

OBSERVATIONS ON THE ACCLIMATISATION OF
THE TRUE SALMON (*SALMO SALAR*), IN TAS-
MANIAN WATERS, AND UPON THE REPORTED
SALMON DISEASE AT THE BREEDING ESTAB-
LISHMENT ON THE RIVER PLENTY.

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Being unavoidably absent from the meeting of this Society held on August 15th, I was unable to contribute my remarks, as I should have willingly done, upon the subject of the disease among the salmon under cultivation at the breeding establishment on the River Plenty, recorded in *The Mercury's* report of the proceedings of the meeting, together with the announcement that it had been considered desirable to remit specimens to skilled zoologists and botanists in Sydney to report upon its nature. The wording of the announcement referred to being, though probably unintentionally, such as to lead the reading public to imagine that a peculiar and hitherto undetermined malignant disease had attacked the fish, which was quite beyond the powers of our local specialists to diagnosis, I avail myself of this earliest opportunity, and through the same source, of allaying the public mind upon the matter.

The disease, as I recognised immediately upon reading the announcement referred to, is one prevalent among the fish to a greater or less degree at every breeding season, and is caused by the growth upon some wounded or abraded surface of the fishes skin of a species of aquatic fungus, known technically by the name of *Saprolegnia ferax*. From the point first attacked the fungus gradually invades and disintegrates the surrounding tissues, living at the expense of and absorbing all their nutrient juices and ultimately, if not eradicated, destroys the fishes life. The spores or germs of this fungus are almost constantly present in pond or river water and naturally germinate and flourish luxuriantly upon any submerged dead or putrifying animal matter. The mildew-like growth that develops upon dead flies immersed in water, represents one phase of this fungus, and I exhibit this evening examples of it growing on pieces of dead fish and mussel, that have been purposely cultivated for the occasion. Also, fragments of the felt- or paper-like masses characteristic of the growth of this *Sapro-*

legnia upon diseased fish and which have been detached from one of the salmon that recently died at the Salmon Ponds. Mounted specimens, illustrating the more minute structure of this fungus, are exhibited in the adjacent microscopès. This more minute structure as there shown, and which I have also delineated on the accompanying diagram, consists of an interlacing network of branching threads or hyphæ, commonly called the "mycelium" of the fungus, and from which arise erect sub-cylindrical or club-shaped seed capsules or "sporangia." Within each such sporangium may be developed several hundred microscopic seeds or zoospores, every one of which, should it alight upon congenial soil, such as a sore on a fish's back or any dead animal matter, is capable of developing into an extensive fungus colony. Millions of these minute seeds or zoospores may be developed from a single tuft of fungus not more than one quarter of an inch in diameter, and as these are provided with locomotive organs or cilia, wherewith they can traverse the water in every direction, it may be anticipated that in those waters where the fungus is abundant, a wounded fish has little or no chance of escape. There is yet another form of seed or spore known as the "oospore" by which this fungus may be developed, but which is of much rarer occurrence and provides for the latent or resting phases of the species.

At the spawning season when the male fish fight and lacerate one another, and also abrade the surfaces of their bodies in excavating the nests or "redds" in which the ova of the females are deposited, the fungus, *Saprolegnia*, almost invariably attacks them. On some occasions it is so abundantly developed as to constitute a veritable epidemic which may be communicated to apparently healthy fish. It is more than probable, however, that in such cases the tissues of the fish affected are already in a diseased and impoverished state, and present a suitable nidus for the establishment of the fungus. As will be familiar to many present, a very destructive outbreak of this fungoid disease attacked the salmon in the English and Scotch rivers in the year 1878, and has been more or less prevalent in later years. Thus, in the annual report of the local Board of Conservators of the Tweed district for the year 1881, it is recorded that no less than 14,600 salmon had succumbed in that river to this disease, making with the two preceding years a total of over 22,000. While up to the present time nothing is known absolutely or accurately concerning the immediate origin of these epidemic outbreaks, there is, I think, much evidence to show, in the case more especially of apparently healthy fish being attacked, that the absence of sufficient oxygen in the water for the healthy maintenance of the fish, either through

over-crowding, abnormal temperature, or by direct pollution, represents a very if not the most important factor. Notwithstanding, however, the apparently exhaustive onslaughts of this formidable epidemic it is satisfactory to know that the returns of the fish captured in these previously affected rivers within later years has been in no way diminished, but even increased. It is indeed advocated by some authorities on fisheries matters that good is accomplished through the visitations of this epidemic, since it operates as a check by which the old male fish or kelts, which systematically lay in wait for and prey upon the young salmon smolts when descending to the sea, are periodically eliminated.

Whatever good ends in the scheme of Nature may be attained through the advent of this fungus disease in association with the salmon rivers and the natural spawning beds, it cannot be denied that where it invades and affects those artificial conditions brought about by human intervention, the consequences may be altogether disastrous. In illustration of this, I may now refer to the circumstances and phenomena attending the presence of this disease at the salmon and trout breeding establishment on the River Plenty. For many years, or in fact ever since artificial breeding operations have been conducted there, a greater or less number of the breeding fish have been attacked by this parasitic phase of the fungus, *Saprolegnia*, and many fish have died. This mortality, however, has hitherto been associated with ordinary trout, *Salmo fario*, and salmon trout, *S. trutta*, both of which species, being firmly established in this colony, can be easily replaced at the breeding ponds. With the true salmon, *Salmo salar*, however, the case is different. The only breeding stock of this species that has been available this past winter for artificial propagation has been a series of thirty fish developed from the salmon ova brought out by the s.s. Abingdon, in 1884, hatched out that same year, and since retained in the Ponds. These fish, or rather what remain of them up to the present time, not having migrated to salt water, are in a relative dwarfed or undeveloped condition. The largest of them scarcely exceeds a foot in length and they still retain their immature or parr markings. The majority of them have nevertheless manifested a tendency to propagate, and from the entire series a number of ova little short of 4,000 have been artificially expressed and fertilised. I should rejoice to be able to congratulate the colony upon having in this most auspicious anniversary of Her Majesty's reign, and after many years of indefatigable and self-denying perseverance on the part of that very worthy body of gentlemen, the late Salmon Commissioners, succeeded in establishing in Tasmania a race of this noble fish that would

propagate and grow to maturity in its lakes and rivers without requiring to migrate to salt water, and which race might be most appropriately distinguished by the title *par excellence* of the "Jubilee salmon." I fear, however, that the prospects of this achievement are not altogether encouraging.

On September 1st I visited the establishment at the River Plenty, with the object of making myself perfectly acquainted with all the details and circumstances attending the breeding and development of these fish which are now laid before you. From the approximate number of 4,000 fertilised ova obtained by artificially stripping ten female and as many or more male fish, 2,000, or 50 per cent. of dead ova had been already abstracted. It is plain from their appearance that a very large portion will have yet to be removed, and that, as commonly occurs under similar conditions, there will be a large number of deformed fish among the fry that may hatch out. All the ova, in fact, are exceedingly small and wanting in that density and tenacity of the investing membrane as compared with those of mature sea-going salmon. The circumstances that have to be recorded concerning the parent fish are, I regret to say, scarcely more promising. Out of the stock of 30 no less than 17 have died. What is more unfortunate is the fact that 14 out of the 17 were male fish, so that it is doubtful whether any male fish are left for future experiments. The ultimate cause of the death of these fish has been the attacks of the fungus disease described in the earlier paragraphs of this paper, and the thread of which subject may be again taken up with reference to its special manifestations in association with and bearings upon these particular fish. The fungus, as I have determined to my entire satisfaction, is indistinguishable from the cosmopolitan species, *Saprolegnia ferox*, already described, and which engenders a similar disease among Salmonidæ in the three continents of Europe, Asia, and North America.

The form under which this disease has manifested itself at the Salmon Ponds is not that of an epidemic attacking clean and healthy fish, but has in all cases been associated with fish that have received injuries attendant upon the operation of spawning, or at a time when their system is in a low and exhausted state, and, as it were, predisposed to the attacks of the parasitic fungus. The artificial conditions under which the salmon are necessarily maintained at the Ponds is undoubtedly accountable to a large extent to the high rate of mortality among them that is here recorded. Left to follow their natural instincts these fish immediately after spawning would have dropped down stream to the saltwater, and which, as has been ascertained by direct experiment, has the effect of entirely eradicating the fungus from their system. As a matter of fact, I may state that these small parr-marked spawning

fish, had they been permitted to migrate to the sea this last and the preceding spring, should by this time on returning have developed into mature salmon weighing as many or more pounds as they now do ounces. Should the few remaining salmon and their progeny, if reared, be maintained under their existing artificial conditions there is, I fear, but little prospect of their subserving any other purpose than that of confirming the results of previous experiments, and thereby demonstrating that the species will not develop to its normal size and quality if constantly restrained from spending, as is its nature, a large portion of its existence in saltwater. With the view of assisting as far as possible towards the successful conduct of the experiments that may be continued, and towards lessening to the greatest extent the deleterious action upon the fish cultivated of the parasitic fungus which represents their most formidable enemy. I would submit the following suggestions:—

In the first place, it is desirable that more than ordinary care should be exercised in the manipulation of these valuable fish for artificial propagation. During the Conferences at the International Fisheries Exhibition, London, 1883, at which I had the privilege of being present, one of the most important papers contributed was that by Professor Huxley on "Fish Diseases." In this paper the fatal malady caused by or associated with the fungus, *Saprolegnia ferox*, was specially dealt with, and in the discussion that followed many new and valuable data were elicited. In this direction Mr. Wilmot, the Chief Commissioner of the Canadian Fisheries, bore testimony to the fact that at the hatching stations in Canada they formerly lost a very large number of the salmon manipulated through the fungus. "Round the tail, where the men had caught the fish, this fungoid growth appeared and spread until the fish was killed." Also, in handling the salmon "three or four finger marks might be left across the fishes back; a few days after they invariably found three or four stripes of fungoid growth, and the fish invariably died." In order to combat the mortality from this cause, india-rubber gloves were supplied to the hatcheries for the manipulation of the fish and have been used ever since with gratifying results, it being found that the salmon were much less liable to injury and to the attacks of the fungus when so treated. Similar simple mechanical appliances might undoubtedly be profitably introduced at the hatchery on the River Plenty for the future handling of the surviving fish.

While the prevention of the disease should undoubtedly be advocated as being of primary importance, the means that may be adopted for its cure comes next in order for consideration. At various aquaria the rubbing of the fish affected

with salt, and more especially in the case of coarse fish such as roach, dace, pike and carp has been long known to be a fairly successful remedy, but there is no doubt, and more especially in the case of Salmonidæ that the immersion of the diseased fish in sea water works a yet more effectual cure. At the instance of Professor Huxley and as recorded in his paper just quoted, both salmon and sea-trout affected by the salmon disease were confined in coops in the estuary of the Tweed at Berwick in the year 1882. The fish, on being transmitted to him after a short treatment, were found on careful examination being made, by means of sections prepared for the microscope, to be entirely cured of the disease for which they had been treated. The subject of provision being made for the similar treatment of special fish, such as the salmon under cultivation at the Salmon Ponds, is well worth consideration. At a comparatively small cost, tanks or baths of salt water transported in casks from the mouth of the Derwent, might be fitted up at the ponds for the temporary immersion of the affected fish. Or arrangements might be made when the fish are so few in number and of such value, for their transport after breeding operations to salt-water ponds or enclosures that might with facility be constructed in the Derwent estuary. By the adoption of such a system, in point of fact, a solution would be arrived at of the problem of rearing salmon to maturity, and to their normal size and quality, while still retaining them under artificial cultivation, and by such means, in fact, a breeding stock of the species might possibly be permanently maintained.

Before leaving the subject of the fungus disease, I propose to make a few remarks upon its bearings with relation to fish other than the cultivated or acclimatised Salmonidæ, and with regard to the as yet imperfectly understood primary causes of its appearance and development into a devastating epidemic. I would especially draw attention, in this connection, to the circumstance that some 17 or 18 years ago an epidemic, apparently and most probably identical with the fungus disease of the British salmon rivers, broke out among the fish of this colony, popularly known as the fresh water herring or cucumber mullet, *Prototroctes marena*, but which may be more correctly described as a close ally of the European grayling, *Thymallus*. This fact is recorded in Mr. R. M. Johnston's excellent catalogue of the fishes of Tasmania, and has been attested to me by many residents. The fish at this particular period are stated to have been seen floating down the rivers in thousands, covered more or less extensively with a cottony fungoid growth. So virulent and exhaustive was this epidemic that many, more especially of the southern rivers, were more or less completely denuded of their stock

of this species and have so remained up to the present date, though I am trusting that by perseverance with the operations of artificially propagating the species conducted by me within the past two years it may soon again be restored to the Derwent and other southern rivers in its former abundance. The questions very naturally arise as to how, when and where this most malignant epidemic originated, and whether at the time there were any particularly abnormal, natural or artificial conditions associated with the infected rivers? Further information as to the precise date of its appearance, and more especially as to whether it occurred at or about the natural spawning season of the species, March and April, or at a time of drought, with the water at a high temperature, or in an impure condition, would be of much service in the consideration of these questions. The approximate date of the appearance of this epidemic would appear to be about the year 1869 or 1870, periods it may be remarked, of great activity in association with the distribution of the fry of the newly acclimatised Salmonidæ in the rivers of this colony. Is it possible, it may be suggested, that the fungus, *Saprolegnia*, was hitherto unknown to Tasmania and was introduced with the ova of these Salmonidæ, or more probably in the moss wherein they were packed? Under such conditions the germs or spores, like the microbes of measles or smallpox, arriving on a virgin and congenial soil, might be expected to spread with devastating virulence among the aboriginal inhabitants. Again, it might be asked, was the period of its appearance coincident with the first introduction on an extensive scale throughout the riverine districts of the colony of some special fertilising manure, that might be subsequently washed into the rivers by means of floods, or of the general adoption of some poisonous description of sheep dip, and in either of which instances the water might become so polluted as to jeopardise the lives of the fish?*

In the case of sheep-washing, more particularly, conducted on the large scale peculiar to the Australian Colonies, associated with the extensive use of caustic alkaline "dips," and at a time when the rivers are usually at their lowest, it is quite possible that the fish may be affected thereby in a literally wholesale manner.

The circumstance is very familiar to me of the fungus disease developing itself fatally among fish in aquaria supplied with water containing an excess of lime or which would be popularly described as being of more than ordinary hardness. When the lime is present in yet greater excess and

* I have received authentic information of ducks being killed in a rivulet in the neighbourhood of Spring Bay which had become poisoned by the chemicals used at an extensive sheepwash.

of a caustic nature, as in tanks newly lined with Portland Cement, the symptoms of the disease are greatly aggravated. In all of these instances the parasitic growth is commonly known as the Aquarium fungus and was formerly supposed to represent a distinct species. A careful investigation has, however, demonstrated it to be in all respects identical with the *Saprolegnia ferax* of the salmon disease. I would dwell longer upon this circumstance of the alkalinity of the water in association with this fungus, since it has been recognised by one of our highest authorities at Home as not improbably furnishing the key to the origin of the disease. In the course of the discussion following upon the paper on the salmon disease contributed by Professor Huxley to the International Fisheries Exhibition Conference, 1883, already quoted, the Marquis of Exeter, who is a most enthusiastic trout and salmon breeder, drew attention to the fact that the water in the district of his hatcheries was very highly impregnated with lime, that the fish hatched were very extensively attacked by the fungus, and the only remedy for the fish when so attacked being a bath of salt-water. In responding to this and other observations, Professor Huxley remarked:—"That he had been much interested in what Lord Exeter had said respecting the limy character of the water of his district, because when the Fisheries Exhibition was opened all the trout and other fresh water fish in the new tanks, with one consent began to show disease. In fact he had an opportunity of studying in the Aquarium the fungus on one of these fish, and of satisfying himself that it was exactly the same thing as the salmon disease. That interested him very much in consequence of a remark made by Mr. Saville-Kent, who had paid considerable attention to these subjects. He (Mr. Saville-Kent) had said to him as they walked round the Aquarium—that the disease was a matter of course, because the water had not been allowed to run sufficiently long through the newly cemented reservoirs and tanks, and wherever that was the case the *Saprolegnia* was almost certain to make its appearance. That opened up his mind to a very interesting chapter of inquiry. It was very possible that any super-abundance of lime in the caustic state might have a very considerable effect in bringing about the development of the disease. In the first place, fungi of all kinds were extremely sensitive to small degrees of acidity and alkalinity in the water, and secondly, the condition of acidity and alkalinity was extremely likely, however small its extent might be, to have a very definite effect on the epidermis of the fish. This, therefore, suggested a line of investigation that was likely to prove extremely fruitful."

Subsequent to this conference, experiments were instituted

by Mr. George Murray, of the British Museum, at the request of Professor Huxley, with the view of ascertaining what influence lime in the water had in the development of the disease. The results obtained were, however, to a great extent of a negative character only, furnishing at the most, as remarked by Mr. Murray, "starting points for fresh experiments" (Annual Report of the Inspector of Fisheries England and Wales, for the year 1883). To my mind, from a perusal of the report quoted, the lime used in these experiments was probably deficient in strength or in caustic properties, or possibly, the fungus experimented with had been cultivated to such an extent as to have, so to say, lost its virus, or in other words its capacity for propagation.

The actual rôle played by caustic lime, acids, or other chemical compounds in the development of the fungus disease on the epidermis of a fish appears to me to be purely mechanical, and in fact identical with that exerted by hard water on a delicate human skin. It causes it to become, as it were, chafed or chapped in the fishes skin, probably imperceptibly to the human vision, though at the same time in the form of minute raw surfaces sufficiently large for the lodgment and further development of the microscopic spores of the parasitic *Saprolegnia*. Unless in fact there is a crack or abrasion of the cuticular surface, be it however small, the fungus spores may swarm in the neighbourhood without exerting any ill effect whatever upon the fish. In demonstration of this proposition I may mention that at the Fisheries Establishment, Battery Point, I have up to a recent date kept several varieties of indigenous fish, including native trout, *Galaxias truttaceus*, blackfish, *Gudopsis marmoratus*, and the little native perch, *Microperca Tasmania*, in tanks in which the fungus has for many months past developed luxuriantly on any small fragments of mussel or other animal substances used as food and left for a few days at the bottom of the water (Specimens exhibited). Notwithstanding its presence in such abundance the fish have enjoyed a vigorous state of health, their sound and healthy skins, according to my interpretation, affording no foothold for the attachment of the parasitic fungus. Now it so happened that in recently moving the boxes, slates, and other apparatus from certain of the breeding troughs one of the little trout got bruised upon the head, with the consequence that the fungus has immediately seized upon it and its development, if not arrested, will without doubt prove fatal to the fish. This specimen I exhibit on this occasion and propose, should it live long enough, to attempt its cure with a salt-water bath. No more fitting illustration could, I think, be given of the phenomena

attending the origin and development of this disease than are embodied in this brief history.

Proceeding now with the subject of the acclimatisation of the true salmon in Tasmanian waters, it may be remarked that the recommendations already made concerning the construction of salt water enclosures for the temporary lodgment of the fish are necessarily brought forward under the supposition that it is considered desirable to maintain a permanent breeding stock of salmon under artificial cultivation, and premising also that the latest attempts to effect the natural acclimatisation of the species in Tasmanian waters, shall, as in former instances, be productive for all practical purposes of negative results. Should, as I would be only too glad to have to report to you, the species naturally establish itself from the supplies of fry developed from the "Yeoman" importation and liberated in various rivers of this Colony in the year 1885, such special provision for the maintenance of a so-to-say domesticated breeding stock will necessarily be superfluous. On this point, however, I regret to say we have as yet no very encouraging evidence to adduce. In the British salmon rivers it has been conclusively ascertained that the young salmon change from parr to their smolt, or first migratory condition in varying numbers at the end, respectively of their first, second, and third years, they then repair to the sea and may return to their natal rivers the following autumn as half grown salmon or grilse, ready to deposit their spawn. According to statistics collected by Mr. Dunbar, who annually hatches about 500,000 salmon fry in the Thurso River, Caithness, as recorded in Dr. Day's "Fishes of Great Britain and Ireland," about 8 per cent. of the salmon parr become migratory smolts at the end of the first year, about 60 per cent. at the end of the second year, and 32 per cent. at the end of the third year. It is recorded in the same treatise that through experiments with marked fish, instituted by Mr. Ashwerth, at Stormontfield, near Perth, it was ascertained that many of the fish belonging to the first migratory batch returned to the rivers as grilse, weighing from five to nine pounds and prepared to spawn the following autumn, or, within twenty months only of their deposit in the river in the form of ova.

Applying these ascertained facts to the case of the Tasmanian-bred fish, a large portion of the Yeoman fry liberated in the year 1885, should have been, and were to my knowledge, ready to migrate to the sea in the spring of the year 1886, and should have arrived on the spawning ground this past winter (antipodean, June and July) of 1887 weighing several pounds. With the spring now opening out we might also have expected the advent in the rivers from the sea of a yet

larger number of fine fresh run grilse. Neither of these two phenomena can as yet be recorded, though there is yet time for the grilse to put in their appearance, the recent inclement weather, accompanied by much snow water in the rivers, having possibly retarded it. If, however, these grilse do not shortly appear, and still more, if the next autumn and winter of 1888 fails to bring up the main body of spawning fish, the conclusion must, I fear, be reluctantly accepted that the true salmon (*Salmo salar*) does not find the climatic or other surrounding conditions adapted to its permanent residence in Tasmanian waters. This subject has been dealt with in my recently published report, and wherein I put forward what appears to me to be the most probable interpretation of the phenomenon, namely, that the smolts in their descent to the sea, or after a short residence therein, find the temperature of the water so much higher than that in which the species flourishes in the northern hemisphere that they wander away to colder regions, and do not return to their natal streams. In search of a more congenial clime, they might proceed south towards the southern coast of New Zealand, or to Patagonia or the Antarctic icefields. Or possibly, following a uniformly cold abyssal route, they might reappear upon the shores of Japan or North-Eastern Asia, and in which latter region they would have advanced far towards coming in contact again with the northern representatives of their own race. In this connection it is of interest to remark that some few years since the report was circulated that a large number of salmon had been seen taken on the coast of Japan, and it was suggested at the time that these fish had developed, and possibly migrated there, from fry originally liberated in Tasmanian waters. I should be very glad to receive further and more definite information concerning this reported occurrence of salmon on the coast of Japan.

Premising, by way of argument, and in order to account for their otherwise mystical disappearance, that some such suggested migration of the salmon hatched out and liberated in thousands in the rivers of this colony since the year 1864, has actually taken place, such interpretation is found on nearer examination to be supported by many substantial data. In the first place, quoting from one of our highest European authorities, Dr. Gunther, "Introduction to the study of fishes," we find stated—"the true salmon, *Salmo salar*, is not subject to variation, and is very sensitive to any change of external condition, and to every kind of interference with its economy." Now, on proceeding to examine the external conditions to which it has been attempted to reconcile this species in this colony, it is found that they differ very materially from those which surround the species in its native waters. As pointed

out in my report, the temperature of the sea round Tasmania is considerably higher than that of the British Seas, and more nearly approximates that of the Mediterranean shores of the South of France, and where repeated attempts to acclimatise the salmon have entirely failed. The fry liberated in the Rhone and other rivers of Lanjuedoc have thriven therein for the first year or so, but after taking their departure for the sea, as smolts, have failed to return as mature fish to the rivers in which they were originally born and bred.

Regarding this question of temperature, I have instituted during the maintenance of the fisheries establishment at Battery Point a systematic series of diurnal observations, with the view of ascertaining the average range of temperature of the water in the tanks and ponds and in the adjacent sea throughout the year, anticipating, as happens in the present case, that such data might prove of service. These observations have elicited the fact that the temperature of the sea-water in the tanks and ponds ranges from 40deg. Fahr. in winter to 80deg. in summer, while the smaller range of from 50deg. to 70deg. represents for the South Coast the corresponding limit of variation in the adjacent sea. The mean isotherm in either case is consequently denoted by 50deg. Fahr. When recording these observations in my report, I expressed regret that no similar data were available concerning the corresponding temperatures of the British seas, as these might prove of great value in the conduct of this and kindred acclimatisation experiments. It so happens that in the scientific journal "Nature," for June 30th, 1887, quite recently to hand, an announcement is made that such a series of observations is now in course of progress, under the auspices of the British National Fish Culture Association—of which I believe I enjoy the privilege of being a dormant member—and that the results recorded will be shortly published. The same announcement, moreover, contains a record of observations upon temperature made during the past three years in the tanks of the Association's Marine Aquarium at South Kensington, and with relation more especially to its influence upon the vitality of various marine fish. Although no systematic table is given with this announcement, a series of temperatures are recorded indicating a range of from as low as 32deg. Fahr. in winter to 70deg. in summer. This yields a mean isotherm for the entire year of 51deg. only as compared with that of 60deg. which obtains under similar conditions in Tasmania. An analogous comparative ratio will, it may be predicated, be found to obtain in the waters of the open sea on the British coast, and these figures of themselves furnish, to my mind, an ample reason why, that in dealing with a species of fish so

“sensitive to any change of external conditions” as is the salmon, the efforts to permanently establish it in Tasmania have so far proved fruitless.

I may suitably mention here that prior to obtaining this practical information regarding the conditions of temperature, I was inclined to anticipate that some mistake had been made as to the description of ova remitted from England during the earlier years of the acclimatisation operations. This interpretation was to some extent supported by evidence tendered to me, and there, in point of fact, appeared to be no other logical explanation of the circumstance that no undoubted, or at all events matured, examples of *Salmo salar* could be shown for the many thousands of fry distributed in the rivers of this colony for several successive years following upon that of 1864. And taking also into consideration the fact that its near congener, the salmon trout, *S. trutta*, was, and is still, abundantly represented in these waters. A closer enquiry has elicited evidence showing that there is no reason to doubt the specific identity of the salmon ova forwarded in the first consignments through the instrumentality of Mr. J. A. Youl, C.M.G., and certainly, no doubt whatever can be entertained as to the genuineness of the importations more recently received, collected and packed under the personal direction of Sir Thomas Brady, and from which importations the specimens furnishing the subject matter of this communication have been mainly derived.

In conclusion, I would remark that every resource at the command of human skill has been brought to bear upon the naturalisation of the salmon in Tasmania, and no more fitting opportunity than the present could be selected for placing on record the indebtedness of the colony to that body of gentlemen, the late Salmon Commissioners, who have so perseveringly devoted their time and best energies for many years to these acclimatisation operations. And if, owing to an inflexible law of nature, this one species has proved intractable, they will have the satisfaction of knowing that through their accomplished establishment in Tasmania of many varieties of the allied and more plastic forms of *Salmo trutta* and *Salmo fario*, they have conferred on the community at large, if not an equal, yet a very substantial benefit.