On the destruction of fish and other aquatic animals by internal parasites / by T. Spencer Cobbold.

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Held in connection with

The GREAT INTERNATIONAL FISHERIES EXHIBITION

THE DESTRUCTION OF FISH BY INTERNAL PARASITES

BY

T. SPENCER COBBOLD, M.D., F.R.S., F.L.S.

CORRESPONDENT OF THE ACADEMY OF SCIENCES OF PHILADELPHIA

LONDON

WILLIAM CLOWES AND SONS, LIMITED

INTERNATIONAL FISHERIES EXHIBITION

AND 13 CHARING CROSS, S.W.

PRICE SIXPENCE

long years
Having lived in Italy I
can confirm what you
said, but at Ancona
& along the Adriatic
shores naturally
diseased fish

I cannot say that it
is a worm the people
get, but they sicken
an ill. The report
is at the Island

Copies to
Lancet
Folkard.-
Leonard (?)-
Dr Duguain (Lausanne)
Nat Cobbold
Linnean Society
Middx Hospl
[illegible]

International Fisheries Exhibition

LONDON, 1883

ON

THE DESTRUCTION OF FISH

AND OTHER

AQUATIC ANIMALS

BY

INTERNAL PARASITES

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1883

International Fisheries Exhibition,
LONDON, 1883.

CONFERENCE ON THURSDAY, JULY 12, 1883.

Professor HUXLEY, P.R.S., in the Chair.

ON THE DESTRUCTION OF FISH AND OTHER AQUATIC ANIMALS BY INTERNAL PARASITES.

THIS communication is not intended to be an exhaustive memoir. The subject is a wide one, yet it may with truth be said that few persons are aware of its importance. As regards man and the higher animals, physicians and other professional persons have a direct interest in conducting researches amongst the parasites; nevertheless, it is surprising to what an extent mere prejudice has operated to prevent labourers from entering into this instructive field of comparative pathology.

Taking a comprehensive grasp of the study of parasites it will be readily admitted that the extent of the subject is in itself rather appalling. If you consider that for every known species of bird, beast, reptile, and fish, acting as "hosts," there are probably, on the average, not less than four times as many different species of "guests" liable to occupy their bodies, you will then gain some adequate notion of the zoological difficulties of the study. If, further, you will consider that by far the larger proportion of all these parasites undergo transformations, often of a complex

character, and accompanied by a change of hosts, you will realise the practically illimitable extent of the territory that remains to be explored. And if, added to all this, you contemplate the kind of occupation and sacrifices demanded by researches of this order, you will, perhaps, not be altogether surprised that so few scientists have troubled themselves about the entozoa of the lower animals.

Notwithstanding that so little has been done, sufficient evidence can be brought forward to show that grave injuries, and even death itself, result to "hosts" of every degree; but it does not follow that proofs, which to the eye of the practised helminthologist are clear and convincing, will have due weight with those who are new to the subject. No person unfamiliar with the working of parasites, and with the appearances presented on dissection, is in any position to form a correct conclusion. The scepticism which prevails respecting the *rôle* of parasites in professional quarters is painful to the last degree.

When recently at the Royal Society, Professor Huxley communicated his instructive paper on *Saprolegnia ferax*, I felt tempted to rise and speak as to the parallelism which subsists between the injurious action of external and internal parasites relatively, whether animal or vegetable. As I refrained on that occasion, I was the more gratified by the opportunity recently afforded of incidentally calling the attention of the Congress to this subject.* Whilst the fullest attention has been paid to the parasitic fungi, little or no regard has been paid to the entozoa or internal animal parasites. As a matter of fact all the Salmonidæ —not to speak of other families—are liable to be largely invaded by entozoa, but it is hard to say to what extent

* See Reports of the Conference on Fish Diseases given in *Land and Water* for July 7, 1883, p. 11.

any one of the sixteen species known to infest the salmon is capable of inflicting injuries upon this valuable fish. Mere size of any given entozoön affords no criterion of its power for mischief. Amongst quadrupeds even the largest hosts succumb to comparatively small helminths. We see this in the case of flukes causing *rot* not only in sheep, cattle, and deer, but also amongst elephants. In all such cases death is primarily due to over-crowding. As in our big cities overcrowding causes the territory to suffer, so likewise the passages, ducts, and channels of any vital organ of the animal "host" suffer from the multiplication of parasitic residents. Amongst fish, flukes work little harm, since they rarely occupy any vital organ, nevertheless with cetaceans the case is far otherwise. Mammals adapted to enjoy an aquatic existence, and having an organisation otherwise conforming to that of quadrupeds, do not escape injury from flukes. To what extent they suffer is another question. I have dissected a porpoise whose liver ducts were extensively diseased, precisely as in cases of *rot* occurring in their mammalian brethren of terrestrial habits. The new species of fluke which I thus discovered in a Firth of Forth cetacean has since been found by Dr. Anderson in the Dolphin of the Ganges.* This small parasite occurs in prodigious numbers.

Save in exceptional instances, overcrowding, as before remarked, lies at the root of all injury to the host, be it bird, beast, or fish. With fish the tapeworms are most destructive. Much depends upon the situation of the parasite. When one finds the pancreatic cœca stuffed with tapeworms, choking not only these appendages, but

* Details are given in my paper on 'Trematode parasites of the Dolphins of the Ganges.' Journal of the Linnean Society for 1876. Zool. Div., vol. xiii., p. 35 (with illustrations).

at the same time extending into, and well nigh obliterating the lumen of the intestine, it seems absurd to suppose that such a victim can be in the enjoyment of good health. Physiology teaches us that sooner or later the host must succumb to this permanent interference with the functions of digestion and assimilation. If the fish does not die in a direct manner from inflammatory action, it becomes so weakened that it readily falls a prey to other enemies. To be permanently successful in the struggle for existence, all the vital powers of the individual must be maintained in good working order.

As a straw shows the way the wind blows, so do facts that are in themselves sufficiently trifling tend to produce instructive conclusions. One of my early experiences in this matter made a lasting impression upon my mind. Some thirty years ago—at the time that I held office in the Edinburgh University Anatomical Museum—I noticed in a rivulet near Musselburgh, a minnow moving slowly in the water. It seemed burdened, as I supposed, from a superabundance of roe. Having captured it with the hand, I opened the abdomen, when, to my astonishment, there was no roe at all, its body being abnormally distended by a large tapeworm. Here, therefore, was an instance where, to say the least, much inconvenience had resulted to the host, not, be it observed by overcrowding from many parasites, but from excessive distension by a single entozoön. I have since witnessed similar effects in other animal hosts widely differing in the zoological scale. Thus you may sometimes capture earwigs with enormously swollen bodies, due to the presence of a nematode that is eight or ten times as long as the host itself, and it is not uncommon to find other insects similarly affected. I will mention another curious example occurring higher in the

scale of vertebrates. On one occasion when walking in the Zoological Gardens, near the elephant house, an unduly distended mouse was labouring to cross the path in front of me. Having easily killed it, I thought to obtain some embryo mice ; albeit in this I was disappointed, or, rather, perhaps, gratified, inasmuch as the dissection soon revealed the fact that the distension was entirely owing to the presence of several large filariæ within the stomach. (*Spiroptera obtusa*, Rud.) Clearly these parasites had seriously incommoded the little rodent's progress, and, as in the case of the minnow, had led to its capture and death.

But I now proceed to direct your attention to far more cogent evidence, the value of which will be better understood if I first explain the special character of the tapeworms that are so injurious to fresh-water fish. The tapeworm of the minnow just alluded to was an immature ligule. All the ordinary ligules of our fresh-water fish are temporary residents awaiting their passive transference to the body of some higher, definite, or ultimate host. This final host is usually a water bird, which, preying upon the fish, swallows the parasite, and after a very short space of time the parasite itself arrives at sexual maturity. As long as the ligules remain in the fish their development is not complete, but when once subjected to new and suitable conditions their arrival at maturity is only a question of time. If the new residence is unsuitable to the species of parasite, no further development will take place ; in other words, all parasites requiring a change of hosts must have an environment specially adapted to their individual wants.

With the structural changes thus brought about we are not now concerned, but it is worth while remarking that

the question of injury to any fish or other aquatic host is in no way bound up with the mature condition of the parasites themselves. I mean to say that a parasite may, under certain circumstances, prove dangerous at any stage of its life. Now, in the case of fish, it happens that imperfectly-grown tapeworms are more mischievous than the adult parasites. The ligules infesting our fresh-water fish have received different specific names, but most of them are referable to one and the same cestode. The *Ligula simplicissima* of the minnow is the same as the *Lig. tincæ* of the tench, and as the *Lig. abdominalis* of the roach and other species belonging to the genus *Leuciscus*. It is also a mere synonym of a dozen other differently-named ligules found in the carp, pike, perch, bream, goby, char, and so forth. Of especial interest is the fact that this entozoön is sometimes described as *Ligula edulis*, referring to the circumstance that it is an edible parasite. More than half a century back Rudolphi remarked that ligules were eaten in Italy, and his words lead one to suppose that they were regarded not only as great delicacies, but were freely eaten under the name of *macaroni piatti*. In my recent account of a ligule infesting the human body (*L. Mansoni*), read to the Linnean Society, I have referred to Rudolphi's original words, which have also been freely quoted by Diesing, Duchamp, and other helminthologists. Thinking that possibly there might be some mistake in our interpretation of the passage in question, I have, within the last few days, sought to ascertain on what authority Rudolphi based his remarks. Thus in Ferrusac's 'Bulletin des Sciences Naturelles' for 1828 I found an abstract of a Paper by Briganti in which it is stated that the entozoa received the name of *Ligula edulis* "because certain persons eat it fried with the fish, regarding it as a kind of fat of the

latter." This puts a very different complexion on the matter, seeing that the true nature of the alleged delicacy must have been overlooked by those at least who first partook of it. Stimulated to further enquiries I sought and found Signor Briganti's original memoir in the Transactions of the Royal Academy of Naples, bearing the date of 1819, but probably issued somewhat later, since the work by Rudolphi, from which I have quoted, bears the same date. Be that as it may, Briganti remarks that he does not think it need occasion any surprise that the *Ligula edulis* "eaten with relish by not a few with the fish which contains it," causes no injury whatever to their health. He further remarks upon the not unpleasant flavour possessed by the ligules, of which he had been assured, and says that he willingly accepts that view, because the parasite is destitute of any alimentary canal and does not contain any excrementary matters. He refers to the nourishment derived by the parasite from the juices of the contiguous viscera of the host and to other circumstances ensuring its cleanliness. Briganti's memoir, though often quoted second-hand, seems to have been rarely consulted. He gives excellent illustrations. In his first plate he figures three fish of nearly the natural size; one showing the characteristically swollen abdomen, especially in the region of the vent, and another with the viscera exposed to show the position of the ligules. In the second plate excellent figures are given of the worms in various positions, from different media, the first six examples being all removed from one of the fish (*Cyprinus lacustris*). This small Cyprin inhabits Lake Palo, near Contursi, and it was at the time regarded by Briganti as new to science. I have thought it might be useful thus to particularise Briganti's labours, although it is to Dr. Duchamp's recent work that we are principally indebted

for the most solid contribution to our knowledge of the Ligules.*

Writing in 1876, M. Duchamp observes: "During the last seven or eight years a veritable plague has overwhelmed the fish in the ponds of La Bresse, afflicting exclusively the Cyprins and especially the tench, whose deaths may be reckoned by hundreds of thousands. From such a total it will be readily understood, without commentary, what serious losses the country has sustained. It was soon discovered," he says, "that the author of the disaster was a tapeworm lodged in the peritoneal cavity of the fish outside the intestine. Since then, the *white worm of the tench*, for so they call it, has been well known to salesmen in our markets, but no one thought of troubling himself about its zoological history."

From what follows in the text of M. Duchamp's work we gather that until the time in question no notice had been taken, or at least not recorded, of the existence of these parasites. "If they had been encountered, the numbers were so restricted that the fact was passed unnoticed." All at once these parasites appeared in such abundance that they caused terrible ravages amongst the occupants of the ponds, and severe losses to commerce. "Two years ago," adds M. Duchamp (i.e., in 1874), "the malady seemed to be on the decrease; to-day, however (1876), the ligules are so common that we have had no difficulty in procuring them; and, unfortunately, in our country they have not yet arrived at the degree of rarity attributed to them by helminthologists. Whatever may have been their frequency they have remained quartered in the ponds that are encoun-

* 'Recherches sur les Ligules,' par G. Duchamp, M.D., &c. Paris, 1876.

tered at every step on the marshy plateau of La Bresse, and they have principally infected those to which by preference aquatic birds repair, especially ducks, which one meets with by thousands. So far as we know, the parasites have never been found in either of the rivers of this region."

After remarking upon the variable number of parasites found in each fish—commonly four or five, but sometimes as many as fifteen—M. Duchamp continues: "As will be easily understood, the presence of such guests in the midst of delicate organs could not fail to produce a series of morbid phenomena and to give birth to grave anatomical complications. Also, with a little practice, it is easy to diagnose the existence of the ligules, unfailingly. The abdomen of a tench bearing these parasites presents an unusual development, a true tumefaction (*ballonnement*). On applying the index-finger to the lower surface of the body between the pectoral and abdominal fins, an evident fluctuation is felt. At the opening of the abdominal cavity there escapes a noticeable quantity of liquid which is sometimes strongly sanguineous, sometimes thick and purulent, but in both cases always carrying with it large white flakes."

After remarking upon the coagulable character of this fluid and upon the leucocytes, blood corpuscles, and other elements shown by the microscope, Dr. Duchamp observes that "the intestinal circumvolutions, the ovaria and milt glands form a single mass, in the centre or near the surface of which the ligules are found often shut in by peritoneal bands." It is added that the peritoneum is thickened and covered by a layer of false membranes, but there is no trace of inflammation of the liver. In short, the affection produced by the parasite is, according to Duchamp, a veritable *chronic peritonitis*.

The progressive stages of the disease were watched in aquaria. Pathologically they are of great interest. In the anal region a rounded projection makes its appearance, augmenting rapidly in volume until it attains the size of a small nut. It then presents all the external characters of a cyst limited by a more or less transparent membrane deprived of scales, and on whose surface blood-vessels ramify. At the end of some days the cyst ruptures, and the ligules escape by the opening. As to the fish, it does not survive the accident. Such, according to what we have ourselves seen and from the accounts of the fishermen, is the ordinary mode of termination of the malady in our country. Often enough, however, the tench die without any rupture. In this case it is probable that the ligules become free only when a portion of the flesh has become destroyed by decomposition. They may, indeed, live a long time amidst such surroundings. We preserved some for several weeks in rotten fish, and they were still quite alive when we were obliged on account of the stench to stop the experiment. It is a curious circumstance that, on the other hand, those which we saw escape by the opening of the cyst succumbed in a few hours on finding themselves in the water taken from the Rhone, and frequently renewed. One of them, of which a portion remained held within the abdomen of the fish, presented the singular phenomenon of one part of the body being dead whilst the other was living. According to certain observers other parts of the body, besides the abdominal and anal regions, may equally afford means of exit for the ligules. Thus, Block sometimes saw them escape by the belly, sometimes at one of the sides, at the back or at the head, and sometimes even in the region of the tail. The wound left by the worm is oblong like that of an open or bleeding vein.

The same facts were observed by Goeze, who figures one of these instances; but according to him, the wound heals and the fish does not suffer—statements which were confirmed by Rudolphi." This happy result of course shows that in some cases Nature is capable of effecting a complete cure. In reference to what M. Duchamp has observed respecting the vitality of tapeworms in decomposing flesh I have seen much to confirm his record; and, as I have already stated in the pages of *Land and Water*, the specimens of *Triænophorus* (shown by me in this Exhibition) were removed alive by Surgeon-General Day from the stomach of a pike which had already been dead three days, and which, moreover, had been soaking in spirit for twenty-three hours! An old writer has, indeed, alleged that tapeworms can resist the action of boiling water; but modern experiments have entirely disproved the truth of a statement which can only have resulted from imperfect observation. The supposition of Dr. Fock of Utrecht, that persons obtain the broad tapeworm (*Bothriocephalus*) by eating bleak (*Leuciscus alburnus*) is not confirmed. Nevertheless, the observations of the late Dr. Bertolus render it more than probable that the *Ligula nodosa* infesting the trout is the sexually immature condition of our human *Bothriocephalus latus*. Professor Leuckart long ago pointed to the Salmonidæ as the probable source of the broad tapeworm; but the statement recently made to the effect that pike or jack are a source of these parasites requires confirmation.*

Sometimes ligules infest the muscles in great numbers. The following is a remarkable instance, and refers to the

* See the new journal entitled 'Health,' for April 20, 1883, p. 17. The statement is made on the authority of Dr. Braun.

specimens (marked No. 9) in my series of parasites in this Exhibition :—

On the 30th April, 1880, I received from Mr. Robert J. Simpson some interesting parasites, together with portions of the skin, gills, and muscles of a lake trout. The specimens were accompanied by a letter, written from Ambleside, only the day before, and in it Mr. Simpson records the following particulars :

" On Tuesday last a dead *Salmo ferox* was found in the river Brathay, a female fish, in good condition (for a spawned fish), twenty-four inches in length, four pounds in weight. The fish had evidently died from the salmon disease, though this is the first victim yet seen in the rivers running into Lake Windermere. On making a *post mortem* examination I found the fish, I may say, one mass of parasites, all seemingly of one kind, and, from the egg, as minute as can be seen, to worms two inches long. One of the gills was diseased ; the part I have cut off and enclosed in bottle. I also enclose a piece of skin, that had the salmon disease ; also a lot of the parasite at its different stages of growth. To my surprise, in cutting into the flesh under the diseased skin, I found the parasite at fully one and a half to two inches in length. I enclose one bit of skin and flesh with a large parasite in it. I hope you will be able to see it. When put into the spirit its white body was clearly seen, stretched at full length, in the pink flesh. On cutting into the flesh, and examining it more thoroughly, I found the whole flesh, more or less affected with the parasite, some at full length, others in cells curled up. I have not hitherto met with this parasite, nor have I had a specimen with the salmon disease to examine. I have not heard whether this parasite is common to fish killed by the disease. Do you know this

parasite? Can it have anything to do with the disease? The cause of death did not appear clear, looking only at the head, gills, throat, and heart, as, with the exception of the bit of gill sent, these organs seemed right."

On May 1st, and again on the 3rd, I submitted Mr. Simpson's specimens to microscopic investigation; and although neither the long "white body" in the muscles, nor a similar filamentous band two inches in length, and loose in the bottle, turned out to be tapeworms, it was soon perfectly clear that the mass of parasites from the "flesh" were cestode worms. Some were in capsules, whilst others had been liberated, but all, whether encysted or free, were sexually immature.

The examination, in fine, led me to conclude that the parasites were very young examples of *Ligula digramma*, and as such, immature specimens of the *Ligula monogramma* of water-birds. It would seem from M. Duchamp's experiments that after transfer to the ultimate host their arrival at maturity is excessively rapid, an interval of four hours being sufficient for the formation and perfection of the eggs of the parasite. Here, however, I am chiefly concerned to remark upon the circumstance that although Mr. Simpson's lake trout was suffering from *Saprolegnia*, that external parasite was not alone the cause of death. I believe that the larval ligules were in this case the chief cause of the fatal issue. The number of ligules was something extraordinary, and the fish must have succumbed if there had been no *Saprolegnia*. Judging from the sections sent, every part of the great lateral muscle-mass seems to have been stuffed with the larvæ, precisely as one finds measly beef and measly pork overloaded with *cysticerci*. Clearly it follows that if a diseased fish of this kind were devoured by one or more water-birds, the avian host or hosts would

in a very short space of time become overloaded with tapeworms. If it be further asked how the fish in Mr. Simpson's "find" became so charged with parasites in the larval state, my answer is that the fish either actually swallowed part of a dead or dying water-bird charged with mature ligules, or, what would come to pretty much the same thing in the end, it must have swallowed one or several mature tapeworms which were either discharged by the bird, or were seized whilst still remaining suspended from the avian host when swimming on the water. In either case the swallowing of the mature tapeworms would liberate the ciliated ova or embryophores. From the stomach of the fish the six-hooked embryos would bore their way through the walls of the viscera, and then, having gained access to the great lateral muscles, they would rest there to undergo those metamorphoses through which all the tapeworms pass prior to their passive and final transfer to the body of the ultimate host. The disease thus produced I have called *ligulosis*, whilst the flesh of fish so affected may in common language be said to be measled, in the same sense as we employ the term to indicate diseased beef and pork from analogous causes. The term "cestode tuberculosis" suggested by Leuckart, is not I think sufficiently distinctive; it is even perhaps misleading.

One of the reasons why many intelligent observers practically deny the powers of entozoal parasites to produce epizoöty amongst fishes lies in the circumstance that they do not often find heaps of dead fish lying on the surface of open waters. They forget how soon, in the struggle for existence, the weaker members of a shoal are cut off by the numerous enemies that prey upon them, whether these be sharks, or porpoises and dolphins, or again, fish-eating birds. Another circumstance which I am

free to confess is more liable to mislead is the evidence often presented to us of fish swimming about in apparent activity whose bodies, nevertheless, contain many scores, or even in the case of minute entozoa, many hundreds of thousands of parasites. To my mind, however, this only proves the truth of a conclusion long ago forced upon me by evidence. This may be cast in the form of a definite proposition, as follows :—"Fish can sustain a relatively greater amount of parasitism than any other animal belonging to the class of vertebrates." That is a proposition which will, I think, long hold its ground, but in the face of the facts already adduced it is impossible to deny that, even in fish, parasites may be sufficiently numerous to bring about a veritable plague or piscine epizoöty.

I quite agree with Professor Huxley that an undue "fuss" has been made about the nematodes so common in mackerel, cod, herrings, haddocks, whiting and so forth. For many years past I have been favoured with letters on this subject, and I believe that in Denmark such affected fish are rejected at the markets. On the other hand I was told the other evening, by Prince Louis Lucien Bonaparte, that in the Basque provinces *filariæ* are actually collected and eaten under the notion that these parasites are young eels, which have found their way into the bodies of fish that have thus become as it were their foster-parents! It is curious to notice the strange delusions under which continental peasantry everywhere labour. I have remarked the same error of interpretation in England regarding the supposed eel-nature of the lumbricoid parasites of man and quadrupeds; but for one of the most instructive delusions of this order we must repair to the South of France, where to this day, I believe, the large entozoa that occasionally sweep off the wolves of

the Pyrenees by epizoötic disease, are regarded by the peasantry as serpents. In helminthological circles it is generally understood, in accordance with the views originally promulgated of Küchenmeister, that the fiery serpents of Moses were nematode entozoa, or guinea-worms. It was the lamented Russian traveller, Fedschenko, who proved that fresh-water crustacea were the intermediate bearers of the Dracunculus. The boring or tunnelling of the Dracunculus is, in itself, not more remarkable than the boring of certain parasites of fish. I have dissected several examples of the sun-fish, and I shall never forget the first monster (*Orthagoriscus mola*) which came under my observation. The huge liver might almost be said to have formed a mere bag of worms. Hour after hour I tried to dissect out some of the *Tetrarhynchi* or *Gymnorhynchi* (as Professor Goodsir termed them), but they were inextricably twisted one within another. To get out some twenty inches of unbroken strobile was all that could be done. In another, and quite a young fish, the lateral muscles were even more infested than the liver itself; but judging from what has been recorded by others, this muscular parasitism in the sun-fish is exceptional. Be that as it may, it is my firm belief that injuries to the vital organs of fish, such as I have repeatedly witnessed, cannot be produced without sooner or later involving the destruction of the host. I am satisfied that it was the enfeebled condition of one monster sun-fish that led to its easy capture by the fishermen of the Firth of Forth. Parasites are constantly present in the sun-fish. I have just received a letter from Dr. Van Dyck, of Beyrout, stating that he also has encountered the *Tetrarhynchus reptans* in this oceanic monster. I am aware that it was lately announced in the pages of *Land and Water* that a recently captured

sun-fish, when dissected, displayed no signs of parasitism. Over and over again it has been my lot to point to evidences of extensive parasitism in animals where others had previously denied its existence, and even in cases where skilful anatomists have been engaged in dissections, I have witnessed such oversights. These so-called "negative results," as they supposed them to be, arose partly from a want of familiarity with the various helminthic types, but more particularly from the circumstance that the various organs of the body of the affected hosts were not exhaustively dealt with. In this matter I attach no blame to any one; for, had I not by long study and by strange experiences been brought face to face with the evidences of diseased conditions resulting from the action of parasites in all classes of vertebrated life, I should have remained to this day as sceptical on this subject as others necessarily are. Fifty years hence the truth of views that are now commonly rejected will perhaps be accepted not only by professional persons, but also by scientists and by cultured persons generally.

DISCUSSION.

Deputy-Surgeon-General DAY said the meeting must not separate without a vote of thanks to Dr. Cobbold for his exceedingly interesting paper. They knew that amongst the helminthologists of Europe, nobody held a higher position, and that for many years he had been at work on these little animals. It was exceedingly important to know that Dr. Cobbold was as good a practitioner in destroying these parasites as he was in finding them.

Professor BROWN GOODE seconded the motion, which was carried unanimously.

A vote of thanks to the Chairman, moved by Lord Arthur Russell, and seconded by Mr. John Tremaine, concluded the proceedings.

Mem. — The Austrian dep.t at the Int.
Exhib. contains a fine collection
of "Crostacei Parassiti dei Pesci
del Mare adriatico" by Antonio
Valle, Assistant at the Municip.
Museum at Trieste. The
brochure illustrating the Collection
is a reprint (from the Bulletin
Estratto del Bollettino della
Società adriatica di Scienze
Naturali in Trieste, Vol VI.
fasc. 1. 1880. In MS. he adds
the following species: —
1. Encantlius Marchettetti? fr. Branchiæ of Motella tricirrata
2 Nemelis robusta (v. Ben.) : from fr. of Gobius fluviatilis
3 Cyclops pallidus (v. Ben) fr. br. of Cerex Vulgaris.

LONDON: WILLIAM CLOWES AND SONS, LIMITED, STAMFORD STREET AND CHARING CROSS.

APPENDIX.

LIST OF PARASITES OF FISH AND OTHER AQUATIC ANIMALS, SHOWN AT THE INTERNATIONAL FISHERIES EXHIBITION BY DR. COBBOLD, F.R.S.

SALMON.—No. 1, *Bothriocephalus proboscideus.* No. 2, *Tetrarhynchus solidus.* No. 3, *Distoma varicum.* No. 4, *Ascaris clavata.* No. 5, *Caligus stromii.* The tapeworms marked Nos. 1, 3, and 4, were collected by Professor McIntosh in 1862 and 1863 from Tay salmon. No. 2 is from a Lune fish, which was also much infested with Ascarides. The worms last mentioned were collected by Mr. Harker, of Lancaster, 1880.

RIVER TROUT.—No. 6, *Bothriocephalus proboscideus.* Collected by Mr. J. H. Steel, 1877. Nos. 7 and 8, two species of *Echinorhynchus* from a Colne trout captured by me in 1880.

LAKE TROUT.—*Ligula* from the muscles. Particulars of this remarkable "find" are given at page 14 of this Memoir.

CHAR.—No. 10, *Tænia longicollis*, from fish taken in Lake Cym Bychan, near Llanbedr. The fish were sent to me by the late Mr. H. Noel Humphreys, in 1877.

PIKE.—No. 11, *Triænophorus nodulosus.* The specimens of this very abundant cestode worm were removed alive by Surgeon-Major Day, F.L.S., from the stomach of a fish which had been dead three days, and which had been soaking in spirit for twenty-three hours.

PERCH.—No. 12, *Echinorhynchi*, attached to a portion of the intestine. From a Thames fish; Marlow, 1864.

ROACH.—No. 13, *Ligula leucisci.* Sent to me by Mr. J. H. Keene; Feb. 1877.

BREAM.—No. 14, *Ligula abdominalis.* This large ligule appears to be identical with large fish-tapeworm eaten in Italy, under the name of *macaroni piatti.*

CHUB.—No. 15, *Echinorhynchus* from a Thames fish; Marlow, 1864. A portion of the intestine shows one worm attached.

STURGEON.—No. 16, *Echinostoma hispidum*, removed from the spiral intestine; Edinburgh, 1855. No. 17, *Dachnitis sphærocephala*, from the same fish.

EEL.—No. 18, *Echinorhynchus proteus*. Obtained by Mr. Hassall; October, 1882.

MINNOW.—No. 19, *Ligula simplicissima*. This is identical with other larval ligules of our freshwater fishes.

STICKLEBACK.—No. 20, *Tænia fillicollis*, taken from a fish caught at Musselburgh, June, 1855.

CODFISH.—No. 21, *Bothriocephalus rugosus*. No. 22, *Tetrarhynchus morrhuæ*, collected by Mr. R. S. Cooper, 1872. No. 23, *Filaria* (*Agamonema*) *piscium*, sent by Mr. Hepburn. No. 24, *Lernea branchialis*.

GADUS (species doubtful).—No. 25, *Lernea* from beneath the branchial cover. No. 26, *Lernea* from the tail. These parasites were collected by the late Charles Darwin, F.R.S.; the former off the coast of T. del Fuego, 1834, the latter in 1833.

LING.—No. 27, *Ascaris acanthocaudata*. No. 28, *Dachnitis globosa*. Collected at Edinburgh, March, 1855.

HADDOCK.—No. 29, *Tetrarhynchus* in the larval or scolex condition. Collected at Edinburgh, 1854. No. 30, *Distoma rachion*. No. 31, *Echinorhynchus acus*.

CONGER EEL.—No. 32, *Stelmius*. Some account of this parasite is given in the *Lancet*, September 24, 1881.

COALFISH.—No. 33, *Ascaris clavata*. I obtained numerous examples from a fish captured in the Firth of Forth, 1855.

HERRING.—No. 34, *Filaria piscium*. The extreme abundance of this entozoon at particular seasons is well known.

SPRAT.—No. 35, *Ascaris clupearum*, obtained August 13, 1882.

MACKEREL.—No. 36, *Filaria piscium*. Of late years several correspondents have written respecting the diseased condition of mackerel from this parasite.

CEPOLA.—No. 37, *Nematoideum cepolæ rubescentis*. Contributed by Dr. Günther, F.R.S., in 1861. I have also recently received specimens from Surgeon-Major Day. No. 38, *Pycnogonum*.

SMOOTH BLENNY.—No. 39, *Echinorhynchus tereticollis*. I obtained only four examples from a Firth of Forth fish; 1855.

ROCKLING.—No. 40, *Filaria piscium*. From a Firth of Forth example of the five-bearded rockling; 1855.

HALIBUT.—No. 41, *Scolex polymorphus*. No. 42, *Ascaris collaris*. Firth of Forth, 1855.

SKATE.—No. 43, *Tetrabothrium.* Species undetermined. Edinburgh, 1855.

SUNFISH.—No. 44, *Gymnorhynchus* (*Tetrarhynchus*) *reptans*, from a fish caught off the coast of Fife, in September, 1856. No. 45, *Tristoma coccineum.* Nos. 46 and 47, *Cecrops latreillii*, male and female.

SCHNAPPER.—No. 48, *Tetrarhynchus.* Collected by Dr. Bancroft, of Brisbane, in May, 1879. Dr. Günther has identified the fish as *Pagrus unicolor.*

CATFISH.—No. 49, *Tetrarhynchus* (larvæ). Obtained by Dr. Bancroft in March, 1879. The "host" has been identified by Dr. Günther as *Copidoglanis tandanus.* Surgeon M. C. Furness, Sanitary Commissioner, has recently transmitted some Tetrarhynchi from Madras, and he states that the presence of entozoa amongst fish has caused much alarm. Duplicate specimens have been sent to Mr. Savory, F.R.S., for the Museum of the Royal College of Surgeons.

ANGLER OR SEA DEVIL.—No. 50, *Gasterostoma gracilescens.* No. 51, *Ascaris rigida.* I obtained these parasites from a Firth of Forth *Lophius piscatorius* dissected in May, 1854.

SWORDFISH.—No. 52, *Tetrarhynchus* (larva). No. 53, *Distoma clavatum.* No. 54, *Ascaris incurva.* These parasites were obtained at Lynn by Dr. John Lowe and myself, when dissecting a *Xiphias gladius* captured off the Norfolk coast in August, 1865.

WHITE SHARK.—No. 55, *Tetrarhynchus carchariæ.* No. 56, *Tetrarhynchus squali.* These entozoa were collected by Dr. Seccombe. I also received specimens from the late Dr. W. C. Pechey, obtained in 1868.

BONITO.—No. 57, *Distoma fuscum.* Obtained by Dr. Lauder Lindsay in October, 1863. No. 58, *Echinorhynchus terebra.* Collected by Mr. John Holdich in 1864.

CUTTLEFISH.—No. 59. *Rhyncobothrium paleaceum.* For this parasite I am indebted to Mr. Charles Tomes, F.R.S., who obtained it in May, 1867.

SHRIMP.—No. 60, *Filaria crangonis*, found by Dr. Henry Day. No. 61, *Agamonema palæmonis*, in a shrimp dredged off Shetland by Professor C. McIntosh, 1871.

PRAWN.—No. 62, *Cercaria*, or larval *Distoma*, seen in black specks beneath the skin; found by Dr. Burge, of Shanghae. These parasites are probably the larvæ of one or other of the Chinese human flukes, possibly of *Distoma Ringeri*, which has been discovered by Dr. Manson to occasion lung disease. No. 63, *Bopyrus squillorum*, Eastbourne, 1875.

WHALE.—No. 64, *Echinorhynchus porrigens.* No. 65, *Cyamus balænarum*, collected by Dr. Charles Davidson in the Arctic regions during the summer of 1871.

NARWHAL.—No. 66, *Prosthecosacter minor.* Removed from the ear by Dr. Davidson (as above).

PORPOISE.—No. 67, *Diphyllobothrium stemmacephalum.* Five of these large tapeworms were discovered by me in a porpoise which was shot by the late Mr. J. Jardine Murray, F.L.S., in the Firth of Forth, April, 1855. The finest specimen, 8 ft. long, is preserved in the museum at the Middlesex Hospital. No. 68, *Distoma campula*, from the same host. No. 69, *Prosthecosacter inflexus*, from an animal that died at the Zoological Gardens, London, 1863. No. 70, *Prosthecosacter convolutus*, collected by Mr. Hassall, Nov., 1882. No. 71, *Ascaris simplex*, collected by the late Charles Darwin, F.R.S., off the Island of Chiloe, in January, 1835.

DOLPHIN OF THE GANGES.—No. 72, *Distoma campula*, collected by Dr. John Anderson, F.R.S., superintendent of the Indian Museum, Calcutta. No. 73, *Ascaris delphini*, from the same cetacean.

SHORT-SNOUTED DOLPHIN.—No. 74, *Distoma lancea.* This fluke and the preceding parasites from *Platanista gangetica* and *Orcella brevirostris*, respectively, are described in the Linnean Society's Journal, Zool. Div., Vol. XIII. The parasites were sent in 1875.

WALRUS.—No. 75, *Ascaris osculata.* Obtained in great numbers from the stomach by Dr. Murie.

SEAL.—No. 76, *Filaria bucklandi.* Obtained by the late Frank Buckland from the heart, May 13, 1864. Described in the *Field* of the same month. No. 77, *Ascaris osculata.*

HOODCAP OR HOODED SEAL.—No. 78, *Filaria hebetata.* From a host captured at Frodsham, on the Cheshire side of the Mersey. The seal was procured by Mr. T. T. Moore, curator of Sir William Brown's Museum, Liverpool, and dissected by Professor Millen Coughtrey. *Stemmatopus cristatus* is a rare visitant on the British coasts, and this specimen was exhibited alive for some months. Full particulars are given in the Zoological Society's Proceedings, 1873.

RED-THROATED DIVER.—No. 79, *Tetrabothrium macrocephalum*, Edinburgh, May 8, 1855. The host was one of numerous water birds shot by the late Mr. Jardine Murray in the Firth of Forth, and forwarded to me for dissection.

CRESTED GREBE.—No. 80, *Ligula monogramma.* This parasite is common to many water birds, and represents the ligules of various freshwater fishes in the mature state.

Large Entozoa in Bream.—Amongst a catch of fish taken on August 21 on Fritton Broad, my attention was called to the singular appearance of a small breamflat (local name for the young of the white bream) weighing about 4oz. The abdomen was enormously extended, so I had the curiosity to open it, and found it to contain some very large entozoa. These were four in number, the longest measuring 17in. in length and 5-8in. in breadth the widest part. The other three were each 6in. in length and 3-8in. in width. These worms, especially the larger, show signs of life when partly dry, and after they had been separated from the host some ten hours I had them laid on a strip of paper to measure, and so left them, my attention being called other ways, so neglected to put them into spirits.—T. E. GUNN (Norwich).

"Z & W" Left 13th 1884

The Disease amongst Crabs in Germany.—During the last six years river crabs in Germany have been suffering from a kind of pestilence which has destroyed all the crabs in some water courses. The infectious matter seems to be present in the water, as healthy crabs when placed in the streams thus affected soon fall ill and die. The disease has also been noticed in France and Austria, the following rivers being named by the *Gesundheit* as specially presenting the features referred to :—Rhine, Moselle, Spree, Tauber, White Elster, Altmühl, Wiseth, Ill, Kainach, Mur, Ems, Salz, Wurmsee, Marne, Meuse, and Meurthe. The symptoms of the disease consist in the crabs becoming restless and often going on land. They lose their claws and feet, lie on their backs, and die. In one river alone about 800,000 crabs were destroyed in this way in the space of a few weeks, and according to more recent accounts the disease has manifested itself amongst the Oder crabs, which are much esteemed in Germany. Medical opinion has been at variance regarding the nature and origin of this disease, Professor Harz attributing it to the existence of parasites in the muscles of the crabs, while the researches of Dr. Von Listo go to prove that the malady consists in the growth of an enormous number of small cells which are to be found in all the organs, and which he regards as protozoid in their nature, forming a stage of development of a gregarine or amobe. He considers they are conveyed into the body of the crab with its food and thus spread over all parts of the organism. Although direct steps for saving the crabs from infection are not possible it is strongly urged to carry out indirect measures of precaution by carefully watching rivers and hindering that pollution of streams with refuse and sewage matters which, having gradually extirpated the finny tribe from some water courses, has now brought about this pestilence amongst crabs. The disease is to be regretted from an economical as well as from other reasons, as it involves a reduction of palatable and healthy nourishment for the masses of the population.

Entozoa in Bream.—Referring to the interesting note by Mr. Gunn, of Norwich, in your issue of the 13th inst., it may be useful to remark that the parasites were examples of *Ligula abdominalis*. This entozoon and its allies are very destructive to freshwater fishes. Specimens were exhibited at the late Fisheries Exhibition, and the whole subject will be found fully discussed in the sixpenny *brochure* published by Messrs. Clowes and Sons, and "issued by authority."—T. S. COBBOLD, F.R.S.

Left 27th 1884

LAND AND WATER.

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