling's evidence as to the minnows.

Believes the disease is infectious.

The Eden was the first river affected with the disease in England. Did not hear of any disease till the autumn of 1878. Never heard of it in the Derwent in 1877.

CARLISLE.

The tributaries of the Eden were free from disease in 1878. The Irthing was unusually well stocked with fish then. Overcrowding existed more in the Eden than the Irthing. The Eden was more crowded than the Irthing.

There were only a few spawning beds in the Eden, which were filled with spawning fish. The disease was first seen at Armathwaite, which is above the Carlisle sewage, and in pure water.

Thinks, when various theories are combined, it might be divided between each of the different causes suggested, and that pollutions might have something to do with the disease. (*Hands in letter from Mr. Stirling, describing the fungus.*)

“ DEAR SIR,

“ College, Edinburgh,
26th September 1879.

“ I SEND YOU to-night a box, containing six microscopic preparations of the *Saprolegnia ferax*. They are mounted with all the impurities and detritus of the river, which happens to be entangled among the filaments and the fungus; various kinds of hairs, animal and vegetable, also filaments from minute water plants, &c., are seen mixed up with the fungus.

“ You will, however, easily discern the filaments from the foreign matter.

“ I am, &c.

“ A. B. STIRLING.”

If this is right, all the different causes suggested might have something to do with it. Overcrowding and polluted water might predispose to a disease.

Suggests that it would be advantageous if authority were given to remove fish even suspected of disease. Legally there is no power to do so. The steps taken by the Eden Board were really in defiance of the law. Would take out diseased fish as well as dead ones. Many fish with symptoms of disease, having run down to the estuary, have been sold, and were perfectly good. Would remove these fish, as being the source of contagion. The Board should have power to authorise this.

There should be more power to remove pollution.

In the Eden there are large numbers of “scullies” (chub); they cause disease to a considerable extent. They are a great nuisance, and power should be given to remove them.

There should be more power to deal with pollutions with coarse fish and with diseased fish. Boards should contrive to take action to deal with the disease. Precautions and prompt action might prevent the disease from spreading.

Has not heard that the disease has appeared in Ulleswater. Heard of a trout taken by Mr. Slater there. Assuming the existence of disease in Ulleswater, believes the diseased fish must have run up from the Eden. Salmon might have passed up Eamont Bridge Bay in consequence of the floods this year.

Cannot say how the disease has been carried from river to river. The fish become freed from disease when they get to the sea. It cannot, therefore, originate in the sea. Fish getting to the estuary here and returning to the river, have been found cured.

Cannot explain how the Nith, Annan, Esk, Doon, and Tweed have all been affected at the same time. Has not been able to ascertain the cause of the disease, notwithstanding scientific efforts.

Predaceous birds may, he thinks, have carried the disease. It was shewn that the rinderpest was carried by birds. A bird feeding on diseased fish might get his claws entangled in the disease and carry it from river to river.

The Eden Board have gone to great trouble and expense to trace its origin, but scientific evidence shows that it is not traceable.

Cannot ascertain that any new manures have been introduced into the district. Every effort has been made to ascertain this.

[*Hands in a letter from Mr. Braithwaite in reference to the disease in the Kent. It is as follows:—*

“ DEAR SIR,

Hawesmead, Kendal, June 11, 1879.

“ ABOUT 25 years ago my informants, two brothers, of poaching celebrity, tell me the trout were diseased in the Kent above Levens Park, but they got no sickly ones in the park. Sea fish can surmount an obstruction at the head of the park, but I doubt if many trout can. In the Bela no disease was found.

"It affected their tails and each side of the mouth. They threw them away, not considering them fit to eat.

"One of the brothers examined a trout suffering from a similar disease taken out of the Kent near Nether Bridge on Monday. I have heard of several having been caught. It may be simply an epidemic which, prior to the Salmon Act of 1861 and the appointment of *inspectors*, has at times prevailed, and not been noticed except by *fishermen*.

"Yours truly,

"GEO. FOSTER BRAITHWAITE."

[*Hands in a report from Mr. Nicholson on the pollution in the district.*]

It gives a detailed statement of the factories and other works which discharge their polluted water into the rivers within the Eden fishery district. The following is an abstract of the report:—

" Sewers from city of Carlisle	-	-	-	3
" Dyeing establishments on river Caldew	-	-	-	8
" Tan works	"	"	-	2
" Breweries	"	"	-	2
" Print works	"	"	-	2
" Spinning mills	"	"	-	5
" Dyeing establishments on river Peterill	-	-	-	1
" Tan works at Harraby	"	-	-	1
" Spinning mill	"	-	-	1
" Tan works at Scotby, on Pon Maughan Beck	-	-	-	1
" Tan works at Brampton on Brampton Beck	-	-	-	2
" Dye works on river Cairn, at Warwick Bridge	-	-	-	1
" Paper mill on river Cairn, at Allen Wood	-	-	-	1
" Brewery at Kirkoswald, on river Ravin	-	-	-	1
" Paper mill at Kirkoswald, on river Ravin	-	-	-	1
" Paper mill near Kirkoswald, on Glassonby beck	-	-	-	1
" Alabaster works at Long Meg, Eden Lacey	-	-	-	1
" Penrith sewage, gasworks, &c. on the Eamont."				

The Warwick Bridge pollution has a serious effect on the fish. Hears others have some effect, but the Eden as a whole is unusually free from pollution. Thinks, however, the pollutions may be combined with other causes of the disease and may be a contributory cause. Pollution in a mild winter with little water may predispose fish to disease; the parasitic growth may be fostered by pollution.

The case of the Forth would tend to show that pollutions cannot cause the disease. Pollutions, more or less, with other various circumstances, must, he thinks, have something to do with it.

It would be advisable to open Armathwaite Dam to let the overcrowded fish pass up. This would open 30 miles of spawning ground as far as Kirkby Stephen, exclusive of the tributaries. Fish would get up the Lowther if this were done.

Fish get wounded in jumping at Armathwaite, and fall back into the pool and accumulate there; the fish become disabled and cannot surmount the dam, and when injured they are more likely to sow the seeds of disease.

Does not think Armathwaite Bay is a receptacle for Penrith sewage; it is 20 miles below Penrith.

There are many trees on the river. The leaves might accumulate in the water when the river is low. Does not think they lie very long, but are carried away by the stream.

The water was comparatively warm when the disease was first observed; the winter was mild.

The opening up of Armathwaite would have a beneficial effect in clearing disease. In any case it would be of advantage to the public. Armathwaite is worth 30*l.* or 40*l.* a year. There is no physical difficulty in making a pass there. The Board do not wish to do anything that might seem like an attack on vested interests. They have done all they could to open up the dam.

The dam might have a good deal to do with the disease. The sporules of the fungus would go down the stream, and the disease would spread down-

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wards. The fish being out of condition and being wounded would be predisposed to disease.

The dam has been in existence for generations. The salmon must have jumped at the dam before, but not to the same extent as now, as there has been such a great increase in the number of fish. In 1878 there might be 1,000 fish attempting to jump and only 50 in previous years. The fish congregated there must have generated disease.

The specimens produced are a fair sample of diseased fish.

The spot on the nose originally is very small.

Fresh run fish might be affected.

The Board allows the "scullies" to be killed.

A prevalent feeling is that the kelts not being killed are a cause of the disease. If kelts congregated together they might cause it.

A number of men were employed in catching and burying fish.

T. H. HODGSON, clerk of the peace, and clerk to the Board of Conservators, Carlisle.—The Board has done all it could to cure the disease, and has gone to great expense. As a Board it has no theory to suggest.

JOHN NICHOLSON.—Has been inspector of the Eden Conservancy water-bailiffs for eight years and seven months. There are ten water bailiffs. Watches the river from Skimburness to Kirkby Stephen.

First observed the disease in the beginning of March 1878, two miles above Carlisle. The fish were clean fresh-run fish. They were darting from side to side of the river. The river was very low.

There were also many kelts between Armthwaite and Carlisle, both alive and dead. The kelts were fungous. Did not observe any fungus floating by itself.

The fish begin to run in September, directly the fishing is over, and go on to January. Fishing begins 2nd February.

Many of the fish get blocked at Armthwaite. They fight there in hundreds. The fish knock themselves to pieces. There were a great many at Christmas 1877. There were hundreds and thousands of them. Many get over the bay in September. The water was low in November, and all the winter. The first good flood was in April. The fish were in the pool all that time. There was no water over the weir during the frost.

The fish were three weeks in the pool near the station here. First noticed spots on January 16th. They were there till 5th February. The fish were small. There were six or twelve freshwater trout: they were not fungous. Many of them were a great deal worse than the specimens produced. First noticed one fish affected with a small spot on his nose. The others caught it from him.

Could not say if the fresh-run fish seen with the spot on the nose were just fresh run from the sea.

There are not many villages above the city. The sewage goes in below the Caldew. Has seen dead dogs and cats in the river. It is not unusual to see 20 or 30 dogs in the river, in January especially. The dogs have an awful appearance. They would tend to pollute the river.

Recommends that Conservancy Boards and Local Authorities should be empowered to prevent dogs and cats, and putrid fish, which are thrown into the river by fishmongers, being thrown into the river.

The fresh-run fish coming up the river might get a touch of disease from the sewage or from Armthwaite Bay. Saw a good many unspawned and spawned female fish dead in February 1879.

[*Produces two specimens of skellies with fungus.*]

Their tails were nearly rotted. Since he added salt to the water they daily recovered. Put in one quarter of an ounce salt to one quart of water. It tasted the same as sea water. He gradually increased the salt, and they remained there six years.

The kelts here get fungous. Has seen them with fungus quite a different colour. This is his experience every year. The present disease is a quite distinct disease from the ordinary fungus on kelts.

[*Gold fish produced with fungus attached.*]

His opinion is that the fungus on this fish is the same as the salmon disease.

Has seen crows and rooks eating dead fish. The hooded crows would eat them. Thinks it not impossible that the fungus was carried from head-water to head-water by birds.

Ascribes the disease to a low state of water; with a large number of fish in the river, and little water. Would expect to see the fish diseased.

There was a heavy run of fish in September 1877, after the nets were off. This helped to increase the crowd at Armathwaite. Many of them got over the bay. The disease was not so bad in that autumn. Did not see any diseased fish.

Many fish—hundreds—came up afterwards in November and December that did not get over Armathwaite. They came up to the 1st February.

Knows nothing of the disease in other rivers.

Agrees with Mr. Dunne's recommendations. The half-dead fish should be killed.

The intestines of the dead fish were healthy. Some of the fish had a cancerous sore beneath the outside spot. Has not seen fish with any disease in the mouth. It was always outside. The gills of some have been choked up.

[*Produces specimen found below Irthing Foot.*]

It is covered all over with a whitey-brown fungus, and the gills are affected. The fish is in a bad condition and lean.

The Board should be empowered to authorise anyone besides water-bailiffs to take out dead fish.

Thinks it is a fresh water disease. Fish getting down to the salt water would be cured. The fungus drops off and the sore heals. Has no idea of the cause of disease, and cannot suggest a cure.

Has always buried dead fish since he was here, but not so carefully as since the disease appeared.

1874 was a very good year; also 1877. They were the two best seasons. 10,000 is a very small estimate of the catch of salmon. Cannot say how many were taken in 1877. The take much increased in 1877 as compared with 1876.

CAPTAIN GEORGE JOHNSON.—Is a member of the Eden Board. Resides on the Irthing, a tributary of the Eden. First heard of the disease about two years ago. Has not seen many diseased fish. The Irthing has been free from the disease. The Irthing has always had the ordinary diseased kelt. Presumes this is different from the new disease. His idea is, that the disease, being caused by overcrowding, will not occur in the Irthing.

The fish he has seen in the Irthing have been diseased chiefly in the head, with white spots, sometimes on the tail, sometimes all over the body, and always with fungus. Has been accustomed to see this all his life on both dead and live kelt. Thinks the disease is the ordinary malady to which all unhealthy fish are liable, aggravated by overcrowding and other causes.

Knows of no other remedy but stamping out by burying and killing all diseased fish.

The opening up of Armathwaite would do good, as the fish which have failed to get up and accumulated below have had a tendency to disease. No disease has been seen above Armathwaite.

The disease has diminished the stock of fish in the river. The last year there has not been a good stock.

JAMES H. PARKER.—Has been a member of the Esk and Liddle Fishery Association for seven years. The disease has been very bad in the Esk. There were a large stock of fish for two or three years before 1877. In the winter of 1875-6 there were more dead kippers than before. The disease broke out in the autumn of 1877. The dead fish were nearly all small, mostly partially spawned. They had no particular disease. There were no spots or fungus. Would not say if there was not a little.

The disease in 1877 was entirely new. First saw dead fish in the autumn of 1877, and counted 48 in one poolside on the sand, averaging 20 lbs. each. They were covered with fungus. Captured many diseased kelt with the fly and with shrimps in the spring of 1877. The fish had a white spot and no fungus.

Thinks the white spot is a disease, and the fungus attaches itself to the diseased flesh. Believes it attaches itself to all diseased fish and all diseased flesh. The white spot should be kept in view as the origin. Has seen it from the size of a pin's head to three or four inches across.

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Saw one large spot a quarter of an inch deep, as large as a pin's head. It looked as if it had been drilled out. It was perfectly clean, without filament. Filaments only appeared when the fish got weak. It took weeks to grow. Has watched individual fish for more than two weeks in a pool dying.

Has seen fish in aquaria with fungus, which is an effect of disease and not a cause. Knows nothing of the origin of the disease. Thinks it was due to the large quantity of fish and deficiency of food, or through fish not spawning in 1876. The fish were allowed to lie putrid and caused the disease. It is due, in fact, to overstocking.

A country uninhabited and with rivers unfished might have larger stocks of fish than are found in Scotland. Nature supplies a remedy where there are no men. Has seen fish cured in fresh water without going to the sea.

Has seen fish rising with a dark mark in their head. Is sure the fish had not gone down to salt water. The fish were cured during hot dry weather in the summer.

Thinks the diseased fish should certainly be removed.

Lives at Scotch Dyke, where the Esk is singularly pure. It is a little polluted at Langholm, but this does not affect his water.

The dead fish were numerous in the autumn of 1877 in the Esk. Thinks the disease was carried by the sea from river to river. Has heard of disease in the Tweed. Cannot say how it got there from the Esk.

Thinks it unlikely the disease was carried by birds.

It has nearly disappeared this year, as it did last year. There are still some cases. His man told him a week ago of a case. A few odd cases may carry it through the summer.

Would destroy the kelts. Anglers should be able to take kelts after a certain time. They are in the river in June. A kelt should not be considered a kelt after the 1st May. Many people suggest 15th April. Thinks himself 1st May is a fair date. The salmon laws have over-preserved kelts. The kelts get covered with lice, and spring fish are affected by them; and so all the fish get lowered in condition.

Has no evidence to prove that the sea cures the disease. Takes the fact of clean-run fish being taken diseased in tidal waters as evidence that the sea does not cure the disease.

The Esk now is not overstocked.

In 1876 and 1877 it was overstocked. There was a great run in the autumn of 1877.

Has never heard of a similar outbreak before.

A gentleman living in Langholm has been in the north-west territory of North America, and has seen the same disease there. He says all the fish are destroyed by it. In those rivers where the Indians prevent the salmon getting up, there is no disease. It must be nature's remedy to get rid of overstocking.

Has never heard of a similar disease before. Has spoken to many anglers, who have never heard of anything like it. Thinks that lowering the condition and vitality of the fish tends to invite the disease.

ISAAC WAITE, fisherman, Brough-by-Sands.—Fishes with a haaf net. Began fishing 20 years ago. Fishes from 2nd February to 31st August.

Saw two fish caught at Brough Marsh in June or July 1878; one was an old kelt, the other was a clean fish that had been up the river. The clean fish had fungus on its nose, on the dorsal fin, and on the tail. Thinks the fresh-run fish had been up the river, because it had lost its silver colour, and because it had lost its sea lice.

It is salt water where he caught the fish, but fresh when the tide is down. There are shrimps there. Never saw a fish like it before. Has not heard of other fishermen seeing it before. The opinion is that there was an overstocking of the river in September 1877. Saw many fish go up, and thousands might go up that he did not see. The impression was that overstocking was the cause. Has never been to Armathwaite.

The fishermen have never seen the disease. Neither shrimps, nor flukes, nor sparlings have it. Never saw sea-trout in his district.

The river was low, and the fish were caught by nets. He buried them. Cannot say if they would have recovered. Buried several kelts that had died naturally. Has buried all he has found dead lately. Has not had more than six in two years. There were less fish this year than in the two previous

years. Seasons vary. The water was colder this season than before, owing to the floods.

It would be better if the dogs were not allowed to remain in the river.

SIMON BELL, fisherman.—Has fished in the Eden for 20 years. First saw disease in March 1878. Examined many diseased salmon and cut them open; there was a part quite yellow, unlike salmon flesh. They had white spots outside on the head and tail. Has always seen diseased fish with fungus attached from three or four miles below Warwick Bridge to just above it. Has seen many score and taken them out.

Never saw one in the Coops. Has had Mr. Parker's net fishery for two years. The fish had all been up the river, and were going down. It was the young fish coming down are poorly and in bad condition. At first saw more kelts than clean fish. Has seen diseased kelts all his life. Never saw white fungus. Some of them got better and others die. Has also fished the Esk. Never saw fungus on dead kelts before. Never heard of the same disease before March 1878. The disease has reduced the stock of salmon in the river.

Thinks the pollutions may have something to do with it. To open up Armathwaite would do good and give more room. Thinks, in fact is sure, that the disease is communicated from fish to fish.

The weather of 1878-9 was cold. The water, early in 1878, was low.

The old disease on kelts was like moss. The disease this year was like white cotton wool—like the specimens produced. In the old disease there was no mark on the head. The new disease causes cancerous marks on the head, and it eats away the fins.

Agrees that the dead fish lying in the river caused the disease. Saw 15 fish in 20 yards lying dead just below his fishery; they were brought up by an eddy. Got orders to bury them, and did so. His fishery is 10 miles below Armathwaite by water. The last fish he got was in the middle of August 1879. It was alive and very fungous over the head. It weighed 18 lbs. All the sea-trout he got in May—perhaps six—were diseased.

Thinks the water is overcrowded with rubbishing scullies. Formerly people took 100 stone of scullies in a week—14 lbs. to the stone. The water is so much preserved that the fish grow too fast. They do not get down to the sea. The rubbishing fish feed on sewage, old dogs, or anything. Some of them are 6 lbs. in weight. Many scullies are diseased and die. They have the disease on the head and the back of the tail and on the fins.

The diseased salmon have diseased intestines. They are quite yellow in the stomach. Could not say as to the liver.

The rods ought to be able to take kelts in the spring.

The Kearne joins the Eden at Warwick Hall. Has got three trout in it in three years, half to three-quarters of a mile below the Kearne, covered with fungus.

There is a paper-mill there. The stuff that comes down is the same colour as the stuff on the salmon's head. It is froth, like a mass of scum, 6 feet wide. The pollution is increasing. The esparto grass takes some soda to dissolve the vegetable matter. The trout had no white head till this year and last year. Has caught them up to the end of August.

ROBERT LEACH, Edénbank.—Is a freeholder, and owns a fishery on the river. Fishes with the shoulder net. Has seen diseased fish. It was most prevalent in 1878. It was quite right to bury the diseased fish. Approves of what the Eden Board did in the matter. Has lived on the Eden all his life. Never before heard of or saw such a thing. The disease is atmospheric. The river ought to be disinfected. Does not think overstocking is the cause. The fish were as numerous a few years after 1865 as they have been since. There was no disease then.

Corn Exchange, Melrose, Tuesday, September 30th, 1879.

PRESENT:

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

MELROSE.

COL. ALEXANDER LEARMONTH, M.P., Dean.—Is tenant of the Dryburgh fishings. Has known the Tweed 20 years. The fishing depends on the season; on the whole the river is much the same as when he first knew it. The stock of fish is not so large; that of spawning fish is slightly smaller. It is not an overstocked river. Fishes late in November, and sees spawning fish in the river. Is here a good deal in the spring.

Does not call bull-trout "salmon" or "fish." Taking bull-trout and salmon together, the Tweed is hardly as fully stocked as 20 years ago.

Dryburgh is a few miles below Melrose. The water is affected by the pollutions of the Gala and Ettrick. The Gala comes in a few miles above Melrose, and the Ettrick a mile above it on the other bank. The Ettrick is not so polluted as the Gala.

Has seen disease in the fish after the spawning season, in the spring and towards the end of the winter. Attributes it to fighting among the kippers. The fish had lacerated wounds with a growth upon the side and all over them. Has seen an excrescence from a badly healed wound, not a fungus. When a kelt has been a long time in the water it gets very weak, and loses flesh, and has a mossy or hairy growth upon it. Has seen such fish every year. The kelts die in great numbers here as elsewhere. Has seen no fungus on such fish when dead. Has seen "the" disease in specimens which have been sent to London, but has not seen such fish in the river. The worst he saw was affected on the head. From the eyes to the gills it was corroded almost to the bone with an angry appearance and fluffy exterior. It eats away the flesh like cancer in man. It is very analogous to cancer, and has a cancerous appearance.

The fungus, he thinks, is a growth supervening on the disease. It is an aftergrowth and not the disease itself.

Diseased fish were first seen, he believes, early in the spring of 1879. It was very cold, and the river was quite full of "snow brew" from the end of November to very late in the spring. There was a good deal of ice, but not so much as in former years. This would keep the fish off the spawning beds, but would not injure them. The river was frozen over 10 years ago, and he heard of no disease then. Has heard of fish having been seen simultaneously in all parts of the river from Coldstream to Melrose and above Gala-month.

Has heard from his fisherman that he saw a fish diseased, a grilse, 10 days ago. It was not dead. Thinks it was landed with the rod. A diseased fish will take a fly. The disease apparently disappears in the summer.

Thinks the disease did not originate in the sea; it is a river disease. It will, he thinks, die out like cholera or typhus, but under similar circumstances it will break out again. Cannot suggest a theory as to the circumstances which favoured its outbreak. One idea was the chemical action in the water of snow-water, together with pollutions, at a time when there were many kelts waiting to get down, that these circumstances produced the fungus, which is contagious, and that the fish, touching each other, would contract and spread the disease. Against this is the fact that the river is usually full of snow-water in the winter. But last winter was a most unusually long winter, with much snow-water. Does not think this theory is worth much. It is a visitation which cannot be fully explained; it is like the rabbit disease or cholera. Unfavourable circumstances may exist, and the infection may be brought in some way, and so the outbreak becomes more serious.

Heard of outbreaks in the Eden and Nith in 1877-8; that winter was different and opposite to the winter of 1878-9. It is the fact that the disease is confined to the Border Counties, and to the rivers flowing east and west. The rivers have no communication with each other, but the head waters are very close to each other. The Clyde and Nith are very close.

The disease affects the trout and minnows, so he hears from his man as regards minnows. Has heard of Mr. Stirling's experiment with minnows, which ate the fungus.

The disease may possibly but not probably have been carried by birds from water to water. Has heard that this disease appears in North America, where there is a vast amount of fish, in miraculous numbers, but where there are no men and no pollutions.

It looks as if the quantity of fish may conduce to the disease. One or two sickly fish among the crowds collecting at the caulds would cause the disease. It is impossible to ease the fish down. They are packed close to each other. Cannot say that the preservation of kelts is undesirable, but kelts after a certain date should be caught. Old kelts cannot live, and are a mischief. A few kelts are taken now and then by anglers. Spoon bait and phantom minnows are allowed to be used. The catching and returning of kelts cannot do them any good, as a wound might be inflicted which would be dangerous. Thinks the kelts should be allowed to be taken after a certain date.

In favourable years all the kelts get out to sea. With a long dry season they collect together after spawning and die. Cannot suggest the date after which kelts should be killed by anglers. Would not bind himself to a date, but perhaps the end of April or beginning of May would do.

Would suggest the destruction of all diseased fish at once by properly accredited persons, whether they are slightly affected or severely affected. To kill the healthy fish would be undesirable and impossible. Many, but not all, of the diseased fish could be caught by persons accustomed to watching the fish. They should be destroyed the moment they are observed to have the slightest trace of disease. Only persons authorised by the Tweed Commissioners should be enabled to do this, and the Commissioners should authorise anybody they wished. The Tweed Commissioners would have power, he thinks, to do this under their Act. It would be for the benefit of the river. They have a discretionary power for purposes of science. Does not think it likely anyone would take legal exception to this, but it is perhaps an obstacle. Has no other recommendation to make. Thinks the disease is not attributable to agriculture and pollution, because there are cases of disease where there is no pollution, &c.

The Tweed valley is drained by tile drains, not surface drainage. Sheep washing would occur at a time when the disease is not visible.

The fact that there are rivers without disease and with pollution is against the theory that pollution is the cause.

There is overcrowding above the weirs at Melrose. There is no pass. The fish will not go down without a rise of water. Coming up to spawn the fish collect to a certain extent below the caulds, but generally get over.

Cannot say if the fry are affected.

Cannot say if kelts eat fry.

It would be possible to treat fish slightly affected with salt, but there are not enough bailiffs to do this practically. The fish are cured by getting to the sea.

There are a few grayling in the Teviot. Only heard of one ever caught in the Tweed. There are no chub. Cannot say as to eels. There are only bull-trout, salmon, and yellow trout. Does not see so many bull-trout as formerly. They chiefly go up the Whitadder.

The temperature of the water would be very low during snow-broth.

There is no way to separate the fish. The rocks prevent the nets sweeping the pool below the weirs.

Thinks the unspent baggits caught in the spring must have been kept off the beds by the state of the water. It would not be possible to make an artificial spate from a reservoir. It has been tried on the Ayr.

The lowering of tone in the fish would predispose to disease.

Similar conditions to those suggested exist in northern rivers, where there is no disease; but the fish there are a hardier race. In the Dee the fish rise when it is full of snow water. Here they will not rise with snow in the water. The race of fish in the Tweed is different from the northern fish. A Ness fish may be known from any other fish by its shape. Fish from one river may be affected by disease, and fish from another river not.

The run of fish depends on the state of the river. They may run at any time according to the condition of the water.

MELROSE.

Private registers of the height of the river are kept. At Kelso there is a sort of Tweedometer.

ANDREW GOODFELLOW.—Has known the Tweed since he was a boy. Has seen the disease for 20 years. There was a white spot—a sort of scale—on the surface of the fish, but no fungus. It is worse this year. Did not examine the fish. The fish appeared uneasy. It killed them. Has seen them every season for 20 years. It has been worse this season than ever before. The fungus was worse. Has seen the white mark on the fungus. Fungus follows on the white mark. The white spot comes first, and then the fungus grows on it.

Has cut up salmon the last two years, and has observed nothing the matter with the intestines; the blood was a little pale. They were clean salmon, but there were more kelts than clean salmon. Never cut below the back of the fish.

The disease does not take long to kill the fish; it spreads very rapidly. Has seen it as far as Dryburgh and down to Twizell.

It is an external disease. Did not observe it so much in 1877. It is worse this year than ever. Bull-trout, eels, trout, and all fish in the Tweed are affected.

The severe winter and pollutions are the cause. The kelts were unable to get down. The disease is contagious. The diseased fish communicate the disease to each other.

The pollutions are not much different from what they have been the last few years, except that this season they are much worse owing to the hard winter. The pollution of the water has been the cause.

Overcrowding is not the cause. Breeding fish have been very scarce. The fish must get down to the salt water, but the fish in fresh water get better. Fresh water trout and sea-trout will get better. The disease does not always kill.

Would have all diseased fish taken out; it should be done under the direction of the Tweed Commissioners. It was done last season. Never saw it done before.

Kippers should be taken after the 15th April. There are far more male than female fish in the river. There is little difference between the males and females diseased.

By pollutions means water from the factories at Galashiels. His waters are 12 or 14 miles below there. The pollutions are worse on Monday after 5 p.m. On Sunday and Monday the water is quite clean and pure. On Monday, after 5 p.m., and all the week, it is like ink. It must be bad for the fish. It should be filtered. It is a bluish black.

Has watched fish on the spawning beds. They destroy one another's redds. There are more males than females on the redds. They fight a good deal. Has not observed whether the eggs are diseased.

Has landed well-mended bull-trout with the disease disappearing. Has never caught well-mended salmon getting better.

Kelts do eat a few smolts. The disease, 20 years ago, was always confined to kelts, both bull-trout and salmon. Never saw well-mended salmon with it. Never saw them get better till this season. Saw a good many all spotted over 30 years ago. A good many kelts were diseased, some not. This year, for the first time, the disease extended to clean fish. This was at the end of April. It was in the Mertoun water formerly among the kelts, but not among the clean fish, though there were clean fish there. Saw it himself before he heard of it. First saw the clean fish diseased in April. The extension of the disease to the clean fish is owing to the late winter and the pollutions and the number of salmon. Very few salmon kelts are in the river this season—not one kelt to 20 formerly. There were frequent snow-brew spates. There was fresh water in May and the disease disappeared. The disease disappeared because the river cleared away the disease, and not the fish. The cold weather will cause disease.

The disease never penetrates through the skin. The flesh is perfectly healthy below the spots. Believes, however, it eats in.

ROBERT RICHARDSON, fisherman to Major-General Hendry.—Uses the rod only at Melrose. Begins to fish 1st February, and goes on to 30th November. First observed disease at the end of February 1879. Has seen it

more or less all the year. Has been on the river for 30 years. The fungus existing 25 and 30 years ago was similar to that existing now. Has never seen anything but the same fungus as the specimens produced. It is now an aggravated form of the original disease. Has caught five kelts this spring, and two were a very little diseased on the point of the nose.

The male fish get a little injured on the nose by fighting.

The disease is quite out of the river now.

Saw one or two grayling dead with the disease after the first fresh at the end of May. They had floated down. They were quite stinking. Took them out and buried them.

Thinks the fungus may go down stream by itself, but never saw it. It is very infectious.

Thinks, as to remedies, that the river in the first place should be pure. His water is not at all pure now. There are 100 miles of water above him. Thinks the pollution is both chemical and vegetable—chiefly indigo. The water from the factories is generally cold. Has seen it go hot into the river. The cattle, &c. sometimes drink it when they cannot get any other. Cannot say if cattle have been killed by it. Has seen horses drink it.

The dead fish should be buried. It would be very difficult to catch all the half-dead fish. Half-dead fish should be buried, and all diseased fish should be buried, under the direction of the Tweed Commissioners.

Thinks the river being ice-bound so long was the cause of the disease. It was ice-bound in January and February. The water was very low. Never saw fewer kelts than this spring. In the spring of 1878 there were many kelts. The disease was worse this season than ever before. The river was not ice-bound in the spring of 1878. The river was high all the winter, and got small in the spring. The water was low all the winter of 1878-9.

Has seen 100 fish above the weir at Melrose. There are no sluice gates there.

The fish lay in the pool instead of getting to the sea. The fish will not always go down when they might. A net was used and the fish carried below the weir, and most of them died. They could not get away.

Never got any fresh-run fish with the disease. They are very late here.

All fish should be legally caught after a certain date, say about April.

The kelts always have maggots in the gills. Has seen few fresh-run fish with maggots. The maggots are not so large in the fresh fish. The intestinal worms have nothing to do with the disease. The disease is very infectious. Never saw a well-mended kelt with disease. There are many of them. Never saw anything in their stomachs.

The disease is a very serious thing for the fishery. It will be and has been the loss of several thousand pounds to the Tweed proprietors.

Many fish come up the river in October with a flood. They are bigger fish. The male fish coming up in October are many of them getting red in colour. The females come at the same time. They get on the redds in November. The principal spawning time is December and January. If there is no water to take them away they fall back into the pools. The kelts are overcrowded in March and April, at least there are a great many kelts in the river which ought to go down to the sea. They collect above, and not below, the weirs.

Has seen crows, but not ducks, eating fungousy kelts. The hooded crows are always about.

The disease is an aggravated form of the old disease. The fungus is the disease.

DAVID CUTBERT DONALDSON, Superintendent of Water Police, Melrose. —Has been so for four years. During the close season has 22 men under him in Roxburghshire, 11 in Selkirk, and 18 in Peeblesshire—48 on the average. That is for 70 to 80 miles of river. The men regularly report to him. Has been connected with the Tweed 13 years.

Every spring formerly there was disease among the kelts. There was something like a scurf, principally on the male fish, of a greyish colour. It was on the sides of the fish, and especially above wounds. It was on kelts, and chiefly on kippers. They were left in the water. That disease was different from the existing disease. The disease now, if it is the same, is much more aggravated than before. There always has been disease since he knew the Tweed. The disease formerly principally affected the sides of male kippers. It

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was a sort of scurf. This year all fish, male and female, spawned and unspawned, are affected with fungus. Formerly only a scurf was visible. First heard of it about the end of February 1879, from Kelso and Melrose, and also heard of it near Etrickmouth about the same time, a distance of about 25 miles. It afterwards appeared both above and below these points. The highest point at which he has heard of disease is Biggar Water, 12 miles above Peebles. There was only one fish seen there. There were not many above Walkerburn dam. In Peebleshire there were four fish badly diseased below the dam. It appeared about the same time there as elsewhere. Received instructions to bury all fish, both dead and dying.

[Hands in return of fish buried by him in May and June 1879.]

It is as follows :—

—	Salmon.	Grilse.	Sea Trout.	Smolts.	Fresh Water Trout.	Grayling.	Eels.	Total.
MAY, 1879.								
Roxburghshire -	438	3	55	3	12	25	4	540
Selkirkshire -	7	—	—	14	13	3	—	37
Peeblesshire -	21	—	4	9	6	2	—	42
Total -	466	3	59	27	31	30	4	619
JUNE, 1879.								
Roxburghshire -	21	—	—	—	3	1	—	25
Selkirkshire -	2	—	—	—	3	—	—	5
Peeblesshire -	—	—	—	—	—	—	—	—
Total -	23	—	—	—	6	1	—	30
Grand Total -	489	3	59	26	37	31	4	649

The return does not distinguish between clean and unclean fish. A full return is printed in the Report of the Tweed Commissioners. A large proportion of fish were diseased. Many more died. These are reported because all could not be secured that were seen floating down beyond reach.

Last winter the river and tributaries were frozen close over from 13th to 30th December. There were a few fish up before then, and they were driven down to the pools by the frost, while in the middle of spawning. A fresh came on 30th December and lasted a week, but all through January the river was frozen over again. The fish got on the redds in February, two months behind time. The fish became unhealthy. Much ova must have been deposited in the beds. This retarding of the spawning season would help disease.

Late in autumn there were very few nice floods. The fish did not get away freely. There was a deficiency of water.

Scraped off some fungus. In the early stages of the disease all fish had fungus, under which there was inflammation of the scales. The fungus was the cause of the disease. The flesh underneath was not affected, nor were the internal organs. The kelts were most diseased, because they were most numerous, and they were more liable to disease. The hen-fish were most liable. There were 22 females to one male in the fish buried. In former years chiefly kippers were affected. In former years many were partly spent fish. The clean fish were affected this year by infection. Does not know if in previous years it was infectious.

Would take out all dead and dying fish. Diseased fish in the upper part of the river cannot easily reach the sea, but in the lower parts they might easily reach the sea, where they would recover. It is a river disease.

It would not be difficult to bury all diseased fish.

In previous years there were not too many kelts.

In February and March the fish principally spawned. In April there was a slight flood. In May there were no floods, and the fish could not get down, and died. With the floods after May the disease disappeared among both fresh-water and migratory fish. Has seen two diseased fish since June.

Meantime the disease is out of the river. Is afraid it will return. Saw fish recently partly diseased. Such fish may continue the disease. Severe weather will cause it to reappear. Other rivers are much earlier than the Tweed, which is a late river, and a great many fish would be spawned in other rivers before the severe weather set in. This would account for the absence of disease in other rivers.

Many fish died because they could not spawn. They were two months behind time.

Opened some females, one on 8th April, at Sprouston. Took hold of a female and gently squeezed it, and the eggs were healthy and ripe. The delay in spawning would render fish liable to disease. Formerly diseased females were very rare.

The first week of December was severe weather. The Tweed being a late river, the fish consequently had more severe weather to contend with. The pools were overstocked, and had three times as many fish as usual. Removed fish from the shallow water in December into deep pools to prevent their being frozen.

The Tweed and Gala when polluted are all colours. The sewage of all the towns, except Selkirk and Berwick, goes into the river. The pollution is the same as in 1869. The town pollution must have increased, owing to the increase of population.

Agrees with the recommendation as to Tweed pollutions contained in the Report of the Tweed Commissioners in 1875.

WILLIAM MCLEAN, Inspector Mertoun. — First saw the disease in February 1879 on sea trout. There were white spots on the dead without fungus. Did not take out the fish. Saw numbers afterwards and cut them open. Saw nothing amiss internally. All the organs were healthy. The disease was external. It did not appear sore at first. There were white spots the size of a sixpence, one on the head and one or two on the tail; none on the fins. Saw diseased salmon white all over the head, fins, and tail. Saw a white mark without fungus before the fungus came on them. The disease comes before the fungus.

The first sea trout he saw was at Old Melrose. Has seen them below Kelso, and up to Gala-mouth—25 miles. Has seen a hundred sea trout and salmon. There is no disease now. Has no idea of the cause. Overstocking is not the cause.

Most of the diseased salmon were females, and nearly all kelts. Very few clean salmon were affected. Has seen a few well-mended kelts diseased.

Angling goes on to 30th November.

Approves of taking out dead and dying fish and burying them.

The kelts might be killed by anglers after, say, 15th May. There are too many kelts when the water is low. The river was low and ice-bound last season, and this was the cause of the disease. Believes the disease is contagious.

The kelts could not get down over the weirs. In wet springs they are generally out by March and April. This year they were here till May.

Thinks it is a river disease. The salt water cures them. There is no means of getting the fish down below the cauld without a slap. This might be done. There is no high cauld between Melrose and Kelso. Does not think the proprietors would object to slaps being opened to let the fish down. The Duke of Roxburghe owns Kelso cauld.

WILLIAM MILLAR, fisherman, Old Melrose.—Has known the Tweed for 30 years. Has observed a disease for 40 years in the Teviot and Tweed, chiefly among red kippers. It was a brown scab. There is not the same scab on the fish now. Has seen disease on clean fish this year. It is not the least like the old disease. The new disease is a white fungus. First saw it in March 1879, on both kelts and clean fish. Saw it on kelts first. Got no clean fish diseased at first. It afterwards extended to the trout, minnows, and all kinds. The flesh did not eat much the worse.

Has no idea of the cause.

Saw a fish last week diseased.

There was nothing last winter to cause a new disease. Agrees with burying dead and diseased fish.

The stock of fish in the river is 10 per cent. less than it was 40 years ago.

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It has gradually fallen off. Overstocking cannot be the cause of the disease.

The river is not so polluted as formerly. The pollutions have nothing to do with it.

Think it is a parasite, and the fungus is secondary. It is a parasite, something like ringworm. It is a new thing to him.

Fish were formerly speared more than now. The people used to eat kelts. Is 67 years of age. Remembers kelts being speared. It used to be done before 1856. Both male and female fish were killed. The kelts have fallen off every year since then. The floods used to last much longer then, owing to drainage. 20 years ago the fish could travel a week, but now they often cannot go more than 24 hours. The fish have to come up the river by stages.

When the river is in flood the caulds cannot be seen.

Drainage began 30 years ago.

There are a great deal fewer fish than formerly. When he was a boy the close time was shorter than now.

The nets at the bottom are a cowardly way of catching fish.

ROBERT HONEYMAN, fisherman, Bemerside.—Has fished for 19 years. Saw the disease first on 24th April 1879. Has observed a different disease in former years. It is a distinct disease now.

Has examined diseased fish; found no internal mark; everything inside was first-rate. All the fish he saw were clean salmon, except one sea trout kelt. Took six altogether. There were no sores. They were all seized in the left eye. There was a little inflammation and a small tumour over the eye. When the disease got older they had a scar above the tail.

The sore was quite external. The fish were blind on one side.

Has not seen clean salmon with the mouth and gills diseased. Only speaks of Bemerside waters. All had the same appearance. One had a bare scalp with no fungus. The sore on the eye had no fungus. The fungus comes after the sore. Has not seen it before. Has not opened diseased fish.

On June 5th and 6th took three fish. The last fish he saw was on the 15th June. It looks as if the disease would die out. The cause will be sought in vain. It is like the potato disease.

Many baggits are killed in the Tweed in November by anglers.

The Tweed is a late river: angling should go on all the season. Kelts should be preserved; but baggits should be killed. There can be too many baggits. Took 28 kippers and two baggits in 1878. They were unspawned fish, and they were buried. Some seasons they fight.

The disease is quite distinct from anything ever seen before.

Would suggest that after March all kippers and baggits coming up the Tweed should be taken out. They come up in March to spawn, and turn up the beds made by other fish two minutes before. The first lot of eggs will be destroyed before being hatched.

Saw a small fry on Saturday with inflammation in the vent.

There is a great run of fish now. The first one was caught on 15th June.

They are very red now—as red as foxes.

DAVID JOHNSTONE, fisherman, Dryburgh.—Has heard the previous evidence. Has seen many cases of disease. Saw it 50 or 60 years ago. Thinks the disease formerly seen may be the same as that now. The appearance of the fish is much the same. Inclines to think it as an aggravated form of the old disease.

ROBERT PRINGLE, Galashiels.—Has been a fisherman all his days. Has seen the disease a good deal this winter. Never saw it so bad. Used to see kippers and odd fish now and then affected with white and yellow spots. Did not pay so much attention to it as now. It is a new disease to him now. Saw it in the close time.

Saw foul fish very early in January unspawned at Galashiels, diseased on the head and all parts, and the fish were killed and sold.

Never took fish with clicks.

The first fish he saw was taken out, he thinks, about Eldon foot. All that he saw were diseased.

Thinks the cause was the confinement of the fish into pools. Most of the fish he saw were unspawned baggits. The first fish he saw was a kipper. Could hardly see its head from being covered with white.

Examined the roe. The spawn was half white and half red. The majority of the eggs were getting white. Somebody tried to cure the roe, but it did not cure.

ROBERT HALL, ironmonger, Secretary to the Galashiels Angling Club.—Has known the Tweed since boyhood. The association is for trout fishing. Has no idea of the cause of the disease. Has caught salmon and trout. Does not see any necessity for a trout close time in the Tweed.

The diseased fish should be taken out and buried. Would have no objection to kelts being made legal after 15th April. There is no overstocking. The pollutions have nothing to do with it.

Trout are now running to spawn, and will spawn in October and November. The trout were diseased in great numbers this season, till the salmon left the water.

A friend of his had some sticklebacks in an aquarium which became diseased. He found he had put stones from the Tweed into the aquarium. The sticklebacks were caught about July. His friend thought he had got the disease on the plants from the Tweed. They were long weeds, 10 or 12 feet long.

The Tweed has far more vegetation than formerly.

Many leaves fall into the river in the winter. Never saw any sediment from the leaves.

J. THORBURN, fisherman, Juniper Bank, Walkerburn.—Has known the Tweed for 30 years. Has seen more or less of disease for 10 or 15 years. The disease this year is an aggravated kind of a former disease, with more fungus. The disease has been both above and below the dam. There are lots of salmon above. Never saw disease any year till after the fish had been on the spawning beds a considerable time. This year they were mostly spawned fish.—kelts. There was nothing particular this year to account for the disease, unless the increased pollution has led to it.

The pollution is double what it was in 1874. The fish will catch the disease when the water is low. Wool-scouring sends turpentine, sulphur, arsenic, spirits of tar, and black soap into the river. This comes from the wool in the wool works. Thinks there are no spores of disease in the wool. The fish get unhealthy through pollution. His remedy is a new Pollution Act. The scouring water comes in all day, and every day. It is perceptible five miles below the mills. It has increased very much lately. The fact that there are rivers affected by disease without pollution is against his idea. No steps are taken in his district under the Pollution Act. Innerleithen has turned its pollution (town sewage) into the Tweed within the last two years.

Nothing has been done to Walkerburn; no water passes down the river; it is dry for two miles.

The lade supplies two mills.

Mr. Ballantyne has had filtering tubs built, but they are not cleaned out.

PETER PATERSON.—Has known the Dryburgh and Maxwell waters for 14 years. First saw the disease in the middle of May. Before then got three baggits and cut them up. The spawn was getting bad. He buried them. Has had no kelts diseased this season, but had some clean fish and opened them. Found nothing in them. The clean fish had the face eaten into down to the bone. The blotches on the skin did not penetrate. The disease was on the skin. Kept a river trout, and it got through. It got worse and worse till a good flood, when it mended. The second flood took it up. The sea trout have also been diseased, and also minnows, eels, and all fish.

It is a new disease. It appears on the heads of the clean fish. Thought many of the kippers had been scratched. The spot gets on the clean fish, and is followed by fungus.

The dirty water may have something to do with it.

The fish should be taken out and buried. Has buried eight since May. Sent one to his master, who tried some fungus on the wings of a fly, and it ate away the wings of the fly.

The hard winter may have had something to do with it. The three baggits he spoke of had not spawned. The flesh of the fish sent to his master was quite good.

ALEXANDER PURDIE.—There should be a proper slap in the caulds to carry down the kelts. Fishermen might drive down the kelts to the sea. Observation should be made of the state of the water in May.

Town Hall, Kelso, Wednesday, October 1st, 1879.

PRESENT :

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

KELSO.

His Grace THE DUKE OF ROXBURGHE.—Owns salmon fishings in the Tweed. Has given orders for all diseased fish to be taken out of his water and buried. Ever since he has known the Tweed he has seen several fish diseased every year similar to the specimens produced. This was always after a hard winter. Believes it is owing to the crowding of the fish under the ice. In 1870 there were more dead fish than he ever recollected. Counted, himself, between 40 and 50 in his water at Floors in one day. Some were much marked; others hardly at all.

The water was very low. Cannot say if the disease is owing to pollution.

The disease this year is the same form of disease as that observed every year, but much aggravated. Has seen fish every year with the disease. The fish would be kept off the spawning beds by frost. The fish were kept off their beds for many weeks last winter. The spawning was consequently very late. The fish ran up last year after the nets were off. Many were caught.

Thinks the disease is contagious if the fish are badly affected. Stinking fish lying in the river must be bad for other animals.

Never saw smolts or clean fish with the disease.

Fish badly affected ought to be taken out. Would leave the condition of fish, as to whether they should be removed or not, to the judgment of the water bailiffs.

Thinks the fish assemble below the caulds when going up, and they hang about the pools above when coming down. His water here is full of kelts above the weir. There is a slap to let the fish down at the Putt here, and it is opened under the Tweed Act. The fish will not always go down. A natural rise of 4 or 5 inches will take down kelts but will often not bring up fresh fish.

Has never caught fungous fish with the fly. Has caught them marked with wounds from fighting and also from nets. Wounds would predispose to disease.

Would rather not eat diseased fish.

Thinks the disease, though seen most years, does not recur every year with so much virulence as this year. It is an epidemic.

The water bailiffs should have power to take all fish badly diseased out of the river. Nothing else can be done.

When the water is low, pollution has a bad effect on the fish. Has seen them swimming with the back fins out of water. The water here is not very dirty. The water below the Gaia is very dirty. Does not ascribe the disease to pollution.

Never saw cases of disease in Norway. Never heard of it. The rivers there are not overstocked. There is too much netting at the bottom of the rivers. There is certainly no disease in the Alta.

It was in May that he saw fish swimming about in the water on the surface.

The disease appears first on the head and spreads over the fish. It is like a fungus. There is always fungus on the spot. The fungus is part of the disease. The disease is caused by the fungus. When it gets to a certain state it gets rapidly worse. Has seen fish quite coated over.

The disease is a river disease. When he tried artificial breeding recollects keeping two or three breeding fish in a pond till a baggit was caught and they all had it. Thinks, therefore, that when the fish are kept off the spawning grounds they are always seen with the disease.

The fish are cured on reaching the sea. It would be well to get the fish grown to the sea as quickly as possible.

During the hard frost it was impossible for the fish to spawn. The hard winter had much to do with the disease.

The captive fish he referred to were affected in the same way. One fish was covered with it in a week. It was a largish pond intended for smolts, 13 yards across.

Has seen the disease on gold fish in a bowl.

When fish are buried they should be placed above the highest water mark.

There are nearly always worms in kelts' gills. Does not think this has anything to do with the disease. Most kelts have them.

Saw one or two fish lying about this year, but was taken ill and could not observe them. Believes the disease is the same as that formerly observed.

THOMAS TOD STODDART, Bellevue, Kelso.—Has known the Tweed for 12 years. Is well acquainted with the Tweed and other Scotch rivers. The disease is of long standing; dates it back to the time he has resided here. It has been more virulent owing to certain causes lately. Refers to the fungus and spots.

Has an Annual Register dating back 100 years, which shows that a disease was among the haddocks in the Firth of Forth; only three haddocks were caught. The haddocks alone were affected.

(*Holds in a paper on the disease—published by him in 1872. It is as follows:—*)

“The annual mortality among the salmon has begun at an unusually early period to develop itself in this locality. On Wednesday last (February 7th, 1872) we took a stroll, accompanied by a friend, on the banks of Tweed at St. James' Green, where the pool called the Putt, headed by the Income Stream, is situated. The range of water is not more than the third of a mile in length, if so much—yet in this comparatively short stretch we descried hugging the edge no fewer than ten dead salmon. But for the size of the river and its discoloured state we might have detected more; but ten on one side of a single pool, at the opening of the rod-fishings, was in itself a formidable number, and certainly is calculated to call forth apprehension as to the quality of the water we are using for domestic purposes. On our return from this discovery, we met the gentleman who holds, among other offices, the position of clerk to the Tweed Commissioners, and on communicating the fact to him, authority was instantly given to one of the river police, who happened to be passing at the time, to take the fish from the river by means of rake-hooks. This was accordingly done in our presence. The first fish taken out was a half-spawned kipper of about 22 lbs. It had lain for some days in the river. The cause of its death was probably old age, as there were no marks of violence on its body. The next was a kelt or newly spawned female of 12 lbs. Judging from the eyes and gills, it had died recently. There was a large button mark, as it is termed, on its breast, and a good deal of scarification below it, the result, probably, of attrition while on the spawning bed. There were also diseased marks about the tail, but the flesh was red, and might have looked wholesome in the hands of an adept in the art of cooking it up, which many of the poaching community are. Four fish, averaging 16 lbs. a-piece were then abstracted. They had evidently been in the river for more than a week, and were verging towards the stage of putrefaction. Two of them were kippers, having the milt lobes unbroken, but apparently diseased. But long immersion in the water may have occasioned this appearance. The next fish was a female of 12 lbs. in weight, the *ova*, with the exception of some loose particles, discharged. Death in this case, it could easily be seen, the subject being a fresh one, had resulted from internal inflammation. Of the three other salmon taken out with the rake-hooks, one was in a state of most offensive putridity. They were all male fish. The largest might have weighed about 24 lbs. It was handsomely and powerfully formed; and the only indication of disease presented by it was in connexion with the milt and liver.”

Went 14 or 15 years ago to St. Boswell's, and saw diseased fish there. One year, when fishing below the cauld at Pinnacle Hill saw several diseased fish in Sprouston Water. There was a sort of rabies among them. They were rushing about as if distracted with pain, skimming along the surface of the water.

This is no new disease, but an aggravated form of the old disease.

A combination of circumstances assisted to aggravate the disease. Although it has appeared in the Eden and other pure rivers, a number of circumstances may combine to assist the virulence of the disease.

At one time anglers were allowed to kill kelts. Now they may not do so. Water bailiffs should always remove kelts. Many people have been severely fined for taking out kelts.

KELSO.

The river should not be open till 15th March or 1st April. Trout angling should cease at the end of September. Salmon angling should go on till 15th October because at present the nets get the main catch. Once in July and August, pike were very plentiful in the Duke's water at St. Boswell's, and netting was allowed there.

Owing to drainage there is often at the mill caulds a collection of fish. They will only go down in bodies. In the middle of April 12 or 14 fish in a body may be seen going down. They come up in pairs, and often in shoals.

The fungus is not the disease. It might settle on a healthy fish and create disease. Very small kippers may be attacked by large kippers, and they fight. Cannot say if there is any difference between sores from wounds and sores on diseased fish.

There may be some virus in the beak of the kelts.

The disease is confined to Ayrshire, to the Solway, and to the Tweed. Cannot account for this. There is none in the Forth, which is very polluted. The Lune and tributaries are polluted.

Approves of the watchers burying dead fish. Since the prohibition of roe-fishing roe is a drug in the market and it is used high up the river. One or two watchers here have been watching boys catching trout with salmon roe, while they might be better engaged taking out the dead fish. Many of them are good men, but others do little good.

From 15th March to 1st April kelts should be caught. Kelts don't go down till the middle of April. They are often detained by the mill caulds.

Suggests the removal of kelts and the burying of diseased fish.

The manures for the land may affect fish. The river rapidly falls from flood to a low state through drainage. Many such causes aggravate the disease. [Puts in a letter received by him from Dr. Crosbie, late Surgeon to the Challenger Expedition. It is as follows:]

"16, Gillespie Crescent,

"DEAR MR. STODDART,

Edinburgh, 21st Sept. 1879.

"IN answer to your note of date 17th September, I will now very concisely tell you all that I know regarding the disease of salmon that has lately been brought so prominently under notice. It was in the spring of 1852 that the opportunity was afforded me of investigating the disease. I then procured a salmon very nearly at the point of death; having been struck with the peculiar appearance of ulceration which the fish presented in the water. There were large ulcers from the size of sixpence to that of a crown piece and larger, scattered over the entire surface. A large one had involved the *opercula* of one side and extensively destroyed them. Another had burrowed under and extensively undermined the large dorsal fin. Now all these ulcers, whether superficial or deep-seated, had a peculiar flocculent appearance, and suggested to me a fungoid origin at once. Accordingly I made careful sections of the ulcers in every condition and traced the fungoid growth in all its stages. I demonstrated the mycelium merely affecting the epidermis, then in the scales, next in the subcutaneous tissue, and in the debris of the muscle and bone, that had been destroyed by the growth in the deeper ulcers. I exposed the sections to solutions of various chemical substances, and I found that a solution of salt (I forget the proportion now) completely dissolved the fungus, and left the tissues absolutely free from it. It was clearly a fungoid ulcerative disease. I made inquiries among fishermen and others conversant with the river, and found it was a disease fairly well known in the Tweed. Everyone I consulted agreed in opinion that the disease only occurred in the spring months when the river was and had been for some considerable time below the average fulness, so as greatly to interfere with the progress of the spent and weakly fish to the salt sea.

"I concluded then, 1st, that the real cause of the disease was the retention of the fish in the fresh-water comparatively stagnant, and containing an increased proportion of the lower forms of vegetable life (*Algae*, &c.): that one, perhaps more than one, form of fungus found an abnormal though congenial home on the tissues of the fish weakened to the greatest extent in its vitality by its increased stay in the fresh water: that it was a provision of nature to drive the fish to the sea, similar, but of the opposite tendency, to the tide lice which drive them to fresh water.

"2nd. That the remedy clearly was to provide ample means to allow of the fish following their instincts and attaining the sea.

"3rd. That when the river was very low, especially in the spring months, it became infested with the lower forms of vegetable life. This I have repeatedly proved by examination. When so impregnated, a good flood at once frees it from such, and this freedom continues for weeks. That the disease had occurred in the Tweed at intervals in all times, and was no new disease, I remember distinctly as a boy, again and again. Of course you know of all that Mr. Stirling has written on the subject, in regard to the late epidemic on the Eden and Esk which is without the slightest doubt the same disease that occurs in the Tweed. He has named the fungus '*Saprolegnia ferax*,' an imperfect terrestrial condition of which is common on house flies in autumn. You may have seen flies sticking to the windows with a whitish efflorescence around and on them—that is the fungus. But I am very doubtful of the true nature and affinities of the growth. This *Saprolegnia* is figured in 'Cook's British Fungi,' Vol. II. page 639."

Has seen the disease for many years. Never before had an opportunity of seeing it on clean fish. The disease in former years had the same symptoms as this year, but the fish were not so rapid as this year. It is possible that there is a disease this year under the fungus. There is a British cholera and a foreign cholera. Some medical men say cholera is neither contagious nor infectious. There may be a new disease. The state of the water and various things may have made the disease more intense. Allowing dead fish to lie in the water has helped to cause the disease.

The prohibition of the killing of kelted fish has helped to do this. The river should be opened much later for rods, and kelted fish should be killed and kept if in good condition. Bad kelted fish should be killed and buried. Would repeal the law making the killing of kelted fish illegal. The river should not open till the 15th March or 1st April.

The nets are off on the 1st September.

The conditions of the river are altered. Recollects when 26 and 27 lbs. were the biggest fish. Many of 30 and up to 40 lbs. are now caught. They come up much later. Some gentlemen killing fish with the spear killed 300 spawning fish in September a good many years ago.

Was once in favour of preserving kelted fish. Many of the kelted fish die, and now thinks that after a certain date they should be killed and kept. A kelt improves after a certain time. Has seen them when they could not be distinguished from clean fish. A minnow is a proper bait with two lip-hooks. Has known it used with nine hooks. Fish so wounded must die. The clean fish coming among a number of kelted fish must be affected. Recollects when the fish used only to reach a point where pollutions will not lie.

There are many grayling in the Teviot; many of them were diseased this spring. A boy at Maxwellheugh took five grayling all diseased. They have been nearly extinguished this year. They eat the ova from the beds.

Does not know of eels being affected. Minnows are scarce this year. Cannot say if they are diseased.

Has found fish inflamed from the vent upwards when attempting to get up the caudals when heavy in spawn. They are injured at the head and vent; this predisposes to disease. Has seen fungus floating by itself in the water. It comes off the fish, or may be bred in some other way.

The fungus increases after the kelt is dead.

DAVID KERSE.—Lives two miles below Kelso. Has been a fisherman on the Sprouston water all his life. His father was fisherman for 79 years. Recollects the Tweed for 30 years or more. Always saw traces of disease to a certain extent, but it was different from what is seen now. Generally the male fish were diseased through fighting; they were mostly kippers. They had fungus. This was in the spring months—January, February, and March. They were covered with white fungus. It attacks fish all over. Has seen dead fish with fungus. It is no new thing in the Tweed.

This year when he commenced fishing in February he often saw fish running five or six yards along the top of the water. They were attacked with a serious disease. There were clean fish, and kelted fish as well. They had a sort of fungus; this follows the disease. The disease at first is like a sort of white spot on the head, and the liver gets all affected. Has seen a white spot

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on old kelts formerly but not to the same extent as now. The fish formerly did not exhibit the same suffering as this year. Has seen some with fungus and some without. The fungus was the same as in former years. There has always been fungus in the Tweed, and it has fastened on wounded kipper fish. The old fungus has fastened on a new disease.

Has seen perch, eels, and all fish diseased this year, never before. Has also seen it more on clean fish. This year it attacked clean fish more than kelts. Means the fish from the sea; does not mean fish that have been long in the river. They were strong healthy fish. The state of their constitution would not predispose to disease.

Has opened many diseased fish. Found the liver all gone or diseased and light in colour. The gut was slightly inflamed. The ovaries seemed all right and contained immature ova. The flesh was all right to a certain extent but blackened below the surface. This blackened mark extended a good bit below. Has opened a good few diseased fish. They were all diseased in the liver, &c. The disease attacks them inside first; it is an internal disease.

Was on the Tweed last winter. It was uncommonly frosty. The frost began before Christmas. There was more snow water after Christmas. There was not a great run of fish, and there were also fewer in the autumn.

The Tweed is not overcrowded. Snow and ice continued very late. After the ice got away the fish spawned. Observed unspawned fish late in the spring. Has always seen this. The water was not low. There was plenty of water to take the fish away. The kelts were fewer. There were fewer fish up in the autumn. There was more water than usual.

First saw the disease in the spring fish after February. There had been a few kelts before, but the kelts this year were more distressed. Thinks the kelts were first affected, and that they affected the spring fish. The disease is quite different from what he observed formerly. It is a new disease. The last diseased fish he saw was in the middle of June.

It is a river disease. It has now (October) disappeared. There may be something in the atmosphere to cause it. It may pass off.

Believes that pollutions are a very bad thing. The Tweed is very polluted at Sprouston by town sewage. Much of it comes from Kelso. Thinks the disease is partly due to pollutions. Has heard of the disease in rivers with no pollutions. The Tweed pollutions are increasing. 20 years ago could see pure water 50 or 60 feet deep. It is now always discoloured. All the dye from Galashiels and Hawick come down. It is offensive to the smell in summer, but the fish are not in the water then to get diseased.

All the disease has now disappeared. Last saw a clean fish affected in June. The river is clear of disease now.

The pollutions should all be abolished. It is a pity to spoil the Tweed from a sanitary as well as from a fishery point of view.

It is an epidemic disease.

Some steps may be taken to stop it. Kelts and kippers have always been affected. Would never kill a kelt, or else there would be no big fish in the autumn. If the amendment in the law had not been made, the size of fish would not have been increased. But dead fish should be buried; it could easily be done. Fish should be taken out if affected the least bit. Does not know if salt is a cure. Thinks fresh water during a flood would not cure a diseased fish after it had reached a certain state.

Many kelts have died. Expects the quantity of fish in the autumn will be reduced in consequence.

The pollutions are a great cause of disease. The Forth may be affected after all, though diseased fish have not been observed in it.

Thinks all fish are affected here—pike, perch, grayling, eels. Sea trout were not so bad as salmon kelts. Fresh run sea trout also had it. It was not very bad among common trout, but they all were slightly affected.

It would be better if there were more water for the fish. In 1868 there were 10 clean salmon in the water to one in 1879, and there was no disease.

Fish of all kinds collected together at certain times may predispose to disease. When the river was frozen there was plenty of water. There is nothing like plenty of water. The disease would have broken out long ago if it were due to overstocking.

The Tweed water is used for man and beast.

Is not in favour of killing kelts. Bull-trout kelts might be killed by the rod. They may be taken now (October). Does not think they are increasing very much.

JOSEPH BENNETT, Printer, Kelso.—Has known the Tweed all his life. Has sent specimens of diseased fish to Mr. Stirling. They were affected with white spots and fungus on the nose. There was never a white spot without fungus. One was a minnow and one a common trout. The eyes of the trout were affected. It was like a scale on the eye. It was a fat fish. The fins of one were marked with white. Saw it the first time this year. Thinks it is a new disease.

It has been seen now and again, but the recent disease is of a more destructive character than has ever been seen or heard of.

Every angler knows that great mortality existed last year amongst kelts during the heat of the summer. At this season great numbers are affected with a disease of the gills or lungs, from which they seem to suffer very acute pain from the way in which they throw themselves about in the river. Has seen many instances of this. Believes it to be caused by the low and polluted state of the river and the hot atmosphere. The river is polluted to a large extent from various sources, and the confinement of the fish to pools, where healthy and unhealthy are compelled to remain together until a heavy flood sets them at liberty, tends to disease. A light flood does far more harm than none at all, as it only stirs up the sediment which he thinks has a good deal to do with the disease in the gills. Great numbers of fish die in these pools during the hot weather, and if they are allowed to remain in the river, it is no wonder that a disease of a more virulent form should succeed. Thinks the purulent matter of these diseased fish embedded in the river has been the cause of the disease.

Believes that the severe winter had a good deal to do in bringing about this as the fish were encased in ice for a long period, and would have, through necessity, to seek their food in the bed of the river; and in the search for food, they got inoculated by the purulent matter which afterwards took the form of the fungus disease.

Has no doubt that if the diseased fish were taken from the river, and the water rendered a little more pure, disease would soon disappear.

Approves of water-bailiffs removing the fish; it was done so before last year. Sea trout, eels, pike, perch, and all fish in the Tweed have been affected.

Thinks the impurity of the pools would help to create disease.

Diseased fish of all kinds should be removed.

Kelts, especially bull-trout kelts, should be killed after a certain date. Bull-trout kelts do much harm to smolts and ova.

The water was warm and shallow when he observed the disease. Has seen a salmon smolt diseased—only one; it was alive, at Kelso Bridge, lying close to the gravel.

Never tried inoculating fish.

Thinks old kelts eat salmon fry. Never saw one do it. Has never examined one. The bull trout spawns, he thinks, before the salmon.

ARCHIBALD STEEL, fishmonger, Kelso.—Sells many salmon for Berwick. Has observed no traces of disease in Berwick salmon. Has seen plenty of fungus disease at Kelso as far back as he can remember.

Used to fish for trout when he was at school, and found them diseased. They were mostly full fish. Has seen diseased salmon with fungus on them. They would have been in the river some time and losing their bright colour. Has seen it this year, and thinks it is the same disease. Thinks it has been increased by the severe winter, owing to the confinement of the fish in the pools before spawning.

Has noticed fish alive diseased, and they have been in pain. In former years it was just about the same. Has opened diseased fish. The diseased fish are quite as good as healthy fish. Has found two diseased fish with a bad liver, light coloured, with small white ticks, and enlarged.

The disease is the same as in former years, but aggravated.

All diseased fish should be removed. Would take out living fish as well as dead.

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Kelts after a certain period should be killed. Kelts hooked and played for half an hour and returned to the river may die.

The rod season might be postponed till the 1st April or till the 15th April. Kelts are not good to eat. Would not like to see them sold. If the law is altered as to their capture, the sale of kelts must still be illegal.

A disease occurred about seven or eight years ago in the Tweed. It was an inflammatory disease. The fish were attacked inside. The fish died in the neighbourhood. They suffered greatly. Has seen them knock their head against a stone and turn up dead. They were clean fish, straight from the sea in April and May. The intestines were inflamed. The flesh was covered with ticks like pepper. The vent was also inflamed. The stomachs had nothing in them. The coating of the stomach was nearly all gone. The pylorics stuck to the stomach. The liver was also affected. This was in 1871. Very little notice was taken of it. The fishermen must remember it. Scarcely any clean fish came up after April or May.

After a spate, the green stuff, weeds, &c., in the river are brought down and poison the fish.

The disease lasted only that year. Very few were seen next year. None of the fungous fish have been similarly affected. The river was very low then.

The average size of the fish from the Tweed is 14 or 15 lbs.

Found no worms in the liver among the unhealthy fish in 1871. Has seen them in healthy fish.

The fish in the spring are about the same size as they used to be.

THOMAS SCOTT, Carham.—Has been an angler all his life. There are fewer fish than formerly in the Tweed. Can't say the reason. Has fished regularly in the spring for nearly 45 years. Has seen a disease among the spring fish. Supposed it was in consequence of injury to the fish. The fungus last year was similar to what he had seen in previous years, but the disease of 1879 was a new disease, because it affected fish that were not injured at all.

It affects fresh run fish as well as kelts. Never before caught fresh run fish with disease. After they have been a little time in the river now they get affected. The fish were similarly affected last year. Thinks the specimens produced may have received an injury.

The fungous fish will take the fly, but not very well. In previous years never saw fungus on any clean-run fish; only on wounded fish. Thinks there is a disease first, and the fungus fastens on the disease.

The pollution of the river, if not the primary cause, has much to do with it, such as sheep dipping, sheep washing, sewage and factory refuse. Sheep are dipped in April.

A fish is more likely to be diseased in unclean water than in clean water.

The dead fish and dying fish, and all affected fish, should be taken out. They should be caught by nets.

Net fishing should go on to the end of September. The old close time began on 15th October.

Land drainage has done much to alter the river. If the water rose faster, the floods would be higher; but they are not. Drainage is for bottom water, not for surface water. The water formerly got away in thousands of small streams, instead of, as now, in a few large ones.

The upper proprietors should have rod fishing extended. If any other means could be devised for giving upper proprietors an interest in the river, rods should not go on beyond the 15th October.

A female salmon before spawning will take the fly very readily. The male also.

Some kelts die after being hooked and played, but the majority will not die. The fish are put quietly back. Kelts caught by rod or net should be kept all the season. They should be sent to the market.

Sees no difference in the size of salmon.

Most kelts are down by the 15th April or 1st May. It would be late to begin keeping them then. Well-mended kelts are caught, and should be killed. Has never seen kelts eat smolts.

ARCHIBALD STEEL (*recalled*).—Wishes to explain why kelts should be killed, because he has seen kelts landed with both salmon and trout fry inside, and has seen them chasing the fry.

JAMES KERSE (*recalled*).—Does not think kelts eat salmon smolts. They will only eat what is put before them. Once had a salmon from Berwick in May with a herring inside it. Kelts get nothing in the water but *animalcula*. Kelts will take smolts if they are put before them as a bait.

They get well mended in fresh water before reaching the sea.

T. T. STODDART (*recalled*).—Salmon kelts will attack smolts. Has fished with parr tail or small parrs, and caught kelts. When collected in bodies they will not feed. A yellow substance is often exuding from the vent. Thinks if they take smolts on the line, they will take them swimming naturally in the river. Has seen fish in the spring hunting the parr.

DAVID MILNE HOME, Milne Graden, Coldstream.—Is proprietor of fishings in the Tweed and chairman of the Tweed Commissioners. Has resided on Tweed side for 40 years. The Tweed Commissioners are most anxious to assist the inquiry and to find a cure for the disease.

This particular disease was first observed in the Tweed last February. The Board receives monthly reports from its superintendents. Every year multitudes of diseased fish are seen in all parts of the river in the spring months, *i.e.*, February, March, and April. Generally these diseased fish are kelts, but has heard that clean fish have been seen this year in a diseased state. Thinks the disease is not of the same character as formerly. It has distinguishing features—particularly fungus on the fish—which he has never seen before. Many of the same causes which existed before, and caused death, exist this year. The fact of the fish being kept six months in impure river water causes unhealthiness. The want of nourishment for four months is another cause. The salmon gets food only in the sea, and becomes emaciated in the river. The exhaustion from spawning would also render the fish more liable to disease.

Owing to the circumstance of the spawning beds being destroyed by floods and ice last year, half the number of fish usually spawning did not spawn, and in consequence the fish became unhealthy, and so susceptible of attacks by parasites.

Some years ago the Commissioners attempted to obtain information on the habits of fish, and a circular was issued containing a series of questions, among which was the following:—

Question “Is the spawning time ever retarded by ice, snow, or floods, or any other natural cause?”

Answers were given by the following witnesses:—

“*Mitchell*.—Spawning fish fall off the redds when frost sets in, and cease spawning until the weather becomes fresh, when they resume operations.

“*Smith*.—Hard frost and snow when of long continuance retard the spawning of all kinds of fish.

“*Millar*.—Large floods and ice retard spawning, and are certain destruction to spawning beds.

“*Pringle*.—Spawning is retarded by floods and ice, and the fish are driven from the streams into pools.”

To the Question whether “during the course of the winter or spring dead fish have been seen more frequently than during any other time, and to what cause can these deaths be attributed? Are they chiefly male or female fish, and have they spawned or not?” the following answers were given:—

“*Poston*.—Dead fish are frequently seen in early spring. They are chiefly males, either unspawned or not fully spawned.

“*Mitchell*.—Dead fish are seldom seen till after the new year. They consist chiefly of male fish, either unspawned or only partially spawned. A good many of the deaths result from bites, which appear to mortify in frosty weather. The rays of the gills are in numerous cases grown together, and the milt in some cases is discoloured.

“*Smurthwaite*.—Dead fish are mostly male, apparently from inflammation.

“*Weatherstone*.—Dead salmon never seen until end of January or beginning of February. I attribute deaths principally to want of food and

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" bites from the males. I should say there are 20 males for one female, and very seldom spawned.

" *Smith.*—Have observed most dead fish in January and February, mostly males,—caused principally by inflammation of the milt bed. They are mostly half spawned.

" *Smail.*—Yes, in early spring. The cause is partly from exhaustion in connexion with procreation. They are almost entirely male fish.

" *Dickins.*—In spring, male fish frequently found on river side dead. I attribute the cause to their not being able to meet a female fish, and so get rid of their milt, which congeals and becomes hard. These are termed locally 'swooning kippers.'

" *Rochester.*—The spring. Dead male fish frequently found. I mean dead from disease. Dead females never. The deaths of the males are attributed to their not meeting with females on the spawning grounds. Not being able to discharge their milts without the assistance of the females, it congeals in their bellies, forming a hard substance. These fish are named by Tweed fishermen 'swooning kippers.' Females by titilating their bellies upon a rock or hard gravel can discharge their ova without the assistance of males, hence we have no dead females."

The following answers were given to the Question "What is the food, if any, on which salmon subsist whilst in the river?"

" *Stoddart.*—Adult salmon and grilse, except in the kelted state, rarely incline to feed in fresh water. Food in a tangible state, it would appear, is not essential to their existence in that medium.

" *Smail.*—They eat none that I am aware of.

" *Pringle.*—I have never heard of any food being found by dissection of river salmon. I have never seen them feeding through the day.

" *Dr. John Davy.*—That salmon grow and fatten rapidly in the sea is an established fact. They deteriorate as soon as they leave the sea for fresh water, and diminish in size, owing to taking little food and to the expenditure of their fat or oil. This is most noteworthy during the growth of the ova and milt preparatory to spawning. Fish in the spring, when returning to the sea, have lost their peculiar colour (that of their muscles), with the loss of their fat, which has been absorbed, and is a substitute (it may be inferred) for food."

The Questions with the answers were published in a book by the Commissioners in 1867.

This year the superintendent noticed, among the dead and diseased fish, numbers of female fish unspawned. This large proportion of females is shown in his returns of the number of fish removed and buried in the spring of 1879, first in May, and second in June. (*The following are the returns:—*)

" RETURN OF FISH REMOVED and BURIED in May 1879.

Description of Fish.	Diseased.		Not Diseased.		Total.		
	Males.	Females.	Males.	Females.	Males.	Females.	Total.
SALMON—							
Spawned - - -	88	195	7	13	95	208	303
Unspawned - - -	23	124	1	3	24	127	151
GRILSE—							
Spawned - - -	1	9	—	1	1	10	11
Unspawned - - -	1	1	—	—	1	1	2
SEA OR BULL TROUT—							
Spawned - - -	50	97	25	19	75	116	191
Unspawned - - -	—	1	—	—	—	1	1
Total - - -	163	427	33	36	193	433	659

" RETURN OF FISH REMOVED AND BURIED IN JUNE 1879.

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Description.	Diseased.		Not Diseased.		Total.		
	Males.	Females.	Males.	Females.	Males.	Females.	Total.
SALMON—							
Spawned - - -	3	42	1	—	4	42	46
Unspawned - - -	1	3	—	—	1	3	4
BULL TROUT—							
Spawned - - -	4	35	3	3	7	38	45
Unspawned - - -	—	—	—	—	—	—	—
Total in June - - -	8	80	4	3	12	83	95
" in May - - -	163	427	33	36	196	163	659
Grand Total - - -	171	507	37	39	208	546	754

This gives a total of 754 dead fish taken out of the river and buried in May and June. It will be observed that the greatest number were unspawned females.

The reason why they were unable to spawn was that the river in the spawning districts was for a long time a solid mass of ice, and that the spawning beds were afterwards destroyed by the heavy floods.

On the 30th and 31st December many of the cauldls were destroyed. Was present on the river when the ice broke up. A flood took place on 31st December, and the river rose 10 and 12 feet. The floods destroyed not only the cauldls, but the spawning beds.

The report of the superintendent in January was that "during the greater part of the month, the rivers have been frozen at many places, which has prevented the fish getting on to the spawning streams. Many had to spawn in deep holes. Towards the end of the month, the rivers were freed from ice, and the spawning streams became stocked with numbers of large salmon."

As the fish could not spawn, the retention of the ova and milt was likely to cause inflammation of the ovaries, and the fish being unhealthy were more susceptible to disease.

A friend of his saw three fish in Loch Tay last April with the fungus of the Tweed on them. Mr. Stirling showed this gentleman specimens of the fungus, and he found it was the same as on the fish he had seen in Loch Tay.

Refers to the report of gentlemen in charge of the Government fish ponds at Hüningen in Germany, where fungus existed. A remedy was found in supplying water from springs instead of from the river. The fungus disappeared in consequence. (*Produces a drawing of fungus from Tweed fish.*)

Angling on the Tweed ends on the 30th November. Cannot say if the number of baggits killed in November by rod affects the balance of sexes. They do not spawn till December and January.

Cannot suggest any remedy. Thinks it is an epidemic. Is informed by botanists that parasites exist in all running streams, and thinks the fish, having become unhealthy and weak from atmospheric causes, from the polluted water, and from prolonged starvation, and from being prevented spawning, have been more susceptible of their attacks.

Pollutions alone will not produce it. Rivers exist where pollutions are found and where there is no disease. It may be an epidemic which will die out, as other epidemics have done, affecting both animal and vegetable life. The causes may not occur again next year, and the disease may consequently not reappear. The causes which produced the disease may have now disappeared, and the disease has now disappeared, at any rate for the time being.

The fish, when in the rivers, do not get proper nourishment. Sir Robert Christison made an experiment to prove that the fish lose fat and oil when in the river, and reported the result in a paper read before the Royal Society of Edinburgh. The fish were sent to him from the Tay. The clean-run salmon contained in its flesh 18½ per cent. of oil or fat. The fowl salmon—a kelt caught in March when on its way back to the sea,—contained only 1¾ per cent. of oil or fat. Knows that salmon when they enter the river are found to

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be full of food. Young herrings have been got in the stomachs of fish as far up as Kelso, where they must have been a fortnight in the river.

Since 1860-1 there has been no season similar to last season, and no such obstruction to spawning. One of the causes is to be found in the meteorological circumstances of the year. In Germany at the Government establishment, great attention is paid to the state of the atmosphere, and returns should be obtained from places here in the winter. Mr. Paulin keeps records of the temperature of the river at a point 6 miles above the mouth, and sends them to the Scottish Meteorological Society. It is desirable to have similar returns from places further up-stream. No such records are kept.

There is a water-gauge at Kelso to show the height of water in the river. A very good index exists at the bridge there, but no record of the height of the river is kept.

Approves of burying the dead fish. Is not of opinion that the disease is contagious. The fungus will only grow from spores. Mr. Stirling has attempted to propagate it; but it is impossible to grow it from its branches.

The Tweed Commissioners transgressed the law by taking out fish not dead, but thought this so necessary that they ran the risk.

Agrees with Mr. Kerse that kelts should all go back to sea, to grow into large fish.

Thinks the six months' confinement, the impurity of the water, and the difficulty of expelling the ova, all contributed to the disease. The fish this year could not make their redds: they ran against the frozen gravel with their heads, and so got injured. The fungus attached itself to the head, as the spores floating down the stream would first touch the head.

Cannot explain why the Tay is said not to be affected. Much unwillingness exists to admit the existence of disease.

Facilities should be given to the fish to get up and down over the caulds. The Tweed Commissioners have no power to order the opening up of caulds. At one cauld, the water-bailiffs caught 40 or 50 fish, and lifted them over, the Commissioners having authorised them to catch the fish and lift them over. Great difficulty has been experienced in dealing with caulds. Cannot say if the millers put down the hatches on Sundays. The Tweed Act is defective on this point. The Scotch Salmon Act enforces the putting down of hatches in mill leats, but the Tweed Commissioners cannot do so. The general Scotch law is to the effect that the water shall pass over the caulds and not down the mill leats. Such a power should be given to the Tweed Commissioners. But the caulds are generally built very loosely, so that the water, even when raised by the stoppage of the leats, would percolate through among the stones. Moreover, if the mill leat sluices were put down, the salmon which often come into the leats from want of hecks at the foot of the leats, would be left dry, and the miller or his servants would then catch them. In fact they have been known to let down the sluices for this purpose. It is very desirable that the Commission should take account of these serious defects in the Tweed Act, and recommend Government to bring in a short Act to amend it. Measures should be adopted to stop the abominable pollutions which sicken the fish, and to enable the fish, when they come into the river for spawning, to reach the spawning beds quickly, and then quit the river as fast as possible.

Thinks the fungus attacks the fish in consequence of the fish being previously unhealthy. It attaches itself to fish already diseased. Has not noticed it in previous years on diseased fish. Has heard the evidence, that it has been seen on diseased fish in previous years. Was surprised to hear this. Lives nearer the tideway than Mr. Kerse. At Berwick, the fungus is said to have appeared on fish in the tideway fresh from the sea. It is possible that these fish may have gone up the river and turned back again after contracting disease in the river.

No doubt the fungus kills the fish. The irritation to the fish is caused by the fungus pushing its roots into the flesh. Cannot explain why healthy fish have been, as alleged, affected by *Saprolegnia*. Is not aware that clean fish have been attacked. Spawned fish have been attacked largely. If clean fish have been attacked, this fact is an objection to his view. The disease may be found in rivers where his views are inapplicable.

WILLIAM BYERS, warehouseman, Langholm.—Was formerly surveyor in Government service in British Columbia. Has fished with the rod there.

British Columbia is watered by very large rivers. The Fraser is the largest. It is a great salmon river. Some of the Fraser salmon are the same as those in England and some are different. The salmon run up from April to July in large quantities. Has seen nothing like it in this country. They spawn in August. Never saw them in the head waters of the river, but perhaps as high as 200 miles from the sea. Has seen them in the tributaries. They run down in September. Has seen thousands of diseased salmon in the Harrison river, 60 miles from the mouth of the Fraser. Has seen them in September and October. Has seen a white spot of fungus sometimes the size of his thumb, sometimes quite covering the fish. Some fish were quite dead, others dying. Some had red ulcerated sores.

[Specimens produced of diseased salmon prepared by Mr. Stirling.]

Has seen thousands of heads like the specimens produced. The fish lie stinking on the banks. Cannot say if they have spawned. It is the same every year. There is no pollution and no drainage. The Indians spear the fish on the Fraser river.

Was there 10 years. Some years it was worse. Believes the worst years were warmer. In the spawning season the river is not frozen. It is frozen in the winter. Fish are left in the lagoons and bays in the river. The temperature is much the same in August as it is here. The winter is much more severe. Plenty of good salmon could be obtained in the Pitt river, 30 miles below. Has seen farmers manuring the land with dead salmon. There are a few settlers here and there. They supply New Westminster and other towns. The land is arable. There are no sheep. Was on the Harrison river or one of its tributaries in 1861. The fish are sometimes 70 lbs. in weight. A good fish is 30 lbs. Large fish of 30 lbs. were usually affected. There was one run of fish from 7 to 9 lbs. each, which he never saw diseased. They ran up in June. The majority escape disease. The larger proportion of the larger fish are diseased. The fish were just the same as the specimens produced. Some would have just a spot, others would be covered with fungus.

Knows the "dog salmon" with a hook nose.

The trade between British Columbia and England is chiefly in timber.

A tremendous number of fish die after the spawning season.

Noticed when going north on the Fraser that the Indians have large dams, and baskets are let down and the openings are never left till the run of fish has ceased. There is a tremendous run of fish. Never saw any disease there. The temperature of the Ballacoula and Homathco rivers is much colder than that of the Fraser. Never saw diseased fish there.

The Harrison is two and a half miles wide. It is quite shallow. Its sources are in lakes with a high temperature. It is there that the disease is found. From Harrison lake to Fraser river is 16 miles, and the fish lie stinking there. Eagles, hawks, and all birds wait for the fish. Knew the late Mr. John Keast Lord. Agrees with his description of the disease given in his book "The Naturalist in British Columbia."

Since he came to Scotland he has seen just the same thing in the Esk.

The Indians live on salmon.

Thinks, speaking of the Esk only, that the Esk is overstocked as a salmon river. Thinks the open season for the rod should extend to the end of November. The kelts in the spring should all be destroyed. The Esk is stocked in Canobie water equal in proportion to the Harrison.

Thinks the disease in the Harrison is caused by overstocking. In the Homathco there are not as many fish as in the Harrison. The run into the Harrison is good for the fish and they run up to spawn in enormous numbers. The water is polluted by dead kelts.

Collingwood Arms Hotel, Cornhill-on-Tweed, Wednesday,
October 1st, 1879.

PRESENT :

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

CORNHILL-
ON-TWEED.

JOHN COLLINGWOOD, Cornhill.—Owns a fishery on the Tweed extending from Cornhill down to Norham. Did not take much notice of the disease in former years. His water is netted. Kelts and all kinds are caught in February, March, and April. Salmon kelts are taken in May. In former years the kelts were a little diseased. There was not so much fungus as now. It was like a sore without so much fungus. Cannot say if the fish died.

The clean fish took it from the kelts. First saw it last year on clean fish, taken with rod on February 1st. It went on up to May and June. Saw one half dead by the side of the river in April. This was the only one this year. The clean fish had it on the head, not so much on the eyes, but on the sides. It was a small fish weighing 10 lbs. fresh from the sea. Knows of several seen by his men which were taken with the net. They were not very badly diseased. They were killed and buried.

There were a good many kelts in the river; they were later than usual—the trout especially. There were not more than usual. The water was higher than usual, with snow water.

Thinks there are too many fish in the water and on the spawning beds. The nets are taken off too soon. There are a great many fish up the river now, but none here.

The disease is only among the kelts, originating there and spreading to the clean fish. Knows a man who saw one or two diseased kelts rubbing against clean salmon. This would occur every year. Cannot say why the clean fish did not get affected formerly. The disease this year is the same as before, but more virulent. It is not a new disease. The fish are half dead. Has seen them half dead years ago. They will rush into the water if touched.

To decrease the stock of fish the trout kelts should be killed. The nets should fish to 1st October. The trout run in October. Many would be killed at the end of October.

The take in the Tweed has been less than formerly during the last 20 years. The stock of fish must therefore be less.

There was less drainage in former years, and the floods lasted a week or more. The river cannot carry so many fish now in consequence. Netting should be extended a fortnight. Rod fishers would object to this, as angling would be less productive. The assessment value of the Tweed would be reduced, but more fish would be caught. The nets should begin on 14th February, and rods should also commence at the same time as now.

All kelts, trout kelts especially, should be killed by net and rod.

Bull-trout kelts go to France. The great run of bull trout is in the first half of October.

Pollutions have something to do with the disease. Has fished in Norway for six years, and never saw any disease there. The Norway rivers are frozen over till May. The disease has nothing to do with snow or frost. There was more snow this year than in other years.

Dead fish should be buried, and diseased fish in all stages should be killed.

Perhaps they recover when they get to the sea. Does not think they can get to the salt water from here.

All bull-trout kelts should be killed and sold. Has tasted kelt bull-trout. They are not good, but some people are glad to eat them.

The fishermen who kill them by the rod must sell them. It is legal in Scotland. The sale of fish is a difficult point.

Knows the Coquet. The bull-trout run up there till the 14th October. It used to be a salmon river.

Has marked thousands of trout kelts for several years, and never saw one return.

After the nets are off the grilse and trout run up. There are a new batch of fish in October. Knows a grilse from a salmon by its scales and tail.

Land drainage has altered the periods of fish running up. Formerly they ran up in January.

Does not know what the disease is, nor how to cure it. The Tweed fisheries have decreased. The trout kelts eat the fry and spawn of salmon. Has found six and seven fry in a bull-trout kelt. The kelts eat spawn too.

Believes there are coal-fish at Berwick-on-Tweed, and young saithe.

Thinks most fish die that are hooked and "run" and put back. Has found them dead after he has run them.

Catches well-mended fish. Has not seen so many of them diseased.

Some people think artificial manures are the cause of the disease. The lime from gasworks is used on grass.

The pollutions come from the Gala. There is some also from the Teviot. Cannot see any pollution down here.

Sheep washing does not do so much harm.

People complain of bad water here. Cattle will not drink it in the summer after six or eight weeks of drought. There are wells here and two springs.

The weeds grow in the summer without rain more than usual. They have increased the last few years. The stones get furred with green after a long drought. They are dirty now. The floods clean them.

MAJOR DICKENS.—Has known the Tweed for 29 years, and has known diseased fish for 29 years. Thinks the disease is more noticed now because the clean fish have it. Formerly only kelts and baggits had it.

Never saw clean fish affected till this year. Landed one at Carham this year with fungus on the end of the nose and round the jaw. Next day it had grown worse. Had one that had died. It was too beastly to handle, being covered all over with fungus and scabs, mostly fungus. Has seen white scabs, and the fungus too, on kelts, both trout and salmon, and on baggits and kippers. The fungus is the aftergrowth of disease.

Has heard people talk of pollution as a cause, but disagrees with this idea.

Three hundred yards from here is the second coldest spring in England. To-day its temperature is 48°. In mid-winter it is 45°.

Keeps 10 to 60 score of minnows, which are sometimes affected with fungus. They never have disease till they are full of ova. Some are now affected. They have all spawned. Attributes it to overcrowding.

The ice damming up the streams will engender disease among fish, like men packed in a room without ventilation.

Pollution might aggravate disease, but it is not the *fons et origo mali*. Judges by his minnows. They have it in February and March. He cures them by wiping off the fungus and covering the fish with salt.

Thinks the disease is a fresh water disease, and kills pretty quickly. Fish might be cured by reaching salt water.

Early in the century, when 200,000 fish were killed, there could not have been many kelts. The Galashiels and Hawick poachers, and poachers all down the river, used to poach all the kelts. The poachers prevented the river being overcrowded. Now the river is watched so carefully that the fish cannot be poached.

In 1866 a salmon was brought to him for a wedding breakfast in January. Would commence killing the kelts on the 1st February. Would kill every kelt, because they have fulfilled their mission.

Kelts will eat smolts. Has seen them do it. Has caught them with smolts inside. Caught three grilse kelts with pike tackle, and they took smolts. Has found kelts with seven smolts inside.

Heard the evidence given five years ago before the Tweed Special Commissioners, when it was stated that if kelts were allowed to be killed baggits would be preserved. Has seen the kelts kill smolts dozens of times, and has seen them with smolts in their mouths. The digestion is so rapid that they are not found inside long afterwards. Has seen one kelt with all its food digested except a smolt's tail.

Would allow a fortnight's longer netting. Other rivers can alter their close times by byelaw. The Tweed should do the same.

It is the same disease as he has always seen, but aggravated by peculiar circumstances.

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More money will be paid for a kelt than a baggit. It is inconsistent to kill baggits and spare kelts. Has seen baggits netted with the spawn running out of them. Kelts should be killed and baggits spared. If this were done, rod fishing might be permitted all the year round.

More female fish are killed than males. One male will serve for more than one female fish.

Kippers will not take the fly like baggits. Thinks the disease is the same as formerly. All the symptoms are the same.

On the redds the cocks fight. Has seen them fighting at Coldstream.

There are plenty of eels. Thinks they take salmon eggs. One man has caught six and eight stone of a night this year. They are injurious to salmon eggs.

Foul fish should be buried above high water mark. Thinks disease is caused by overcrowding.

The kelts he saw eating smolts were chiefly bull-trout kelts.

The temperature of the river yesterday was 52°. In May it was 58°. The temperature of his spring was 48° yesterday. Last May it was 43°. The disease was pretty well gone then. Never knew the temperature to vary so much as this year. The spring comes out of a hill near here.

The spawn runs out of the minnows, and they got the fungus when they were spawning. This is the same as the evidence of salmon being unable to spawn in the ice. The minnows did not spawn, but shed their roe.

Pollutions may aggravate the disease.

Thinks the disease is caused by overcrowding from the evidence of his minnow boxes.

JOHN SCOTT, fisherman.—Fishes the Tweed. Has known the river since he was a boy. Fished Mr. Huntly's water for 27 years. Has seen diseased kelts, spotted with white spots. Thinks this was due to fighting. Many lay dead with their tails corroded. Saw no fungus. Round about the wound was a white scab. Has seen this for many years among both females and males—more among the females than the males. Has seen large males without much of a wound lying by the side of the river.

Has seen clean salmon this year with fungus, but never before. First saw it in the beginning of April, when some kelts were lying dead. The disease was at the back side of the head. Believes it is like a cancer. Could put his thumb into the hole. It eats away the ventral and anal fins, and half the tail, so that only the stump is left. Never saw it before. The fungus eats away the flesh. Noticed one especially, and could put a stick right into the skull; it had a little sore also on the nose.

The frost broke twice, and there were a number of salmon, and no eddies for them, and they could not make their nests. The salmon got damaged, and could not get any rest till they got into deep water. Many went to the sea. The ice broke, and the fish rose up and got injured in the ice.

Never saw so many spotted fish. The kelts were all torn to pieces with the ice. They are not so strong as the clean salmon, and they could not withstand the ice.

The fungus is a disease of itself. Never saw it before. It is quite new. A gentleman got 400 salmon all with fungus, and they were all buried. This was on the Esk, in Sir F. Graham's water. There was no disease here then. Plenty of dead fish used to come down formerly.

The factories are the cause of it, by sending pollutions into the river. One fish ran right into the bank, and it was quite stiff, through something wrong in the inside. This was two or three years ago, and happened close by here. Thought the fish was poisoned by the pollutions coming down. There is much manure laid on the lands, and it is injurious to the fish.

The fish jump right up and rise differently from what they formerly did. Believes this is due to the pollution. People drink the water because they cannot get any other. The manufacturers should make catch pits to catch the pollutions. Mr. Huntly promised to endeavour to cure the pollution.

The kelts—trout kelts especially—should be all killed, if not by net, at any rate by rod.

They should be sold. Cannot see why their sale should be prevented.

There are plenty of good fish now coming up. They are taken by the rod, and are very fine fish. Early in the spring some clean salmon are caught.

The netting season should be extended for a fortnight. The fish do not take in September.

WILLIAM JOHNSTON, fisherman.—Has fished for 50 years on Tweedside. Saw the disease 50 years ago. Saw fungus on the fish then. Another man told him it was through fish fighting on the beds. Never saw it on clean salmon before, but chiefly among kippers. This year it has been among clean salmon. The clean fish, coming in contact with the kelts, have been infected.

Has seen the scab and fungus coming together. Plenty of bull-trout, grayling, minnows, and all Tweed fish were affected this year. It has disappeared now (October).

Pollutions are a bad thing. Fishes are liable to disease, like anything else.

The crowding together of fish in small pools might be a cause. Has thought for some years that the Tweed is overstocked. Would allow kelts to be killed in February. The bull-trout kelts eat the smolts in the spring. Would give another fortnight's fishing. The salmon are decreasing. There are more bull-trout now than 20 years ago, but fewer salmon. Would allow only four months' close time, as formerly. The fisheries would be improved, and the disease reduced.

Never knew any fresh-run salmon diseased; they had all been up the river, and had come down to the lower waters. The salt water would cure the fish. When diseased the fish all seek the salt water.

Would have a month longer netting. Fewer fish spawned formerly than now, and there are too many to spawn now. Found fewer dead salmon formerly.

Bull-trout sometimes fetch 1*d.* per lb. more than salmon. The French like to boil the fish whole, and so prefer the smaller fish. The fish go in ice to Dover by rail.

The quantity of water in the river is altered by drainage.

The river is overstocked at this season. A month longer should be given for netting.

HENRY JOHNSTON, fisherman, Cornhill.—Has fished for 56 years with the net. The river has changed; it is not so big as formerly. The drainage is the cause. The marshy ground is drained which used to keep the river up. It has fallen away for 30 years.

The fish run up all the year. In the summer they cannot get past Cornhill. The fish make a rush up after the nets are off. A small fresh will bring a few fish up. More fish are in the river now for breeding. They were formerly killed in the upper waters by leisters. Used to catch most hens when leistering. The superfluous fish were kept down. Some of the fish were fit to eat; some of them were not.

There are too many breeding fish in the river. The netting season should be kept open a month longer. Every kelt should be killed.

The fish are bigger in general than formerly. Saw salmon as big 50 years ago as now, but not so many of them.

The rods should fish all through the year. There are plenty of fish past the nets this year, as far up as Peebles. The nets are off from 6 p.m. on Saturday to 6 a.m. on Monday. Would agree to take off his nets at noon on Saturday if another three weeks were given at the end of the year.

Plenty of smolts came up last spring. A few salmon spawn down here.

JOHN FULTON, fisherman to Mr. Milne Home.—Has seen diseased fish—kelts—for many years in the Tweed. The disease this year appears the same. The spots are the same. The kelts exhibit the same symptoms. There is nothing particular in the river this year to account for it.

The river is much more stocked than formerly. The old style of fishing was different.

Too many big old fish go up. Would give a month longer as formerly, *i.e.*, fishing to 15th October instead of 15th September. Would not alter the close time for rods. Would sanction the killing of kelts, by spearing, and all modes. Has talked with Mr. Milne Home about the disease, but does not agree with him.

JAMES GRAY.—Has heard the evidence as to extending the fishing season. Thinks it would be beneficial. Would give 6 or 12 hours weekly close time in

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exchange for another month's fishing in the autumn. The men ere would benefit, as the Berwick nets would let the fish up to them.

THOMAS SLY.—Does not agree as to altering the close season. The present close season is right. All kelts should be killed.

JAMES GRAY, fisherman, Lennel Newtown, Coldstream.—Has been a fisherman on the Tweed for 46 years, and is at present employed on a fishery five miles from Kelso. Has seen about 40 dead and dying fish at that part of the river in about half a mile of water. The most part were spring salmon: saw grayling, fresh-water trout, smolts, eels, and some kelts. Examined the salmon carefully, and found fungus on the head, fins, and tail. Found the skin and flesh eaten away to the bone on the head. Found the gills full of slime, and unhealthy: the liver of a greenish yellow colour, and much diseased. All other entrails were healthy looking. Found the flesh quite good.

Noticed in February a great many of the spring salmon had the upper part of their tails worn off, and with a bloody and inflamed appearance. Noticed a whitish spot on the point of the nose about the size of a thumb nail.

Believes that the fish having got hurt in some way, the unhealthy state of the river in April and May caused the disease to come on the fish. As soon as the river became flooded in June, there was no more disease to be seen.

Does not believe that overstocking the river has anything to do with the disease, as it is not the same disease as that which autumn fish die of.

Formerly saw a great many more kelts in the river than he has seen this year, and a great many more dead autumn fish, but never saw the spring fish die as they did this year. Used to see some spring fish dead, but not through the disease like this year.

WILLIAM SCOTT, fisherman.—Agrees with William Johnston's evidence. Thinks the disease is due to overstocking at this time of year. The fish going up in September and October are not spawning fish, and most of them die unspawned during the winter. Has seen them and opened them.

Agrees to the proposal as to the alteration of the weekly and annual close seasons.

All kelts should be killed. There has always been plenty of big fish. The big fish came up formerly, but were not caught, as fishing only went on to 7th October.

JAMES SCOTT, brother to previous witness.—Has heard what his brother has said, and agrees with him.

JAMES EASTON, Tillmouth.—Agrees with the evidence and corroborates William Johnston.

WILLIAM SWAN, Twizell.—Agrees with the evidence, and has nothing to add to it.

JOHN SWAN, fisherman, Twizell.—Agrees with the foregoing evidence, and has nothing further to say.

WILLIAM MALCOLM, fisherman.—The salt water comes up about 12 miles, as far as Northam, six miles from here. Has seen diseased fish. The cause of it is that the fish are too long in the fresh water. They are perhaps five or six months in the fresh water. They would bring a deal of money if they were killed. The fish begin to decay directly they are in fresh water.

The disease is contagious. Last year many clean fish went up and caught the disease from the fish in the river.

WILLIAM ROBSON.—Has known the Tweed for 60 years. Has seen diseased fish in the spring for 40 years. They were all kelts. Never saw the clean fish affected till this year. It is a distinct disease this year. Has seen a few clean salmon diseased from mixing with the kelts. Has seen white spots about the nose. Has seen the spots in the earlier stages without fungus. The fungus follows the disease.

The length of the winter has caused the disease. The winter began in November, and lasted till the beginning of February. Never remembers anything of the kind before. It was twice as long as an ordinary season.

A combination of causes has led to the disease. Insect life abounds in all rivers, but this year the fish could get no food, and got starved. At Cloven Ford could see salmon, 20 lbs. in weight, just falling down, quite listless, and without any motion.

The pollution may help to cause disease, but the severity and length of the winter has been the chief cause.

Minnows and eels have burrowed, and the salmon have had no food. The pools also were covered with ice, and the fish could not get into them for warmth.

The disease is produced by natural causes, and will die out.

The fish will recover in salt water. It is a river disease.

Has seen a few bull-trout diseased. They are a stronger fish than salmon.

Kelts should be killed. Has seen six fry in a bull-trout keit. Under the old law the nets caught all the bull-trout. Remembers 50 years ago 50 or 60 bull-trout being taken in one net in a night. There are ten bull-trout now for one when he was a boy. They breed in the tributaries. Salmon are never seen in the Whitadder.

The disease is owing to the state of the river the last year.

The condition of the Whitadder was the same as that of the Tweed.

A few bull-trout were diseased, but not one tenth of the number of the salmon diseased. The bull-trout are different from the salmon, and this explains the fact that there was no disease in the Whitadder, which was similarly circumstanced to the Tweed. Trout are stronger than salmon, and are nearly recovered after spawning, when the salmon are very weak. Bull-trout kelts are generally free from disease.

Has seen smolts and minnows affected.

The fish were starved, owing to all insect life being killed, and they had to go into stagnant water, where the water was not running. Hence they became "overcrowded." The length of time they were in fresh water also helped the disease. More severe frosts have been known, but it was the continuance of it that did the mischief.

The disease broke out in the Esk and Eden in the previous winter, which was mild.

Heard of a salmon that was caught at Carham, and six weeks after it was caught with the hook in the Tyne.

The disease in the Esk and Eden in 1877-8 might be due to prior circumstances. On one occasion a great deal of lime was thrown into the Tweed, and cartloads of fish were carted out of the locks near here.

WILLIAM SCOTT (*recalled*).—Caught some diseased clean-run fish in the spring of 1878—at the end of April or beginning of May. Perhaps six of them. Could not tell if they were males. They were a little marked on the head, nearly all the same. They went to market, and no complaint was made. The river was lowish, but not very low at the time.

Town Hall, Berwick-on-Tweed, Thursday, October 2nd, 1879.

PRESENT:

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

GEORGE ROBERTSON.—Was manager of stake-net fisheries on the coast for Mr. Crossman for 30 years. The fisheries have decreased greatly, more particularly the last ten years. His fisheries are at Goswick, south of the river seven miles from Tweedmouth. The disease has been chiefly in salmon and grilse. There has been no decrease but rather an increase of trout. The disease is owing to the way in which the fish come to the coast from the middle of August to the close of the season, when they make for the river.

The river gets overstocked. There are too many fish in the breeding season, but too few in the fishing season.

Has seen no traces of disease in the sea. The salmon and trout are always healthy there.

Knows nothing of the river fisheries. Has heard of the disease, and thinks the season should be extended; that would help to stop overstocking. Used to

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fish to the 15th of October, and many bull-trout were killed then which are not killed now. The bull-trout come up later than the salmon. The bull-trout used to come up as the fishing ceased. The alteration in the close season has preserved bull-trout and not salmon. Bull-trout should be killed more. Cannot say if the Tweed Commissioners would agree with his proposal. Mr. Crossman agrees with him.

Has no other recommendation to make. This would be the best way to get rid of the disease.

Cannot speak as to the spawning beds.

The salmon at the end of August are in good condition. Very few are getting red at the end of September. They are in good condition to the 15th October. Very few are getting red then. They could be sent to the London markets.

Bull-trout are not in good condition as late as the 15th October. After the middle of September they begin to get black and discoloured. Does not think they are good then. Would destroy the fish then, however.

Can say nothing as to the Paris or other markets.

The bull-trout feed upon the young fry. Has caught bull-trout kelts with salmon fry inside them. Does not make a practice of cutting them up. Knows bull-trout kelts from salmon kelts.

Has not observed any sea fish, neither haddocks nor anything else, with a fungus. Does not recollect any disease in 1871.

To prevent overstocking the netting season should be extended.

JOHN SEBRIGHT, manager to Messrs. Marsh and Meadows.—Has been water-bailiff for 18 years. Has seen one fish that had been diseased. It was a good salmon. Saw a diseased fish caught in the Tweed. The fungus was only on the shoulder. When he scraped off the fungus it was quite whole below. The scales were complete. It was a well-shaped, fat salmon. Has seen several fish in the fish-house here in a bad state. The salmon he caught was taken two days before the nets were off.

There should be a longer netting season. The fish are in better condition here than in the Spey or Dee or Deveron, till the middle of October; these rivers close on 26th August. The fishing here should be extended, on account of the condition of the fish. They are in their prime on 15th September. They are in good condition now (2nd October). Has fished in other rivers up to 14th September. The fish here are better than in the northern rivers.

The bull-trout will eat the salmon spawn. Would kill bull-trout all the year round. People would perhaps sell salmon kelts as bull-trout kelts; but if this could be prevented it would be well to allow bull-trout kelts to be caught.

Has seen fish on the spawning beds, and the bull-trout eating the eggs.

Cannot speak as to the kelts eating fry.

Does not get many bull-trout. The netting on the Tweed should be extended a fortnight. The fish coming up at the end of November are fresh fish. Knows the Spey and Deveron. One race comes up to spawn, and is followed by another, and they cut up each other's beds. The fish at the end of November or beginning of December are healthy. The fish before then are spotted and diseased. There are too many spawners for the redds. Would approve of a longer fishing season here, and on the Deveron also. The Spey and Findhorn are earlier still.

There are more salmon kelts than bull-trout kelts, from what he has seen, in the Deveron. Cannot speak as to the Tweed. Sees few kelts in his stake nets. Only fixed nets are used here. Has seen no hang nets here. No net is allowed within four miles of each side of the Tweed or five miles to seaward.

Catches fish at times marked by nets. If the water is clean they do not hurt. If the water is thick they are harmed. Does not get very many here so marked.

The fungous fish he saw was caught by his net in the sea, four miles from the mouth of the river. It was on 12th September. If he had not seen other diseased fish in the fish-house he would not have known what it was. It was spotted on the side. It came off quite easily when he rubbed it. It was like a bluish mark below, like a scald on his own hand. The flesh was quite whole. When eaten it was quite good. It was a hen fish. Thinks the fish was curing.

The fish may have been up the river and have come back again. The flesh below the mark was quite good. There was a good lot of fungus on it. Its fins were not injured. BERWICK-ON-
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Once got a herring inside a salmon at Aberdeen. Cannot say what the salmon eat here.

JAMES NISBET, salmon fisherman.—Had stake and bag-net fishings last season at Lannerton, five miles north of Berwick. Has been there once since. Was at Goswick 14 seasons up to last year with Mr. Crossman. The fishing has been very bad. There are only bag nets at Lamberton.

Has not caught half the quantity this year. All the fishings round Scotland have been bad this year. It is a general bad season. Does not think the fish he catches are all Tweed fish. Salmon have a tendency to go to their own river. Can tell a Tweed fish from a Norwegian. Has caught Norwegian fish here at the back end of the year. They were a blacker fish.

Was watching at Peebles for five or six years, and saw a few bad fish last season. The previous season and the season before that he saw many bad fish. Left Peebles at the beginning of April. Has seen diseased fish there, like the specimens produced, for five seasons. They were mostly male fish. Saw them as far up as Stobo, but not many there.

The disease now is the same as he has seen in previous seasons. Saw nothing in the middle fisheries. It is owing to the hard winters; the ice floating down injured the fish. They are mostly kipper fish. Hardly ever saw a female fish diseased at Peebles. There are too many males, far more than females. Has seen them below the cauld. Did not see many till after the New Year at Peebles. They were trying to get up the river. The male fish got up easily, and the females were left behind at Walkerburn; hundreds lay there because the water fell, and they could not get up.

The fish have to jump up a slope. The water falls perpendicularly down, and the fish cannot get up. Much of the water goes down the mill leat. A pass could easily be made. There is plenty of spawning ground above Walkerburn. There are Manor, Lyne, Biggar Water, Spiddal Burn, and other tributaries containing above 100 miles of water. The fish should be passed up. Knows Walkerburn Dam well. The millers let the water run down the leat on a Sunday. The water should be passed over the cauld. When the water is small it would make little difference. The cauld is not 2 feet high. Thinks the owners would allow a secondary weir to be built below the cauld.

GEORGE BROWN, tenant of Captain Milne Home's fishery at Paxton.—Has been a fisherman all his life on the Tweed. The fishery is below the Suspension Bridge, in tidal water. Always, every year, sees diseased salmon. Never saw it on the head till the last two years. There has been plenty of fungus on the kelts for years past, but never saw a clean fish till two years ago. Saw it first on kelts, and afterwards on clean fish in the spring (March and April) of 1878, and also last year. It was worse this year than last. It was all over the fish. Never saw fungus on the head till 1878. Always saw kelts dying and dead in former years in shallow water, but first saw clean fish in 1878 and 1879 diseased with fungus. Many of them never recover.

In 1878 it was ordinary weather. The river was in ordinary state, not very low. This year the river has not got very low. It was cold at the beginning of the season. The clean fish and the kelts were coming down.

The foul fish are too long in the river, and become attacked. Not so many clean fish were attacked in 1878 as in 1879. No clean fish came up from the sea diseased. Believes more clean fish were attacked because there were more clean fish up the river early in the year. There was a great run of clean fish in February 1878 and in February 1879. The fish died in his water. Not very many got to the sea.

Gets the same fish over and over again, at different fisheries, and finds they are getting worse.

All the foul fish should be killed. All the kelts should be killed. Kelts were once allowed to be killed, and since this was stopped clean fish have got scarcer.

The water is not salt at Paxton. When the river is small it tastes a little brackish at high tide. Net fishing should be continued longer, because more bull-trout would be killed.

They devour the salmon spawn.

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The Tweed Acts are a good deal wrong. When the close season lasted only three months, before 1831, there were plenty of fish. The close time was from 10th October to 10th January. There was not so much rod fishing then. Would have an extension of the net fishing to improve the river. It would help to cure the disease.

Thinks it is "poverty" that brings it on. The clean fish catch it from the unhealthy kelts. Cannot say why the clean fish did not catch the disease before 1878. There was pollution then. The clean fish were never affected on the skull till last year. The disease is like a cancer. The cancer on the head was never seen on the old kelts. Has seen river trout with the old disease. The fungus on the clean fish is the same as the fungus on the kelts formerly seen.

Lives near the Whitadder. A few salmon may go up it. The bull-trout go up. They are diseased. There are foul fish in the Whitadder. Does not fish the Whitadder, and cannot speak much about it. The Whitadder is usually as clean as the Tweed. The Blackadder and Whitadder both come from peat.

JAMES PAXTON, Superintendent of the Berwick Shipping Company, Horncliffe.—Has been so for 25 years. Never saw the disease on clean fish till this year. Has seen kelts in former years with fungus on them after they had been in the river a long time. Has not seen many clean fish attacked. Some of them were eaten quite into the brain by a deep cancerous sore. It has been very bad, especially on the head, in many clean fish. Has seen the sore without the fungus; it is like a raw sore. Has seen much flesh eaten off its head. Cannot say if he has seen fungus on clean fish formerly, but has seen old fish in former years all covered with fungus.

Has known the Tweed for 60 years. Formerly there were many bull-trout. The greater proportion of trout was caught in the middle of September. They were dark coloured fish, but good.

Thinks salmon and trout run up all the winter. Formerly used to fish till the 10th October. Thinks they stop too soon now. All the valuable fish coming in after 15th September are lost now. They are in first-class order. The best salmon are lost. An extension of the netting would help to stop disease. The fish run up long before spawning, and if they were caught they would not get crowded up in the river and lead to disease. The fish about December are in good spawning condition.

Large fish go up as far as Peebles. Too many spawning fish are brought up, one batch after another, through the long close season. They destroy each other's spawn.

Kelts might be killed, but the preservation of kelts has led to an increase in the size of fish. Bull-trout kelts might be killed. Overcrowding and the long stay of the fish in the river have helped to cause disease. The net fishing should be extended to 10th October. The fish injure each other.

It is many years since there was such a long cold season as that of 1878-9. Cannot recollect another such.

As a rule too many fish get up in the autumn. The fishing should be extended to 10th October.

Was a water bailiff for 20 years from Carham to Berwick—16 or 17 miles. Sometimes went up as far as Peebles. Knows the river from Peebles to the mouth.

Was never close to Walkerburn. The salmon try to get up over Peebles cauld. There is a slap in it. It is a great obstruction. Many fish spawn below it. A good slap should be made in it. There is good spawning ground above in the tributaries.

Much poaching takes place about Peebles. Many fish go up.

Peebleshire is the best spawning ground. Few clean fish, but many kelts, are caught there. Anglers are displeased at not being able to kill kelts. Clean salmon seldom go up.

The floods do not last long now. Formerly, before there was so much drainage, they continued twice as long. Gauges of the river should be kept always. There is one at Kelso.

Pollutions may have something to do with the disease. The river gets fouler than formerly. The bed of the river is covered with a green deposit. Does not think the river is shallower as a general rule.

If fishing were allowed to 10th October, the fish would be in the best condition. A salmon was caught a short time ago on 10th October for the

Experimental Committee of the Tweed Commissioners. It was an excellent fish, and quite fit for the market.

If the nets were allowed to go on, there would be sufficient fish left for the rod. The nets do not take all the fish. The fish begin to take the fly about 10th October.

The 6th section of the Act of 1857 is strictly adhered to. Has no objection to kelts being killed. The kelts may be caught many times by different nets, or even several times at the same fishery, and they get exhausted in consequence.

Has heard of the clause in apprentices' indentures against eating salmon more than once a week. Fish were formerly very plentiful. There was a custom for every beggar to ask for a fish at every fishery.

The railway came here in 1846.

A great shoal of black trout came in in the middle of September. They destroy a good many spawn. These fish are good for food, especially as kippers. Has seen them selling at less than 3d. a lb.

Never saw disease on clean fish before 1878. Mr. Brown may have seen it. If it had existed he would have seen it. The fish with the raw sore had not, he thinks, been in the salt water. There was no fungus. Cannot say if the fungus had come away. The sore was close down to the bone.

ALEXANDER LILLIE, fisherman, Paxton.—Fishes for the Berwick Fishery Company. Has known the Tweed 53 years. Has seen no disease till last year—1878. Only saw one that year—in April. It was a clean fish. Kippeded it. It was in good order. It had been a little while dead. Got it in the net, and it was dead. The fish was diseased all over the body, and a little on the head. The fungus was all over it. Found no sores. Did not remove the fungus. Opened the fish; the inside was all right. Nothing wrong with the liver. This was the only diseased fish he saw in 1878. Saw plenty in 1879. Saw the kelts coming down then. Never saw diseased kelts before. Most of the kelts were diseased—head, body, and all. They were worse mended than usual. The disease extended to the clean fish. Saw 10 clean salmon diseased all the year. Saw 200 not diseased.

The clean salmon were diseased before they became more plentiful. There were too many fish in the river. The last two years there were no fish in the river in the summer, but too many in the spring. The river was overstocked. Recollects ever since the new Act the fish have been scarcer in the fishing season. In the spawning season they have been plentiful. The fish have been more plentiful in the spawning season and fewer in the fishing season. Has seen a great many fish in the spawning season going up both the Tweed and the Whitadder. After the net season was over the fish came up. It is their season to come up then.

Never saw such a mortal disease. Never saw clean fish diseased before. If they had been diseased he would have seen them. Has seen kelts with fungus on them for 50 years. It is quite a different disease to the fungus on clean fish. The wound on the head causes death. The place on the head eats entirely into the brain. There is no fungus on the head. It is not the same fungus as the old kelt fungus. The fungus does not grow on the "trouble" on the head. Has seen far worse fish than the specimens produced. The fungus is caused by "poverty." By itself the fungus will not kill.

The fish get up the pools and have no room. It is poverty that causes the sore.

Fish require a great deal of water. Put two or three kelts in a deep pool, and in three or four days they were attacked by fungus.

Would have another month's fishing with the net. The fish get up and do not spawn because they get into a low state and cannot spawn. The real months for fish to go up to spawn are November and December. The close season was altered because of the rod fishermen. The river is entirely useless. The anglers might agree to altering the close time.

The fish have got fewer and fewer as there have been three, four, or five months of close time.

The kelts should be killed. They eat the spawn and turn up the gravel. Has seen them do it. Would kill all kelts. Would sell them. They are wholesome enough.

Since kelts were preserved the fish are not larger. Saw as big fish 30 years ago as now. The kelts do not come back. Kelts used to be sold and caught as kelts. They were sold cheap. Would like to return to the old law. The

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river could stand an extra month's fishing and the killing of kelts. The kelts should be killed at the beginning of the year. Would not change the rod season.

Had a diseased fish (trout) in 1874. It had come down with the kelts. It had caught the disease in the river. It was an average specimen.

The salmon are worse than the trout. The salmon, he thinks, would all die if diseased.

There have been very few smolts for six or eight years. The spawn is all eaten by bull-trout.

The Tweed will soon be ruined.

Never saw diseased smolts. Has seen yellow-fins; they are fresh-water trout. They had just the same disease as the salmon. Never saw it till last year.

The smolts are falling off. They go down in April and May. There has been scarcely any for 12 years. There has not been a fourth of the usual number.

Seagulls seldom eat smolts.

GEORGE HENRY LIST, Chief Constable of Berwickshire and Haddingtonshire.—Has had charge of the coast, and of the Tweed from the mouth up to Carham, 17 miles, for nine years. First heard of the disease in March 1879. Drew the attention of the Commissioners to it. Examined many fish, and sent specimens to Mr. Buckland and Mr. Stirling.

There were three different appearances—a white mark on the top of the head, a growth of fungus, and a suppurated sore. Has seen cases where the fungus could be rubbed off and left the skin clean. It does not at first attack the large scales, it attacks the soft skin round the tail and fins. There is no sore beneath the fungus. Some sores were eating into the flesh till it was quite red: others were white. They were cancerous sloughing sores. Cannot say which is the first stage. Did not make experiments, not wishing to make too public the fact of the disease. Proposes experiments this season. It is most important to ascertain the causes. His impression is that the disease is the fungus, which eats into the flesh. Cannot say if it leaves its root in. The fish he has seen have had the skin quite entire, and yet were affected by fungus. It kills when it affects the head and mouth. Has heard of it in the mouth, but has not seen it.

Has no opinion as to the cause. Thinks overcrowding in certain pools during the frost and ice, not overstocking, may have been a cause. The fish so crowded would be liable to disease. Has seen wounds from fighting. The sores this year are quite different from such wounds. Has never seen it before nor heard of it. Few males died this year. Every year there are many dead males, but fewer this year.

Received authority to remove all dead and diseased fish.

[Hands in a return of salmon, grilse, and sea trout, found dead in the River Tweed between Berwick-upon-Tweed and Carham, and buried above flood mark by the river police in May and June 1879. It is as follows:—]

—	Male.	Female.	Total.
“ Diseased fish :			
Salmon - - - -	115	364	479
Grilse - - - -	2	10	12
Bull-trout - - -	54	133	187
	171	507	678
“ Dead, but not diseased :			
Salmon - - - -	9	16	25
Grilse - - - -	—	1	1
Bull-trout - - -	28	22	50
	37	39	76
Grand total - - -	208	546	754

The following is a return showing the proportion of spawned and unspawned fish :—

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	DISEASED.		Total unspawned.	Total spawned.	NOT DISEASED.		Total unspawned.	Total spawned.
	Males.	Females.			Male.	Female.		
“ Salmon :								
Spawned - -	91	237	—	328	8	13	—	21
Unspawned - -	24	127	151	—	1	3	4	—
Grilse :								
Spawned - -	1	9	—	10	—	1	—	1
Unspawned - -	1	1	2	—	—	—	—	—
Bull-trout :								
Spawned - -	54	132	—	186	28	22	—	50
Unspawned - -	—	1	1	—	—	—	—	—
	171	507	154 524		37	39	4 72	
			678				76”	

This includes 14 female salmon, clean fish, diseased.

Could not say if these clean fish had been up the river and had fallen back again.

On 31st May got a diseased sea trout near the Whitadder which was put into a floating cage in the water opposite the quay : the fish died on Sunday week ; it had a sloughing sore, but it was quite healed when it died. The salt water will cure the disease. A fish placed in pure fresh water at a distance from the original place where it was taken will also heal.

Urged that diseased fish should not be killed, because he thought they would heal both in fresh and salt water. Was disinclined to urge the slaughter of all diseased fish. Proposes to carry out experiments next spring. At present little is known about it.

Has considered the argument for an extended fishing season. The run of fish up to September does little good to anglers. They do not take the fly readily. They deteriorate. Thinks their ova do not come to maturity. Thinks fishing should go on to 1st October. Has had charge of the experiments carried on by the Tweed Commissioners for nine years, and has tested the fish every year up to November and December, and has found them very good indeed in October and November. Has seen three, four, or five fish tested in October every year, and they have all been good.

The anglers will object to an extension of the netting. The middle netters propose another six hours' weekly close time. The lower proprietors would object to this.

Thinks if the fish were transferred up stream, and lay in the pools in the middle of the summer, they would sicken and tend to disease. There would be no objection to extending the clause as to restricting netting. The fish would fall off in the upper waters, but the middle fishers would be benefited.

The dead fish should be taken out and buried above high water flood mark.

Smolts are certainly diseased. Sent one to Mr. Stirling. It was a salmon smolt, diseased under the throat. It had its sea-going dress on.

The sea-trout are also diseased. Perch, trout, and eels are diseased. Has heard of grayling diseased, but has not seen them.

If a market can be found, the bull-trout kelts should be killed. Would hesitate as to salmon kelts. Salmon kelts would be taken and sold as bull-trout kelts, and bull-trout would be sold as salmon. The watchers would have to be more numerous. There would be unpleasantness between the watchers and the fishers.

The preservation of kelts has tended to increase the size of the fish. To kill them would reduce the size.

The Crown, in exercising its right to salmon fishings, has let its fisheries the last few years. Speaks especially of the Cove fishery. It let formerly for a fish a year; then for 5*l.*; now for 90*l.* Heard last year that the take was one and a quarter tons on a Monday. These are new fisheries. Can the breeding ground bear this great drain? The mode of fishing has been extended from small fly and bag nets to outriggers, and three bags instead of one which break up the shoals as well as intercept the fish. There are 200 or 300, he thinks, of these fisheries round the coast which were unfished 30 or 40 years ago.

Thinks there must be an Act to authorise artificial breeding ponds. It is calculated that not one in 1,000 eggs ever comes to maturity naturally.

All unchartered waters belong to the Crown. These are now being let.

There is a falling off of fish all round the coast. If there are 200 more fisheries now than formerly, and little additional breeding ground, the destruction of stock must be enormous. This is all round the coast, and not only near the Tweed.

The Tweed Commissioners have instructed the water bailiffs to report all weirs that are destroyed, and insist on passes. If Walkerburn is broken away, a pass will be made. The Commissioners have endeavoured to induce the owners to build a pass.

The Peebles cauld is a great obstruction, and fish could hardly get above it even if the fish were passed above Walkerburn. Kelso, Walkerburn, Peebles, and Selkirk cauld are all obstructions. There should be powers to enforce passes, but this would interfere with much property, and many would cost much money.

124 of the diseased females returned as unspawned were gravid fish in May. These figures refer to the water below Carham. Cannot say if they had dropped down the river. Such a thing never happened before. There was nothing apparently to prevent them spawning. There were 23 males. The spawn was ready and loose.

It would be objectionable to allow the sale of kelts. They are not worth 2*d.* per lb. Their sale might give salmon a bad name, and depreciate the value of salmon. Would rather deal with kelts as clean fish. If the trout could be killed up to 1st November and sold by the Commissioners, and their value applied to a reduction of the assessment, it would be a more practicable plan. Anglers would object to an extension of the net fishing season, unless they got an equivalent. The influence of anglers is too great, and Parliament would not agree to it. If it were proposed to alter the law, the angling season would be shortened by a month. The latest Scotch rivers close on 9th September, and there are already five days longer on the Tweed than on these rivers. Legalizing the killing of bull-trout kelts means, that if a man is found with a sackful near Kelso he could not be touched. Poaching salmon would be encouraged. If the possession of bull-trout kelts were allowed, poaching would be encouraged. Fish caught by rod are now sold, and it is difficult to stop it.

Many salmon kelts are so injured by spinning tackle and worm fishing that they die. There would be an opposition among the net fishermen to allowing anglers to kill kelts after a certain date. The extension of the netting season to the end of September would not affect the disease.

The fish going up after the close time add to the number of sickly fish, and so conduce to disease.

Has heard that salmon are extinct in the Coquet. If the bull-trout were killed out of the Whitadder, it would not, he thinks, hold a single salmon.

Bull-trout might be caught for exportation, but they extend over such a large area that it would be difficult. Parliament would hardly allow the food to be exported when such a scarcity exists that food is imported from abroad. The Tweed is very similar to the Coquet.

It is a pity that the dams should remain impassable. It is difficult to ask a proprietor to pull down his cauld and make a slap. To pay the expense out of an assessment would make the amount too high. It would be advisable to pass the fish over the weirs.

Has got the owner of the mill on the Whitadder to put down his hatches on a Sunday, but the fish will not go up. In three days the bailiffs took out 1,200 bull-trout and put them over the weir. This was five years ago. Would rather have a pass to utilize the Sunday water. Has found the proprietors ready to do anything they can if appealed to.

There is no power to put hecks at the bottom of the mill leats. This would be advisable. The owners of mills object to any interference. At Churnside paper mill the proprietor put up a heck on being asked. The fish do not go up the leat, and the heck is repaired annually and kept in order.

It would be desirable for the provisions of the Scotch Acts on these points to be applied to the Tweed Act.

The mouth of the Tweed alters slightly every winter. The Harbour Commissioners can say if there is any permanent alteration in the mouth of the river.

Approves of burying dead fish. Such work would be part of the experimental powers of the Commissioners.

The females could not get on to the spawning beds for eight weeks. This would account for the large number of females found unspawned. Thinks they were so weak that they could not go over the caulds. Previously it was the reverse: the dead males were more numerous.

GEORGE L. PAULIN, Secretary and Manager to the Berwick Salmon Fishing Company.—Has been so for 20 years. Very accurate statistics of the fishery have been kept. His father was manager before him. Never heard of a disease before, and his father never spoke of it. Has had his attention directed to it this year. His waters are quite tidal. No diseased fish was found there before 19th April 1879. On the 20th there was another, and from 19th April to 15th May there were 38 diseased fish. On 23rd May another was taken, but no more till June 9th, when two were found; on June 18th one; on June 17th one; making a total of 43 salmon. 21 of them were taken at the mouth of the Whitadder.

They were all salmon. Saw also three diseased bull-trout; there may have been one or two other bull-trout, but has a record of only three.

The salmon were brown and discoloured, with a brownish-red coloured fungus. Agrees with Mr. List's description of the disease. Saw a white mark below the fungus, when it was rubbed off, on one or two fish only. Cannot say if the white mark was caused by the fungus or *vice versé*.

Saw one fish with a suppurated head. The fish in the upper fisheries were not worse than in the lower. The water is saltier in parts, and the fewer fish were seen in the saltier water. The fish were not getting well in the salt water. His idea is that the fish were seeking the sea, having been a little time in the fresh water. They were going down.

Heard Mr. List's evidence as to the gravid females found dead in May. Caught none in his nets.

Has had no opportunity of seeing kelts. His men would hardly have reported them as diseased. Some fishermen have told him of kelts with fungus in former years.

This year is one of the very worst seasons he has known. There was a singular absence of salmon in the river. Has statistics of the number of kelts caught. They were much the same this year as formerly. There was no excessive number of kelts this year. Some of the kelts might have come down later. The kelts coming down in his district are not all seen. Many may go that are never enclosed in his nets. Many kelts are caught 10 or 15 times over. Still if more kelts were there he would have had more caught.

Has no theory as to the cause of the disease. Has heard all the evidence. The general idea is that there has been an overcrowding of fish in the pools with very little water. Besides this there must be some original cause.

To prevent the recurrence of the disease the diseased fish should be killed. If near the tideway the fish should be brought down. A certain distance above they should be killed. They may recover, but still they may convey the disease to others. A line should be drawn at Cornhill; below there the fish might all come down or might be brought down. Above this they should be killed if they could not be brought down.

A very large quantity of fish go up in September. The greatest take of fish in his early days was in July and August. Now it is in August and September. The fish are later. There is a great decrease of grilse. The fish going up at the end of September are in good order and quite saleable; they deteriorate in the pools above, and do not spawn, and die. The fish decrease in weight as they lie in fresh water. Fish will decrease in weight 1 lb. in the pools in the tideway. In 1863 he found that (there being no rain for six

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weeks) the fish were 1 lb. less in each month than the fish taken by him on the average. They fell off in the upper tidal waters, and still more so in the fresh water higher up.

During the 16 days of the September fishing more fish are caught. On 13th September this year over 70 salmon were taken in one tide at one station—48 in one net. The great run of fish was only then beginning.

[*Produces table showing the periods at which the fish are taken.*]

The trout crop is exhausted by the middle of the summer.

The grilse are much the same.

With salmon the highest take is at the very end of the season. There are apparently three shoals of fish coming in. The mass of trout run in June; the autumn school run after 30th September.

Would be in favour of extending the net season for the benefit of all parties. The date should be decided by experiment. The returns of former years might be referred to. The proposal would be for the general good. Some of the upper proprietors might object, but they would not suffer. The rod fishing would not be interfered with.

Would not kill the salmon kelts. Thinks the kelts come back as clean fish.

Believes the bull-trout do not come back as clean trout, and there is no increase in their size or number. If they do not come back they go to Yarmouth. Bull-trout kelts should be killed if they do not return. Has it recorded that they have been caught at Yarmouth and Tynemouth.

Formerly the sale of kelts was legal. Cannot say where they were sold. An upper proprietor told him that the kelts were killed annually, and fetched 30*l.* or 40*l.* a year.

Many bull-trout might be sold as salmon. This would not interfere with the prosperity of the salmon fishing. Has no other recommendation to make.

The disease is quite new to him.

The fungus only appeared formerly on the kelts, and so did not excite attention. The breaking out of the disease on clean fish and in other rivers has attracted attention.

Would prefer the close time to be made a hard and fast line, and not be liable to change by local byelaws, as there might be much difficulty in settling any change. The close time could be altered with advantage.

Thinks the fish have been predisposed to disease by overcrowding in the pools. Thinks the origin of the disease has not been found out. Thinks the fish get too many in a pool, fall into a low state, and contract disease.

Will do anything he can to make experiments; but is unable to suggest any steps.

R. B. WEATHERHEAD, solicitor, Berwick.—Has heard the evidence, and has paid much attention to the Tweed from his infancy. The cause of the predisposition to the disease is the overcrowding of the pools. Fish of all kinds require much oxygen. If the water is not aerated they will not live. They absorb all the oxygen if overcrowded, and become predisposed to disease. Diphtheria is caused by malarious exhalations, and the fungoid growth on the fish is somewhat similar. The want of oxygen in the water will predispose to, if not actually cause, the disease. Has observed the description given by Mr. List of the three stages of the disease. Has only seen two or three diseased fish. There was a fungus as well as a suppurating sore; and a sore without the fungus. Cannot say whether the fungus or the sore is the cause or the effect.

The disease is a fresh-water disease. Thinks salt water may cure it. In the tideway the fish get more aerated water. Thinks whenever fresh water is given in sufficient quantity the disease could be cured. The salt water is the natural element of the salmon: when they enter the fresh water they become weakened, and lose colour, fat, and health.

Thinks the fungus is contagious. The overcrowding of the fish tends to disease. There are too many spawners.

Would make a fixed rule as to the sale of kelts; but would make much more stringent laws as to the killing of baggits. The kelts would be well out of the water. His father was one of the directors of the company. The company were unwilling to kill the kelts, but some fishermen and occupiers at

Whitadder mouth killed them, so the company did the same. In the following season there was an immense increase of fish. This would be 40 or 50 years ago. They ceased to kill the kelts, and the fishing fell off. Some years afterwards the kelts were again killed, and in the year following the take of fish increased. Cannot say if the *post hoc* is a *propter hoc*. Experiments have been made to see if the bull-trout kelts returned; but no bull-trout kelts have ever been caught after returning. Instituted experiments with Mr. Paxton in 1850. Marked a lot of black fin and orange fin smolts, and five per cent. of the black fins were recovered in 1851.

None of the fish that were marked as orange fins were recovered; if they had returned they ought to have been found marked.

There is no evidence that the kelts ever returned.

Would allow fish to pass over the caulds. This could be done with the consent of the proprietors. Invented the secondary dam principle 40 years ago in the Till.

The later fish destroy the spawning beds of the earlier schools.

To prohibit the sale of kelts is to deprive the public of a large amount of food.

Would propose that kelts should be killed, but that possession of baggits should be more severely punished.

In section 72 of the Act of 1857 a provision exists to recover penalties before county courts.

The Act of 1857 was passed under a misapprehension.

Attributes the disease to the fish remaining long in the river before the spawning season. The overcrowding of the kelts would also predispose to disease. The early fish wait to get over the pools, and cannot get up; but the later fish get up and spawn without delay.

Cannot say if snow-broth has more oxygen than rain-water. Thinks the freezing of water does not remove the oxygen.

W. HOLMES, fish merchant, Berwick.—If he owned the Tweed he would not fish the Tweed till 15th March; and would go on to 15th October at least. Would kill trout all the winter in the small rivulets, and sell them on the continent. Would apply the produce to defraying the expenses of watching the Tweed. Would allow rod fishing all the year round.

If trout kelts are not killed the grilse will be extinguished. The olden times should be recurred to. The baggits should not be killed; but killing the kelts might be made legal.

R. B. WEATHERHEAD (*recalled*).—Agrees to fishing all the year with the rod under certain restrictions.

Balmoral Hotel, Edinburgh, Friday, October 3rd, 1879.

PRESENT:

FRANK BUCKLAND, SPENCER WALPOLE, and ARCHIBALD YOUNG,
Esquires.

GEORGE MUIRHEAD, factor to several estates in Berwickshire.—Has known the lower portion of the Whitadder for nine years. It is chiefly a bull-trout river, and also has some common trout. Has never seen salmon in it. The fishing for river-trout has fallen off for ten years, owing to the number of bull-trout which prey on the fry. This is the general view among anglers. Yesterday he was told that the take had fallen from 10 trout in an average day's fishing six years ago to 6 trout a day now. The trout fishing in the Whitadder would be improved by destroying the bull-trout. The Tweed Commissioners should have power to net the bull-trout.

Has seen diseased bull-trout with a fungoid growth on the head. First saw it in 1877, about the end of April or beginning of May. Saw it on bull-trout in the water. The trout used to come to the side of the water, and were milky-white about the head. Did not catch any, but thinks it is the same disease as that among the salmon. There were whitish spots on the head and neck.

EDINBURGH. Thinks the fungus is the disease. Thinks the spores of *Saprolegnia ferax* are more or less in the water always, and seize on any substance congenial to their growth. Cannot say if the fungus lives in salt water. Saw one or two bull-trout lying dead, partly covered with water. Thinks they were killed by the disease.

It attacks the fish in the pools in low water. They could not get over the shallows, and being prevented from getting up or down, they got into a weak state and became attacked. Thinks the overcrowding of certain pools is the cause, not the overstocking of the river. The fish can, he thinks, get up the Whitadder, but is not sure. Has not heard of any new dams being erected during the last 20 or 30 years.

The bull-trout, being crowded in small pools, are predisposed to disease. Thinks facilities should be given to fish to get down to the sea at all states of the river. Speaks only of the Whitadder. Does not know the Blackadder. Imagines the fish go up it.

Thinks the value of the sea fishing has increased very much the last few years. Many more fish are taken in the sea than formerly, owing to the improved engines for taking them.

A. B. STIRLING, assistant curator of the Anatomical Museum, Edinburgh University.—Has examined many cases of salmon disease. First heard of it in March 1878 from Carlisle. Dr. Philip Hair sent him part of a salmon. It was a good deal mutilated. Saw it was attacked by fungus. Afterwards received two river trout and one sea trout. Ascertained the fungus to be the *Saprolegnia ferax*. Had some whole fish sent to him. They were all attacked, and in all parts of the body. The worst injury was generally on the head. Has also had specimens this year from the Eden, Nith, Caldew, and Tweed. The disease was identical in each case.

[*Produces specimen of testicles of a male salmon.*]

The spermatic ducts are injected with red. It is intended to show the healthiness of the organs in a very diseased salmon.

[*Produces the ova of a female fresh-run fish taken at Berwick.*]

The fish was very much diseased, but the ova are healthy.

[*Produces the cloaca of a female salmon to show how the ova escape.*]

Much has been said of fish not being able to spawn, owing to detention and being prevented from reaching the beds. When the ova are ripe, and dehiscence takes place, spawning cannot be retarded. The fish has no power to retain the loose ova, even for a short period. The mere motion of swimming would cause the ova to extrude. The abdominal pore is always large, and much larger during spawning. There is no ovi-duct.

The ova and ovaries produced were taken from a fish sent by Mr. List on 11th April. The fish had 24 patches of fungus, some of them 4 inches long, one in the mucous fold of the mouth. The fish could not breathe freely, and would have died from its effects. The whole of the germinal membrane was healthy and full of next year's germs.

It was an abnormal time for the fish to be gravid.

Ova ripen at different seasons. The ova are not mature till they are separated. It is remarkable that Mr. List should find 124 female fish in May with the ova ripe. The ova would have run out if dehiscence had taken place. Redispersion of the ova in the ovaries cannot take place.

The male salmon seeks the eggs, and is content if he gets the eggs and sheds his milt over them to fructify them. There is no sphincter muscle in the abdominal pore of a female salmon.

The disease cannot have arisen from the retention of ova. Has seen more females than males diseased. They have been clean fish mostly. Has seen spawned fish diseased, both male and female. The fish from the Caldew was spawned. It was killed on the 2nd February 1879.

The fungus has been well-known since 1836. Its mode of reproduction is described by German authors and by Dr. Burden Sanderson. His own observations agree with their descriptions. The fungus is both a-sexual and bi-sexual. First, there are zoöspores which are very plentiful, hundreds in a spore case. They are produced in the filaments of the fungus. The zoöspore produces a plant which produces another spore called oöspore. These are found in a globular cell called *ogonium* by botanists. These are different from the zoöspores. Has only seen four cases in which there were from four to eight spores in each

ogonium. These are called "resting spores" because they do not die for some time. They are emitted and rest. Cannot say what they fasten on. When they settle, and the plants grow, then the plague commences.

The *Saprolegnia ferax* has been known many years. It is present, he thinks, in all waters, at all times.

Cannot speak as to the temperature favourable to its growth. Botanists say there is a climatic influence of which they are ignorant. It is equally present in both pure and impure water. It is not proved if impurities are favourable to its growth.

The resting spores of the fungus may be in abeyance for an indefinite time, and propagate under certain climatic influences. They might rest for many years, and in a year like this, when the hawthorn was everywhere in blossom, the fungus might produce thousands of plants with zoospores; the oöspores may have rested, and at last spread under peculiar circumstances.

First saw it in the Tweed in 1878 and in the winter of 1879. The winters of those two years were very different from each other. Perhaps the number of oöspores was not plentiful enough to reproduce the *Saprolegnia ferax*, although the peculiar circumstances may have existed in 1877.

The sporadic cases of fungus on unclean fish, similar in appearance to the *Saprolegnia ferax*, were perhaps the same fungus.

The new fact is that the clean fish have been affected. The action exerted by the fungus on the fish is mechanical. The number of small fish affected in the Eden was hardly 150 of big fish. The spores lighted on the big fish easiest. The head being without scales is usually first attacked. A kelt in a slimy state would hardly be more favourable for their growth than any other fish. Has seen specimens from fish slightly as well as seriously affected. The first symptom is a small spot, quite invisible till it has grown for hours. To the naked eye it would be a white scurfy spot. Under the microscope it is seen to be covered with filaments which cannot be seen by the naked eye. They grow into long hair-like filaments. Made a cord from the fungus and tied up a roll of paper with it. It held the papers for a day, but broke when dry.

The fungus absorbs the mucus and eats through the skin. It continues to grow until a counteracting influence appears.

Sir Robert Christison sent him a grayling from the Nith. In one day the fungus grew all over the fish. It grows on dead fish. It kills fish by hiding the light, preventing endosmose and exosmose at the skin, and by suffocation.

Has seen many cases of fungus inside the mouth. The attack in the mouth is more deadly.

At first thought the affected fish might be in a condition predisposing to attack, but after observation does not think there is any functional predisposition to the fungus disease. All kinds of fish and in all conditions are liable to it.

It adheres more readily where there are no scales.

Thinks the fungus is the same on both clean and unclean fish.

The action of fungus is mechanical. The attack of fever in human beings is zymotic. It is purely cutaneous. The fish might contract the disease by contact, but the fungus is matted with mucous, hair, sand, diatoms, and all kinds of rubbish.

Cannot say why the disease is confined to the Border rivers. A climatic influence might have existed specially there.

The seeds might be carried by birds. Ducks in the spring, wading among the fungus, might carry it away. It is no objection that the birds have carried it to certain rivers only. It is possible that the disease, being stimulated in one place, might be carried to others by birds. It is not probable however.

[Specimen produced of fungousy fish from the Usk.]

The wound on the right pectoral fin is like a wound from fungus. Its head resembles the head of a fish from which he removed the fungus.

Cannot explain why only the kelt has been attacked in the Usk, and not the clean fish.

All rivers are liable to be attacked.

Salt is stated to have cured it. Cannot say if salt would kill the fungus. Has fungus preserved in salt, which shows the same appearance as before it was put in. Could only dissolve it in *aquafortis*.

The fungus was dead sporadically, but alive vegetatively, on all the fish, with one exception, he has received.

The overcrowding of fish in pools would not, he thinks, cause the fungus. Overcrowding and hunger would tend to indisposition. But water is always passing over them. It is not as if they were confined in a room, and overcrowding in a stream would not predispose the fish to disease.

The fungus would break out whether there was overcrowding or not.

The evidence as to British Columbia does not show that the prevention of overcrowding would prevent disease.

The fish should have free access up and down the rivers. They should be enabled to change their ground, and get to the sea if necessary.

The burial of dead fish would be an advantage, by reducing the disease by the extent to which it exists on these fish.

When fishing the Tweed on 14th August 1877, he saw salmon lying in the water covered with fungus, looking like a sheep's back covered with wool. Could not examine them because he was afraid of the law. The fish were completely covered. Thought the fish were logs of wood. The fish were dead, and rotting in the water. They must have been a source of pollution. Would let the diseased fish get to the sea. The fish themselves would not know what was the matter with them, and so would not go instinctively to the sea.

A fresh supply of water might wash away the fungus. Cannot think it would kill it. Thinks female fish will wound each other, but the male fish could not. A spore falling on a wound might infect the fish, but it would not grow any faster on the raw flesh than on the mucus of the skin.

[*Parr produced taken in the Tunnel and supposed to be diseased.*]

Sees no evidence of disease on it. It is a healthy well-fed fish.

There are other fungi fastening on fish.

The ordinary fungus in aquaria is a confervoid, and belongs to a distinct family. Has tried to grow *Saprolegnia ferax* on the house fly. The fungus he has seen on the house fly is not *S. ferax*. *S. ferax* is a water fungus. There are analogous fungi, green in colour, while the *S. ferax* is white.

The minnows referred to by Major Dickens must be attacked by some other fungus.

Has tried to grow *S. ferax* on minnows. Put in a piece of fish covered with mass of fungus. The minnows ate the fungus and remained in perfect health.

Thinks the disease will die out.

[*Gold fish produced attacked with a fungus, taken from some ponds near Dumfries.*]

The confervoid fungus grows on the edges of the fins. The fungus on the gold fish is not *saprolegnia*.

A fish out of health would take a fever more easily than a healthy fish, but the mechanical action of *S. ferax* does not require unhealthy fish. A kelt is healthy, but in an abnormal condition. Unhealthy fish crowded together would get still more weak.

Has spawned fish artificially occasionally. Does not know that a fish can retain her eggs for five minutes.

The eggs in the specimen produced were out of the ovaries and loose in the abdominal cavity. The eggs he took had no white speck on them. They were not "blind" eggs. The eggs produced were all in the fish, which was about 8 lbs in weight. The next year's eggs were appearing. The fish was staid in the return to be a spawned fish.

The female cannot retain her ova after dehiscence. A female will shed all her ova in a day. A male fish can, he thinks, retain the milt. The eggs fall simply into the abdomen when ripe, and the fish having no sphincter muscle cannot retain them; every motion extrudes the eggs. The spores would take effect on fish crowded in a small space more readily than on scattered fish. The rivers should be opened up. Pollution should be kept out. Fish do not like dirt, but fish will live in a very dirty river. Salmon pass up the Broomielaw at Glasgow, and get up to the Falls of Clyde. Has seen pailsful of descending smolts picked up dead notwithstanding.

The Tweed contains pollutions. It is blue from indigo, and a great deal of town sewage goes into it, and wool refuse also from the mills. The wool is

not manufactured, and sheep-wash would be in the refuse water. If the raw wool is washed in the river it must be very bad for the fish. Sewers and factories should be attended to. EDINBURGH.

The disease is virulent in pure and in impure water. If there were no sewers and no factories the dead fish alone would make the water stink. Would bury a fish half dead. Would leave the condition of fish to the judgment of the local watchers.

[Drawings produced of fungus, published in a Polish pamphlet—"Pathologia Ryb"—by Michal Girdwoyn.]

They are certainly *S. ferax*.

Has never bred fish. Cannot speak as to young salmon with gill fever, and fungus stopping up their gills.

A spore floats in the river like a thistle-down in the air, and will alight on fish. The spores will float downwards, and adhere more readily to the unsealed parts of the fish.

Is quite certain that all the cases of aquarium fungus that he has seen are not *S. ferax*, but a confervoid fungus. The filaments may be seen with the naked eye, but the spores cannot be seen.

A duck might carry the spores. Has seen hooded crows feeding on dead fish, but cannot see how they could bring the spores into the water. The wild duck's foot is so large that many spores might adhere to it. One hundred spores might be on the point of a needle.

Has picked up grayling dead in the Clyde. There is no *saprolegnia* there. If there be truth in the bird theory, the Clyde would probably have been affected, but the birds might fly to one river and not to another.

[Produces a specimen of the head of a fish diseased with fungus.]

Thinks the fungus is the disease, and not an aftergrowth on a previously diseased surface. The fish's skin is quite perfect, without any sore. There is fungus all over it and on the lips. The skin of the lips is eaten away and in shreds.

[Produces the tail end of the same fish.]

The fungus is transparent, and the scales can be seen below quite whole. The fungus is not superadded to a disease.

Kelts have been known for hundreds of years to die after spawning. Attributes this to the labour of spawning, to the want of food, and the emaciation caused by the absorption of fat for the formation of ova or milt.

The fish make their redds with their body. Never saw fungus on ulcerated sores in kelts.

Never saw specimens of sea fish with fungus. Believes salt will kill the fungus. The fish going to the sea will probably be cured.

His minnows ate the fungus. They were among the fungus from the beginning of May to 18th June. The fungus was removed then, as the fish were not affected by it. The fungus may have been dead when he put it in, but did not know it was dead. The fungus on the fish sent to him was barren. The experiment with the minnows was futile. Cannot say when the fungus reproduces. Got grayling from the Tweed with living fungus in April. Saw the spores moving, and saw them become stationary, and the filaments grow from them. The cilia had disappeared. This all took place in an hour. To the eye the growth of a filament under the microscope gives an impression of length equal to half an inch.

The oöspores might lie quiescent for many years. When stimulated into great reproductive power, a numerous crop of fruit would grow from them. This fruit (zoöspore) is what causes the plague. It produces the plant, and the plant produces the oöspore. After the plant is dead the disease must cease till the activity of the oöspore is kindled.

Fungi are capable of producing zoöspores. Unless the oöspores are highly stimulated the fungi are barren. The zoöspores are only an aggregation of granules. The oöspore has a cell-wall and a nucleus.

Sir ROBERT CHRISTISON, Bart., Moray Place, Edinburgh, Honorary Vice-President of the Royal Society.—Has paid attention incidentally to the salmon disease. Has received specimens of diseased fish from the Nith and Tweed. They were both kelts, and perfectly sound fish. Nothing was to be seen outside except the fungus. Sent them to Mr. Stirling, who showed that

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the internal organs were perfectly healthy. They were eaten, and were quite good. The disease is purely external: it is a vegetable parasite, which is the cause and not the effect of disease. It takes root apparently in the cutaneous tissues of the fish and grows there. It is like muscardine on the silkworm, and like fungoid diseases affecting the human race, or vegetable fungi on trees.

Cannot say what is the cause. Thinks a crowded state of the pools with all kinds of fish would, if long continued, injure their state of health. If one or two fish died it would make matters worse.

Objects to pollution, which may, if of certain kinds, affect fish, but not, if only moderate. In the Water of Leith, about one mile from Edinburgh, an open town drain enters at Coatbridge, and there used to be a great collection of trout below it forty years ago. One was caught 8 lbs. in weight, but there are none now there, the stream being now excessively polluted. All animals will survive a certain amount of pollution, but will not sustain it if it is concentrated. The water runs slowly. Indigo is purely vegetable; thinks it is not a poison. Snow-broth does not, he thinks, contain less oxygen than rain-water. If water freezes, then oxygen is given out. Water unfrozen will retain its oxygen, and the more so because it is cold. The melting of ice will not affect the supply of oxygen in the water. It will readily absorb its oxygen. The current of water may be stopped by ice, and the fish would then be deprived of oxygen. The fish would be suffocated. The ice in ponds must be broken, or the fish would be killed. At Linlithgow Loch the eels last year died because the ice cut off the supply of oxygen.

On general principles, the weakening of the constitution of fish would predispose them to the attacks of *Saprolegnia ferax*. It is the feeble fish that would be attacked first, as feeble men chiefly are the first attacked by any epidemic. But when epidemics occur the healthy soon also suffer.

Blood poisoning has a restricted meaning, and the overcrowding and unhealthiness of fish could hardly be called blood poisoning.

Does not know if the fungus in the Nith and Tweed is the same as that observed on the kelts in former years. Evidence is required to prove this.

Fungi cannot be distinguished without microscopic investigation. Disease always exists sporadically, but certain causes must concur to render it an epidemic. Thinks the same rule may hold good with regard to the *Saprolegnia*. Grouse disease, and cattle plague, and potato disease, are analogous.

It is a purely cutaneous disease. Thinks so because in the slighter forms he has seen the fungus removed, and no sign of disease underneath except a slight discoloration.

Has frequently seen ordinary fungus on gold fishes, and also saw it on minnows in a polluted mill dam at Dunfermline. Sewage was there. It seemed the common confervoid fungus.

Dead salmon should be buried, and dying fish too.

Knows the Whitadder. Fished there from 1822 to 1832. Caught very fine trout and sea trout. Examined the fish, and never saw anything like disease in the spring at that time. Fished a fortnight every spring. The sea trout were usually spent fish. The sea trout used to run up the river then, and salmon as far as Abbey St. Bathans.

Floods have been much affected by land drainage. From 1822 to 1832 the floods made the river unfishable for three or four days, and the river kept in good condition for a week afterwards for fly-fishing. The river now can be fished in a day after a flood and is run too low again to be fished in a day or two. Thinks this may affect the running of salmon. The draining of the hills in the south of Scotland had begun before the Drainage Act of 1847.

The fish should be distributed as much as possible, and should be passed up weirs and down again easily, especially down, because it is then that the disease principally appears. Apparently sea water kills the disease. Has heard, on inquiry, of no case of disease in the sea fishings of the Tweed. Desires to see experiments carried out as to overcrowding. This can easily be done. Would also have in different rivers, both diseased and exempt from disease, experienced observers to see when and where the disease begins.

Observations on temperature should be made.

The fishermen and others should be better instructed by competent authorities how to examine the specimens of fish.

By overcrowding refers principally to *salmonidæ*.

Observations should be made on rivers where dams absolutely exclude salmon, in order to see if the trout are affected by the transfer of the poison from other head waters.

The Leithen was formerly blocked completely. Understands it is so still. It would, therefore, answer for experiments. So would the upper Clyde.

If the *S. ferax* is present in all waters, it might break out in the Leithen. If it does not break out there, it is proved that the fungus is absent, and is not brought there.

Wishes it to be tested whether the disease on the spring kelts is the true *Saprolegnia* or not.

Human infectious diseases may always be met with here and there, and from certain causes one of them breaks out as an epidemic, and affects healthy as well as weak people. When it begins to break out, it is first among the weaker subjects, and spreads to all. Cannot say if the sporadic cases of disease among human beings are confined to unhealthy people.

If a river exists where kelts are always attacked, and clean fish not, an explanation should be arrived at by experiment. Does not, however, believe in the exemption of clean fish.

Would make experiments as to overcrowding by confining fish in a stream where there is plenty of good water and food.

Thinks the absence of the spores from the Forth and Spey might account for the absence of disease there, though in other circumstances these rivers may be similar to the Tweed, but there are no obstructions, and very little pollution. Cannot think pollution will account for the disease; but it may favour it.

ANDREW GREG ANDERSON, fish merchant, Edinburgh.—Has been in business for 25 years. Has fished on the Forth, and Tweed, and on the Conon for six years, and on the Dee in Kirkeudbright. There has been very little disease on the Dee. Has seen six salmon from the Tweed diseased. Examined them. They were as if the scales had been burned by a hot iron. They were yellow underneath, and had white spots on the front of the nose. There was no fungus. Has only seen fungus on one fish brought to him by Sir Robert Christison.

The fungus has nothing to do with the disease. The fungus gets on the fish when they are weak, and there is no current of water. Never saw it before. But saw disease on the tail of a salmon in 1875. It was a disease on the lower part of the tail fin, which was eaten away up to the point of the tail. It looked as if small barnacles were along the edge of the fin. It was a clean fish. It was a distinct disease from the present. There were no marks on the body or the head.

The first instance he saw this year was in a salmon from the Eden, brought by Sir Robert Christison.

Has seen two similar fish taken at Largo in the sea in bag-nets. They had come from the deep sea. Thinks they may contract the disease in the sea. Thinks most of them had the disease in the sea. They were totally covered with marks, but had no fungus.

Salt water does not therefore cure the disease. There may be one disease in the salt water, and one in fresh water. Largo is 20 miles below Queensferry. The nearest river is the Leven. This is $1\frac{1}{2}$ miles from the nets. Thinks the fish had not come back from fresh water. The disease was just commencing.

Got two salmon for the aquarium here, one was alive for a fortnight. A few scales were injured, and in a fortnight it was covered with disease from head to tail. There were some trout there in the same tank, and they were not touched.

The only river near his nets is the Leven.

There is not so much pollution as formerly. The vinegar works are bad from the vitriol. Pollutions have nothing to do with the disease.

Craigforth cruive stops the fish; every winter it is partly broken. Fish cannot get up in the winter except in flood. There is a fine spawning bed below the dyke.

Saw only two fish diseased from the Forth.

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Had one salmon and four grilse, diseased, from the Conon on the 2nd July. They were taken one mile below Conon Bridge. They were just the same as the fish from the Eden and Largo. There was no fungus. Thinks the disease he refers to is distinct from the fungus disease.

All the rivers were frozen last winter for nearly five months; from 11th November to 26th April.

Too many large fish get up and fight; diseased fish lie about all the winter. The fish are bigger than ever, owing to kelt preservation.

The season on the Forth should be extended for a fortnight or 10 days. The close time should begin on the 14th September, and so many days should be taken off at the beginning. Rod fishing should be allowed all the season.

Suggests that the Tweed should be open to 12th October for nets. Sixty clean fish were taken at a shot the last day this season. They are better than in June. Thousands of pounds' worth of fish are lost through early closing. Nearly every year thousands of dead salmon come down. The fish won't take the fly till the end of September. October and November are the best angling months. The fish are frightened by the falling leaves.

The Kirkcudbright Dee produces grilse very early. They run first in May. June is a very good month. This year about half the usual weight of fish was taken. A run of fish takes place in November to spawn.

In 1875 saw diseased fish at Kinfauns like those from the Forth. They were as if they had very small barnacles growing to the lower tail fin. The fish were in good condition. Sir John Richardson had several fish examined in March and the beginning of April.

The diseased fish in the Forth were taken $1\frac{1}{2}$ miles from the Leven, and there have been no salmon bred in the Leven for 20 years. They were Forth fish. The nets are in the Forth, 50 miles from fresh water. The fish were skinned along the jaws, and marked as if blistered with fire.

Thinks the fish had not fallen back from fresh water, because the fish always head for fresh water. The fish were very weak; thinks they were not healing, but that the sores were opening.

There was a great run of fish up the Solway in the end of September 1877, and up all the rivers except the large grilse rivers.

The trout are all over by that time except in the Tweed. This run of fish were not caught, and they helped to overstock the rivers, and were lost to the market and to the river.

Bull-trout average this season 1s. 3d. per lb. Any quantity could be sold during September. The fish could be sent to Berwick. The Commissioners should send a permit with the box, stamped with the number and weight of the fish. This could be done like branding herrings. This is done with the Dutch salmon now, and it answers.

Sells rod fish. Rods will never hurt a river, and might be allowed all the year round.

The upper proprietors on the Tweed should be conciliated by giving leave to angle for kelts in the spring in return for an extension of the netting season. Anglers would rather take home the kelts in the spring. This should be legal after say 1st May. There are few kelts left by 15th May.

Bull-trout kelts should be killed; they spawn before the salmon, and eat the salmon eggs.

Thinks, and his father thinks too, that too many breeders go up. Would allow netting at the back end of the year. Netting should begin on 1st March.

The 60 fish caught on 13th September referred to were worth 130*l.* They were the precursors of a shoal coming up.

Drainage has altered the nature of the river.

The fungus can be removed by a run of fresh water. The aquarium people put trout, pike, perch, gold fish, haddocks, and whiting in with the diseased salmon, and applied a strong jet of water and washed off the fungus in an hour. A flood of water down the river would have the same effect.

Has seen diseased fish from the Tweed taken in fresh water. Has also seen diseased fish taken from the Conon in brackish water, and others at Largo taken in salt water. There was no fungus on them. Has never seen fungus. The fish referred to, he thinks, were diseased in the sea. Thinks it was the

commencement of the disease, and that the fungus got on the fish in the stagnant pools in the river. There was a yellowish sloughing sore, like as if the skin had been burnt.

ROBERT SHORTRED, fisherman to the Nest Angling Club, Galashiels.—Has been so for 30 years. The club fishery is three miles above Ettrickmouth. Has seen plenty of disease on salmon for 30 years, but not so much as lately. The fish were kelts forming, *i.e.*, spawned fish. Fresh-water trout and grayling have had it the last two years. Never saw clean salmon with it before. The appearance was the same on all fish, like a white spot and an inflamed mouth; the liver was nearly rotten. Has opened a few; the liver was always rotten when they were far gone.

[*Specimen produced of a diseased Tweed fish.*]

It is lighter in colour than what he has seen. Thinks it is the same disease. Never saw it before on fresh water trout and grayling.

It was long before the fish got on to the spawning beds last year because of the ice. The female fish lie in the pools if they cannot get on to the spawning beds. The eggs will come out. They will not lie more than six weeks, but will lie six days. They will not lie long if they are ripe to spawn. The eggs will run out.

Never saw any clean salmon diseased. The spots seemed to come first on the body. They were light-coloured spots. They turn rather darker before the fish dies.

A "gay few" fish got up to the Nest fishery. Not more than usual. The water was not overstocked.

The water is pretty pure there; but a good bit of pollution comes down quite black.

Never saw trout and grayling diseased till this year; never heard of it. It is

The kelts should be taken out and buried. The dead fish pollute the water.

The cauld at Walkerburn does not keep the fish back in high water. The fish are stopped in the lade. The pollution is bad for the fish. When the water is small the dirt is all over the bottom of the water. It is worse now than 30 years ago.

Plenty of fish collect below Walkerburn dam at the back end of the year.

G. L. PAULIN.—Omitted to say yesterday that on 26th August a grilse of 2 lbs. was taken in the Tweed just above the mouth of the Whitadder, with fungus on the side. It was not in such good condition as grilse are usually. It seemed to have been in the river some time. Sea lice were upon it. The river there is quite salt. Thinks the fish had contracted the disease in the river.

WILLIAM MENZIES, Secretary to the Nest Angling Club, Galashiels.—Has known the Tweed for many years.

[*Produces a report on the pollution of the Tweed dated 1878.*]

The report was made for the Angling Club by Dr. Stevenson Macadam and printed privately. It shows that the Tweed water is much polluted by various mills. Thinks the matter bears on the condition of the fish in the Tweed. The pollutions are worse than formerly.

Has never seen clean salmon diseased. All that he saw were kelts or unspawned kippers. It seems the same to the eye as the old kelt disease. There is fungus along the side of the fins and tail. Has seen no sore, but only fungus. Thinks the fungus is the disease. Has seen diseased fish for 25 years among kelts and kippers.

Refers to Walkerburn and the Innerleithen pollutions. The pollutions in the upper waters are increasing.

There was no increase in the number of fish last spring. The dirty water from the wool is put into the water.

JOSEPH NAPIER, Superintendent to the Forth District Fishery Board, Stirling. Has given much attention to the disease.

[*Hands in a statement on the subject. It is as follows:—*]

" I have been upwards of 13 years superintendent of the salmon fisheries in the Forth district, and previous to that I was inspector for nearly five years in the Tay district. During this time while engaged on duty I was in a position to observe salmon both in their foul and clean condition. I have

EDINBURGH. " seen statements in the newspapers with reference to salmon disease in the
 " Tweed and other rivers. I cannot say that ever I saw any diseased salmon
 " either in the Tay district, while I was there, or in the Forth district,—that is to
 " say, disease of the kind referred to. The kelts, especially in the spring
 " months, are generally in a very poor condition, quite soft and flabby, and dark
 " in colour. I have seen numbers of them with scabs and sores on their
 " heads and other parts of their bodies, but this is nothing uncommon for fish
 " in the spawning season which have been a long time in fresh water. They
 " continue in this condition until they reach the stage of what is called 'well-
 " mended kelts,' when they are proceeding down to the sea. I have no doubt
 " that they fully recover themselves while in the sea, and afterwards return
 " to the rivers as clean salmon and in good condition.

" I decidedly object to the rivers being netted during the close season for the
 " purpose of taking out the sickly, or so-called diseased, salmon, and destroying
 " them, as I believe strongly that the greater portion of the clean salmon
 " which are caught during the fishing season were or may have been at some
 " time numbered amongst those so-called diseased salmon.

" The pollutions that are now so largely run into some of our fine breeding
 " rivers must be very injurious to the produce of salmon, as the young, while in
 " the smolt stage, are often destroyed in large numbers when passing through
 " polluted waters while on their way to the sea, an instance of which is seen
 " yearly in the river Devon, a tributary of the river Forth, which at one time
 " was famed for the purity of its water, but is now very much polluted, and
 " rendered unfit for the use of either man or beast. I myself have taken
 " hundreds of young fry out of that river between Glenochil and Cambus
 " during the spring and summer months which had been killed by the
 " polluted water.

" During the spring months large numbers of large dead salmon are found
 " yearly in the rivers in the Forth district, and on the banks, but I do not
 " consider pollution the cause of this. The greater portion of those dead fish
 " are males, in the proportion, say, of 10 or 12 to one female. I have often, on
 " finding dead fish, cut them up, and found them unspawned, the milt of the
 " males being generally hard, and of a dirty yellow and bluish colour, having
 " all the appearance as if mortification had set in before death.

" I consider that all dead fish should be immediately taken from the river
 " and buried; the water would thereby be kept free from contamination, and a
 " source of temptation would also be removed from the poacher and river
 " prowler. Since I have been superintendent of the Forth district I have given
 " instructions each year to the river watchers to remove all dead fish from the
 " river and banks, and to bury the same, and these instructions are fully
 " carried out by them. The death of these fish is certainly a loss not only to
 " the fishery proprietors, but also to the general public.

" I think if the net fishing season were extended, say from eight to ten days,
 " when the fish are still in good condition, it might remedy this to a certain
 " extent. This would tend to reduce the number of breeders, but I believe
 " there would still be a sufficient number left for all breeding purposes, and
 " it would also tend to increase the food supply during these eight or ten
 " days, and reduce the number of dead fish in the spring.

" I have seen cuts and scars on numbers of clean fish during the open
 " season, but I believe that these have been caused by seals at the mouths of
 " rivers.

" I never saw any sores or diseased spots on clean fish.

" The salmon caught at the opening of a season are generally large fish,
 " averaging about 20 lbs. each, which I have no doubt are fish which have
 " been preserved kelts in former years. If netting the river were allowed in
 " the close season for the purpose of destroying kelts, there would be com-
 " paratively speaking a small number of salmon caught at the opening of the
 " season, as the young fish or spring salmon, ranging from 8 lbs. to 12 lbs.
 " each, do not, as a rule, come up the river until the middle or end of March."

Has heard Mr. Anderson's evidence. Knows Largo. The statement as to
 " diseased salmon there is new to him. Does not think a diseased fish would
 " come up from the sea. The sea would help to cure it. Never saw any fish
 " from the sea with the slightest appearance of disease. The fish from the sea

are in the best condition. Could not say if the fish referred to had been up the river.

The burial of dead fish has tended, he thinks, to prevent disease. Dead fish should be taken out of all rivers, but diseased fish would recover. Floods would carry them down to the sea.

The sewage of Stirling and pollutions from many works go into the Forth. The Teith is the only clear river of all the tributaries of the Forth. The Devon is a little better than formerly as regards the Dollar sewage, but the refuse from factories is very bad. The Devon is a beautiful spawning river naturally.

Craig-forth cruive stops the fish in the open season.

It is used as a cruive, and is very deadly.

Would be satisfied if netting went on to 6th or 8th September, not later. Would be satisfied to go on to 5th September. The breeding season should not be interfered with. Thinks the Tay and Forth are both well stocked.

The Tay is earlier than the Forth by eight or ten days. Would continue the fishing season on the Tay in proportion to that on the Forth. The run of fish up the Forth before 5th September are in good condition till the end of October, and spawn at the end of November, December, and even to January. The early fish are also spawning fish. Thinks the late fish in November might keep up the stock of fish alone.

The kelts are down by the end of March, or later in dry weather.

Hundreds of dead males, mostly unspawned, are found every year. Has seen them all spotted and scabbed, but has seen nothing like the specimens of fungous fish produced. It is their nature to be scabby. They are thin and lean. Has seen no vegetable growth on them in either the Tay or the Forth.

When he was on the Tay he buried all the dead fish. Cannot say if it is done now.

A feeling prevails in favour of extending the open season.

Many dead fish are found in the Teith. They float down the Forth.

There are few spawning beds in the Forth.

A few fish do go up to Loch Ard. Glasgow obtains its water from Loch Katrine; below it are Loch Achray and Loch Vennachar. Compensation water is supplied to the Teith from Loch Vennachar. A current always runs down the Teith every day. When only the compensation water comes down, the Teith is very low. There is not sufficient water to carry down the kelts.

The river was generally in flood last spring. The pools are crowded with kelts in dry weather in January, February, and March.

Cannot say why the Teith and Forth are free from disease.

The compensation water coming down the Teith is very small, and cannot affect the fish. It lasts all the 24 hours. The lakes overflow in wet weather, and act as reservoirs. The floods would run off much quicker without the lakes. The lakes help to keep up the river at a higher average level.

The land drains into the Teith, Allan, and Forth.

There are no pollutions in the Upper Teith. They commence at Stirling.

Smolts are often killed by pollution.

The Tay and tributaries are very pure.

Forth salmon get into Loch Vennachar.

JOSEPH BISSET.—Lives at Stirling. Has been employed in salmon fishing for 38 years. Has had the management of different salmon fishing stations for 26 years, and has been one of the lessees of the town of Stirling's salmon fishings in the Forth for the last five years.

Has seen very little of the disease into which the inquiry is being held. Did see a few kelts so affected about the end of April this season. Only a few; not more than half a dozen. Is unable to suggest a satisfactory cause for the disease, but thinks it more than likely that the very severe winter had something to do with it. The frost dried up the rivers to a great extent. Has no doubt this was unfavourable to the health of the fish, there being so many in the rivers at the time.

His opinion is, that in many of our rivers the net fishing is too early closed, consequently an overstock of fish ascend, with a preponderance of males, and the result is that many hundreds die, principally male fish. This is a great loss to the proprietors and tacksmen of salmon fishings and to the public. Believes that it would be right to kill the fish when they are in good condition for human food, and there will always be enough left for breeding purposes.

EDINBURGH. Thinks that in several rivers the net fishing should be continued for at least 14 days longer. Seventeen years' trial is enough to prove that the early closing of the net fishing has been a grievous mistake in many cases.

Has fished in Ireland as well as in Scotland.

The fish diseased referred to were all kelts. They had white spots without any fungus. They were generally males. They were seen above Stirling, above the Cruive Dyke. Saw no clean fish affected. The fish were very sickly, and came into the shallow water.

JOSEPH COWEN, practical angler, Edinburgh.—Has taken great interest in pisciculture.

Thinks the disease, which is now most common amongst male kelts, is owing to the rivers being overstocked with these fish, especially during the spring months after spawning, when they are in an exhausted state, through an insufficient supply of food, or wounds by fighting, and through the breaking up of the ice after a severe winter. The fish become chipped and scabbed, and remain confined in a limited space of water till a flood carries them to the sea.

As a field can only support a certain amount of sheep, so can a river only support a certain amount of salmon. Salmon will get diseased, like human beings, if there is an insufficient supply of pure water and food, &c.

The drainage of land has caused the rivers to be either in a high state of flood, or in a very low state, which is favourable to the spread of fungus disease. Previous to the drainage of land the rivers continued to run moderately full for some days after rain, producing a more regular supply of fresh water and food.

Canlds were also fewer formerly. Suggests that the water-bailiffs should hook out and bury dead and diseased salmon, instead of looking out for some unfortunate angler who may happen to hook a kelt.

Fair anglers should be encouraged instead of being compelled to return kelts to the water. Kelts which have been hooked and run seldom or never live. Kelts should be taken, but with the fly only.

Anglers would help to keep down poachers.

Kelts may return to the river next year very much larger, but the flesh of an overgrown salmon is coarse.

Kelts also eat parr.

Pollution may be a cause of the disease. Has a friend in California who saw an enormous quantity of kelts dying in the rivers there. They die after spawning.

Anglers, if encouraged, would become watchers. Kelts should be taken if hooked. Anglers have killed kelts rather than let them be taken by others. Anglers will not take an interest against poachers under the present law.

Has seen diseased salmon. Finds that diseased trout, if put into fresh water, will get well. The fungus follows on some other disease.

Pollution and dead kelts should be removed.

Has hooked kelts, and found eight or nine parr partly digested inside them. They will take a parr in the spring rather than a fly.

There are five angling clubs in Edinburgh, and about 1,000 anglers. Anglers wish to kill kelts.

Thinks it is illegal to have dead fish in possession.

Thinks rivers rising in a loch are not so liable to disease as others without a supply of water from a loch. Fish run all the year round in the Tay.

Has fished the Eden, but does not know much about it.

Craigend, Stirling, Saturday, October 4th, 1879.

PRESENT :

ARCHIBALD YOUNG, Esquire.

SIR JAMES R. GIBSON MAITLAND, Baronet, Craigend, Stirling.—Thinks in early cases the fungus is not the disease but an aftergrowth. The disease can exist to a fatal extent independently of the fungus. There cannot be fungus on a perfectly healthy fish. There must be, under ordinary circumstances, previous debility. There cannot be the fungus without the presence of one of three conditions:—1. A want of healthy slime on the scales. 2. Injury. 3. Excreta of parasites. The disease may kill by suffocation. Has known it kill in 60 hours. The diseased white spot is the result of debility. Does not consider the disease to be in any sense contagious, although many fish with fungoid growth would undoubtedly increase the number of germs of fungus to the cubic foot of water. Overstocking is not the cause of the disease. All the Lochleven trout (about 12,000) now in the three large ponds here were in the three small 130-foot ponds during the last winter. These ponds were completely frozen over from December to February, and were not perfectly free from ice from the 1st March. The ice during most of the time was over 15 inches thick. A small hole about 2 feet in diameter was broken in the centre of each pond every morning. The loss of fish from November to March, under these circumstances, was only one per 1,000. The trout in these ponds were from half a pound to five pounds in weight, and were hatched in 1875, 1876, and 1877.

CRAIGEND.

Thinks that the salmon disease may be communicated from one watershed to another, where the head waters of the rivers are in close proximity, by birds carrying the germs of predisposing causes, be they seeds of vegetable growth or zoospores of fungoid growths, but does not consider that feeding on diseased fish would render them more liable to do so. Thinks that some well-informed local official should have discretionary power, with the consent of the Salmon Commissioners, to remove diseased fish from the water; all dead fish should undoubtedly be removed at once and buried above flood-water mark.

The circumstances and facilities of returning to the sea vary so much in different rivers and in different parts of the same river that no hard-and-fast rule can be laid down. It seems to be an economical question whether, in the case of the Commissioners coming to the conclusion that all diseased fish should be removed, those slightly diseased might not be sold for food, in accordance with the evidence of Sir Robert Christison and others, and the proceeds applied to the expense of stamping out the disease. Personally holds no opinion on this point. In all cases of disease that have come under his observation the fish died where the bleeding sore occurred. Considers that the vigorous application of bay salt removed the cause, but did not cure any advanced stage of the disease itself. Will, however, make further experiments next season.

It is certain that exceptional circumstances of temperature and rainfall will affect the causes of the disease; the extraordinarily rapid vegetation of an Alpine region is a proof of the effect of a severe winter on the growth of algæ and other water plants.

Thinks that probably the action of rainfall is confined, first, to the modification of temperature; second, to increasing or decreasing the facilities for the passage of fish; third, to the destruction of algæ by depositing mud from the neighbouring lands. The common green frog-spittle which grows on the banks of ponds may be exterminated in a few days by raking up the mud. Rainfall may also act in a secondary manner by its necessary accompaniment of cloud, absence of strong light being unfavourable to the growth of water vegetation. Cloud is also a possible vehicle for fungoid germs.

Feels great diffidence in offering an opinion on Dr. Crosbie's letter on the salmon disease, handed in by Mr. Stoddart at Kelso. The description of the

CRAIGEND. peculiar appearance of ulceration which the fish presented agrees with what he has himself noticed, with the exception that some of the earlier ulcers showed no appearance of fungus to the naked eye. Did not examine them with a microscope. As matter of fact, in the case of fungus destroying an ovum, the fungus does not germinate on a healthy egg in the first instance. When an egg dies and turns white in from 12 hours to six days according to the temperature (from 33° to 50°) byssus appears on the shell, after some time its hair-like threads involve a neighbouring ovum, on which next day a small round white spot will appear, showing that the spores have pierced the shell and admitted water. A new crop of byssus springs from this spot, and in time involves the next ovum, killing it in like manner, till at last a dozen eggs are entangled in a white mat; but in no case will byssus germinate on a healthy egg unless its roots are already feeding on a dead one, and even then it is possible that it first kills by the mechanical penetration of its spore admitting water. In this respect byssus differs from algae.

Very young fry are much subject to fungus; but jumping against screens and nibbling at each other are generally the prime causes.

Does not agree with that part of the letter which considers the disease a provision of nature to drive the fish to the salt water. It seems unsupported by sufficient evidence.

Thinks the disease probably exists every autumn and spring, and that circumstances not yet understood determine its extent and virulence. Now that public attention has been drawn to the subject many cases may be heard of which would formerly have passed unnoticed. Care must be taken that this is not taken as a proof of increase in the prevalence of the disease.

Will expose a diseased fish to a current of fresh water and note the effect, and will again make experiments with salt water, and will dissect the next fish that dies and carefully inspect its internal organs, and report results.

Craigend, Stirling, Thursday, March 18th, 1880.

PRESENT:

ARCHIBALD YOUNG and SPENCER WALPOLE, Esquires.

SIR JAMES GIBSON MAITLAND, Baronet, Craigend, Stirling.—Has given special attention to the disease since 4th October last. Has noticed fungus on male fish shortly after their milt was ripe. Up to the middle of December found the disease entirely confined to males (last case observed was in March). In every case of male fish dying of disease, the duct leading from the milt sac contained a whitish liquid, which ran freely on the fish being held up by the gills. A discoloured spot was frequently present between the pectoral fins, varying from the size of a sixpence to that of half-a-crown, and slightly indurated to the touch. This spot and the liquid in the milt duct seemed to be the earliest symptoms of the disease, the ulceration of the mouth appearing from the 4th to the 10th day. The fungus usually appeared in spots about the fourth day.

Thinks the male fish might die before the fungus appeared. Thinks that a common origin of the disease is in the fact of the males, from some cause, not being able to shed their milt so rapidly as it has ripened in the milt sac; the glands become relaxed, and the re-absorption of milt so often noticed by pisciculturists does not take place; some of the zoöspores probably die in the duct (the very slightest penetration of the water is sufficient to cause this), and set up an irritation, &c.

Anything tending to increase the disproportion of males to females on the spawning ground would probably increase the number of victims to the disease. Has known hen fish die egg-bound with and without the appearance of fungus. Thinks fungus is always present in water, and readily attacks fish so diseased.

Thinks *Saprolegnia ferax* is probably dangerous in two forms, the vegetable cell rooting only in favourable soil, and the microscopic seeds shed by the

bursting oöspore. Thinks that the conditions favorable to the impregnation and ripening of the spore of the *S. ferax*, must be present in all cases where the fungus assumes an epidemic form. Has found that a very small quantity of bay salt (56 lbs. to 650,000 gals.) sufficient to stop any new cases of fungus. Found in all cases where the discoloured spot existed between the pectoral fins the fish died sometimes before the fungus appeared. Found if only slight fungus existed, as occasionally occurred in spring, the fish generally recovered. Found few hen fish with fungus, and these possibly injured on the spawning bed. Thinks the fungus itself sufficient to cause death in summer and autumn, the higher temperature being more favourable to its rapid development, but considers the fish disease as above described during winter and spring is a nursery for the summer crop of *S. ferax*. Has about 12,000 Lochleven trout weighing 20,000 lbs. in three ponds, each 300 feet long, 45 feet wide, and of a depth varying from 6 to 13 feet.

George Hotel, Girvan, Tuesday, April 20th, 1880.

PRESENT :

SPENCER WALPOLE and ARCHIBALD YOUNG, Esquires.

JAMES BUCHANAN.—Has been tacksman of fishings on the sea coast at Mellin, and in the river at Girvan Mains for 16 years. Holds the former from the Crown, and the latter under Mr. F. Kennedy. The fishery has fallen off considerably, some seasons more than others, but the decrease has been progressive. Protection, however, recently has increased the stock of fish, but before this there was a considerable decrease.

The rivers are now overstocked, the Girvan especially. Thinks so because there are many more fish than in other years. Saw fish breeding after 9th September. There were plenty of fish to stock the river before then.

The rivers are getting later. The instinct of the fish teaches them to be later.

The nature of freshets in the river has altered. Formerly there was no fresh for 24 hours after rain, now the freshets come down at once in a flood and fall off in 24 hours. The drainage of land has altered the character of the river.

The fish are later also in growing to maturity. The roe and milt are not ripe so soon as they used to be. The fish and the river are both later; there has been a gradual change.

Has seen no disease in the Girvan, but expected to do so because the river was overstocked. On his own premises small fish confined in a small quantity of water have got spotted. Gold fish may be experimented with. They will get spotted.

Drainage has caused the pools to become so soon empty that the fish get overcrowded and blood poisoning ensues.

Resides at Kilmarnock. Heard of the disease first from his men in January 1880. The first fish was a clean salmon, unspawned. It was a fish that had not spawned this year, but it was ready to spawn. It was found near here. It was dead and had come down the river in a flood. His factor called attention to it. Cannot say if the disease has been confined to clean fish. His men will say.

Has observed the disease in small fish in cisterns. Has seen spots and fungus growing and thought it was due to blood poisoning. The water would get contaminated, and in passing through the gills would cause blood poisoning. The same thing occurs in a river. In a pool capable of holding only five or six couple of fish a second run of fish come and they get ill.

Has had experience on the Irvine. Knows the Tay. The water supply is very much better in the Tay than here. There were more fish killed in the sea when he first knew the Girvan than now, and a better supply of water. Now the drains cause the river to fill up rapidly and to fall rapidly. The disease may have been in the river before he heard of it. The river would have

GIRVAN.

been pretty well supplied with water at that time (January), but in the winter the rains run off more quickly than in the summer.

Net fishing should be continued later. Holds his fisheries on lease. Does not know if the landlord would agree to an extension of the fishing season. This would increase the value of the fishery. The result would be for the general good. The upper proprietors only go in for rod fishing. The best fish are in the sea, and the proper place to take them is in the sea. Does not know if the upper proprietors would object to an extension of netting. The extended close season has caused over preservation.

Would extend the fishing season to the middle of October.

There are seven obstructions on the Girvan. The dams have not been made passable, but subsidiary dams are being made. There was a dam at Bridge mill, and it is proposed to put up a subsidiary dam there. At Daily there is another dam, but nothing has been done there. At Kilkerran and Kirk-michael there has been no alteration. Passes should be made to enable the fish to get up all through the season, instead of merely in floods. The pools are empty because of the rapid fall of the river.

The disease is new. Has always got fish spotted from wounds, or damaged by nets or by enemies; but never saw fungus on such sores. Thinks it a fresh-water disease, and that the sea cures it. Badly diseased fish get cured if they get down to the sea.

Overstocking is the cause.

The fish were not so plentiful in the winter of 1879; last year they were more plentiful than ever before.

Never cut up a diseased fish. There has been no netting in the river for eight or ten years. Outside the river stake or bag nets are used.

THOMAS ALEXANDER, tacksman of Lord Stair's fisheries near the Girvan.—They are in the sea, outside the estuary line. Has been connected with the river for nearly 50 years. The fisheries have greatly fallen off. There are not now half the fish in the river that there were when he first knew it. There has been a gradual falling off.

Never heard of anything like the salmon disease before last year. Did not see any fish taken; but some diseased fish were taken.

Net fishing in the river was stopped ten years ago, but never saw anything like the disease then. Has no idea of the cause. Thinks only four or five diseased fish have been taken. They were chiefly kelts.

Does not agree that overstocking is the cause, or the disease would have occurred before. Mr. Buckland calculated that the river would hold 1,000 fish for every one in it in 1870. The dams may possibly cause a falling off, but they were the same when he began as they are now.

It is a new disease or it would have been seen before.

HUGH DICKIE, miller, Bridge Mill.—His mill is a quarter of a mile from the sea. The weir is not very difficult for the fish to pass if there is any water; but if there is no water they can't go up. Knows nothing about the disease. Has seen little of it. First heard of it since January, and was shown a fish.

Was born on the banks of the river and has known it for 60 years. Formerly it was much purer than now. The water could be used for all household purposes except in floods. Now it is polluted.

The volume of water is also much altered. Formerly it took 36 hours' rain before the river was seen to rise; this was up to 15 years ago. Since then three hours' sharp rain will cause a fresh in two hours afterwards. Even at its purest, where he could formerly see it in the summer to the bottom, it is now muddy. Attributes this to the change in the uplands and to surface drains. The rain is carried off instantly, whereas formerly it filtered through. Pollution is now at once carried into the stream. By pollution means vegetable matter in a state of decomposition. The old gravelly pools are now covered by slimy mud.

The uplands are sheep walks. There is decaying vegetable matter in all grass lands, especially in summers like last summer, which was so wet.

Knows of no remedy. The river must give way to the sheep walks.

Nothing in the shape of pollution comes into the river different from what has come in for 40 years past. The sewage may be a little worse. Thinks no artificial manure is used, only on agricultural lands, and there the drains are 4 feet deep, and the water would get filtered before reaching them.

JAMES MILLIGAN.—Was formerly water-bailiff on the Girvan. First heard of disease on 1st February 1880, through the papers. Afterwards saw fish in the river. They were covered with white spots the size of half-a-crown. The fungus was above the scales. The fish were kelts. They had a beak on the jaw. They were all kelts. Saw dead salmon 30 years ago scarred from fighting, but the appearance on the kelts this year was quite new. It is a freshwater disease.

The river is the same as it was 30 years ago. Can assign no cause. The dams are not sufficiently opened up. There are seven of them. The second mill dam (Baron's Mill) is the worst, and prevents the fish getting up. It is a wooden dam, and the water filters through. The stock of fish would improve if the dams were opened up. There is much valuable spawning ground.

Thinks the river is not overstocked. Observed more salmon this year below Bridge Mill than ever he saw before. The fish were weak and could not ascend.

Heard W. Dickie's evidence. There is always a kind of green slime in the water.

The fish he saw were affected about the gills.

THOS. GAUNT.—Gamekeeper to Lord Stair. Lives at Bargany, three miles up the river. There are not many fish there. The fish run up in June and July, and spawn in his water. There were fewer than usual last year.

Has seen diseased fish. Saw six this season, both clean fish and foul fish. Means fish about to spawn or spawned. The clean fish he got was about to spawn. Has known the water for 16 years. In July 1878 saw an ulcer on a salmon, on the back of the neck. Afterwards saw nothing till December 1879. The fish were in the water from December to middle of February. Saw six diseased fish. The fish were given to the dogs. Opened them and found nothing peculiar inside. The liver was darkish in colour. One fish was 20 lbs. in weight. It was a she fish with the roe well developed. The fish were diseased on the back of the head, on the dorsal fin, and on the belly.

The first fish he got was a he fish marked on the forehead.

Has no idea of the cause.

There are not enough fish in the river. Another month's fishing would extirpate the fish.

The fish were more plentiful formerly than they are now. Lord Stair does not draw his own pools; and since then the fish have decreased. There is no fishing in the reservoir.

ALEXANDER MACLELLAN, gamekeeper.—Has known the river eight years and a half; knows it all. First heard of the disease in February 1880. Has seen scars on fish from fighting. Saw fish spotted four years ago at Kirk-michael. It is not a new disease. Saw a fish covered with ulcers; it appeared to be slimy. Found three little threads, which went into the flesh. The intestines were quite healthy. There were three threads $1\frac{1}{2}$ inch deep in the flesh. Has no idea of the cause.

The Girvan is not overstocked. Has fished for six years, and kills from 10 to 15 fish every year in about three miles of water. Has killed some fish at Kilkerran, but most at Cloncaird. Thinks three weeks longer for rods should be given. The fish would, some of them, be quite good. Does not take full fish. Killed one fish last year in June, 18 lbs. in weight.

Has seen fish spotted before.

Has seen fish jumping at Blairquhan, and very few got up. It is good spawning ground above there. The Linn could easily be blasted. The fish fall back on the stones and are wounded. The fishing would be improved if the dams were made passable.

J. McTEAR, watcher to Mr. Kennedy.—Has known the river for two years. Knows no other river. Has seen two or three diseased fish. Saw these fish in February last. Reported the fact to Mr. Kennedy. The fish were all diseased kelts. Thinks they died of the fungus.

There are a "good few" fish in his water. In half a mile of water saw one dozen fish lying. Cannot say if it was overcrowded.

H. THOMPSON.—Has been gamekeeper for three years to Lord Ailsa, on the Upper Stinchar. Has known the river many years. It was a very good river formerly, but not so good lately. There has been a great decrease since he knew it. There is not one fish for 20 formerly.

GIRVAN.

There are very good spawning beds.

The fish are very heavy. The fish coming to spawn nearly all died last season. Saw fish affected first in the middle of January or 1st of February 1880. Saw one spawned fish. Saw three or four pairs altogether. Never saw it before. The disease must be new. Saw one fish nearly dead; caught him by the tail. Has often seized full fish by the tail, when healthy, and found as a rule that he could not hold them; but the diseased fish was easily held. The skin was as it were dried. Generally one wants a mitten to hold a healthy fish. The diseased fish had no natural slime. Left it for three hours and found it in the same position. There is little obstruction to fish on the Stinchar.

There is one little stream which he knew when a boy which contained plenty of fish, but now it has none. Attributes it to sheep washing. The stream was formerly full of fish. Took five dozen yellow trout when a boy in a day; now there is not a fish there.

When the water is low something gets into it which kills the fish.

There is no netting in the upper waters.

The diseased fish in the Stinchar were all dry like leather. They had no slime on them. Has never noticed it before. The fish he alluded to was alive. The slime generally comes on the fish through spawning. Could not say if the absence of slime in the diseased fish was the cause or the effect of disease.

The fish was spotted near the back fin.

JAMES WASON, Corwar.—Knows a tributary of the Stinchar called the Duis. Has fished in nearly all the rivers of Scotland for the last 20 years. Has not of late years observed any disease; but has been fishing principally in the north of Scotland, and in Norway.

Saw diseased fish 18 or 20 years ago in the Stinchar. Recollects one case in particular, when his brother had hold of a kelt in February, and in attempting to gaff it, he gaffed another fish, which had a blotch on its head, and was blind on one side. It was a kelt. A good many similar fish, he believes, were there then. Has seen kelts maimed, but not fungous. One year he caught 200 kelts in the Spey; they were damaged in all ways, but had no fungus. This year has seen none.

Remembers a general talk of many bad fungous or diseased fish in the river 20 years ago.

There were then 20 fish to one now. Six or seven years ago there was a good year, but the river is growing overstocked in the spawning season. Overstocking cannot be the cause of disease.

Has a theory that the drainage has caused it by carrying down the dirt from the uplands. The Stinchar is pure, but the Duis is foul, coming from moorland. The Stinchar is pure, but its tributaries are as black as peat. The black colour is owing to surface drainage. The matter carried down is partly decaying vegetable and animal matter. There is much surface drainage.

The rivers rise much more rapidly than formerly. 15 years ago he would fish three days after a spate, but now the rivers rise and fall in one day. Formerly they kept in fishing order for a week.

These are unpreventable causes.

Much filth is washed down, and slimy matter may be seen on the stones wherever hill drainage takes place.

Knows the Thurso; it is a dirty river. There is very little hill drainage there, the river running through arable fields. The dirt is from the land.

Surface drainage was started 20 years ago, and has gone on continuously with great benefit to the land.

There are natural reservoirs at the head of the Cree, and a small sluice might be put up to let the water out occasionally and wash out the river. An artificial spate should be made to clean the river. A natural spate brings dirt. Clear ponded-up water should be let down, which would cause the river to rise without fouling it.

Artificial breeding would, he hopes, act well. Saw the Culzean ponds last week. Has not seen Sir James Maitland's ponds at Craighend.

Upper proprietors should have another fortnight's fishing. The salmon in the Stinchar on the last day of the season are quite fresh from the sea, but heavy in roe.

WILLIAM LAWSON, gamekeeper to Captain Hamilton, of Pinnore.—Has known the middle reaches of the Stinchar for 40 years. The fishing has desperately fallen off. There is not one fish for many before.

Saw one fish diseased. It had the whole head as if a white nightcap had been put over it. This was on the 1st April 1880. Never saw anything like it before. It is quite a new thing. Only saw this one. Cannot say if it was a kelt. It was in a pool for a week, and seemed to be getting better, as black spots appeared on the head and the white seemed to be going away.

Dirty water and sheep dipping have something to do with it. Sheep dips and the salmon disease have come at the same time. Sheep dips are now used regularly.

There is no overstock, nor one-third of a stock, in the Stinchar. There is not one fish for 20 formerly.

Never heard of anything like the disease before. Two or three other fish have been got. Saw five or six good fish in a pool, and they had nothing the matter with them.

There is often a gravel bar at the mouth of the Stinchar washed up by the sea. Not a fish gets up till a spate comes down and clears it away. It is as high as a house, and lasts often for weeks. This has always been so. The fishermen gather the smolts into baskets and put them into the sea.

Findlay's Hotel, Colmonell, near Girvan, Wednesday, April 21st, 1880.

PRESENT :

SPENCER WALPOLE and ARCHIBALD YOUNG, Esquires.

JAMES GALLOWAY, keeper to Mr. McConnell.—Has known the Stinchar for 23 years. Has always seen fish with scabs and scars among the kelts in the spring. [*Photograph of diseased fish produced.*]

Has seen something like the fish in the photograph with white blisters on the back, but with nothing growing on it. The scabs were a little swelled up above the skin. Has seen it for many years. The scabs were along the back of the kelts. The fish were dead. Has seen nothing different from that this year; but has seen fewer scabby fish. The fish altogether are scarcer in the river than they have been for 15 years at least. Has seen no more disease. Mr. Hamilton's keeper told him of a diseased fish.

The nets at the mouth of the Stinchar are too near the mouth of the river. They are within 300 yards.

The Stinchar is very pure. There are very few dams on it, and no obstructions to prevent fish running up. Has no idea of the cause of what he has seen.

JOHN LOGAN.—Has been on the Stinchar all his days. Agrees with the previous witness. Has seen diseased fish all his days. Formerly the river took longer to rise and fall than now. Saw a grilse with white spots as if it had been hurt, like new scabs coming over a wound. There was no growth upon it.

PETER LAURIE, coachman to Mr. McKinnon.—Last season, about June 1879, Mr. McKinnon took a grilse, well made up, with a spot on the right side, looking whitish, something like the fish in the photograph.

The keeper and he found a fish of 30 lbs. this year—a kelt—completely covered with whites. It was nearly dead, and had its skin covered with something like cotton wool. Never saw one as bad before, but saw plenty not so bad, marked across the back. This was a month ago. A flood took the fish down.

THOMAS CAMPBELL, keeper to Mr. McKinnon.—Saw the fish referred to by previous witness.

Has fished the river Minnock for the Marquis of Ailsa, and there was scarcely a day but he saw fish similarly affected.

COLMONELL. They were all kelts with a woolly growth on the fins. This was last year—in November 1879.

The fish spawn early there. They were just the same as the fish in the Stinchar.

J. GALLOWAY (*recalled*).—Wishes to speak as to the bag nets at the mouth of the river. They are within 300 yards of the river. They are very destructive, and the fishing is very valuable. There is one set of nets with a second set beyond them. They are all bag nets.

They should be three quarters of a mile from the mouth of the river. Perhaps Lord Stair would not agree to this. No fishing with net and coble inside the river should be allowed. A boat fishes a pool below the bridge at Ballantrae.

The kelts sometimes do not get down till May. There are few clean fish till then. It is June or July before any clean fish come up.

Has never seen salmon, but has seen trout, before May.

Galloway Arms Hotel, Newton Stewart, Thursday, April 22nd, 1880.

PRESENT:

SPENCER WALPOLE and ARCHIBALD YOUNG, Esquires.

WILLIAM MILLIGAN, gamekeeper to Lord Galloway.—Knows the Cree as far up as Loch Moan. Has been keeper 21 years; but has only been connected with salmon fishing in the Cree and Minnock since 27th May 1879.

Has not seen fish so badly spotted as those represented in the photographs, but has seen them marked between the eyes with white marks. When he examined it, they were like sores on the skin, near the head and tail, but not many on the body. Never saw the disease before last year. Plenty were taken out dead. Saw some in the water. Cut one fish through above the tail fin. The flesh was natural, and the wound was only skin deep. This was in November, just about spawning time. The fish had mostly spawned. Is quite sure of this, the salmon coming in October. The Cree is a late river.

Never saw the spots on clean-run fish. Some of the fish were unspawned. Has kept no account of the number he saw, but has seen at least 100. Saw some dead fish not marked at all. Perhaps they were merely exhausted by spawning. They seemed in good condition.

Thinks the cause is the wet seasons of 1877 and 1879. Last year was very wet, and so was 1877. 1878 was dry and cold.

So much water coming down in 1879 filled up dirty places near the banks, and made the whole river dirty. The Cree is not as pure as the Minnock. Many sheep drains run into it.

Is nearly sure that the disease originates from sheep dipping. It poisons the water to some extent.

The Cree does not rise so quickly as the Minnock, but keeps up longer after a flood. The Minnock is purer than the Cree.

There are 10 fish in the Minnock for every one in the Cree.

The Lins should be put down. They keep the fish in one place, and the fish can only go up when the river is rising and falling before and after a flood. The Lins of Cree could be improved by blasting, at little cost. The obstruction at the Lin of Cree is worse than it used to be, but fish do get up.

Has seen dead fish on the banks of the river in November. Believes these were the fish that were spawned by Lord Ailsa's men for artificial breeding. Saw the operation of catching and spawning the fish. Cannot say if the fish were squeezed. The ova would run out. This was October. Has seen fish spawning in the middle of October. The fish that he saw dead were spawned fish, mostly she fish, without disease.

Saw also diseased fish dead, both male and female. Has only had one year's experience. Never heard any one say it was a new disease. Has heard it said that it was on the trout in the small burns.

Has no instructions to take out dead and diseased fish.

THOMAS CRAIG, tacksman for 41 years of sea fisheries in the Cree, 14 miles south of Newton Stewart.—Uses stake nets. Takes Cree and Bladenoch fish. The fishing, especially the summer fishing, is falling off. Thinks the grilse are considerably decreasing, but summer fishing last year was very good. Has no experience of any autumn runs of fish.

Has seen the disease. It is a skin disease. The fish were chiefly diseased on the head. In most cases the skin was nearly all off the forehead. Never saw a grilse diseased.

When he has seen fish affected on the body, the disease was more like a scab; but with fish diseased on the head the skin is all off. Generally the fish that he has seen have been improving. They were all in salt water. Thinks they were curing in the salt water. Thinks that they cure fast. Kelts are always worse than mending fish. The fish with the skin off forehead were seen in the spring. They might have been sent to market but for the disease.

The disease this year was worse than ever before. One fish had the eye out of its head.

Has seen the disease for three years. Two years ago saw three fish; last year saw 20 or 30. This year has heard of a score. Would have seen it if it had existed before.

Has always seen fish diseased towards the end of September, but they were not so badly advanced as the fish now attacked by disease. Has seen fish all his life marked with little red spots. The fish seemed to get further advanced towards spawning time. Is speaking of 20 years ago. Used to see some fish, red and spotted, then, in September, but not so aggravated as the fish seen now. Thinks the disease is much aggravated. Has seen nearly 20 cases this year. Never saw a clean fish affected. Thinks the disease attacks the fish in the rivers, because they were all kelts or mending kelts that were attacked. Never saw fresh fish so affected, but has seen them wounded by bites.

The fish he has seen have had sea lice on them.

Has no experience of river fishings, and has no qualification to speak of the cause of the disease. Has no recommendation to make.

Has heard that overstocking is the cause, but the fish are falling off in numbers.

Some of the fish had "mended" or "mending" sores. Young skin was coming over the wounds. Some of the worst fish had the fins and tail eaten clean off, and blood oozing from them this year. Thinks such a fish would recover.

One of the fish, being put into a pool, died. He examined it, and opened it. The fish was quite good inside and marketable, and it had a very small indication of milt. The liver was a little yellower than usual—a brighter colour than usual. It was not much enlarged; it was not rotten.

Thinks the kelts are early kelts, and supply the early spring salmon.

Never saw any fungus on the fish. It is wholly a skin disease.

Netting ceases on 27th August and begins on 10th February. The fish in September are not good. The fish formerly caught in September were spotted. Thinks the present date for closing is too early. From 10th September to 20th February would be a good close season. The first clean fish come up in February. Has caught seven fish in February.

The two fish he got on 20th February were much worse than those in the photograph, but were recovering.

GEORGE HOPKINSON, salmon fisher and tacksman of fishings from here to Creetown.—Fishes with net and coble. Has known the river since 1865. The fish have greatly fallen off in numbers. Has seen fish with marks to a certain extent on their body. Saw one with a mark on the dorsal fin in July last year. Its head was also diseased, and was very white and soft. The tail fin was almost eaten away to the bone. The fish seemed to be fresh run out of the sea, and was in splendid order except for the disease. Thinks the fish had got the disease in the sea. It had many sea lice on it, and yet was very badly diseased. Its flesh was quite good.

Got a well-made fish in the beginning of August similarly marked. Took it to Mr. Drew. The head was all white, and the tail eaten away. It was a splendid fish, coming up from the sea.

NEWTON
STEWART.

Saw four diseased fish in the river up to 27th August. They had a brown sore, and matter putrefying. Over a portion there was a fluffy appearance. The head was quite white. The flesh was quite good. Did not notice the liver.

Is sure the fish had got the disease in the sea.

This season has not seen more than six fish diseased. The first was lying dead, and washed up by the side of the river. This was in January. Saw another lying dead, close to Newton Stewart, and has seen four since. The last was a month ago. They were all kelts, except the last, which was well made up. The flesh of it was good and red. It had been down to the sea, and was coming up again. Cannot say if it was a spring fish.

It is a skin disease.

Four of the fish were caught in his nets, and two were fished up dead.

Thinks the disease did not originate in the river, because the fish had sea lice on them.

In other seasons, at the end of July and beginning of August, has seen red-spotted fish. Many fish had red spots, both male and female, and particularly female.

Does not think that the fish in July had been up the river and dropped down after contracting the disease.

One fish in September had the river mark (dark scales), but the others had bright scales; if they had been in the river they would have had the river mark. The first two fish were quite silvery, and the other two quite dark scaled.

Has noticed in dry seasons that fish are more abundant and more apt to get injured by rocks, &c.; these wounds are distinct from those on the diseased fish.

Has seen red-spotted fish every year with red spots half the size of a small pea all over their body. This is merely a change of colour. There is no sore. It is something like the "red kippers."

The diseased fish had white fungus on the head. One had the head all over white. It was caught half a mile from the tide. It had sores, and parts were all bare. The fins and tail were eaten away. It had sea-lice on different parts of the body, mostly towards the tail.

JAMES McWILLIAM, river watcher, Glenluce.—Has been 10 years on the Luce. The river is doing pretty well. There are far more fish this year than last year. Has seen spots on the fish more or less every year, chiefly on kelts. Sees dead kelts every year, mostly spotted. During the last year the spots have been more numerous, and kelts have been more numerous. Saw one clean fish dead in the second week in January. It had no roe. It was a spring fish. It had lots of fungus. This was the only dead one he has seen or heard of. Has seen living ones in the pools with spots on them.

Noticed white spots in the autumn of 1878—in July and August. The fish had white spots on the head. The tide reached them every second week at spring tide.

Has seen it also higher up the river on clean fish. Never saw it before 1878.

Has seen ever so many more fish with spots of the same character as formerly. Thinks the new disease is an aggravated form of an old disease. Did not open any of the fish.

Has not heard of fish in the sea being diseased.

The fish spawned later this year than usual, at the end of December and beginning of January. They usually spawn at the beginning of December.

Rods are off at the beginning of November. Nets are off on the 10th September.

Never saw the disease in other years.

The Luce is chiefly a sea trout river. This year saw rather more sea trout than salmon.

Takes out the dead fish and buries them.

The Luce is strictly preserved.

There are two mill dams surmountable in floods.

JOHN MCGOWAN, watchmaker, Wigtown.—Is tacksman of fishings in the Bladenoch. His fishings are in both salt and fresh water. Fishes with net and coble. Has known the river 40 years. There are fewer fish now than formerly.

Has seen fish in the Bladenoch marked with the disease. The year before last saw a fish with red and bloody spots, and the fins all eaten away. There

was not much white growth on them. It was a kelt. This was early in April, or at the end of March. Never saw it before.

The sewage of Wigtown goes into the Bladenock, and there are dye mills on it.

There are three dams with passes. Think it is pure above Wigtown. Thinks the pollutions will not cause the disease, unless it is the manures.

Did not cut up the fish he saw.

This season there have been about six diseased fish.

His brother saw two lying in the mill lade at the distillery. Has seen dead fish in the river before, but not diseased.

The Bladenoch is a late river.

MAJOR COLIN STEWART.—Has been acquainted all his life with the Cree, the Minnock, the Fleet, the Bladenoch, and all the rivers hereabouts. Thinks the fishings have most decidedly fallen off.

There are nothing like so many salmon as before. Does not speak so much of the Luce. There is nothing like the same quantity of fish as formerly.

Has seen fish diseased, and believes there was hardly a sound fish in the Cree. Saw 60 or 80 bad fish, piebald, like a magpie, in October, November, and December 1879. Has seen it before after very wet seasons. Has seen burn trout diseased.

Think it is the excess of rain water which causes it. There was a very wet season in 1877 and 1879: thinks the disease was started and spread in 1877, and increased in 1879. In dry weather the disease, he thinks, will disappear.

The salt water cures. Has not examined the intestines of the fish; but has cut the flesh.

Has shot diseased fish in the river, and taken them out. Many were covered with a white woolly flocculent matter. It floated in the water. The whole of the head was covered, and all the fins were off, and the tail quite eaten away.

A dreadful number of diseased fish were in the Cree. There were very few healthy fish in it in September, October, and November. Lord Aissa's men, who were collecting ova, said that the ova was all right in the diseased fish.

The spawning season on the Cree is from the first week in October to December.

The Luce is very late, and the spawning is chiefly in November.

Sea trout and herlings have been very badly diseased in the Palmure. Has also seen grilse diseased.

Thinks the Lin of Minnock should be opened for spawning fish, but on the Cree it would be better not to let them up.

Thinks the excessive rain water is of a different character to ordinary river water. The usual supply of the river is from springs, but the excessive rain water makes the water too soft. The springs are from granite.

Has heard from shepherds that burn trout in the fields have for 30 or 40 years past had the fungus after very heavy rains.

Thinks the softness of the rain water is the cause of the disease, and not the surface drainage.

Sheep drains are very hurtful in causing the rise and fall of rivers to be sudden and extreme, instead of gradual as in former years. This is not so much the case with pipe drainage. Does not think that the decomposing matter going through the drains into the rivers has anything to do with the disease.

The sudden floods tear up the spawning beds, and the lowness of the water afterwards exposes the beds to injury. The scarcity of fish is due to these causes.

More fish are marked than formerly in proportion to the stock.

There are fewer fish on the spawning grounds, and so overcrowding cannot be the cause of the disease. But thinks in the case of grouse that the overcrowding theory holds good.

Does not attach any importance to the statement of Mr. Hopkinson as to the fish being affected fresh from the sea.

Thinks surface drainage and other causes have altered the natural circumstances of the river.

Has only thought of his theory as to rain water in connection with the Cree. Cannot apply it to other rivers. In former years has seen 60, 80, or 100 fish in one pool in the river, but no disease among them.

NEWTON
STEWART.

Artificial breeding is very good when the upper proprietors attend to it, but nature will breed more fish than man.

Does not agree to the proposed extension of net fishing to 20th September. Thinks that rod fishing will do no harm if extended longer.

Used to think artificial floods by means of sluices at the head of a river would be a good thing. It has been tried here, and does quite well. The river may be raised eight or nine inches in five hours, and induce the fish to run up.

Rivers with lakes are always early.

Diseased fish should be killed and removed.

CAPT. JAMES DALRYMPLE HAY.—Agrees with the evidence of Major Stewart; but cannot speak as to his theory about rain water.

Thinks the kelts being crowded in small pools when the river is dry in the spring, leads to disease.

Speaks of the Luce. Formerly the river did not dry up as now. Has seen the river fall six feet in 14 hours.

Would have it compulsory to have all pools cleared and all fish destroyed with any sign of disease after 1st April. The Luce is very late, and kelts will stay in it till May. Would even authorise the destruction of kelts by anyone after 1st April, even if not diseased. This might also apply to the Cree. It is a disease that attacks kelts.

Saw some salmon two years ago, in 1878, badly marked on the dorsal fin.

It is a new disease to him, but has heard of it before.

The salmon in the Luce have much fallen off during the last 16 years. In 1866 it used to remain in fishing order for two days, and now it is only in order for six hours after a flood.

Sea trout have enormously increased. They run up to 9 lbs. in weight.

Reverend JOHN BARCLAY.—Has lived on the banks of the Cree for 30 years. Has heard the evidence as to the disease. Attributes it to over-fishing and other causes.

The stake nets are too near the river.

Has seen a few diseased fish. The first was about two years ago in the Cree. Saw a kelt on the bank; it was all yellow, and had a decayed appearance. Saw last season several fish, all decayed, left on the bank. Saw no fungus on them. Believes it is due to the foul water from drainage and sewage. The effects of sheep washing are infinitesimal.

The sheep drains in the summer are infested with moles: dead sheep are buried; and the refuse from these, together with the droppings of the sheep, &c., is carried into the river, and the collection of putrid matter causes disease. Fungi (toadstools, &c.) grow in the grass which grows where this sediment falls. The side pools of the river are not cleaned out by floods, and the water coming out of these pools helps to poison the fish. Thinks the rivers should be flooded and washed out every week.

Major Stewart's theory may be right in excessively wet seasons.

The Cree rises in a great deep lake, 2 miles long by 1½ miles wide.

The Lin of Cree should be opened up. Lord Galloway has the right of fishing on one side and Lord Ailsa and Mr. Wason on the other side.

GEORGE F. HOPKINSON (*recalled*).—Thinks the fish might go down to the sea as diseased kelts and get partly cured, and go up again with the sea lice on them, and yet only partly cured. This may account for the fish he caught, fresh from the sea, with both the disease and sea lice on them.

County Hotel, Lancaster, Saturday, April 24th, 1880.

PRESENT:

SPENCER WALPOLE and ARCHIBALD YOUNG, Esquires.

WILLIAM FOSTER, water bailiff, Lune Fishery district.—Has been so about two years. His district extends from Newbiggen to Watermeetings, a distance

of 15 miles (from 6 miles above Tebay to the confluence of the Rathod and the Lune). The water is pure. Had little experience of salmon fishings before 1878, and never watched a river before. Noticed the disease in the fish, which were spotted white, chiefly on the back. First saw it in the back end of the year before spawning. The fish begin to spawn here in December.

The fish were both dead and dying. Took 106 males and 26 females and buried them. They were dead, and chiefly spawned. They were mostly taken out in January, between Kirkby Lonsdale and Killington Mill. The greatest part were taken out near Barbon. Only took out two or three between Newbiggin and Killington Mill. The most fish in his length of water were taken out between the mill and Watermeetings.

There were very few fish diseased at the top of the river, but they got diseased as they got lower down. The water is pure. The river was chiefly low then. The weather was dry and frosty.

Was at Halton in the spring of 1879 for fourteen weeks. Large quantities fish were in Halton Water the whole time, nearly all spotted. The salmon went down over the Skerton weir on the 25th May 1879.

Took large quantities of dead fish out of Halton Water during the 14 weeks. Forge weir was blown down then. Very few fish spawned at Tebay. Not over 12 pair in 1878-9, but a large quantity have spawned this season. This season very few fish were up before 11th October.

The kelts were chiefly diseased, and a good lot were dead. Buried them. There are as many diseased fish this year as before—perhaps more.

Has heard old men talking of it, and some of them say they have seen it before, but not so bad as it is now.

JAMES GORNALL.—Has been water bailiff on the Lune district for seven years, and has known the river longer. Knows the whole river. Has seen many hundred salmon marked with white spots. Saw it a few years ago, but not so bad as now. The disease has gone on increasing since 1873. Saw it on kelts, but never on clean fish before this year. Has seen it on fish going to the spawning beds. Saw it first on 30th November last year, on an unspawned fish opposite Wenning Foot. Saw about two in a week—both females, and very badly diseased. The setting-on of the head and fins was like a cotton wool substance.

Cut up many a score. The intestines were quite healthy. Did not particularly notice the liver. The flesh was discoloured under the scales.

The river is little polluted except by a few sewers.

The fish are terribly bothered about getting over the rivers at Skerton and at Halton. The fish cannot get freely over. The passage of salmon should be made easier. This has much to do with the disease.

The weirs have been a long time there.

It is a fresh-water disease. Cannot say if the salt water will cure it.

The Lune is a very late river. There are not many clean salmon in it till May. The best fishing season is in summer and autumn. Netting ends 31st August.

Last year the fish were detained in Halton water and could not get over the middle weir, and the pool was overcrowded with salmon. The kelts came down, and the up-fish were there four months altogether.

The river was very low in the winter of 1878-9. The fish were not crowded higher up.

Has seen some disease ever since he has known the river. There has always been a disease. Cannot say if it is the same. Has seen scabs without fungus. It seems as if the male fish knocked their scales off, and that a scab was formed.

There are many more fish now than when he first knew the river. Used to fish a whole season and not catch a fish, but since the Association was formed he has caught many.

Of late years the heave-net fishermen have not done so well, because of the heavy water and the drift-nets.

Would clear away the weirs if the river were his, and the fish would have a clear run up. Has known the fish stop in fresh water for nine months.

In 1877 the salmon came down to Forge Weir on the 29th March and left on the 15th May.

LANCASTER.

In 1878 the salmon came down to Forge Weir on the 24th April and left on the 15th May.

In 1879 Forge Weir was washed down.

In 1880 salmon and smolts came down on the 19th April.

Thinks they keep so late because of the weirs.

Proper passes should be made in the weirs.

The fish rise in the water as if in pain. Takes out and buries the dead fish.

Has taken 255 females and 114 males during the spawning season of 1879-80 at Barbon and Halton. The she fish did not commence to die in any numbers till after spawning, but has caught full fish dead and dying.

The late fish cannot get over the weirs. They spawn below the first and second weirs. The river is full of spawning ground.

In his length of river from Kirkby Lonsdale Bridge to Wrathay Foot the quantity of spawning fish was not as large as in former years. A number of late fish do not get over Halton Weir, and some seasons they turn over the spawning beds below the weir three or four times. Never saw so few spawning fish during the time he has been on the river as in 1878-9. Came to Halton on the 21st January 1879. A large quantity of fish were in Halton water. Many died, and very few went over Skerton Weir before the 25th May.

Has seen large quantities of fish above Forge Weir, but never any overcrowding in the higher parts of the river.

WILLIAM SEED, water bailiff.—Has known the Lune for 20 years. His district extends up to Kirkby Stephen, and a few miles below Hornby.

Has seen more diseased fish this year than ever. Twenty years ago there were no fish at all. They began to come in 1860. The Act of 1861 greatly increased the supply of fish.

Has seen fish with spots for several years. First saw the spots 10 years ago on spawned cock fish. Lately the spotted fish have increased gradually.

They are a deal lighter coloured than they were. The old spots looked like bites, and they had no fungus. They were like sores. First saw the fungus on old fish nine years ago. It has got worse every year. It is worse this year than ever. A few fish came in February without spots, but nearly every fish had spots and fungus. Afterwards in his water there were in one stream 100 pairs, and nearly all alike. They were very badly covered with the fungus. The female fish did not all die; all the male fish died.

Buried about 167 males and 70 females. This was between Tunstal and Hornby. There are not many diseased fish there now. They have come down the river.

Saw a good many smolts diseased when the ice was on the river. They were white just the same as the salmon. Picked some up dead. Also saw some common trout dead. The disease is getting worse. There were 10 diseased fish in the river this year for one last year. As many died last year in proportion as this year. There was no overcrowding last year, and the disease was just as bad as it is now.

Has seen more salmon, but never as many spawning at one time on the higher part of his length of river as there were this season. The first were well paired and not overstocked with males; but nearly all were spotted with the disease. There was no overcrowding except at Cunnygarth near Tunstal, where the beds were well turned over after the first ice broke up. There was not the usual quantity of spawning fish below Gressingham Bridge. In 1878-9 there was a scarcity of spawning fish. Saw no diseased fish before the 20th November. Never saw so few salmon up the river during the netting season as last year.

Knows of no pollution in the river.

Has opened diseased fish. Took a diseased fish in the beginning of December which had half spawned, and died. The spawn in it was like roasted bacon, and not a good colour. It was a nasty yellow colour. The liver looked all right. The fish was all blown up, and the spawn was bloody.

The fish were kept off the beds by the frost, and all came up at once. Last year there was a nice size of water for spawning.

The weirs bother the fish. They cannot get over them. It is possible this may have something to do with the disease. The fish should be let up more freely.

THOMAS KIDD, gamekeeper and water bailiff.—Has known the Lune for 31 years. The fishing has greatly improved. The weirs existed when he first knew the river. The fish were not there then. They have increased since 1861.

Never observed the disease till four years ago. Got a diseased fish in the summer four years ago. The fish was a little gone about the head. It was found opposite Tunstal. It was a clean fish.

Most of the diseased fish were kelts. The disease is increasing. It has been worse than ever this year.

Has cut up some fish. The skin-disease appears to get stronger, and the white fungus appeared this season for the first time. Four years ago the spots were grey, and not so white. There is fungus now. Thinks it has been increasing by degrees. Ten years ago many male fish died from fighting. Thinks it has gone on increasing till it became more noticeable.

It is due to the fish being kept in the tideway. If there is any sewage there, this would cause the disease. They stay too long there. Knows of nothing higher up to cause it.

The fish are increasing, and in good seasons there are plenty of fish, but in dry seasons few. Has plenty of fishing on the whole.

Represents the river from Tunstal below the Castle to above Hornby. This season there has been as much disease there as elsewhere. Many males may always be seen in the pools, but this season he has hardly seen an undiseased fish. The disease kills the fish; as they get lower down they die.

The water bailiffs have buried the majority. Has opened some fish, and found a more yellow colour in the flesh than there ought to be.

The fungus is the disease. Has tried to scrape off the fungus, and found its roots growing deeper and deeper into the flesh. The head is more deeply eaten into than any other part.

Last season there were more fish than usual in the river. The fish are on the increase in the river. The weirs are improved. The season but one before this was as good as this. In 1877 the disease was not so bad. In 1878 the fish were purer, and the fungus was not so white. The male fish have been more covered this year than before.

THOMAS GORSE, gamekeeper, Hornby.—The water at Hornby is good. The fish have decreased. Last season was very bad. The fish could not get up for want of water. On an average the fishing is going back. After the nets are off the fish come up abundantly, and there are too many fish in the water then. They go far above Hornby. The rod fishing is improving. Saw the disease about five years ago. It was similar to the present disease, but the scab was not so white. The fish are whiter and more covered with fungus now. Thinks it is the same disease, but cannot say why it is whiter. The disease has been getting worse. Has found a good many fish dead in consequence. Has opened fish, and they seemed some of them to be rather discoloured.

Attributes it to the fish being blocked below. The fish are too long below Skerton and Halton. Would like to see Halton Weir pulled down. Both weirs should be removed.

The disease is increasing. Yesterday a friend of his found several fresh-water trout in the Greta diseased. Mr. Foster agrees with him as to the fish being blocked below.

RICHARD CLEMENSON, rod fisherman.—Has known the river for 15 or 20 years. Fishes the upper part from Halton to Tunstal, a distance of 15 miles.

The rod fishing has very much improved. When he first began he could not get a fish at the back end of the year. No fish get up till the nets are off.

Has seen the disease for many years. Particularly noticed a fungus first among minnows. They had like a moss growing on them; it was darker in colour than the growth on the salmon. It seemed to grow out of them. They died by suffocation.

First saw disease in salmon eight or nine years ago, but not so bad as now. The salmon have a lighter coloured fungus on the gills, fins, and tail, and all over the head. There was a fungoid growth on salmon and trout in Halton water. Has also seen it on eels.

Has only seen one clean salmon diseased. Mr. Sharp landed one in September last, and it had two spots on the cheek and back just commencing. The fly is principally used here. Only knows of this one case of a diseased fish taking the fly.

LANCASTER.

Stagnant water has much to do with the disease. Trout from a pool are often slimy. The disease, he thinks, settles on the slime. Thinks Halton water is the great breeding place of the disease.

In January 1880 saw a shoal of 200 fish, and about half a dozen were just commencing to get diseased, when a flood came, and they went to Halton spawning beds, and they were nearly all covered with fungus. Has no doubt overcrowding breeds the disease.

The fish should have a free passage up the river.

The stock of fish is increasing. The disease has not decreased the supply.

Before the passing of the Salmon Act the netting went on to the 29th September. The shortening of the season has been a good thing for the river. Would object to an extension of the season. More breeding fish should get up early in the year than is the case now.

No fishing should be allowed below the weir at Skerton.

The fish have greatly increased.

Most fish run up in August, and a few in June and July. The large fish come up after the nets are off, and up to Christmas.

THOMAS EDMONDSON.—Owns a fishery above Halton. Does not know that more fish are in his water than there were three years after the Act of 1861. During the last few years he has had no fish. The catch depends on the water. Has seen the disease lately. There is a theory that the bottom of the river is tainted by the disease, and the fish get infected.

Calls attention to the pollution of the river by sewage, &c. Believes the fish come up fouled from the dirty water. Thinks the fish get the disease from each other. The river is not contaminated above Halton, except by some washings from a silk mill at Bentham.

Thinks the disease originates in the lower end of the river.

Hears that fish are caught in tidal waters with the disease.

Some control should be exercised over the pollutions and sewage.

It would be better if more fish were passed up.

In Skerton Weir there is only one pass. The two original diagonal passes should be replaced.

Thinks most fish are turned back at Skerton.

THOMAS G. THOMPSON.—Is a conservator of the Lune. Has known the river all his life. Has fished with net and with rod. There have been far more fish in the river since 1861 than before. The increase of the fish has followed the erection of the passes and the shortening of the fishing season, and the enactment of a weekly close season. Has seen a disease among the salmon for 28 years. It is not new. It has got very much worse during the last few years. It was formerly confined to kelts. The first clean fish that he saw diseased was in August 1879. Has only seen two clean fish diseased. They were not very badly affected. They were taken in the tideway.

Thinks the fish are overcrowded in the winter. This is not caused by the weirs. The whole river is overcrowded in the winter.

The best fishing month is August, and formerly it was September. The old netting season should be partly restored. Would have fishing extended to the 15th September. The fish have increased since the month of September was taken off the fishing season. There is no greater take now than there used to be, but there are 10 fish in this river to one formerly, and as many are taken up to the end of August as were formerly taken up to the end of September.

There is no pollution in the Lune.

It is a fresh-water disease. A fish diseased getting into the sea would get partially cured. The fish he refers to might have been partially cured in coming up the river again. The diseased fish should be destroyed somehow.

Has seen hundreds of fish that the bailiffs have not seen. The numbers returned by the bailiffs are not one fourth of the actual number diseased.

Agrees that there are thousands of fish in the river in the winter. One day counted 60 in an hour go over Skerton Weir, and 100 in less than an hour on another day.

His mill has been stopped three times by dead fish. More than 50 dead fish had collected under the wheel each time. They were all covered with fungus, and were mostly unspawned fish. They were thrown into the river and allowed to float out to sea.

Has skated up the river and found many fish lying at the bottom covered with fungus.

Has seen dead fish lying in a pool three weeks without coming to the surface. The river is overstocked. If the river was in a natural state the fungus would kill them.

The fish have no difficulty in getting over the weirs. They have no trouble at Halton when there is water. There are no fish when there is no water.

The disease formerly was not so bad in proportion to the stock of fish as it is now.

The disease has killed more fish than the nets.

Has a fishery in the Ribble. The disease is appearing there. The stock of fish there has been small. The disease has appeared in the upper mill above the Hodder, between Watermeetings and Higham. The Ribble is now largely stocked, more than it has been for many years.

There are a few morts and sprods here; they have the disease. Cannot say if there is any disease among the morts and sprods in the Ribble.

T. EDMONDSON (*recalled*).—The fish never get up the weirs till the nets are off. They are kept down by the miles of netting in the estuary, and by the netting above and below Skerton Weir. The netting season might be extended if fish were allowed to get up during the season. Some years ago Halton Weir was blown down, and there were plenty of fish above the weir then. The she-fish go up in the summer and the males later. The weekly close time should be lengthened if the autumnal close season is shortened.

J. LAMB, clerk to the Conservators of the Lune, Lancaster.—In November, December, January, and February has seen 40 or 50 fish trying to get up Halton at a time. They eventually spawned below the bridge.

Has known the river 50 years. Has noticed minnows with their tails and fins eaten off. In 1873 first saw salmon affected. Many fish were caught that year above Forge Weir. The bailiffs buried them. They were not so badly diseased then as now, and had no white "night caps" then.

Thinks the disease is due to overcrowding behind the weirs. In 1873 the fish were greatly overcrowded. Hundreds were packed in a space of 100 yards by 20 yards wide. They were packed quite close, and the river was quite blue with them. The water bailiffs buried four or five every day.

Thinks the disease has always existed. Last year the fish did not get down till 25th May. It has been suggested that the fish should be let down earlier, but they will not go down. They try to get through the gratings when the mill is started, but afterwards will not go down over the weir. The whole river was let off to repair the weir once, and yet the fish would not go. The smolts have gone down, but not the kelts, when the sluices were lifted.

Will not agree to killing the kelts. The great detention of the fish occurred in 1873.

T. G. THOMPSON (*recalled*).—No fish have been caught between the aqueduct and the railway bridge this year. Six salmon have been taken at Halton and two at Lancaster Quay this year.

Last year the weirs were down, and yet the fish would not go down.

Saw a diseased smolt dead on 23rd March. On 16th April two diseased salmon smolts were caught at Halton. Observed river trout also dead.

FRANK RABY, Cockersand.—Rents the baulk at Cockerham. It is a large fishing weir. Last season was a very poor season. The season before that was the worst the fishermen ever had.

Has seen diseased kelts coming down the river. Has seen more this spring in February and March than ever. They were very dirty, as if covered all over with mortar. They are getting better.

The water where he fishes is salt. The fish seemed to be getting better there. The last fish he had covered him with fungus as he carried it.

When the fungus comes off, it leaves a mark on the fish as if a scale was scraped off. There is no sore under it. The sore may be healed perhaps. The fins are sometimes eaten away, but this is quite common at all times with kelts. Never saw any dead kelts. Saw many full-bellied fish driven down by the ice. They were chiefly males. They had no marks of disease. Did not open them. Some of them were good fish, not long from the sea.

Thinks the disease is not new. It gets worse from overcrowding. If the fish were caught in September it would be a good thing.

LANCASTER.

The upper proprietors should come down and see what is being done in the sea. For seven hours out of every twelve there is no netting: this is at high water. The men commonly fish at low water.

The fishing season should be extended. Fish have been dearer since the Act came into force. Before then he sold fish at 4*d.* per lb. in July. The weekly close time keeps the price up by preventing a glut in the markets.

The disease is proportionately worse now than formerly.

JOHN HARKER, M.D., medical officer of health, Lancaster.—Has known the Lune for 24 years.

Has examined portions of diseased fish and a smolt from the Lune. They were diseased. Thinks the disease is the usual fungus that affects fishes. The fungus and its effects cause the disease. Considers that where the fish had lost tone or had not good feeding ground they would be more liable to the disease. It is a cutaneous disease.

Attributes it to the production of fungi as all fungi are produced. Hardly thinks an injury to the fish would predispose them to its attacks. The spores would settle on the fish and spread. Diseased fish might affect healthy fish.

Thinks the spores are present in all continuous waters, running or not. It seems a common fungus. There must be some causes to predispose the fish to any disease. Overcrowding might do so. Thinks the Lune is overcrowded in September and October. There should be an extension of the fishing season to increase the supply of good fish for food.

The diseased fish have sometimes been sold as food. Thinks they are not good for food, but has not seen any one poisoned by eating them. Thinks the law should prevent diseased fish being sold as food. The diseased fish are going to decay, and, being unwholesome, should not be sold as food.

Has very carefully examined a smolt. The disease was on the skin. It had passed through the scales and got into the true skin. The roots of the fungus, no doubt, produced pain. The internal organs were not different from those of a healthy fish. Did not examine the brain.

If a cutaneous disorder suddenly broke out among the people in Lancaster, he would search for general causes, and then for causes affecting the spread of the disease by contact. Would look to the health of the patients generally, and would then look to the local disease. Ringworm, for instance, would be produced by spores of the ringworm fungus.

The lowering of the tone of the fish by detention and by want of sufficient food, with the presence of the spores in the water, might result in an outbreak.

Ringworm would probably spread to healthy children if suddenly brought into activity. There would probably be among fish a predisposing cause; if the fish had suffered in health, and the fungus were present, the fungus would spread.

Thinks the spores are present in all continuous waters. Ordinary pure water would be as likely to retain the *Saprolegnia ferax* as the atmosphere is likely to retain the fungus of ordinary mould. The disease has broken out because the rivers are overstocked. Preservation has overstocked the fish, and the long detention of the fish in the water, the absence of natural enemies to keep down the surplus stock, and other causes have combined to assist the spread of the disease.

Sporadic cases have, in fact, always existed, but they have now developed into an epidemic.

The sewage is turned into the tideway, but the river generally is very pure.

The disease is a fresh-water disease.

Berwick-on-Tweed, Monday, May 3rd, 1880.

PRESENT:

ARCHIBALD YOUNG, Esquire.

WILLIAM JOHNSTON, fisherman, Cornhill.—Fishes at English water on the south side of the Tweed, below Coldstream Bridge. This season has landed

with the wear-shot net between 40 and 50 clean salmon and sea trout affected by the disease. From their appearance they had all been in the water for a considerable time. Has observed several diseased clean fish floating or swimming down the river, tail foremost, and near the surface of the water. BERWICK-ON-TWEED.

Has never seen a diseased fish attempting to go up the river. The diseased fish, when handled, have a slimy feel, whereas a fish direct from the sea is not slimy. It is natural for a kelt to drop down the river, and for a spring fish to go up. But this year the spring fish are dropping down the river towards the salt water. Thinks that this is owing to the fungoid disease with which they are affected. Is of opinion that the disease is a river disease. Never saw the disease on clean salmon before this year.

THOMAS SWAN, fisherman, Twizel.—Fishes with the wear-shot net. Has this year landed between 20 and 30 diseased clean fish, chiefly salmon. They had all been some time in the river. Has frequently seen diseased clean salmon swimming down the river with their heads at times above the water, but has never seen any such fish going up the river. Salmon which have been for some time in the fresh water are much darker in colour than fish direct from the sea. Is of opinion that these diseased spring fish had gone some distance up the river, and were on their way down to the sea when caught in the nets. Both kelts and clean fish are now diseased.

First saw clean spring-run fish diseased last year. The spring fish used formerly to remain for some months in the river; now they are leaving it and going down much earlier. Thinks the disease weakens the fish and drives them down to the salt water. Some of the diseased fish seemed, from their silvery appearance, to have been only about three weeks from the salt water. Thinks the disease is worse on the spring fish than on the kelts. River trout, grayling, and smolts have all been attacked this year.

Thinks the pollution of the river is the cause, or one of the causes, of the disease.

JOHN BOLTON, fisherman, Norham.—Fishes at Westford fishery. Has seen five clean salmon and four clean trout landed with the net there, all diseased. Caught two or three of them when they were dropping down the river, tail foremost, and near the surface of the water. In ordinary states of the river the salmon ascend at a low cauld, known as Westford Dike. This year has caught several clean fish after passing over the dike. None of them were diseased. Never saw or heard of diseased fish coming up over the dike. None of the diseased clean fish had the appearance of having come direct from the sea. Has no doubt they contracted the disease in the river. It is a fresh-water disease.

Has observed that the heads of the spring salmon are more severely affected by the disease than the heads of kelts. First noticed the disease in the clean spring-run fish last year. Both last year and this year they left the river earlier than usual. Believes the disease to be the cause of this.

THOMAS SCOTT, fisherman, Birgham.—Fishes at Wark fishery. During the months of March and April last, landed more than a dozen diseased clean fish, chiefly salmon. Cannot say whether they had been much farther up the river; but from their appearance they seemed to have been in the river for some time. Has seen a good many dead and dying clean fish, with their heads diseased, lying at the side of the river. Has never seen a diseased fish which seemed to be fresh from the sea. Has occasionally seen undiseased clean fish dropping down the river in company with kelts.

This year and last year saw diseased spring fish dropping down the river.

The river is now not half as clear as it used to be. Cannot see half so far down in it as formerly. Pollution is the cause of this. Owing to the increasing pollution the fish do not take the river as freely as they used to do. It sickens them. Never saw clean fish diseased before last year and the present year. Believes that this year the disease has killed most of the kelts; and the majority of the spawning fish have this year been affected by the disease. Noticed 170 diseased fish, mostly unspawned, between the 6th of November last and the beginning of February 1880.

JAMES SMITH, Tweedmouth, lessee of Bailiffs Batt and Craws Batt fisheries for the last three years.—Has been salmon fishing all his life, but for the most part in the north of Scotland. During the spring of the present year has seen about a score of clean fish affected by the disease. Saw them

BERWICK-ON-TWEED.

also affected by it during the previous spring. Has no doubt that these diseased fish have gone up the river and contracted the disease there, and were returning to the sea when caught. They seemed to have been some time in the fresh water, as they were out of condition and dark in colour. They felt slimy and had not the firmness or silvery look of a newly-run fish. Never saw disease on a salmon with the tide lice on him. Believes the disease is a river disease. The fresh-water fish, such as trout, graylings, &c., have the same disease, but no diseased fish are ever got in the sea.

JOHN FULTON, tenant of fishings at Milne Graden.—Is 66 years of age, and has been a fisherman all his life. Believes the salmon disease to be a new disease. Has frequently seen kelts dead or dying in the spring after spawning. First saw clean-run spring fish with the fungus disease last year. Has seen more of them this year than last year. Has caught salmon which have come up from the sea since January. Such salmon used generally to remain in the river and afford good sport to rod fishers in April, May, and June. But this year the greater number of the spring-run fish caught in the nets have the fungus disease on their heads. Thinks that these fish are going back to the sea, finding that the river water sickens them. Believes they contract the fungus disease higher up the river, and this drives them down towards the sea.

The river is much more polluted at Kelso than down here, and it seems probable that the salmon may catch the disease owing to the pollution.

Never saw the tide lice on any salmon affected by the fungus disease. Has landed this season at least 20 diseased clean salmon and trout (chiefly salmon). Some of these were silvery, but by far the greater number were dark in colour, and not so clean and bright as fresh-run fish. The dark coloured were the most diseased. All of these were dropping down the river. Has never seen a diseased clean salmon swimming up the river.

THOMAS SLIGH, Coldstream, fisherman to Mrs. H. Huntley, at Carham.—Thirty years ago first saw the salmon disease on kelts, and 10 years ago first noticed it on clean fish. Has landed with the net this year 10 clean salmon diseased and 10 bull-trout. Believes that this year the disease has killed by far the greater number of kelts in the river. The liver of most of the diseased fish was enlarged and discoloured. Has seen clean spring-run salmon and trout killed by the disease. On one occasion saw three clean salmon and two bull-trout dead, and several others apparently dying. The diseased clean fish caught in the net were dark in colour, and had not the appearance of fish direct from the sea. There was a difference in handling them. They felt slimy, whereas fish fresh from the sea feel firmer and are cleaner in the skin.

Never saw diseased salmon with the tide lice on them. Has often seen diseased clean salmon swimming down the river near the surface, and has no doubt they got the disease higher up the river.

Thinks pollution is the cause, and the pollution is increasing. Smolts, minnows, trout, grayling, pike, and eels are now affected by the disease. The Carham water is an excellent angling water; but it is falling off very much owing to the disease. Only nine salmon were caught last year, and eight this year; whereas 30 to 40 used to be taken. Diseased salmon will not rise to the fly.

Edinburgh, Friday, May 21st, 1880.

PRESENT:

ARCHIBALD YOUNG, Esquire.

CHARLES BELL, M.D., 14, Stafford Street, Edinburgh.—Has been an angler for upwards of 30 years, and is well acquainted with the Tweed, Nith, Clyde, Brora, and Helmsdale. The pollution of rivers has very greatly increased. One cause of this is that waterclosets were formerly almost entirely out of doors, and their contents were spread on the fields; now they are generally indoors, and their contents are discharged into drains, which convey the pollu-

tions to the rivers. Thinks that town-sewage is highly noxious to fish life. The evil results of this pollution have not shown themselves sooner, because, formerly, the rivers did not rise and fall so rapidly as at present, and there was a greater volume of water to dilute the pollution. Now, there is a noxious sediment on the stones and on the bottom of the Tweed, which, when the fish get sores from fighting or rubbing themselves, irritates and poisons them and produces the disease. Has examined the sore microscopically, and is of opinion that it is of a diphtheric character arising from blood-poisoning, which he believes to be caused by the pollution of the river.

Has examined some cases of salmon disease, and, in all of these, has found the liver to be a mass of fatty degeneration.

Thinks town sewage more injurious to fish life than manufacturing refuse. Thinks the fungus is not the disease, but a fungoid growth following on the sore arising from blood-poisoning. Has no doubt that the disease is a river disease.

The cauldns on the Tweed are objectionable. When the water is low the kelts are crowded above them, and cannot get down. They have insufficient water and insufficient food, and this may have something to do with the disease. In such cases would net above all the dams and put the fish over the cauldns so as to let them get to the sea.

Thinks kelts are too much preserved; they destroy salmon fry. They should be killed after the 1st of April.

Thinks the disease an old disease which has recently broken out with exceptional violence, owing to the presence of certain conditions, with which we are as yet but imperfectly acquainted. It may be contagious, but is rather inclined to think it is not.

Thinks it would be desirable to have a careful analysis of the water of the Tweed taken from several points; first, below Coldstream, where it is comparatively pure; 2nd, at junction of Tweed and Teviot, near Kelso, where there is considerable pollution; 3rd, at junction of Gala and Tweed; 4th, at junction of Leithen and Tweed, where there is also great pollution; and, lastly, about Neidpath, above Peebles, where the water is comparatively pure.

Is in favour of removing all dead and badly diseased fish from the river, and burying them; and if possible would remove the less diseased fish to the salt water, where they might be saved.

Does not think that overstocking is the cause of the disease. Thinks it might tend to counteract the ravages of the salmon disease if a river were artificially stocked with healthy fry. Disease in a pure river may possibly arise from fish contracting the disease in a polluted river, going down to the sea, and ascending the pure river. For example, diseased fish from the Doon might contract the disease, and then ascend to the Stinchar and spread the disease there. Does not think the disease could arise in a perfectly pure stream.

Thinks that the present virulent aspect which the disease has assumed in the Tweed has arisen from the effect of the poisonous sediment caused by the manifold pollutions of the river acting on sores which the fish have contracted through fighting or rubbing themselves.

Would suggest that there should be a close season for river trout from 1st October to 1st April, and, in order to prevent poaching, every fisher should have a license, the cost of which should not be less than 2s. 6d.

APPENDIX No. II.

OBSERVATIONS ON THE SALMON DISEASE,

BY

- I. M. C. COOKE, Esq., M.A., LL.D.
 II. C. L. JACKSON, Esq.
 III. HENRY LEE, Esq., F.L.S.
 IV. PROFESSOR GEORGE ROLLESTON, M.D., F.R.S.
 V. ERASMUS WILSON, Esq.

I.—OBSERVATIONS by Dr. M. C. COOKE.

DR. M. C.
COOKE.

What is the Salmon Disease?—However absurd it may seem to start with a question to which an answer might readily be given, on the faith of a lamentable experience, by a host of individuals, yet it is always advisable to proceed in matters of this kind from some recognized basis, and to make sure of some common ground as a starting point. This disease may be described as consisting of morbid discoid patches, which first manifest themselves on the naked parts of the fish body, as the head, tail, and fins, afterwards spreading to other portions covered with scales. These patches are recognized at once by the whitish filaments of a fungus which grows profusely upon the patches, and which is known in science as *Saprolegnia ferax*. The external evidence of the disease is the fungus seen growing on the morbid spots. From this disease the fish evidently suffer considerable pain, and ultimately they succumb and die. Thus far all seem to be agreed, that the disease manifests itself externally by certain morbid spots on which a fungus flourishes. There also seems to be an equal agreement in the results of examinations of the internal anatomy of diseased fish that, apart from the spots, there is no evidence of the presence of fungi in the viscera, heart, and other internal organs. In fact, that the whole action of the fungus is confined to the external surface. This is an important point, and one about which there should be no mistake. Is there, or is there not, any evidence of the existence of fungoid spores or threads, or of fungus action in fish previous to the external manifestations, or in the earliest stages of the appearance of fungus on the surface? Hitherto I have heard of no instance in which the fungus has been found internally, up to an advanced stage of the external manifestations. The conclusion to be drawn from this is, that the fungus is *not* developed from within outwards, but establishes itself on the surface, and works its way inwards. There is by no means a unity of opinion whether the fungus is the cause or a consequence of the disease. We recognize the diseased spots with the fungus growing upon them. They seem to be indissoluble. Let us, however, attempt to consider them apart.

The Fungus.—This has been so often and so fully described that it is unnecessary to enter upon a long and elaborate description. Seen in the water it consists of a dense mass of slender whitish threads, which are attached by their base to the diseased spots, and radiate with their free ends in all directions. The base consists of a creeping network of similar threads, which are constantly growing and extending into the tissues, like as the roots of a plant grow and extend themselves in the soil. These basal threads or root-like filaments are called the *mycelium*. In the mushroom just such threads are

called the "mushroom spawn." They serve the purposes of roots, attaching the fungus to the substance upon which it grows, sucking in moisture, and spreading with enormous rapidity when the matrix is favourable. As these root-fibres spread, they continue to send up new stems or filaments, and thus as the root filaments spread in the juicy flesh, so does the tuft of fungus grow larger and larger every hour, by the constant production of new threads, which spring from the spreading roots. It need cause no surprise that, when one spot has begun to grow its fungus the progress is extremely rapid, and the patches grow larger every hour. But it may be asked, how do they commence? Let me answer this somewhat suppositiously, from analogy of the process in other fungi. The border rivers, for example, contain myriads of germs of this fungus from previous years, which float in the water in search of some suitable spot on which to grow. They will only grow on certain substances, and one of these is the bruised or abraded flesh of the salmon. A fish having a bruised spot no larger than a pin's head, affords a suitable locality, and the spore or germ adheres to it, and begins to grow. The growing point at once enters the wound or bruise, and, when once entered, it spreads in all directions with rapidity. As soon as the mycelium, or fungus roots, are well established the stems are produced and the first little tuft appears, two or three, then twenty or thirty stems, and shortly a patch visible to the naked eye, and thus the fungus commences upon each spot. Naturally enough the fungus makes its appearance first on the fleshy parts of the fish, such as the head and tail. The softest parts are most liable to have suffered injury, and the soft parts are those on which the spores would attach themselves, and begin to germinate. The germinating threads are delicate and would fail to penetrate the scaly parts. Probably when the fungus does extend over the scaled parts of a fish it does so by the spreading of the root threads, under the cuticle, from the older patches on the head and fins. This, however, is conjecture. One fact is certain, the fungus always commences upon the soft parts of the fish. There must be some *cause* for this fact. This cause I believe to be that all external injuries to the fish are inflicted on the exposed parts, and such injuries prepare the home for the fungus; and, moreover, there is no obstruction to the growth and development of the germs in the naked parts. It is a difficult thing to demonstrate by experiment whether the germs of the fungus will commence to grow upon healthy unpunctured skin of a salmon, or, if they germinate, whether they possess the power of perforating the skin. My own opinion is that they would not. In plants the germs of the parasitic fungi commence growth on the surface of the leaves, the extremities do not pierce the very delicate cuticle, but enter by the stomata, or breathing pores. It is scarcely probable that threads equally as small and delicate would penetrate the cuticle of a fish.

When the threads of which this fungus is composed become fully matured they produce fruit. I need not detail the process which terminates in the upper parts of the threads being filled with minute bodies, nearly egg-shaped, but exceedingly small, which escape by a perforation at the end. These germs are called zoospores, each being furnished with a pair of delicate hairs, endowed with active motion, and like a pair of oars propel it actively through the water. Every tuft of fungus produces swarms of these active moveable germs ready to attach themselves to any unlucky fish. If they do not find the suitable spot on which to grow they never germinate at all. It is altogether an error to suppose that they will grow upon any other substance than their natural pabulum, which is fish of almost any kind, fish ova, the spawn of frogs and newts, and probably of some water snails. There is also another kind of fruit which this fungus produces in little capsules, or cells, terminating short side branches. These are the resting spores, which fall off and sink to the bottom of the water and rest through the winter, ready to burst and liberate the imprisoned germs, which each one contains, in the early spring. Thus nature has provided against all the zoospores being destroyed by a hard winter, and the fungus extirpated, by enclosing from five to twenty in a thick tough skin or shell, which rests quietly in the water until the return of spring."

Fungoid Parasitism.—The parasitism of fungi on plants is unfortunately but too common, and the parasitism of fungi on animals is by no means rare. In both instances this parasitism is of two distinct kinds. That of animals concerns us most, in this inquiry, and we shall chiefly address ourselves to

them. The two kinds of fungoid parasites may be termed entozoic and epizoic; since these terms will indicate their distinguishing features, which corresponds to the *Endophytes* and *Epiphytes* of plants. Those which we term entozoic, are fungi which enter the animals in the embryonic stage, develop themselves in the interior, and exhibit a tendency outwards. Such a parasite is the muscardine. The epizoic parasites are those which establish themselves on the external surface of the animal, and by means of their root fibres force themselves inwards. Examples of this kind are more rare. The entozoic parasites are most undoubtedly the causes of the results which supervene upon their development. The spores germinate in the interior, produce an abundant *mycelium*, or mass of root fibres, ultimately absorbing and replacing the whole of the internal organism of the animal, gradually converting it into a mass of fungoid threads, and in the unequal struggle the animal at length quietly succumbs. In the case of the silk worm moth the disease called muscardine follows this course. In other instances insects become the prey of different species of fungus called *Torrubia* which destroy the insect, and then burst through and reach their ultimate and perfect state in large fleshy protuberances on the outside. The fungus of the salmon disease has no points of similarity with these entozoic parasites. The whole interior of the salmon is not converted into a mass of fungus spawn before the fungus appears on the outside. There is no evidence of the fungus originating from the interior at all. No indications of its belonging to the kind which I have termed entozoic fungi.

On the other hand epizoic fungi (or epiphytic when occurring on plants) attach themselves in the embryonic stage on the outside, where their life is commenced, and they become parasitic by forcing their root filaments through fissures in the cuticle or skin, and thus become established. This is the case with the fungus which develops itself on frog-spawn, on the ova of fish, on carp and other fish in aquaria, and also on salmon in this fatal disease. Undoubtedly this *Saprolegnia* answers to all the characteristics of an epizoic fungus. In this point it accords with some of the most destructive of plant diseases, with the potato-disease, with the vine disease, with the hop mildew, all of which are epiphytic, and I might enumerate many others. In a recent lecture on the salmon disease the lecturer stated (*Land and Water*, 1880, pp. 401), when speaking of the potato and vine diseases, that "the fungus on those plants will not grow on those which are perfectly healthy, but that a disordered condition is necessary as a predisposing cause;" and again "it is contrary to anything that I have read or known for fungus to grow on either healthy animal or vegetable." These observations should have been more qualified, because, under the ordinary acceptation of the term "healthy," both vine and potato must be included, for the most healthy of both are attacked. The fact is that continued cultivation, "over-culture," has injured the constitution of both to such an extent that they do not possess sufficient force to overcome the attacks of the parasite. Strong plants when attacked would repel the invader; the weak must succumb. The essential element of successful attack of epiphytic fungi on plants is a debilitated constitution caused by over-cultivation. How far similar causes are in operation with salmon will have to be alluded to hereafter. For the present it may be remarked that the same fungus is not so successful, or so destructive, to plants of the same species in a low state of cultivation, or uncultivated, as when under high cultivation.

Causes.—One of the alleged causes of the salmon disease has been referred to *pollution* of the rivers. This may easily be dismissed on faith of the evidence that it is not confined to polluted streams. But the term needs definition. What is meant by polluted? If it only means water unfit for drinking purposes; that is not pollution as far as inferior animals is concerned. Horses and domestic cattle always drink the stagnant water of a horse pond in preference to pure water, and yet the horse pond swarms with low forms of animal and vegetable life. That they *do* prefer it is an undoubted fact, and that their instinct is a better guide than our reason, as to what is best for them, may be taken for granted. The entomostraca, or minute crustaceans, which abound in streams and ponds, constitute in large measure the food of fish; and minute aquatic plants also contribute. Doubtless the presence of living animal and vegetable organisms in water is *not* pollution in the estimation of fish. Whether decaying animal or vegetable matter is injurious may be an open

question. Unless excessive it can hardly be cause of appreciable injury in running streams. These remarks must not be construed in favour of permitting dead fish, suffering from this disease, to remain in proximity to the living. An exception which is necessary to be borne in mind. There is no evidence that the fish fungus will grow upon dead quadrupeds, and all experience is at variance with the supposition. Hence dead dogs and other quadrupeds do not serve as a source of the disease. Another alleged cause is the presence of bacteria in diseased spots, upon which the fungus is supposed afterwards to locate itself. I fear that this view cannot be maintained, as the presence of bacteria is the consequence, and not the cause, of morbid tissues. A third cause is that alleged by Dr. Erasmus Wilson, who is no mean authority on cutaneous diseases. He says that he is "more and more convinced that the fungus is a morbid growth of the mucus, produced by the skin of a diseased animal, and not a vegetable parasite." The evident meaning of this rather vague statement is, that the so-called fungus is not a true fungus, or vegetable parasite, but a morbid development of the mucus. I wish that I could agree with this, but I cannot, because this growth, whatever it may be, produces within itself certain germs, which may be transplanted, and will grow, and produce other growths just like that from which the germs were taken. Even as an acorn produces an oak like the tree which produced the acorn, so these germs produce a fungus like the parent from which they are taken. There is no morbid growth of mucus which could do this; but the power of reproduction exhibited *must* belong to some distinct organism, capable of reproducing its species. "Morbid growth of mucus" would simply mean an unusual and diseased development of the skin of the fish, which could consequently perform no vital functions of its own.

I should be most willing to believe with those who assert that the salmon disease is a contagious disease which spreads from fish to fish, producing blotches or eruptions, upon which a parasite afterwards establishes itself. I would accept this as a reasonable and sufficient cause, if I could find any evidence in its support. It is certainly not an impossible cause, and none of the evidence really contradicts it; but I fear that is all which can be said in its favour. If there were any proof of the existence of a few fish which had given evidence of the presence of this disease, but which had not suffered from the fungus, it would suffice. A single fish with the skin and flesh diseased in the identical manner as in the ordinary disease, but from which the fungus was wholly absent, would suffice to prove that the fungus is not the cause of the disease. In the absence of this single evidence I am afraid I must confess that, as far as we at present know, the fungus (*Saprolegnia*) appears to be the active agent in the salmon disease.

Let us endeavour to ascertain how far history gives a collateral support to this view. In the year 1821 Grunthuis described this fungus under the name of *Conferva ferax*,* and in 1823 it is again alluded to under the name of *Hydronema* by Carus;† and even at this early period it is recognised as a fish-parasite, although only until lately proved to be a fungus. All the early writers considered it a water-weed, *Conferva*, or *Alga*, which seems to have been most common on the Water Salamander. In 1831 Nees von Esenbeck referred to it, and it was probably mixed up with another species of the same family, the *Achlya prolifera*,‡ which grows upon dead insects in water. Passing over some intermediate writers we find in 1841 Valentin writes of it as occurring "on the ova of fishes, it constitutes a very powerful preventive," he says, "to their development, and its progress is so rapid that a single egg infected with it will in a very short time infest many hundreds and thus destroy them." Afterwards he adds, "in fishes also, as the *Cyprinus nasus*, when kept in narrow vessels, and the water not quite sweet, he observed the same fungus on all parts which might be abraded, as, for instance, the head and tail."§ Strangely coincident this, which was written 40 years ago, with the facts of to-day.

* *Nova Acta Naturæ Curiosorum*, 1821.

† *Ibid*, 1823, p. 491

‡ *Nova Acta Curiosorum Naturæ*, xv. (1831) p. 375.

§ Valentin's *Repertorium*, 1841, p. 58. Cooper's *Microscopical Journal*, 1841, p. 155.

In 1844 Unger furnished a long and most explicit account of this fungus which had proved so destructive to the carp in the tanks of the Botanic Gardens at Gratz. He described the appearance of the fish, their movements, the effects of the parasite, and finally gave a full description, with excellent figures of the fungus itself.* From this account it is clear that there was no other disease, but that the fish were being destroyed by the parasite. The quotation of his entire paper would only be to rewrite what has already been written of the salmon disease.

In 1851 M. Davaine exhibited at a meeting of the Société de Biologie a carp suffering from the attacks of this disease, and the subject came under discussion, the gist of which was afterwards published in the *Comptes rendus*. Thus, coming down to our own times we have records of the same form of disease attacking fish, especially the head and tail, and the same fungus present upon the diseased spots.† The fungus of the salmon disease is precisely identical with that of the carp, the ova of fishes, and that also which is found on the pike and other fresh-water fishes, including sticklebacks.

Some years ago, when aquaria were the fashion, I had an aquarium. It was a large bell glass, reversed, capable of containing about a pail of water, and in it were three carp. The water was seldom changed or aerated, and one day I discovered the head of one of the fish quite flocculent with the disease. At once I determined upon giving the fish a tonic. They were evidently much debilitated. Therefore I placed the aquarium under the water-tap of the cistern, and allowed the water to run in a continuous stream, the overflow passing down the "sink." Day and night for a week this constant flow of fresh water was continued. The fish became quite lively, and the operation was afterwards repeated daily, for about an hour every day. The diseased carp wholly recovered, all signs of fungus disappeared, and I had them for a twelvemonth afterwards, until the glass was accidentally broken, and never replaced. This incident is quoted to show the influence of well aerated water in recovering the healthy tone of the fish, and enabling them to overcome the attacks of the disease. It seems to show that an invigorated constitution is antagonistic to the parasite.

Secondary Causes.—These may be of such a nature as to influence very materially the prevalence of the disease. There is no probability of its being wholly eradicated, but it may be mitigated, and this more by attention to the secondary causes than by any process of destroying the fungus itself. One of the evident helps, or secondary causes, of the disease are wounds or bruises on the naked parts of the fish. These may originate by fighting together for mates, or in unsuccessful attempts to overcome obstructions in their passage up or down the river, whether weirs or dams, whatever impedes their progress leads to effort, and in making continued efforts, and failing, the soft parts are bruised, or wounded, it may be but slightly, and yet sufficient to afford a nidus for the fungus spore. It has long been known that it is the bruised ova which are first attacked, even so slightly as may be caused by a touch or beating against the side of the vessel which contains them. So it is with fish in aquaria; if they are handled they are predisposed to attack, unless in robust health. If salmon are in robust health even a slight bruise would not result in parasitism, but it is evident that their constitution has not been so good as formerly, because the disease has been in existence half a century, and only recently so fatal in effects, which points to a second accessory cause, namely, that of constitutional debility. All the evidence goes to show that it is debilitated fish which are in most instances sufferers. Instances of known debility from retention of ova, or spawning, make the bulk of fatal cases. The few which are supposed to have been strong fish were, it may well be assumed, exhausted, or otherwise "low." Even if they escape wounds or bruises in overcoming obstacles in their way up, the efforts would produce an exhaustion favourable to attack. Human experience teaches us that fatigue and exhaustion are helps to the attacks of epidemic disease. It must not be forgotten that low water is a source of debility to fish in general through lack of food. What angler does not know that when waters are high, succeeding plenty of rain, that food is washed down from the land, and successful angling out of the question. The

* *Ann. des Sci. Nat. (Botanique)*, 1844, p. 1.

† A resumé of this history will be found in Robiu's *Histoire Naturelle des Végétaux Parasites*, (Paris, 1853), p. 382.

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fish are well fed, and will not be tempted by a bait, but, when water is low, it is a common proverb that fish will be hungry. With an influx of additional feeders, such as would be the case when salmon return to the rivers, and this taking place at low water, a scarcity of food would follow, and hence debility. It might even be supposed that gravid fish would be more than ordinarily voracious, which would tend to a diminution of the food supply. Another of the consequences of low water is that the fish congregate in the holes of the stream; and in this overcrowding, which is an inevitable consequence, another source of debility is provided. Overcrowding in holes of this kind is analogous to overstocking an aquarium, the water gets no aëration, its air is exhausted, and the fish must become the prey of disease. On a large scale it is a repetition of the experiment of carp in a tank. Before salmon disease was thought of, it was known that carp and other fish would be attacked by the same fungus if too many were together, or the water was not properly aërated. There is another problematic view in which this collecting of fish in holes is to be regarded. If it is assumed that the resting-spores of the disease, being heavier than water, sink to the bottom, they will consequently be washed into the holes, which would become reservoirs for the zoospores which are liberated in the spring from the oogonia, or resting spores. If this be the fact, and it is plausible, then there is also an excess of fungus spores in the holes waiting to attack any sickly or debilitated fish. When the water is high and plentiful the fish do not collect in the holes, are not debilitated by overcrowding, and are not forced into the midst of contagion; consequently at such times there is less disease. This is not mere speculation, it is a view which is fully borne out by the evidence. We cannot forget that the fish-fungus is no respecter of species or individuals. It attacks nearly all, if not all, freshwater fish. It exhibited its predilection for carp before the salmon disease became prevalent. How is it that all the fish in the infected rivers are not destroyed as well as the salmon? The only answer possible is, that in some condition of bodily health, or physical weakness, the salmon falls a prey, whilst the carp and roach by a more robust constitution, or some peculiar circumstances which the salmon does not enjoy, escape "scot free." If the conditions of all were equal, the consequences also would be equal. Some weight must be attached to the argument which has been advanced, that disturbing the natural conditions, by protecting the salmon, has tended to the production of a weaker and physically degenerated race. We cannot deny that artificial arrangements for the control of nature inevitably fail. We make war upon small birds, and then exhibit surprise that the insects make war upon us, or upon our fields and orchards. We destroy all the destroyers of sickly salmon and then express surprise that we rear a sickly race. The argument was placed in a strong light when compared with the grouse disease. One writer says, "Take the case of the red grouse on our moors. The birds " are protected by law for the greater part of the year, and their natural enemies, " the various raptorial birds, are so assiduously hunted down as to have " become in some cases practically extinct in this country; and the consequence " of this destruction of their natural enemies has been that all the weakly " birds, which in natural circumstances would have been picked off by " the larger hawks have remained to breed and perpetuate a still weaker " progeny. In a race of birds thus weakened the parasite found everything to " favour its propagation, and the grouse disease became an epidemic; and " many proprietors recognising this are now protecting the peregrine falcons " as strictly as they preserve the grouse. Something very similar has taken " place with the salmon. The otter is the natural enemy of the salmon in the " fresh waters, but they have been hunted, trapped, and shot, till not one " remains, where formerly there were dozens. The otter, like the peregrine, " takes the prey most easily captured, thus removing the weakly, the sick, all " those which, from whatever cause, would cause a degeneration of the breed. " If there had been otters in the district in the numbers in which they once " were, those wretched looking salmon to be seen along the sides of the Nith " would all have been dragged out and eaten by them. I am confident the " disease would be checked if the otters, just for a change, were protected for " a year or two. The course of the salmon disease and the grouse disease tells " us in unmistakable language to beware of altering the balance of nature. " Left to herself the great law of the 'survival of the fittest' would always

“keep nature’s numerous family in a prosperous and healthy condition.”* We might inquire which has destroyed the largest per-centage of fish, the otter or the disease? Which left the survivors in the best condition to fight the battle of life in the succeeding seasons? Probably few would hesitate to welcome back the otters if they could be assured that thereby the disease could be controlled. Yet we may rest assured that it is hopeless thinking of killing off the fungus. We have not killed the potato disease, and no prospect of doing so. If success is to be at all achieved it must be by restoring to the salmon such a constitution as will enable it to defy the attacks of its parasites.

Remedies.—I have already said enough to obviate any suspicion that I intend to propose any universal panacea. Suggestions affecting what I have termed “secondary causes” are all that I would offer, and these would suggest themselves to practical men more readily than words of mine, if they will accept the definition of secondary causes as sufficient. If the annual recurrence of the disease is destroying the constitution of the salmon, it must as a consequence follow that the disease will increase rather than diminish, unless some means of invigorating the salmon can be found. If the parents are becoming debilitated, how can a healthy offspring, or a robust future generation be anticipated from the same stock. If obstructions in the rivers become still more formidable when they have to be encountered by a weakened race, it will soon become a question of “salmon or no salmon.” If badly diseased, or dead fish, are permitted to remain in company with the living, it only increases enormously the risks of the healthy fish. The destruction of all the diseased fish in any river would not by any means imply the destruction of the disease, especially so long as the secondary causes remain unchanged. Low waters are not to be improved by Act of Parliament, but with low waters follow longer leaps to overcome increased distances at the weirs, and ordinary obstructions attain extraordinary dimensions. These are questions which are scarcely within my province, and as the task to which I applied myself has been accomplished, however imperfectly, I may leave what I have written to a careful and candid consideration, in the hope that it may prove of some service in an excellent cause.

M. C. COOKE, M.A., LL.D., A.L.S.

146, Junction Road, N.
June 1, 1880.

II.—LETTER FROM C. L. JACKSON, Esq., Consulting Naturalist to THE
SOUTHPORT AQUARIUM.

MR. C. L.
JACKSON.

GENTLEMEN,

I HAVE watched with great interest the progress of the investigations into the nature, probable cause, and question of cure of the salmon disease or fungus. I have not hitherto joined in the discussion or advanced any theory, as I have thought all along that microscopic examinations alone and post mortems on dead fish would not throw a very clear light on the subject, and I did not see how the disease itself in its rise, progress, and symptoms could well be watched; chance has, however, enabled me to do this to some extent. I regret extremely, that owing to your having to present your report, I must send you my observations now, for there are still several points which only some weeks watching and experiments can clear up. Ultimately I hope to let you have all the information I have been able to get.

A very serious outbreak of *Saprolegnia ferax* among our fresh-water fish at Southport Aquarium has afforded me the opportunity of observing the disease in all its stages, and in its different phases.

One question in connexion with it is whether it is a new disease or merely the old aquarium fungus. I have no hesitation in saying it is a fresh disease, or, if it has been known before, it is not our old friend. I am well acquainted with the old pest. In the earlier days of our aquarium we were

* *Land and Water*, May 8, 1880, p. 401.

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sadly troubled with it. Healthy fish put into the tanks would be mouldy in a day or two sometimes; some would pull through, while others got smothered. Our losses were so serious that I persuaded our directors to allow me to have a large reservoir and pumps so as to use the same water continuously, pumping it round exactly as we do with the salt water. We constructed two large reservoirs holding nearly 100,000 gallons, and put down pumps. On getting to work, the water gradually became beautifully clear, highly oxygenated, and the fish recovered. The splendid collection of carp, presented to us by Prince Christian, in particular were very badly affected, but speedily got clear, and never were attacked again. So certain was it that the fungus could not stand before the very healthy condition of the water, that we had no hesitation in putting into the tanks affected fish, for if not on the point of death, they recovered. About a year since we received a quantity of char from Windermere, which had evidently been in a tainted coop, they exhibited fungus at once, but those that did not die almost at once soon recovered, and the disease did not attack one of our own stock. I have frequently, when fishing on Windermere in summer shut up a quantity of perch, &c. in a coop floating on the lake, and in two or three days have found them almost smothered. So utterly impossible has it been to introduce the fungus into our tanks even to experiment on, that I was obliged to apply to Mr. Carrington, of Westminster, who kindly gave me some fish to examine, which he said had only been in his store tank two or three days. So much for the old customer, it can certainly easily be grappled with by proper circulation and aeration, is often quick in its action, but by proper arrangement is curable.

At the latter end of last year we purchased from Scotland a quantity of carp and tench; several of these had small white marks, but they were very little, and did not resemble the aquarium fungus, so were taken little notice of. In time, however, they began to spread, but still so slowly that we did not suspect what was the matter until about two months since, when several of them became very sore. A gentleman, whose name I cannot ascertain, first alarmed us by pronouncing it to be salmon disease. The fungus then appeared in blotches on several fish, which became very emaciated, and showed very inflamed places. I was going from home, but Mr. Long put them in a store tank; unfortunately one of the men threw them away, and when I returned there were no fish with fungus very mature. I took, however, a couple showing sore places, and subjected them to a careful examination. Under the microscope the inflamed places showed numerous points of irritation towards which the blood was pouring through very much distended capillaries, presenting a most curious and beautiful sight. I have seen exactly the same appearance (and in fact have produced it to show the phenomena of inflammation) in the web of a frog's foot, by touching it with a needle dipped in nitric acid, or some such irritant.

Soon after this the blotches on some of the fish became very ripe, and the fish died. On placing the fungus under the microscope it was clearly *Saprolegnia*. All these fish showed much inflammation, and in many places where there was no fungus. On examining the gills it appears clear that this is the fatal point of attack; they were very slimy, and had unhealthy marks on them. Taking a little mucus from these and examining it, proved it to be one mass of *Saprolegnia*. Mr. Long drew my attention to the death of a number of tench, which had rapidly gone to skin and bone, and died without external sign of disease. Suspecting that in some cases the fungus might attack the gills only, I examined them and found it was so, the gills were unhealthy and full of ripe fungus.

The disease hitherto has run its course, and killed off chiefly the tench we imported, but has also attacked the splendid golden tench presented to us by Mr. Higford Burr; some of these are dead, others dying. At the opening of the fishing on Windermere we obtained a very fine shoal of char, and a grand specimen of lake trout, about five pounds weight. This fish was attacked a few weeks after it came; its head became matted over, and it shrank away to a skeleton. The char are now beginning, but in their case they show no sign of fungus externally, except one of them; but many show very inflamed places, particularly on fins and tail, and they are going as if an internal fire was burning them up.

I think you will see from the above description that there is a great difference in the action of the two diseases. The *Saprolegnia*, though comparatively slow

in laying hold of its victim, is far more deadly, and will flourish where the other cannot gain a footing. Pollution may aggravate it, and also overcrowding, but they are not necessary to its existence. Our tanks are so clear a pin can be seen through 14 feet of water, and, except for this disease, every fish is in grand condition; but in spite of all this it remorselessly seizes fish after fish, and all die.

The appearance of the disease is very different; the ordinary fungus is more fluffy, stands up higher, and the fish does not appear distressed. The *Saprolegnia* is a more compact mass, more like blotches of velvet, but with a soreness that gives it the appearance of some scrofulous affection. The outline of the blotches is more sharply defined. The fish seem very much distressed, and when it fairly gets hold waste away to nothing. The fungus also is more firmly attached. The points I should have liked to have more time to work out, are: 1st. Whether all freshwater fish are subject to it. It is rather singular, our roach, dace, gold-fish, gudgeon, and crucian carp, though exposed to the full infection, show no sign of taking it, yet these fish are peculiarly subject to the aquarium fungus. The large carp which came with the tench had some of it growing on them six months since, but do not seem to care about it, while all our tench and golden tench are dead or terribly ill, the trout are gone, and the char are fatally struck.

2nd. Whether a change to salt water will cure it. We have several migratory trout in our freshwater tanks, but at present it has not struck them. They have been with us a long time, and are in grand condition. When it attacks them, as soon as it is fairly developed they will be put in sea water and the result observed. I fear, however, this hope must be abandoned. We have in one of our sea-water tanks two splendid sea-trout. They came to us a few ounces in weight about two years since, and are now several pounds in weight. They have not been in fresh water since they came, but one of them I fear is affected. During the last month he has got blotches precisely similar in appearance on his head, side, and tail, and they are rapidly spreading. He does not, however, yet show much falling off in condition, probably because the disease has not attacked his gills. I could not examine him microscopically, for it is important to watch the disease and see whether (if as I am almost sure it is the same) its effects are the same in the sea as in the land. Lastly, I want to ascertain the exact locality from which the infected fish came: that I have not yet been able to accomplish. I think it is clear that the disease is highly infectious, is not produced spontaneously, but is imported, as it clearly is in our case. Our tanks are isolated from one another in the building, but overflow through one pipe into the reservoir some 30 yards away. The water is then drawn to pumps in engine-house and pumped up. The spores to infect all the tanks must have gone all this round, and through the pumps. If the sea-trout is attacked (as I believe) by the same disease, the spores must also be capable of being carried through the air, as there is no connexion between the tanks. I think they must also have a high vitality in sea-water, for the tank where this fish is, is right at the opposite end of the place, and a thick wall is between it and a freshwater tank. The probability is that the spores would fall in the nearest tanks, in which case they must have gone through the whole circulating system, and affected all the tanks before they reached the one where the trout is. (The disease has, however, not attacked any other fish in salt-water.) If this is so, the disease may be spread by salmon from different rivers meeting in the sea, and also may be carried through the air from river to river. While I do not think microscopic observations alone are sufficient, I by no means despise them, my reason for wishing to observe the progress of the disease is the great difficulty of accurately distinguishing some of these low organisms merely by their micro appearance. In this case, however, the two fungi are very distinct. The engraving Mr. Walpole sent me from the "Field" is very good of the *Saprolegnia*, but it is very unlike the other. In *Saprolegnia* the spore cases appear like thickened fibres, some with a knob at the end, full of spores. In the other the spore case is almost like a short pea pod, borne at the end of a long and very thin stalk. I hope, however, to show you this so that you may judge for yourself.

As regards cure, I see nothing that can be done except to try to make our rivers more healthy, and rigorously destroy and burn every infected fish. We

MR. C. L.
JACKSON.

must then hope that the disease will run its course speedily, and disappear as epidemics usually do. I must, however, reserve giving an opinion until I have had time to watch it still longer, and to work out the points indicated above.

I have, &c.

C. L. JACKSON.

Hill Fold, Bolton,
June 20, 1880.

MR. HENRY
LEE.

III.—LETTER FROM HENRY LEE, Esq., F.L.S. (formerly Naturalist to the BRIGHTON AQUARIUM).

GENTLEMEN,

IN accordance with your request, I send you a few remarks on the fungoid disease of salmon. It is unnecessary for me to enter into details, as the subject has been carefully and fully treated of in various reports which you have received, notably in that by Dr. M. C. Cooke, who is our chief authority on microscopic fungi. *Saprolegnia ferax*, the fungus which is the cause of the so-called "salmon disease," has long been well known. It is the same fungus which attacks other fishes in fresh water. Its identification is not difficult, and the descriptions of it by Dr. Cooke, Professor Roileston, Mr. Worthington Smith, &c., may be accepted as conclusive. I have not seen the reports of the two gentlemen last named, but I am glad to perceive that Dr. Cooke asserts that which the experience of some years as naturalist to the Brighton Aquarium has led me to maintain, namely, that this fungus will not attach itself to the uninjured skin of a healthy fish. A variety of circumstances, and, in my opinion, especially overstocking, may cause the salmon to lose its healthy tone and vigour, and to lapse into a constitutional condition favorable to its becoming the recipient of the disease; and any healthy salmon whose dermal membrane of either the scales, head, or fins, may be injured or abraded is instantly laid open to its attack. I have seen this exemplified in a remarkable manner in fresh-water fishes, such as carp, roach, &c., brought to the Brighton Aquarium after having been taken by a net. Wherever a knot of the net had pressed on the fish and bruised the cuticle of the scales, there a tuft of fungus would soon become apparent, and it was curious to see these tufts growing for a day or two at equal distances from each other—the distance from knot to knot of the net in which they had been caught. By vigorous oxygenation of the water, healthy strong fish, which had been but little hurt, would recover and get rid of the fungus entirely as their skin healed. Unhealthy, exhausted, and severely rubbed fish died after the fungus had established itself beneath their scales.

At first we tried to free the fish from this fungus by removing them to a stream of running water, but as this involved their capture in the landing net, and, consequently, fresh abrasion of their scales, we soon found that this made matters worse. The best remedy we then knew of was to leave them untouched, and invigorate them with as much oxygen as possible by well aerating the water. We afterwards discovered that immersing affected fish for a few seconds in salt water, or lightly sponging them with it, frequently cured them, and destroyed the fungus in cases where its mycelium had not obtained too firm a hold.

Briefly, then, my opinion is, first, that the spores of *Saprolegnia* are constantly present in both pure and impure water (though more abundantly in the latter), and ready to attach themselves to any surface suitable to their growth.

2ndly. That a strong and healthy salmon, the dermal membrane of which is in every way uninjured, does not furnish any such suitable surface, and is impervious to the fungus.

3rdly. That a salmon is in a condition to become the recipient of the fungus when from any cause its vitality is lowered, when it is weak and out of health; and also when any portion of its cuticle has been abraded, even if the fish be in good health.

4thly. The possible predisposing causes towards the salmon becoming weak and sickly are, of course, numerous. I believe that overstocking is one of the chief of them.

MR. H. LEE.

Margate, July 20, 1880.

I have, &c.
(Signed) HENRY LEE.

 IV.—LETTER FROM PROFESSOR ROLLESTON, M.D.

PROFESSOR ROLLESTON.

GENTLEMEN,

I HAVE little to add about the diseased condition of the various specimens of diseased salmon lately sent to me besides and beyond what is contained in the letters already published in "Land and Water"* by myself, by Mr. William Hatchett Jackson, F.L.S., and Mr. A. Heneage Cocks, after examination of specimens as they come to this museum.

There are, however, one or two more or less general remarks which I will take this opportunity of making, as they arise more or less directly out of the observations recorded in those letters, or out of the reading which those letters led me into.

The problem we have before us is the possibility of abating the violence and intensity of a fungoid disease which we have some reason for thinking is never wholly absent from our fresh waters, but which we have the best reason for knowing is just now very unusually destructive.

The first remark which anybody with experience of epidemics affecting our own species will make is, that similar alternations between intensity and obsolescence similarly characterise these latter epidemics. Cholera is probably never wholly absent in any one year from the Ganges Valley, but it is only occasionally that we have it intensified into the proportions it assumed in the year when it struck Lord Hastings' army. The salmon disease epidemic of 1880 may be paralleled by the cholera epidemic of 1817.

The increase of the disease in either case must be held, under all the circumstances, to have been due either to some quantitative increase in the amount of the poisonous agents or to some qualitative intensification of their malignity. For there is no special reason to assign any very large share in the causation of the increase in question to any increase in the predisposition of the passive subjects of the attack.

Firstly, as regards the alternative which might seek to explain the increase is the activity for mischief of the salmon-fungus (*Saprolegnia ferax*) by the hypothesis of some qualitative increase in its *modus operandi*, I have to say that there does not appear to me to be any reason for adopting this view. It is true enough that the malignity of certain epidemics affecting ourselves may be illustrated and made more intelligible, if indeed not explained, by the cases in which variation or sporting as of a peach into a nectarine has been observed to intensify the peculiar properties of a well-marked and otherwise presumably stable species. And secondly, in the way of experiment, it has been discovered that by successive transplantation into successive hosts the virulence of septic agents may be greatly increased. But I do not think that these parallelisms apply here, however suggestive they may be as to the phenomena of other epidemics. For the working of the salmon-fungus appears to me to be mainly of a mechanical kind; it smothers rather than poisons; it chokes rather than intoxicates; it interferes with the functions of the gills in the way that a wet blanket properly applied might interfere with the functions of our lungs rather than in the way in which other fungoid diseases are reasonably supposed to act, namely, by throwing a quantity of poisonous material into the circulation to work on what it finds there, and by subsequently, in some cases, entering it themselves. And its operation on the external integument is similarly mechanical; the mycelium of the fungus lives at the expense of the fish's integument; it may spread from head to tail in as short a period as three days in a thick feltings; and, as nothing can come of nothing, this growth of

* See "Land and Water," Jan. 24, 1880, p. 74; Jan. 31, 1880; April 10, Prof. Rolleston; April 10, 1880, Mr. W. H. Jackson; April 3, 1880, Mr. A. Heneage Cocks.

the fungus entails a corresponding loss of substance in the way of erosion and alteration of the fish. These lesions of course put the functions of the skin into abeyance, and call out reactions in the fish affected in the way of rubbing the sores, &c., but they are not due to anything of the nature of a qualitatively toxic agent.

The problem we have to deal with, then, reduces itself to an inquiry as to the causes and as to the arrest of the quantitative increase of a particular fungus which infests and affects salmon much as many *Peronosporæ* and *Mucorini*, and notably the *Hemileia vastatrix*, which produces the "coffee-leaf-disease," and the *Pellicularia koleroga*, which produces the "coffee rot," infest and affect plants. Instances of increase in the numbers of individuals of species which in another year may be comparatively rare are very numerous. Everybody has observed how in one year some species of insect, say such as the Humming Bird Moth, may be as abundantly as pleasantly present, whilst in another it may never be seen except by a skilled entomologist familiar with its special haunts and habits. Of course the less pleasant presence intermittently of insect plagues is another exemplification of the same rising and falling off in the numbers of the same species, and other exemplifications are not far to seek in other sub-kingdoms of animal and plant life. Upon what do these more or less chronometrically measurable increases depend? As I imagine in most cases, and know in some, upon a diminution in the numbers of the natural enemies of the organisms, animal or vegetable, thus intermittently increasing. Insects multiply into plagues when birds have been reduced in number by frosts, and rabbits desolate a district which has lost the protection of domestic and wild carnivora, cats, ferrets, and mustelines generally. The natural enemies of the fungi are, I suspect, those of their own household; other forms, in this particular case, and still lower forms of fungoid life. But how to command these lower forms, or how to favour their multiplication, I have no very definite idea. Still I very strongly incline to thinking that it is in this direction that we ought to turn our eyes and our microscopes, if we are to obtain proper notions as to the causation, not to say as to the prevention, of the salmon disease. It does not seem to me that any greater abundance of fungus food, or of other favouring conditions of the surrounding medium, is likely to be the cause of the increase in the disease-producing organism. For the salmon is the food of the fungus, and as far as we know there is no other host concerned with this lodgment or sustentation. Indeed, the *Saprolegnia* which multiplies both sexually and asexually, goes through both modes of self-multiplication whilst growing on or over-growing the "king of fish," as well as other less dignified and less migratory occupants of fresh water. In the language of botanists, it is not "*heterökisch*;" it does not, like the wheat rust, infest the cereal at one stage of its existence, and a *Rhamnus* or *Berberis* at another; nor like *Roestelia*, infest a juniper (*sabina*) at one time, and the pear at another; nor finally, like the fluke of the sheep rot, infest the sheep in the sexual, and the snail, or, as I believe, a slug in its non-sexual stage. The concatenation of mischief which we have to deal with here is a shorter and, I fear, a stronger chain; at any rate it has much fewer links, and we therefore have much fewer chances of striking one out and setting our clients free.

I have not gathered from my observation and reading any hint that inorganic agencies, such as climatic changes, chemical pollutions, or any other forces unconnected with living operations, except perhaps the lowering of the water, have very much to do with even favouring, not to say with producing, the increase of the malady.

Not do I think that predisposition counts for very much in the matter either. No doubt an animal in a depressed state, such as that of a "spent fish," is more liable to contract many diseases, though this cannot be said to have been made out with reference to some of the diseases dependent on *contagia viva*, which affect our own species. No doubt organs and tissues in a depressed state of vitality will succumb to the septic action of lower fungi than our *Saprolegnia* more readily than will organs in full force, but then we have not here to deal with *septic*, but with *mechanical* work; and as a matter of fact, perfectly healthy salmon, as well as perfectly healthy roach, dace, and gudgeon, young perch, and young pike, may be killed with the all-embracing but cruel kindness of *Saprolegnia*. The fact that age protects the two last-

named fish does show that predisposition may tell in certain cases; but the salmon does not get any advantage with years. The truth, however, is, that the analogy of such fungi as the fermentation and putrefaction—producing fungi, does not help us much. They kill and destroy not merely by mechanical increase, but by the poisonous effect of the result of that growth, operating on fermentescible and putrescible substances in the infested organism, and expressed in terms of alcohol, butyric acid, lactic acid, nitrogenized, and many other products; and this result is an achievement of which *Saprolegnia* and its allies cannot be accused, however luxuriant their growth may be.

It is easier also to arrest fermentative and putrefactive action, than the more general nutritive action which is limited to vegetative increase; and hopes therefore, which might be founded on such success as we have attained in the way of arresting infection by bacteria, as well as other fermentative work, are fallacious.

Even if this were not so, the quantitative disproportion which must exist, firstly, between any available quantity of disinfectant and the cubical bulk of a salmon river, and secondly, between the concentration of any disinfectant solution strong enough to kill a fungus, and the resistance opposable by the gills of the fish affected by it, are obviously incompatible with hopes of help from the employment of disinfectants.

It has often been observed that closely allied species, or even varieties, so called, of one and the same species, may vary from each other as to their amenability to disease; and some hopes might on this general ground have been entertained as to benefiting our salmon-consuming population by the introduction of a new variety of salmon. But the *Saprolegnia* appears not to be specialized, as are some other parasites, to one host only. Several freshwater fish have been already mentioned as being fatally infested by it, the eel alone of the freshwater fishes observed by Dr. W. S. Church in a pond at Ightham, in Kent,* enjoying an immunity from its attacks. A similarly indiscriminating parasitism appears to characterize the *Hemileia vastatrix* which does not spare any variety of the coffee plant which comes in its way; any more than (with perhaps the single exception of *Isabella*) the animal *Phylloxera* spares any variety of vine.

The first of two practical points which I should, with my present knowledge, or rather with my present ignorance, insist upon, would be the expediency of removing, if possible, and as early as possible, all infected fish out of the river. But what are these possibilities? This you know much better than I do, and you can, I daresay, suggest or order plans with dredge or trawl, which would effectually catch up and scoop out the dying or dead fish enveloped in their fleece of *Saprolegnia*, and would so far stay the plague.

I wish to suggest as my second practical point that by the employment of some such contrivances as the "hempen tangles" used on board H.M.S. "Challenger" for sweeping other organisms from off the deep-sea bottom, we might strain or filter a very considerable quantity of salmon fungus out of our rivers. But to the "swabs" or "tangles" for the salmon fungus I should add coal tar, thinned with coal oil, just as the Americans use it smeared over their coal tar "pans" for the destruction of locusts. The admirable "First Annual Report of the United States Entomological Commission," 1878, gives at p. 281-401, a detailed account of the efficiency of coal tar as a locusticide, with many illustrations of the various mechanical contrivances for expressing as large a square area as possible, shall be, when thus prepared, put in the way of these insects. Figures of the "hempen swabs" or "tangles" will be found in Sir Wyville Thompson's "Depths of the Sea." And I cannot think that it is entirely absurd to suppose that we may not, with a due square area of coal tar, thus spread out at once to entangle and to poison, being at once sticky and toxic, the amount of fungus, and the risks run by salmon may be considerably lessened in many of our rivers at no very great expense. Instances of success following the use of similar agencies against similar enemies are not altogether wanting.

I have, &c.

(Signed) GEORGE ROLLESTON, M.D., F.R.S.

Anatomical Department, University Museum, Oxford, May 20, 1880.

* See Mr. A. B. Stirling, Proceedings, Edin. Royal Society, 1879-1880, p. 273.

MR. ERASMUS
WILSON.

V.—LETTER from ERASMUS WILSON, Esq., F.R.S.

GENTLEMEN,

I WAS very glad to have the opportunity of seeing the diseased salmon this morning; their appearance convinces me more and more that the fungus is a morbid growth of the mucus produced by the skin of a diseased animal, and not a vegetable parasite.

The appearance of the disease very closely resembles ringworm in the human subject, in which also there is a fungiform growth, and I have no hesitation in referring the cutaneous disease of the salmon to a similar cause. The parts most affected were those most distant from the centre of circulation, namely, the fins and tail, and of these the whole surface was coated over; whereas on the fleshy parts the disease was developed in circular discs, each about the size of a shilling, while here and there a cluster of discs had become blended into a broad irregular patch. Again, where the fungiform growth was scraped away, the scales were imperfect or lost, and the growth had taken the place of the scaly covering. The parallel with ringworm is very striking.

You mentioned that the fish were females exhausted by ovi-production and ovi-position. They were much emaciated and their flesh was pale and flabby.

The gills were sound and there was some excoriation about the snout and head, resulting from forcible rubbing off of the fungous growth.

It is clearly evident that the fish are debilitated, and out of condition, and to this, and this alone, must be attributed the production of the fungous growth on their integument. And their state of exhaustion is such that they must necessarily die, unless means can be devised for supplying them with water of a purer character, and also it may be presumed with more congenial food.

I would venture to suggest that the rivers are in the first instance contaminated by excessive numbers of fish, and that the evil is multiplied manifold when, in addition to impurity from numbers, there is superadded the presence of diseased fish, and furthermore, of dead fish. It is possible that certain seasons, or certain states of the atmosphere, combined with certain peculiarities of soil, may predispose to impurity of the rivers, and that at such times the water is less life-sustaining than at others. I mention this as a probable explanation of some rivers escaping whilst others are attacked; but in reality no simpler or stronger argument is required than that of a surplussage of fish. For many fish in a globe of water would share the same fate; as likewise, too many children packed together within a too limited cubic space of air.

The remedy which naturally suggests itself for this state of things is *more water or fewer fish*. A natural remedy would be to keep down the numbers of the fish; and the fact cannot be questioned that a river of given dimensions may be ample to support a certain number of fish, but no more. Again, every facility should be given to the fish to deposit their ova without fatigue or exhaustion, especially those dreadful barriers, over which no fish-power can accomplish the leap, should be removed. Exhausted by fruitless attempts, the poor creatures become ill and die, and a beginning is thereby made for the contamination of an entire river.

Piscatorial experts ought to be able to judge of the numbers of fish in a river, and when they are present in excess, means might be adopted for thinning them out. Even plants fail to grow when packed together too closely; how much greater the evils must be where animals are concerned. The first effect of overcrowding is to engender debility; the sick fish renders the water impure. Then others become sick and some die, giving rise to further vitiation of the breathing element, until at last the evil becomes almost too great to cope with.

I am not an ichthyologist, but I would ask you, How about food for the fish in a crowded river? Is not the provision of food limited as well as of air? If so, we then have two energetic causes of disease, both acting in unison,—starvation and suffocation. I quite agree with you in your proposed remedy: As we cannot renew the water of a stream nor add to its quantity, the only alternative that remains is elimination of the dead fish, and, if possible, the driving of the diseased fish out to sea.

I hope the interesting and important nature of the subject will plead my excuse for this long letter.

Yours faithfully,

ERASMUS WILSON.

17, Henrietta Street, Cavendish Square,
February 12, 1880.

APPENDIX No. III.

EXTRACT from a PAPER read before the ROYAL SOCIETY of EDINBURGH (Session 1870-80), entitled "ADDITIONAL OBSERVATIONS ON FUNGUS "DISEASE OF SALMON AND OTHER FISH By A. B. STIRLING, "Assistant-Curator in the MUSEUM of ANATOMY in the UNIVERSITY "of EDINBURGH. Communicated by Prof. Turner."

I shall now give an account of the very remarkable epidemics which occurred at Ightham in Kent, the particulars of which were kindly communicated to me by Dr. W. S. Church, Physician to St. Bartholomew's Hospital, London. They are of so much interest in the history of the fungus disease, that I feel warranted in bringing them to the notice of the Society. Ightham House dates from the time of King John, and the fish ponds were probably constructed at the same time, to supply the house with fish. The house is built in the form of a square, and surrounds a courtyard. The house in its turn is surrounded on all sides by a moat, the water in which is from 5 to 9 feet in depth. The present arrangement of the ponds, garden, &c. was probably made in the time of James I. The house drains into the moat, and the drains issue into it by separate openings from two sides of the square. The stream which supplies the ponds and moat is formed by the surface water of a small valley, but is principally supplied by two very fine and strong springs, which come out of the Kentish limestone. The stream is only about a mile in length before it enters the upper pond, and there is at all times a strong run of water in it. It is perfectly free from drainage contamination, and enters the upper pond perfectly pure. There are two cottages and a small fold yard on the side of the stream, but no drains flow from them to the water; the fold is in a ruinous condition, and is not in use.

The ponds are much larger than the square of the house and moat. The upper pond is situated about 100 yards above the moat, the greater part of the space between them being occupied by a bowling green. This pond is shallow, and has reedy banks, with flags and aquatic plants growing on the margins; a strong current flows constantly through it to the outlet, and the water leaves it by a stone channel falling perpendicularly about 5 feet.

Immediately beyond the fall, the water divides and forms two open streams, which supply two small ponds or stews at a short distance below, on the right and left sides of the fall. The water leaves the stews by conduits, which pass underground to the moat, and enter it by two falls of between 3 and 4 feet each, which fall clear of the breastwork. In addition to the main stream, through the conduits there are two other strong feeders of the moat, which flow into it from springs on opposite sides, and there is a continuous current flowing through it. The water leaves the moat by culverts to the lower pond, and from the lower pond by a fall, and flows through grass fields for a mile, where it enters another fish pond.

No epidemic of fever or other zymotic disease is known to have taken place in the house, and only two cases of sickness (measles) during the last fifteen years. The gardener, his wife and child, were the only occupants of the house during last winter, spring, and summer, the family being from home.

Several severe epidemics of fungus have been observed in the ponds and moat. One occurred about the year 1850, but no particulars have been preserved, and mild ones may have passed without much notice. "Furred" fish, and even a few dead ones, have been often seen by the gardener. In the spring of 1874 a very severe epidemic occurred, when all the ponds and the moat suffered heavily; nearly all the fish died in the moat, and the disease was very destructive in both the upper and lower ponds.

This attack was inquired into by Dr. Church, who satisfied himself that the fungus affecting the fish was *Saprolegnia ferax*. The fish consisted chiefly of roach, pike, and dace in the moat; roach, perch, and pike in the upper pond; roach, dace, perch, pike, and gudgeon in the lower pond. The roach, dace, and gudgeon suffered the most, only the small pike and perch were affected, and none of the large pike or perch were found dead, and not a single eel.

FISH
EPIDEMIC AT
IGHTHAM.

Many of the fish looked, when in the water, as if covered with a halo, remaining at the surface nearly motionless, frequently putting their mouths out of the water, and turning belly uppermost immediately before death. On examination, the fungus was found to be most thickly matted on the shoulders just behind the head, clogging up the gill openings, on the pectoral fins, and tail portion of the body. Whenever ulceration had taken place, it was seen to be due to the fungus, as the parts most ulcerated were those most densely covered with fungus. Death was caused by suffocation in every instance.

The last fungus epidemic which occurred at Ightham moat and ponds began in the latter end of October of the present year, and continued to the middle of November. About eight or ten days after it had commenced, the numbers of the fish were observed to be dying. Dr. Church very kindly favoured me by sending a number of specimens that had died in the water, and also a number that were affected with the fungus, but were still alive when taken from the water. Dr. Church informs me that in this epidemic it was chiefly the fish in the moat which were affected and died, and only a few in the lower pond were observed to be affected; none were found affected in the stews and upper pond, although the stews were swarming with fish. As during the epidemic of 1874, the roach and dace suffered first and worst; the pike, perch, and eels have not been affected during this epidemic.

The diseased fish sent to me by Dr. Church were roach, 17 in number; 7 were dead when taken out of the water, and 10 were alive when taken. They average 2 oz. in weight each, and were all packed in fresh grass; those taken alive were put at the bottom of the box, with grass under and over them, and the others at the top of the box were packed in a similar way. The fish at the top of the box were overlying each other, and appeared as if they were enclosed in a common envelope of fungus, and such was actually the case; the fungus having continued to grow vegetatively, had, as it were, woven the whole group in a web of fungus. The new growth had a perceptible pink tint, the same as I had seen upon a greyling sent to me from the river Tweed last spring, and may possibly be the natural colour of the fungus when it grows in the air. I confirm Dr. Church's statement that the fungus was *S. ferax* and identical with that found upon diseased salmon from the Tweed and Solway rivers during the epidemics of 1878 and 1879. I observed that the majority of the filaments of the fungus found upon the Ightham fish were spear-shaped, very few had clavate fruit heads, and I saw none with ripe zoospores, indicating that the reproductive power of the fungus was feeble, and was producing only barren filaments, which appears to be always the case when the epidemic has run its course.

Only four of the 10 specimens had any external blemish upon them, which consisted of slight ulceration upon one pectoral fin in two, and in the caudal fins of other two; several of the rays were broken, and portions of them were hanging by the filaments of the fungus. In all the specimens the fungus covered the greater part of their bodies; and the heads of several, including the eyes and nostrils, were completely covered over. In none of the fish were the gills affected, but five of them had the opercular opening of the gills nearly closed up by the fungus.

On opening the abdomen the viscera were seen to be white, firm in position, and with a fair amount of fat upon the stomach and intestines. The roe in the females was firm and clear, and though very small, it was more advanced than the milt in the males. The heart, liver, and spleen were normal in size, and not the least appearance of extravasation in any of the organs. On opening the stomach and intestines I could not determine what the food of the fish had been, as only white glairy mucus in small quantity was found in any of them.

The blood was perfectly normal in all, and the subcutaneous tissue was in no instance discoloured, even under the thickest patches of fungus, showing that up to the time the fish were captured no ulceration, or indication of any, either on the head or scaled parts of the body, had taken place. The seven specimens preserved and submitted to the Society will be found to be without a sore or an ulcer on any part of them, which *S. ferax* could claim as a pre-existing nidus upon which to plant itself.

I may notice here that there seem to be two ways by which the fungus causes death by suffocation. The first and quickest way is when the fungus gets seated within the mouth and upon the gills at the same time, which I have

observed occurs oftener in the large fish than in the small. The second, and probably a slower way, is when the fungus grows over and closes up the opercular openings of the gills, which seems to be the way those specimens have been suffocated, being shrouded while alive in fatal fungus, they have died in their beauty, with their silvery skins unbroken.

There is one fact connected with the Ightham epidemic, namely, that the large pike, perch, and eels were not affected by the fungus disease. I am unable to account for this immunity on physiological principles, and refer it to the hypothesis of the "struggle for existence and survival of the fittest." It would be difficult to find anywhere a purer collection of water than the Ightham ponds. The main stream, upper pond, and stews, being virgin spring water, uncontaminated with any pollution, so that I am convinced that *S. ferax* can and does exist where no source of pollution is present, and exercises its destructive influence upon the fish, as is evidenced by the numerous deaths in the epidemic of 1874 in the Ightham upper pond. Up to the present time it has generally been held that fungus epidemic, or, as it has been called, salmon disease, was confined to and had its origin in rivers frequented by the migratory *Salmonidae*. At an early stage of the inquiry, Sir Robert Christison referred to this, and urged that if possible it should be ascertained whether the disease had ever been observed in the head waters of any salmon river above any impassable obstruction, either natural or artificial. The epidemic at Ightham moat and ponds answers the question Sir Robert desired to be cleared up, and proves that *S. ferax* is not confined to rivers frequented by salmon.

In a former paper, I stated that the so-called salmon disease did not depend upon a pre-existing functional disorder in the fish. I am still of this opinion, and point to the fish from Ightham as a further proof that this is the case. I also stated my belief that *S. ferax* existed at all times and probably in all waters, and that the presence of fish and *S. ferax* in the same water under certain climatic or other at present unknown influence, seems all that is necessary to originate fungus epidemic.

The epidemic at Ightham in my opinion does away with the theories of overcrowding, including overstocking. Overcrowding of salmon in a pool in a river is not analogous to overcrowding of people in a room or in a prison cell, where only a certain amount of air can circulate. Salmon crowded in a pool in a river, through which a stream of water flows freely, are in a condition similar to a herd of cattle crowded in a pen or fold, in the open air on a hill-side, where pure air is inexhaustible. In like manner, salmon crowded in a pool are provided with a continuous supply of oxygen by the constant flow of the river through the pool.

As to overstocking, my own opinion as an angler of 50 years' experience, and as a net fisher for a fifth of that time, is that I never found the fish too plentiful anywhere; and I do not think there ever can be too many, especially trout, grilse, and salmon, in any of our rivers. Very curiously, those who advocated the theory of overstocking as the cause of the fungus disease are in many instances the very persons who grumble at the scarcity of the fish in question, and propose to increase their number by killing them for eight or ten days longer at the latter end of the season, when the fish best adapted for breeding are entering the rivers. Regarding the food supply in overstocking, I quote the following statement cited by Sir Samuel Wilson of Ereildoune, Australia, in his work on the acclimatisation of Californian salmon. "It is stated by Mr. Vincent Cooke of the Oregon Packing Company, that out of 98,000 salmon caught in the Columbia river in 1874, three only were found with some trace of food in their stomachs, and those seemed to have quitted the salt water very recently."

The fact that the house drains into the moat might be urged by some as an argument that the water there is rendered foul by the house sewage, and that the pollution of the water may have had some influence in developing the disease. In reply to this it must be stated that as Dr. Church points out, a large body of water flows through the moat hourly, and so far from ordinary house drainage being prejudicial to fish, where the water is frequently changed, the finest fish as the pike, perch, and eel, are to be caught in the neighbourhood of the house drains. But if it were proved that the house drainage mingling with the water of the moat served as an exciting cause for the

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EPIDEMIC AT
LIGHTHAM.

development and propagation of the fungus in the moat, this could not be advanced as a reason for the appearance of the disease in the upper pond, which was fed by an uncontaminated stream. Neither could diseased fish from the moat find their way to the upper pond so as to infect the fish there, as there is not only a clear fall of between three and four feet between the moat and the stews, but one of about five feet between the stews and the upper pond, thus presenting obstacles such as the fish living in these waters could not surmount.

In conclusion, I feel convinced that the so-called salmon disease is *the fungus* itself, and that no structural disturbance in the fish is necessary to cause fungus attack; that this appears to me to have been abundantly proved by the 60 specimens which I have dissected and examined; that it is useless to look for more information on the origin and cause of fungus epidemic, from the carcasses of salmon or other fish affected with the fungus; that the origin and cure or prevention of the plague must be sought for in the life history of the plant, which is more the work of the botanist than the anatomist.

APPENDIX IV.

LETTER from DAVID MILNE HOME, Esq., Chairman of the TWEED COMMISSIONERS, with Observations on SALMON DISEASE. MR. MILNE HOME.

DEAR SIRS, Milne Graden, Coldstream, February 28th, 1880.

I send back to London the proofs of my evidence given in the salmon disease inquiry, which your secretary was so good as to allow me to revise. I at the same time beg leave to offer to you some further information since obtained by me, and which appears to throw light on the important and difficult inquiry in which you are engaged.

This information is not on this occasion from my own observation or personal experience, but is derived from the perusal of fishery reports published by the Canadian Government. In these reports I find that the same fungoid disease which has lately appeared in our rivers is stated to have been known for some years in the Canadian salmon rivers. The reports appear to me so instructive, as to the symptoms and causes of the disease, and as to the remedies adopted for it in Canada, that I have made extracts, and desire to offer them to you for consideration.

The reports were sent to me by my brother commissioner Sir George Houstoun Boswell, whose eldest son brought them from Canada a short time ago. Mr. Boswell fully confirms all that is said in the reports, as to the abundance of salmon in the Pestigouche river at present, but from which river, a few years ago, salmon had almost disappeared.

In the Fishery Report for the year 1877, I find the following statement by Mr. Venning, inspector of fisheries (New Brunswick), in a letter dated 6th November 1877 :

“I made searching inquiries of the men employed in catching the fish (for the hatcheries) as to the cause of the *fungus growth*, and was informed that a great many were thus affected at the time of their capture. I also inquired of old fishermen if they could give any reason for this, and was told that some seasons a great many salmon show those signs of disease, but they were not agreed as to the cause. Some thought it resulted from injuries received in the set nets during their ascent of the river, others were of opinion that the cause was rough handling in capturing and conveying them to the hatching house; while others thought they were caught too early, and kept too long in confinement. This last opinion is, to some extent, strengthened by Mr. Mowat’s experience last year, when *several hundred fish taken by him early in the season and kept in confinement, showed precisely the same symptoms, and had to be liberated before they were ripe for spawning.* Both Mr. Hogan and Mr. Sheargreen (hatchery overseers) assured me that all care was used to handle and transport the fish as tenderly as possible, and that a very large number was affected by the *fungus growth at the time of their capture.* This statement is borne out by the fact, that of the 12 taken by me under your instructions, eight were more or less *diseased, and covered by large patches of white fungus.*”

“On 29th October last, overseer Hogan informed me, that he commenced fishing for salmon early in September. By the middle of October, he had secured over 50 parent fish. Part of these were placed in the pond and part in the reception house, where a good flow of water continually passed over them. In a short time, the greater part of these in both places, began to show marked symptoms of disease. *Large blotches of fungus appeared on their bodies, which spread rapidly, and ended in the fish becoming hard, and finally dying.* On opening several of those that died, *the ova were found to be congested into a hard mass.* As this disease appeared to be spreading rapidly, and *affected the healthy fish,* Mr. Sheargreen was obliged to liberate them, retaining only such as gave promise of maturing their ova.”

In a letter dated 6th February 1878, by Mr. Samuel Wilnot the Chief Superintendent of the Fishery Commissioners, addressed to the Honourable Mr. Smith, Minister of Marine and Fisheries, the following statements occur :

“In the investigation that I made, the overseers gave it as their opinion that the death of the fish had resulted from some peculiar disease which had attacked the salmon not only in the ponds, but in the *open river as well* :—

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“ that they presented a weakly and sickly appearance when first captured, their bodies being covered in many instances with sores, which when the surface was removed, presented the appearance of prout flesh formed in wounds, and that a growth like *fungus rapidly spread over the bodies of the fish, quickly causing them to die.* This *fungoid growth* upon the bodies of fish is of no uncommon occurrence, where abrasions of the skin are made either in netting them or in rough coarse handling. Afterwards, a *parasitic growth* sets in, which in close confined limits, or in small supplies of fresh water, spreads over the body of the fish very rapidly, causing extreme weakness, and finally death.

“ Another malady is found among fish, particularly when they are far advanced in pregnancy, in the *caking and solidification of the ovaries*, by the stoppage of the fluids through the small membranes by which the eggs are connected together and fed previous to their maturity. From the observations I have made as to the cause of this disease, I am of opinion, that it is brought about by the close confinement of too many fish *within small circumscribed limits*, in which they are unable to roam about and partake of sufficient freedom and exercise of body, thus preventing the healthy circulation of the natural functions so requisite at this critical period, the ‘*spawning season.*’ (Page 64.)

“ During their sojourn in the pond, let it be for either a long or a short period, the fish nether take nor require food of any kind for their sustenance. It is now a well known fact in ichthyology, that *salmon eat nothing on their migration up rivers to their spawning grounds, after leaving the tidal or salt waters of the sea.*’ (Page 65.)

“ Mr. Wilmot explains pretty fully his opinion, that the pond into which about 300 salmon had been put, was only large enough to hold 100 salmon in health; and that this confinement ‘produced the effect of sickness, disease, *fungoid growth*, and *caking or hardening of the ovaries of the fish*, and consequent death of the numbers reported. This view is sustained by Mr. Venning’s statement, that *the eggs were hardened* in about 300 salmon that died.’ (Page 67.)

“ In the report for the year 1878 there is a letter, dated 31st December 1878, by Mr. Parker, a fishery superintendent, who was desired to investigate the cause of deaths among the salmon kept at Miramichi’s hatchery. He states in reference to the deaths which occurred, after the fish had been placed in the reception pond, that some persons attribute it ‘to the badness of the water. From this opinion I differ, as I consider it is from the way the fish are handled during their conveyance to the pond. The fish were drawn up with a horse and stick, and the fish were lying partly dry and knocked about on the rough-made cribs they use for transporting them. Consequently the fish get badly bruised before reaching the pond. When they thus get injured, *a growth of fungus begins upon the bruises*, and under these conditions, the fish soon sicken and die.’” (Page 355.)

In the report of 1877, some remarks are made as to the changes which have taken place in the state of the rivers, unfavourable to the health of salmon. Mr. Samuel Wilmot, the Superintendent of the Fish Breeding Establishments, in his letter to the Minister of State at the head of the Fishery Department, in a letter dated 31st December 1877, observes that:—

“ ‘The Detroit River, though to outward appearance, indicating purity, is nevertheless, at times very largely filled with earthy and decomposed vegetable matter. This *injurious fungoid-looking substance*, being in the lakes above, and storm-stirred to the surface, is brought down by the current of the river in the most inconceivable quantities. These extremely minute spores permeate through every description of screen through which the water will pass, and lodging upon the eggs, when in a quiet state on the ordinary hatching tray, commences its insidious *byssus-like growth*, which, unless quickly removed by the process (known in fish-cultures) of feathering and washing, soon grasps in its poisonous meshes the adjoining eggs and produces deadly havoc amongst them.’ (Page 12.)

“ ‘The river has become *thoroughly changed from its normal state*, v salmon in the olden times so largely frequented it, for spawning purposes. Then it was simply supplied with a flow of fine, cold, limpid water forest from the source of the stream, all the way to its outlet into

“(Ontario) was in its primeval state, overshadowing it from the sun’s rays and influences. This, with the multitude of springs of icy cold water, oozing out here and there, and little rills trickling along the ever-shaded surface of the earth, together with the constantly splashing current against logs and fallen trees, gave both aeration and hiding places innumerable for the fish. These obstacles also prevented the gravelly beds in the stream from being shifted or carried away by the force of freshets. All these were Nature’s provisions for assisting migratory fishes in the reproduction of their species. But now the forest has all disappeared, laying bare the face of the country to the rays of the sun, and general influences of the atmosphere, whereby the process of absorption and evaporation have almost wholly dried up the numerous springs and wells which were the original feeders of the creek. This has also diminished the flow of water fully one half, and increased its temperature to such an extent during the spring and summer months, as to create enormous quantities of infinitesimal spores for growths of fungi and other deleterious matter.”

“In addition to the above, there is the ungovernable force and destructive consequence of immense freshets, rushing down the now unimpeded course of the stream, carrying away previously-formed spawning grounds, sweeping down the offscourings from ploughed fields and turnpike roads, and rotten vegetable substances from barn-yards, compost heaps and other deposits of foul matter, and the refuse from saw-mills and other manufactories erected on the stream. This turbid state of the water (and it is the same in all others in populous districts) takes place just previous to or immediately at the critical time in the spring of the year, when the fry are emerging from the eggs. These difficulties cannot be overcome or even ameliorated in the course of natural reproduction. The foul sediment permeates everywhere, covering the eggs during the course of a few hours with a muddy mixture of putrid earthy and vegetable matter. These and other causes had well nigh exterminated the salmon from the waters of Ontario. But now a remedy has to a certain extent been instituted, through the instrumentality of your department, in the formation upon this stream of a commodious artificial fish-breeding establishment.” (Pages 16-17.)

“Mr. Venning in his report to the Minister of Marine and Fisheries for the year 1878, dated 31st December 1878, also adverts to some of the evils which are fast hastening the extirpation of salmon from the Canadian rivers; he says, ‘In the county of Carleton alone, there are now 36 mills of various kinds, and the whole of their rubbish is allowed to pass into the river. This has had a most injurious effect upon the salmon and shad fisheries along the whole extent of the river. If this is allowed to continue a few years longer, it will destroy the fisheries, for it is fast covering the spawning grounds, and driving the fish from their accustomed haunts.’” (Page 254.)

“The steady falling off in the three most valuable food fishes which resort to the St. John’s River, viz., salmon, shad, and gasperaux, has become so marked of late years, that there are substantial grounds for apprehending their total extinction. Advancing civilisation is producing its usual results. The settling of the country, the clearing of the wilderness, the extension of lumbering, the multiplication of mills, and the increasing extent to which fishing is pursued, all combine to alter the old condition of things, which were more favourable to the natural increase of fish. It is not matter of surprise, that the supply is becoming less, when the breeding stock is yearly becoming smaller.”

“The only remedy I can suggest for this result, is the extension of artificial hatching. By the natural process, it is shown by those who have made the subject a special study, that not over five per cent. of the eggs deposited by a female salmon are developed into young fish. By the artificial process, it has been proven that seventy-five per cent. can be hatched with certainty. A hatching house for salmon at some suitable place on the St. John river might yet restore these fisheries to a healthy state.” (Page 255.)

Ample proof is afforded of the success of the Canadian fish hatcheries in these reports. Thus, on the same page of the report from which the above extract has been taken, the following paragraphs occur :

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“ ‘ *Restigouche County.*

“ ‘ Overseer Mowat, of the upper division of this county, reports the catch of salmon to be double that of last year. This great increase he attributes almost entirely to the success of artificial culture, which has added so largely to the natural stock of the river. This increase in the catch has incited a great number of persons who never before engaged in the fisheries, to apply for licenses.’

“ ‘ Overseer Ferguson, of the *East* division, also reports, that the catch of salmon was double that of the previous year, and he also attributes it to protection and artificial culture.’ (Page 255.)

“ ‘ Mr. Wilmot in this same letter (page 342) says that the marked success which has already attended the protection of the salmon rivers in Canada, and also in some of the maritime provinces, cannot be gainsaid.’

“ ‘ As an example he refers to the *Restigouche* river, in which in the year 1868 the total catch by anglers was only 20 salmon; whereas in the year 1878, *by one angler alone*, 80 salmon were killed, to say nothing of the quantities killed by about 100 other anglers.’

Mr. Venning in his yearly report for 1878, makes some remarks of a general nature, which with much force might be addressed to the Government of Great Britain. He says that the facts appearing in his own and his predecessors’ reports prove “ that the time has come, when our fisheries require “ ‘ for their preservation more effective measures than have yet been provided “ ‘ by the department charged with their conservation.’ ‘ These facts show a “ ‘ very alarming decrease in the stock of all the anadromous fishes that “ ‘ frequent our waters. They show that this decrease has been caused by “ ‘ wasteful and extravagant modes of fishing in some places, and by over- “ ‘ fishing and insufficient protection everywhere. They show that fishing “ ‘ operations are annually extending, while protection is becoming less, and “ ‘ that all the causes of exhaustion which follow in the train of a rapidly “ ‘ increasing population, are in full and increasing activity. They show that “ ‘ everywhere, *except where artificial culture has arrested the decrease*, the “ ‘ salmon fisheries are in the same ‘ danger.’ (Page 266.)

“ ‘ The success attending the Fish-breeding Establishments in the Dominion “ ‘ with the immense stores of naturalized fish eggs now within their walls, is a “ ‘ matter of much congratulation. The progress made in the science of fish- “ ‘ culture in Canada since its inception, is quite beyond the most sanguine “ ‘ anticipations of its originator and of the Government under whose auspices “ ‘ the work has been carried on. When it is shown that within a few years “ ‘ since the birth of this new industry seven imposing structures for arti- “ ‘ ficial propagation have been erected, and when it is shown that ninety-four “ ‘ millions of fish-eggs of the salmon family have been collected, and that “ ‘ fifty-three millions and upwards of young fish have been hatched and “ ‘ distributed in the waters of this country, what mighty results may we not “ ‘ look forward to from the introduction of fish culture into Canada.’ (Page 367.)”

In several parts of these Canadian reports, allusion is made to the arrangements in the United States of America for the protection and multiplication of salmon. It appears that the United States Government did not adopt these arrangements, till after a commencement had been made in Canada:—and it is no small proof of the excellence and success of the Canadian system, that after a minute and searching inspection and study of it, the American Government resolved to copy it. It is stated that in 1870 no less than 27 *State Legislatures* had concurred in the necessary arrangements for keeping their rivers and lakes supplied with the different kinds of fish, which are by nature adapted to thrive in them. An immense Fish Hatchery has been established in one of the Western States near the coast, from which fry are sent out, on payment, to any state, society, or individual who applies for them. This Hatchery is upheld by Government.

I will not trespass farther on your attention by giving more extracts from these instructive Fishery Reports. Allow me only in conclusion to say, that the Canadian Fishery Department seems indebted for its success in keeping the rivers well stocked with salmon, in spite of the disease, to two causes. One has been alluded to, viz., the large supplies of young fry which are put into the rivers from the Fish Hatcheries. The other is the

appointment of Government officers to visit the rivers, to see that the laws for keeping the rivers free from pollution are carried out, and also that the weirs or dam dykes put up by millers have sufficient gaps or slaps in them through which the fish can freely ascend and descend in the rivers, and that when no such gaps or slaps can be made, structural fish passes are fixed on the caulds.

May I venture to express a hope, that in the Report which you are to make to Her Majesty's Government on this important subject, you will advert to the system of protection for Salmon which exists in Canada, the United States, and also on the Continent, for undoubtedly in these countries there are arrangements very deserving of being adopted in Great Britain.

I remain, &c.

DAVID MILNE HOME.

To Messrs. Buckland, Walpole, and Young,
Commissioners in the Salmon Disease
Inquiry.

MR.
MILNE HOME
—



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REPORT

ON THE

DISEASE WHICH HAS RECENTLY PREVAILED

AMONG THE

SALMON

IN THE

TWEED, EDEN, AND OTHER RIVERS

IN

ENGLAND AND SCOTLAND.

BY

FRANK BUCKLAND AND SPENCER WALPOLE, ESQRS.,
INSPECTORS OF FISHERIES FOR ENGLAND AND WALES;

AND

ARCHIBALD YOUNG, ESQR., ADVOCATE,
COMMISSIONER OF SCOTCH SALMON FISHERIES.

Presented to both Houses of Parliament by Command of Her Majesty.



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