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T A S M A N I A.

H O U S E O F A S S E M B L Y.

S A L M O N.

HISTORY OF ITS INTRODUCTION; AND DISTRIBUTION OF
OVA, 1869-1872.

Laid upon the Table by the Colonial Treasurer, July 22, 1873, and ordered by the
House to be printed.

SALMON COMMISSION.

SIR ROBERT OFFICER, KNT., M.H.A., *Chairman.*

M. ALLPORT, ESQ., F.L.S., F.Z.S.

W. ARCHER, ESQ., F.L.S.

J. BUCKLAND, ESQ.

THE HON. H. BUTLER, ESQ., M.H.A., F.R.C.S.

W. A. B. JAMIESON, ESQ.

CAPTAIN THE HON. W. LANGDON, M.L.C.

R. C. READ, ESQ.

J. M. CLARKE, *Secretary.*



Hobart Town, 17th July, 1873.

SIR,

I HAVE the honor to forward herewith, for the information of the Legislature, a Report of the progress of the introduction of Salmon (*Salmo Salar*) and other *Salmonidæ* to the waters of Tasmania; together with a Return showing the distribution of Ova and Fry, made up to the end of the Season of 1872.

I have the honor to be,

Sir,

Your obedient Servant,

R. OFFICER, *Chairman Salmon Commissioners.*

The Honorable the Colonial Secretary.

*BRIEF history of the introduction of Salmon (*Salmo Salar*) and other *Salmonidæ* to the waters of Tasmania, by MORTON ALLPORT, F.Z.S., F.L.S. Extracted from the Proceedings of the Zoological Society of London for 1870; with an Appendix by the same Author, continuing the history to the present time, June, 1873.*

IN the year 1841 the late Mr. Frederick Chalmers, of Brighton in Tasmania, who was then Master of a vessel trading from London, applied to Dr. Mackenzie, of Kinellan, by Dingwall, Ross-shire, Scotland, with a view to obtaining Salmon-fry for transport to Tasmania. The fry were not obtained in time for the departure of the vessel, as appears by letters published in the 'Proceedings of the Royal Society of Tasmania,' (vol. i. p. 281); and this abortive attempt would scarcely be worth recording but for the curious fact that even then Dr. Mackenzie suggested the sending impregnated roe as more likely to lead to success than any attempt to carry the living fish. The Doctor's description of his method of impregnating the roe from fresh-killed fish by rubbing it and the milt together would, however, astonish a modern pisciculturist as much as his notion that the impregnated spawn placed in a basket of gravel and hung in the ship's tank could possibly live many days in tropical weather.

In the year 1848 a gentleman belonging to the Tasmanian Survey Department, Mr. James Ludovick Burnett (then on leave of absence in England), visited Mr. Young, of Inverness-shire, manager of the Duke of Sutherland's Salmon-fisheries, and consulted him on the practicability of introducing Salmon and Trout into Tasmania. Mr. Young suggested two methods for trial—one, to bring out the spawn; and the other, to bring young fish. On the whole, Mr. Young gave the preference to the latter method, which is the more remarkable as from the account of one of his experiments it is clear that he had accidentally been upon the verge of discovering the very method which, after many years, led to success. In the experiment alluded to, Mr. Young caused the fecundated ova, packed in baskets of gravel, to be hung in a running stream at different distances from the shore. During a severe frost one or two of the baskets nearest the bank, and which were in comparatively still water, were frozen hard on the surface, and Mr. Young supposed that the vitality of the eggs was destroyed; but he let them remain, and discovered that the only effect of the reduced temperature was to delay the hatching of the ova for several days.

On August 13, 1849, Sir William Denison, then Lieutenant-Governor of Tasmania, wrote to Earl Grey on the subject of the introduction of Salmon, and in his letter mentioned that several attempts had been made to bring out the spawn, but they had all failed. Unfortunately no official record seems to have been kept of such attempts; but they were probably made in some of the vessels employed in the convict-service, and entrusted to men who took little or no interest in the experiment. A long correspondence afterwards took place on the subject, which was wound up on May 16, 1850, by a letter from Earl Grey declining to take any further steps in the matter, on the ground that the project of fitting up a welled smack to carry out the living fish, as finally suggested by Mr. Young, would involve too great an expense.

Mr. Burnett and Sir William Denison still firmly believed that Salmon were to be brought out; and that belief culminated in the first attempt, of which any detailed record can be found, to transport Salmon-ova to Tasmania. The Home Government employed Mr. Gottlieb Boccus, under whose superintendence a large oval tub was constructed of wood cased in lead, capable of containing sixty gallons of water besides the requisite quantity of gravel; and on the 31st of January, 1852, this tub, containing 50,000 ova of Salmon and Trout, was shipped on board the "Columbus" at London, and slung below and on one side of the fore hatchway.

Mr. Boccus, who himself procured the ova, gave minute directions as to the change of the water at fixed intervals, and warned the captain of the vessel that he might expect the Trout-ova to hatch about the 15th and the Salmon-ova about the 20th of April. On the 1st March, however, in latitude 14° 30' north and longitude 26° west, the ova of both began to hatch, and continued to do so for about a fortnight, after which time the water became thick and putrid, the weather being intensely hot. As the ship approached colder latitudes, the water gradually cleared, but no symptoms of life appeared in the tub; and when the vessel arrived in Tasmania, Dr. Milligan, then Secretary of the Royal Society of Tasmania, and Mr. J. L. Burnett carefully examined, first the water in the tub, and then the gravel, but without finding any traces of either spawn or fish.

Mr. Burnett, in an admirably written account of this experiment, published in the 'Proceedings of the Royal Society of Tasmania,' (vol. ii. p. 288), suggested that in future the temperature of the water in which the ova are placed should, if practicable, be regulated by means of ice.

From a letter from the Duke of Newcastle to Sir William Denison, dated the 2nd of June, 1853, enclosing a voluminous report from Dr. Boccus on the causes of failure, it appears that the cost of the experiment in the 'Columbus' was £300, which was charged to the land-fund of the colony.

On the 12th of June, 1852, J. C. Bidwell, Esq., Commissioner of Crown Lands in New South Wales, forwarded to His Excellency Sir William Denison a paper entitled "Notes on the Establishment of Salmon and other Fish in the Rivers of Tasmania and New Zealand," which paper was published in the 'Proceedings of the Royal Society of Tasmania,' (vol. ii. p. 326). The following extract will show that Mr. Bidwell was the first person who recommended the exact process by which success was ultimately attained more than ten years afterwards, though several have claimed the merit of the discovery at a later date. "On mentioning the subject of the introduction of fish from foreign countries to the late Earl of Derby, he informed me that he had been extremely unsuccessful in his attempts to breed exotic fish in England; and I do not think that there is an instance of any fish not belonging to the Cyprinidæ having been successfully established as colonists in any country; but I believe the want of success may have arisen almost entirely from the small number of individuals, which, if imported alive, it would be at any time possible to turn loose, and that if thousands could be liberated at once, the chances would be in favour of any predaceous fish establishing itself in a new river in any suitable climate. Now to do this it would be necessary to bring and hatch the spawn. *And I think that by packing spawn in ice there would be no difficulty in preserving its vitality for a much longer time than would be required. It is not probable that the vitality of fish-spawn would be destroyed even by freezing; but by merely packing it in ice there would be no danger of actual freezing, as the ice would always be in a melting state.*"

Thus the whole difficulty was foreseen and provided against; and it seems marvellous now that Mr. Bidwell's suggestion was not earlier acted upon; but after the paper was read, it was little likely to attract attention, as it was indexed in the volume referred to under the letter B simply as a letter from J. C. Bidwell on the introduction of fish, and was only recently brought to light in the close search for every scrap of information relating to the early history of the Salmon experiment.

Early in the year 1858 the Royal Society of Tasmania appointed a committee of Fellows to consider certain questions submitted by the then Colonial Secretary relative to the introduction of Salmon into Tasmania, and the payment of a reward of £500 voted by the Tasmanian Parliament for such introduction. The report of this committee, dated the 16th of March, 1858, amongst other things, strongly urged on the Government the necessity of providing breeding-ponds for the deposition of ova or fry on their first arrival in the Colony; and on this suggestion the Government afterwards acted.

In the year 1859 Mr. James Arndel Youl, a gentleman who from that date expressed his conviction of ultimate success, and has exhibited untiring zeal and industry in the management of such portions of the various attempts as had to be conducted in Great Britain, prevailed upon a body of gentlemen in England, known as the Australian Association, to take up the cause; and ultimately they despatched about 50,000 Salmon-ova in the ship 'S. Curling' from Liverpool, bound to Melbourne, under the charge of one Alexander Black.

The 'S. Curling' sailed on the 25th February, 1860, having fifteen tons of Wenham-Lake ice in an ice-house on board to keep down the temperature of the water supplied to the apparatus in which the ova were placed; but on the 24th of April, and the fifty-ninth day out, the last of the ice melted and the last ovum died, no practical knowledge whatever having been derived from the experiment. By some accident no intimation of the intention to despatch ova by the ship 'S. Curling' reached Tasmania till after the departure of the vessel from England; but upon the intelligence being received, and to prevent the loss of any ova which might have arrived, the Government caused suitable ponds to be rapidly constructed on the banks of a small stream known as the "North-west Bay River," about twelve miles from Hobart Town. These Ponds were ultimately abandoned in favour of a more suitable site.

In the year 1860 the question of the introduction of Salmon was referred to a joint committee of both Houses of the Tasmanian Legislature; and, acting upon a suggestion of that committee, the Government

afterwards appointed a body of Honorary Commissioners to whose management the whole experiment was thenceforth intrusted.

The next attempt was made in 1862, in the 'Beautiful Star,' a small iron vessel of 120 tons burden, built for a steamer, but sent out under canvas.

An ice-house was built between decks, and very elaborate apparatus of two kinds prepared for the reception of the ova, 50,000 in number. In the ice-house a deal box containing ova packed in wet moss was imbedded, at the suggestion of Mr. C. H. Moscrop, Manager of the Wenham-Lake Ice Company, London, as appears by a letter from that gentleman published in the 'Times' of the 13th July, 1863. The management during the voyage was intrusted to Mr. William Ramsbottom, who had been engaged in Melbourne and sent to England for the purpose. On the 4th of March, 1862, the 'Beautiful Star' left London, and on the 8th was compelled, through stress of weather, to put back to the Downs; in this short period from 6000 to 7000 of the ova died. On the 13th of March the 'Beautiful Star' left the Downs; and on the 16th the filler-in of the screw propeller was carried away, which compelled her to put back to Scilly for repairs. The vessel left Scilly on the 24th of March, and encountered a furious gale in the Bay of Biscay on the 27th, during which time the ova were destroyed in vast numbers. Fine weather succeeded the gale; but it was manifest, from the delays already experienced and the bad sailing-qualities of the vessel, that the ice could not hold out even to get through the tropics. At the end of April and beginning of May the temperature of the water began to rise, and many of the ova died on the point of hatching, a large number with the head of the fish protruding. On the 8th of May Mr. Ramsbottom, much against his will, was compelled to enter the ice-house to procure blocks of ice, which he placed in the deck-tank, thus reducing the temperature of the water. After using a considerable portion of ice, Mr. Ramsbottom came upon the deal box which had been placed in the ice-house, the lid being broken by the rolling about amongst the ice. Lifting out some of the moss, Mr. Ramsbottom thought the ova looked healthy, and procured a vessel of clean water and placed ova and moss together in it. To his utter astonishment he found nineteen living and healthy ova, which he carefully transferred to the trays in the suspended apparatus.

On the 17th of May the ice was finished; on the same day the temperature of the water rose to 65°, and the last of the ova died, seventy-four days from the commencement of the voyage, and eighty-eight days from the taking of the spawn from the fish. Towards the end of April from three to six of the ova were hatched per day; and thirty of those hatched appeared in perfect health; one lived ten days. The ova taken from the deal box lived nine hours longer than any of the others, and withstood a higher temperature.

Taking into consideration the pertinacity with which a portion of the ova retained life for seventy-four days in spite of the disastrous circumstances to which they were subjected during this voyage, the Tasmanian Salmon Commissioners felt certain that the ova could be introduced, and made a strong appeal to the Government of the Colony to repeat the experiment. Upon receiving Mr. Ramsbottom's report, they decided upon sending him to England expressly to try the experiment of packing ova in ice with a view of retarding their development; and this experiment was accordingly tried in London under the direction of Mr. Youl during the winter of 1862 and 1863.

The wonderful success of that trial, showing that ova may be hatched safely after being buried in ice 150 days, has been fully published to the world; but why this was likely to prove successful has not perhaps been publicly explained. Even Mr. Frank Buckland, in his book on fish-hatching, speaks of freezing the ova, and thereby greatly misleads his readers. It was long ago shown that actually to freeze ova was to kill them in a few days, or, at most, weeks. The question then was, how could they be kept at an equable temperature just above the freezing point? If a block of ice (the sensible temperature of which is 32° Fahrenheit) be immersed in water of a higher temperature, a portion of the ice will melt until the heat of the water falls to 32° F., but no more of the ice will be afterwards melted until the temperature of the water is again raised. If the ice could cool the water below 32°, a portion of the water would be frozen; but to effect this, a further portion of the ice must be melted, and water at 32° is not capable of melting ice. If vessels containing cream be immersed in ice for a month, no change takes place in their contents; but convert a portion of the surrounding ice to water by the admixture of any deliquescent salt, and the submerged creams are instantly frozen. Therefore, by this beautiful provision of nature, any substance above the freezing-point buried in ice can never fall to the freezing-point till the ice next to it is converted to water; and so long as any ice remains, the buried substance will continue at a low temperature certainly, but above the freezing-point; and to this principle success was due.

After many interviews with the owners of various ships, Mr. Youl (to whom Tasmania is greatly indebted for his determined perseverance in this respect) received the munificent offer from Messrs. Money Wigram and Co. of 50 tons of room gratis in their clipper-ship 'Norfolk,' bound to Melbourne. An ice-house capable of holding 30 tons was built in a situation admirably chosen for the purpose—on the lowest deck, amidships, and equidistant from stem to stern, in the position in which the motion of the vessel would be least felt. With much difficulty, and at the cost of great personal exertion on the part of all concerned, about 90,000 ova of the Salmon (*Salmo salar*) and about 1500 ova of the Trout (*Salmo fario*) were obtained and safely packed in deal boxes, each a foot long, 8 inches wide, and 4 inches deep. In some of the boxes a layer of charcoal was first placed on the bottom, then a layer of moss damped in pure water; then ova were lightly placed on the moss, and the whole covered with another layer of damp moss, upon which the lid was screwed down. In the remaining boxes the charcoal was omitted, the packing otherwise being the same. Through the lid and bottom of each box several small holes were drilled; and all the ova were packed in 181 boxes. The boxes were next placed on the bottom of the ice-house, which was filled up with Wenham-Lake ice, and the whole securely closed. All being complete, the vessel sailed from London towards the end of January 1864, and left Falmouth on the 28th of that month. On the 15th of April the 'Norfolk' arrived in Melbourne. On the next day the ice-house was opened and the small

boxes unpacked. The lid of one box was then removed by Mr. Ramsbottom with fear and trembling; but, to his great satisfaction, a large number of the imbedded ova were found to be alive. Eleven of the small boxes were then left in Melbourne; and the remaining 170 were placed on board Her Majesty's colonial steam-ship 'Victoria,' in large open packing-cases with holes drilled in the bottoms. Broken ice was placed on the tops of the small boxes in each packing-case, larger ice was piled on the cases, and the whole were then covered with bags of sawdust and blankets; about half the ice had melted during the voyage. On the 17th of April the 'Victoria' left Melbourne, and arrived at Hobart Town on the 20th. The packing-cases and ice (of which latter there still remained more than ten tons) were then carefully placed on a barge packed as before, and were towed to New Norfolk, twenty miles further up the Derwent than Hobart Town, by the steamer 'Emu,' which was detained till a late hour on the night of the 20th on purpose. From New Norfolk the barge was towed by boats to the falls three miles further up the river on the morning of the 21st; and the packing-cases were then landed and slung on stout poles and carried by hand to the ponds already prepared at the river "Plenty," three miles further up. The remaining ice was transferred to the ponds in carts, the contents of each being well covered with straw. The first batch of cases arrived at the ponds about the middle of the day of Thursday the 21st of April, 1864, ninety days after the placing of the ova on board the 'Norfolk.'

On their arrival, Mr. Ramsbottom immediately proceeded to prepare the gravel-beds for the reception of the ova. A slight description of the ponds is here necessary. These ponds are twenty-six miles from Hobart Town, and were arranged in accordance with designs brought from the Stormontfield establishment on the Tay. Water is led from the river Plenty by a race to a small plot of grass-land above flood-mark. Sluices are placed on this race to regulate the supply of water. From the main race a smaller one leads directly into the clearing-pond, which is circular, about five feet deep, and forty feet in diameter. Thence the water is led by two covered wooden troughs into an open wooden trough at right angles with the covered troughs. From the open wooden trough small sluices let off the water in any quantity desired directly into the gravel hatching-beds. These consist of wooden boxes about five feet long by 2 feet wide. There are twelve of them, arranged in four rows. The water passes with a slight fall into the upper end of the first box in each row, over the lower end of that box into the upper end of the second box, and so on to the lowest, where the water from each row passes over a series of shallow gravelly pools to a pond about 120 yards long and 40 feet wide, varying in depth from 2 to 9 feet. All the surplus water from the clearing-pond also finds its way into this larger pond by a covered drain, ensuring a permanent supply of clear cool water. All the entrances to and exits from the pond and hatching-beds are carefully guarded by covering them with perforated zinc. As the day on which the first of the ova arrived at the Plenty was warm, with a bright sun shining, a tent was erected over the gravel-beds, the temperature of the water in which was found to be 55° Fahr. Ice was then freely placed in the transverse open trough at the upper end of the gravel-beds and the temperature thus reduced to 44°. About four o'clock on Thursday, the 21st of April, the first box of ova was opened, and, to the dismay of Mr. Ramsbottom, a very large proportion of the eggs were dead; but in the second and third boxes affairs looked more hopeful, and by the time a dozen were unpacked it was manifest that a large proportion would be saved. In unpacking, as soon as the lid of each box was unscrewed, the top layer of moss was quickly removed, and the lower layer of moss with the ova was then lifted out, and at once turned upside down on to the cool water running over the gravel beds. By this means the ova soon separated from the moss, and distributed themselves amongst the gravel, after which the moss was carefully removed bit by bit. The unpacking was continued by candle-light through a great portion of Thursday night, and was renewed at daylight on Friday morning. By Friday night the last of the boxes were finished, and Mr. Ramsbottom calculated that about 35,000 living and healthy ova were safely deposited. Of these only about 300 were Trout-ova, which were placed in a separate gravel-bed constructed on purpose and closed at each end by perforated zinc. The percentage of living ova varied greatly in the different boxes; but the largest number were invariably found in the boxes in which the ova were more thinly scattered amongst the moss, and had been subjected to only just enough pressure to keep them steady.

During the unpacking on Thursday night several living ova were unavoidably picked out and left in the heaps of damp moss beside the gravel-beds through the night. On searching the heaps of moss on Friday morning, several ova were recovered from amongst the moss, and one or two from the stones underneath, and transferred safely to the water.

Bedded in the moss of one of the boxes an English Wasp was found, which evinced slight signs of animation. On placing the insect in the sun for a few minutes it became quite lively and walked quickly away. It is true that wasps are scarcely desirable subjects for acclimatization, but surely this circumstance ought to teach us a useful practical lesson as to introducing valuable insects and other similar organisms, especially in their embryonic stages.

A few of the boxes of ova had been placed in the vaults of the Wenham-Lake Ice Company for six weeks before the 'Norfolk' sailed; and in these boxes, though a larger percentage of ova were dead, the eyes of the fish were distinctly visible in those which were living, the development of the embryo having reached a higher stage.

Before the whole of the ice was used up, the temperature of the water of the river Plenty fell to 42°, and averaged about 47° for some time afterwards. The only object in cooling the water with ice at first was to prevent the transition of temperature being too sudden. For several days after the deposition of the ova Mr. Ramsbottom was busily engaged in removing all dead ova and pieces of moss, charcoal, &c. from the gravel-beds; and for some time afterwards the average death-rate was a mere fraction; but it increased as the hatching approached.

On the 4th of May, 1864, Mr. Ramsbottom had the high gratification of seeing the first Trout burst its egg in Tasmanian water, and on the following day the first Salmon.

The ova continued to hatch until the 15th of June, 1864, by which time Mr. Ramsbottom (then appointed Superintendent at the ponds) estimated the number of young Salmon at about 3000, and of young Trout at about 50. There are two reasons for the vast difference between the estimated number of living ova and the number of hatched fish:—one, that a large percentage of the most healthy-looking ova turned out absolutely barren through defective impregnation; another, that a large number of deaths occur at the very point of hatching, the embryo dying without being able to free itself from the egg. Early in August the perforated zinc guards at the lower ends of the breeding-boxes were removed, and the Salmon-fry permitted to drop down with the stream into the shallows at the upper end of the large Salmon-pond, whence they gradually found their way to the pond itself.

By the end of August several of the Trout (all of which, up to this time, had remained in the trough in which they were hatched) died, and many others showed symptoms of disease. As no cause could be traced for this mortality, a gravelly rill was constructed at the upper end of the clearing-pond, and the entrances to and exits from the whole were guarded with perforated zinc. The Trout were then transferred to the rill; and it was ascertained that so many had hidden away under the gravel that, instead of 50, close upon 300 young fish were counted. In the clearing pond the young Trout continued to thrive, and grew amazingly, no deaths being observed. Amongst the Salmon the mortality was, up to this time, trifling, being confined to such few weak fish as were driven against the perforated zinc guards and had not strength enough to fight against the stream.

On the 4th of October, 1864, a leak was discovered, by which a large run of water found its way from the Salmon-pond into the Plenty; and, fearing lest the Salmon should have been escaping, the Superintendent placed a box in such a manner as to intercept any fish passing through. One was soon found in the box, and an attempt was unsuccessfully made to remedy the leak. From the 7th to the 25th of October a trench was cut across the place where the leak occurred, and the defective place puddled, and the leak ultimately stopped; but during these nineteen days 240 fry were captured which had passed through, and it is certain that a very large number had previously reached the Plenty.

Till March 1865 everything continued to progress in a satisfactory manner at the ponds; the young fish, which had been at first supplied with boiled liver powdered fine, were now almost entirely fed on gentles, and up to the 10th of March exhibited all the appearance of vigorous health. From the 10th to the 15th of March no less than forty parr died: all of them appeared plump, well-grown fishes; and it was difficult to assign any reason for their deaths. Owing to an unusually hot and dry autumn, the Plenty was very low, and the temperature of the water rose above its ordinary summer heat. This may have been the cause of the mortality, especially as the Salmon-pond then consisted almost entirely of still water; and the Commissioners therefore determined to liberate the bulk of the parr at once. Up to the 19th of March nine more fish died; and on that and the two following days the pond was lowered, and 419 Salmon parr were liberated into the River Plenty, half a mile above its junction with the Derwent.

Fourteen of the smallest fishes caught were retained in the pond; and a number which could not be caught, and of which number no accurate estimate could be made, still remained. Many of the parr liberated exceeded 5 inches in length, being then ten months old.

Every thing progressed favourably from the end of March; and on the 23rd of October, 1865, the first fish which had assumed the Smolt dress was seen in the Salmon-pond, and between that time and the end of the year thirty-three fine Smolts were liberated. In January, 1866, some alterations were made in the clearing-pond; thirty-eight trout (*Salmo fario*) were then liberated in the Plenty, 133 being returned to the pond.

The Tasmanian Government, encouraged by the success of the attempt in the 'Norfolk,' determined to obtain a second shipment, that no chance might be lost of rapidly carrying the undertaking to a successful issue; and on the 8th day of February, 1866, the ship 'Lincolnshire' left Plymouth bound for Melbourne, having on board about 103,000 ova of Salmon (*Salmo salar*) and 15,000 ova of Sea-trout (*Salmo trutta*) stowed in an ice-house of rather larger capacity, but of much the same construction as that built in the ship 'Norfolk' for the same purpose two years before. The whole of the arrangements for shipping were superintended by Mr. James A. Youl, who again exhibited the determined zeal upon which so much depended in the former experiment. The method of packing the ova in the boxes and the boxes in the ice-house was identical with that adopted in the 'Norfolk.' After a rather long passage of seventy-nine days, the 'Lincolnshire' arrived at Hobson's Bay on the 30th of April, 1866, and the ova and ice were at once transhipped to the steamship 'Victoria,' again most liberally placed at the disposal of the Tasmanian Salmon Commissioners by the Victorian Government, and arrived in the Derwent on the 4th of May, and by 8 P.M. on the following day the last of the ova were placed in the hatching-boxes at the Plenty, the water, by the help of the remaining ice, being reduced to 45° F.

One remarkable fact in this experiment was the forward state of the larger portion of the ova, the fish being distinctly visible, furnishing abundant proof that a large number, at any rate, had been successfully impregnated. This was especially observable in the Sea-trout, the pupils of the eyes in which last stood out as black spots on a yellowish-white ground, the enveloping tissue being more transparent than in Salmon-ova.

The proportion of living ova deposited was estimated at above 45 per cent. of all sent out. Since the deposition of the ova in April, 1864, several great improvements had been effected by the Commissioners in

the arrangements at the Plenty, the chief of which was the alteration of the gravel in the breeding-boxes. To explain the change and the advantages of the present plan, it must be remembered that in its own rivers the Salmon chooses for its spawning-beds shallow rapids running over a bottom of coarse river gravel, consisting of pebbles weighing from half a pound to three or four pounds, the spaces between which are of course large enough to permit the ova to roll down to depths varying from a few inches to a foot and a half. This is no doubt a wise provision of nature for the protection of the ova and the helpless young fry from their innumerable natural enemies, but has serious objections in artificial rearing. To begin with, it is absolutely impossible, in the first instance, to separate the dead from the living ova; all must be rapidly transferred to the water together, and the dead ova gradually picked out afterwards. In 1864 numbers of dead and living ova together got out of sight between the interstices of the gravel purposely made to resemble as nearly as possible the natural spawning-beds, and much of the living ova was assuredly destroyed by contact with that which was decomposing, to say nothing of the ill effects which the decaying ova would have upon the water generally. Again, it is now an ascertained fact that a considerable admixture of atmospheric air is indispensable in hatching the ova of most of the *Salmonidae*, and that, consequently, the further the ova are from the surface of the water, the more tumble and splash you must have in the water to drive bubbles of air through and amongst the gravel. It follows that if in artificial rearing the ova are allowed to get some 3 or 4 inches down into the gravel, a sharp stream of water must be directed over the artificial beds to supply them with the air necessary; but that if it is desired to keep the ova in sight, they must be placed on fine gravel, and an even, gentle stream of water about an inch or an inch and a half in depth must flow through the beds. As in the artificial process the boxes are thoroughly guarded from all possible enemies, the advantages are so manifestly in favour of keeping the ova in sight, that the Commissioners replaced the coarse gravel formerly used by an even bed of very fine pebbles on which the ova rested about an inch from the surface of the stream, which was made to flow gently and evenly through the boxes. The result was, that the moment an egg became opaque, or, in other words, died, it was removed, and all danger to the neighbouring ova was avoided. Besides this alteration, a long series of gravelly rapids, with a few deep places interspersed, was added to the lower end of the Salmon-pond, and a new circular pond with a gravelly rill attached was constructed for the Salmon-trout.

On the 8th of May, 1866, the first Salmon-ovum per 'Lincolnshire' hatched, and on the 12th of the same month the first Sea-trout ovum. By the time all were hatched the Superintendent reported that he had counted up to 4490 Salmon-fry and 496 Sea-trout fry, and estimated those he had been unable to count of the Salmon-fry at about 1500.

In July, 1866, all the remaining parr, seventy-seven in number, of the shipment per 'Norfolk' were liberated; and every fish showed distinctly the approaching change to the Smolt form.

On the 3rd of July ova and milt were taken from the first pair of Trout (*S. fario*) which ever arrived at maturity in Australia. By the 7th of August fourteen females had been stripped, yielding about 4050 ova. Shortly afterwards five pairs of Trout (ten of the thirty-eight fish turned into the Plenty) were observed constructing rids in that river. The Trout in the river were considerably larger than the largest in the clearing-pond, though several of the latter weighed more than a pound each.

During July and August, 1866, a large number of deaths took place amongst the fry from the last shipment of ova; the total loss being 470 Salmon-fry and 65 Salmon-trout fry.

On the 30th of September, 1866, the Trout-ova taken from the fish in the clearing-pond commenced hatching; but a large number of eggs proved barren.

During August the fry, both of Salmon and Salmon-trout, *ex* 'Lincolnshire,' were permitted to escape into the large pond and the rill attached, with the exception of a few pairs of Salmon-trout, retained in the pond and rill purposely constructed for them in the hope that spawn might be obtained without the previous migration to the sea. From the end of September the operations at the ponds were simply repetitions of what had taken place with regard to the first experiment, some variety occurring through the addition of the Salmon-trout and the occasional capture of large Trout in the Plenty. One was taken on the 13th of January, 1867, 17½ inches in length, and weighing three pounds.

Although the bulk of the Smolts of the first shipment left the river in October and November, 1865, and should, according to most authorities, have returned as Grilse in the February following, no report reached the Commissioners of any thing resembling Grilse having been seen. Mr. Ramsbottom always maintained that the Smolts did not return as Grilse in three months, but that they would return in one year and three months; and so convinced was he of the correctness of this view, that he made no systematic watch for the fish in 1866. The mere fact that no report of the fish being seen reached the Commissioners by no means proves that they did not return in February 1866; for it must be remembered that, under the most favourable view of the case, not more than 1000 or 1500 Smolts can have left the Plenty, and were thenceforth distributed over a river but little smaller than the Severn in England, and into which numbers of large tributaries, admirably suited for Salmon, emptied themselves.

In February and March, 1867, fifteen persons, including Mr. Ramsbottom, reported that they had seen Salmon or Grilse in the fresh waters of the River Derwent. Several of these witnesses were gentlemen of high respectability; and it is impossible to conceive that they could have been mistaken, because no indigenous fish in the fresh waters of the Derwent (except Eels) ever exceeds one foot in length or weighs more than three quarters of a pound.

Mr. Ramsbottom began early in February 1867 to walk morning and evening from his house to the Derwent and back (more than two miles each way) to one likely spot, keeping a regular systematic watch.

for the Grilse; and the following extract from his journal of March 15 will serve to show the deep interest he took in his work:—

“It is with feelings of thankfulness that I can now say I have this day seen a Salmon in the Derwent.

“This morning, after an early breakfast, I started off, for the sixty-ninth time, to the river to look for Salmon. At about 10 A.M. my assistant, J. Stannard, came to me at the Dry Creek and told me that Lumsden (water-bailiff) had seen no less than half a dozen Salmon playing about in the long pool where he was on the look-out this morning. This joyful news again put new life into me; and I at once started off for the spot, as I now meant to see a Salmon if one was to be seen at all during the day. At a little before 12 I took a seat on a log which is in the river about 15 feet from the side, in order to command a good view; here I sat for about two hours under a burning sun, when I heard a kind of rush behind and rather below me. I looked round, and saw it was the motion of a large fish, but could not persuade myself it was a Salmon. In twenty minutes more I saw the partial rise of a fish, head and breast out of water, but could not be sure yet as to whether this was a Salmon or not, as the fish rose at too great a distance from me, and did not make the same splash in the water as I thought a Salmon ought to do; yet the fish looked larger than any I had before seen in these waters, so that I now got very uneasy in mind, sometimes doubting, and at other times believing, they must really be the Salmon; and in this excited and perplexed state of mind I was kept until 3.40 P.M., when, to my exceeding great joy, I was delighted to see nothing else but a Salmon jump clean out of the water, and show himself broadside on; and, judging from his appearance, I should call him a Grilse of about 5 lbs. weight. On seeing the Salmon, it is impossible for me to describe my joyful feelings.”

Three days afterwards (on the 18th of March) Mr. Ramsbottom saw seven fish rise in the pool above mentioned, two of which he stated positively were Salmon. On the 17th of June, 1867, a large male Trout was found dead in the Plenty. It was a spent fish, much knocked about probably by fighting with other males: it measured 19½ inches in length, and weighed 3½ lbs. This fish was just three years old.

During June, July, and August of 1867 the Trout (*Salmo fario*) were again stripped of their spawn artificially, about 11,500 ova having been taken from forty-seven fish. After this spawning several of the spent fish were killed and eaten by a family of Yellow-bellied Beaver-rats (*Hydromys chrysogaster*) which found their way to the rill, but which were ultimately trapped and destroyed.

A large supply of this season's Trout-ova was sent to Victoria and New Zealand; and on the 14th of September the residue commenced hatching. About 2000 young fish were ultimately distributed from this source amongst suitable streams in various parts of Tasmania.

A report having reached the Commissioners that Salmon had been seen at Dunrobin, thirty miles further up the river than its junction with the Plenty, Mr. Ramsbottom was despatched to the spot, and learnt that a young man, a native of the Colony, who knew nothing whatever of Salmon, had a month before stated to his employer that he had seen a pair of very large fish on one of the shallows of the river. Mr. Ramsbottom questioned this young man very closely; and his accurate description of what he saw left no doubt on Mr. Ramsbottom's mind that a pair of Grilse had actually spawned in the upper waters; and though the river was too high from recent rain to find the rid, the spot pointed out was one as well suited for spawning-ground as any in the world.

On the 19th of October (the majority of the parr hatched from the shipment of ova per 'Lincolnshire' having assumed the Smolt dress) the perforated zinc obstructions were permanently removed; and such of the fish as chose to leave found their way from time to time into the Plenty, and thence to sea.

On the 10th of November, 1867, Mr. Ramsbottom left the ponds at the Plenty with 270 Trout-fry in an apparatus of his own arranging, and landed in Melbourne on the 15th with 248 living fish, a feat in pisciculture which had probably never been surpassed, and which again proved his peculiar fitness for the position he filled. During the months of February and March 1868 the river Derwent was unusually high, heavy rains having fallen upon the mountain-ranges in which its western tributaries rise; and partly on this account, and partly on account of the serious illness of the Superintendent (Mr. Ramsbottom), no regular watch was kept for the return of the fish: two or three reports only of their having been seen (one from an authentic source) reached the ears of the Commissioners.

On the 27th of June, 1868, a Trout (*S. fario*) was caught in the Plenty, 26 inches long, and weighing 9¼ lbs.

As a large number of the Trout-ova artificially taken during the seasons of 1866 and 1867 proved barren, whereas the eggs naturally deposited in the rill almost invariably contained fish, it was determined to remodel the rill at the upper end of the Trout-pond, and to make it resemble as nearly as possible a series of natural spawning-beds. This was done, and a temporary fence was erected down each side as a shelter, from which the fish could be observed, and to prevent their being disturbed while on the spawning-beds. During the winter of 1868 no spawn was taken artificially, but the whole of the Trout were left to their own devices. For more than a month pairs of fish could be seen day after day making their rids and depositing the ova. When the last of the fish had spawned, a perforated zinc guard was fixed across the lower end of the rill, and the old fish thus prevented from leaving the Trout-pond and interfering with the ova or young fish. Large numbers of the ova being required for distribution in Victoria, New Zealand, and Tasmania, the water in the rill was occasionally lowered, a rid or two opened, and the ova carefully picked out by means of a curved glass tube. Scarcely a dead egg was found; and from one shipment of

800 ova sent to New Zealand, 750 fry were liberated at four months old. In due course the rill became alive with thousands of Trout-fry, which were distributed in numbers of suitable streams and lakes in divers parts of Tasmania. Another large shipment of Trout-fry was also successfully transported to Victoria in Mr. Ramsbottom's apparatus, under the personal superintendence of Mr. John Buckland, one of the Salmon Commissioners, who, out of 226 taken from the ponds, delivered 225 healthy fish to the Acclimatisation Society in Melbourne, thus accomplishing even a greater feat than that performed by Mr. Ramsbottom the year before. During this season the numbers of fish seen spawning in the Plenty were amazing; and for several miles up the river, rids were to be seen on every suitable spot. Some of these rids were from 8 to 10 feet long, and must have been formed by enormous fish.

During the winter of 1868 Mr. Ramsbottom, who had long been suffering from lung-disease, became much worse, and sailed for Sydney on leave of absence, in the hope that the change might benefit him; but he died in September, universally regretted by all who knew him or took any interest in the Salmon experiment. In reporting the death of their excellent Superintendent to the Government, the Salmon Commissioners unanimously expressed their sense of his great merit and the loss which they and the enterprise in which they were engaged had sustained in his death.

In October 1868 the residue of the parr brought by the 'Lincolnshire' put on their silvery scales, and took their departure from the pond seawards in the form of Smolts.

During the summer of 1868 and 1869 reports of Salmon or Grilse having been seen were numerous; and in March of the latter year, the river being low and bright, the fish were seen so frequently at a favourite pool near the entrance of the Plenty, that numbers of people used to spend the evening watching for them; and on one occasion no less than twenty people were gratified by seeing several large fish, which could only be Salmon, sporting on the surface and occasionally breaching above the water. Amongst others, several residents on and near the river, who had always been most sceptical as to the presence of Salmon in the Derwent, became converted, and strongly condemned in others that disbelief which they themselves had fully concurred in but a short time before.

At this time the Commissioners and others made many unsuccessful attempts to capture a fish that had returned from the sea. The cause of failure can be readily understood by any one who has seen a large river, the banks of which are, for the most part, in a state of nature. There being an absence of large indigenous fish, no motive has hitherto existed for clearing the dead timber from the stream or the living scrub from the banks; and before either the angler or the net-fisherman can ply his calling successfully, considerable expense must be incurred in preparing suitable stations. It might be thought that at any rate it would not be difficult to hook a fish, even if it could not be landed; but it must be remembered that the fish to be caught were yet few in number, and that small indigenous fish swarm in myriads, furnishing such a supply of food that no bait will be likely to tempt the Salmon till this profusion is somewhat thinned. It is possible that Grilse or Salmon might have been taken in the tidal waters between Hobart Town and New Norfolk, a great part of which has been and could be worked with seine nets; but the local fishermen had so denuded the river of indigenous species of fair size by excessive netting at all seasons, that they had been for several years compelled to use nets of so small a mesh that even a Smolt could not pass through; and rather than run the risk of sacrificing the whole experiment by the destruction of any of the small consignments of Smolts sent seaward, the Commissioners exercised the power given them by the Legislature, and closed the river above Hobart Town altogether from the time the first batch of Smolts entered the brackish water. All attempts to take fish having failed, when the first rains of winter came on and the fish proceeded further up the river, the Commissioners came to the conclusion that the first undeniable proof they should now get of the success of the experiment would be the capture of Parr or Smolts in the coming spring, as such Parr or Smolts could only be the progeny of fish returned from sea, the last of the Smolts from the transported ova having left the ponds in the spring of 1868 and being therefore either dead or approaching grilsehood.

In June 1869 the Trout again commenced spawning in their rill; and towards the end of the same month five pairs of the Salmon-trout (*Salmon trutta*) formed rids on the shallows attached to their pool, which shallows are now, in October, alive with their fry. The success of this portion of the experiment may therefore be considered as complete as that of the Trout (*S. fario*), as a noble river, the Huon, has been purposely left unstocked, with the intention of turning into it all the Salmon-trout fry except those retained for a breeding-stock.

About the middle of October 1869 a strong freshet came down the Derwent, the result of heavy rains at its sources; and on the night of the 21st of October four fishermen were hauling their seine on a sea-beach about two miles below Hobart Town, and on the opposite side of the estuary of the Derwent. At one of the hauls almost the only fish in the net was a well-grown healthy Salmon-smolt over 10 inches in length, and which, though taken in water as salt as the ocean, had but lately left fresh water; for the silvery scales rubbed off at the slightest touch, showing the colouring of the parr beneath. Half an hour later, and on a beach a mile nearer the town, a second Smolt, not quite so large as the first, was captured. The seine net used was a large-meshed one of an inch from knot to knot, which accounts not only for the capture of a single Smolt at each haul, though they are usually gregarious, but also for the unusual size of the specimens: the probability is that the net had in each instance surrounded a school, but that the ordinary-sized fish had easily passed through, while these two, larger than their brethren, had been dragged out. The fishermen, well knowing that these were not indigenous fish, made a shrewd guess at the nature of their capture, and, on the 22nd of October, brought them to the Salmon Commissioners, who at once pronounced them veritable Smolts.*

* [One of these "Smolts" was sent home to be exhibited when the present paper was read, but upon being submitted to Dr. Günther's examination was determined by him to be a dwarfed example of *Salmo trutta*, and not a *S. salar*.]

Before concluding, it may be well to state that the whole of the expenses hitherto incurred in the conduct of the experiment between January 1860 and October 1869 amount to £8835 12s. 2d. Of this sum, £6990 11s. 2d. was paid by the Tasmanian Government, £995 1s. by the Victorian Government, £200 by the Acclimatisation Society of Victoria, £300 by the Provincial Government of Canterbury, New Zealand, £200 by the Provincial Government of Southland, New Zealand, and £150 by the Provincial Government of Otago, New Zealand. Credit must also be given to the Victorian Government for the large amount which must have been expended in freight had not H.M.C.S.S. 'Victoria' been twice so liberally placed at the disposal of the Tasmanian Salmon Commissioners.

APPENDIX.

ABOUT six weeks after the capture of the two Smolts above referred to, a much larger specimen was caught by the fisherman hauling a seine net on one of the same sea beaches. After carefully comparing this fish with the written descriptions of Yarrell and Dr. Günther, the Salmon Commissioners arrived at the conclusion that it could only be a true Salmon Smolt, presenting no difference from those formerly caught beyond that due to its longer residence in salt water. After obtaining Dr. Günther's opinion mentioned above, that one of the two Smolts first captured, was a dwarfed example of Salmon-trout (*Salmo trutta*), the third and more developed specimen was sent to England by the Commissioners; and Dr. Günther, having examined it minutely, found that it presented the usual characters by which the true Salmon (*Salmo salar*) is distinguishable from its nearest allies.

In the summer of 1870-71, one Parr was captured with rod and line near New Norfolk, which could not be distinguished from those reared from English Salmon eggs. This specimen, and another hatched from the first shipment of ova, are now preserved side by side in the Royal Society's Museum.

In November, 1871, a heavy fresh came down the Derwent, during which a quarter of mile of the river, at the head of the tideway, was alive with fish for two days. Many people saw them and were puzzled because none of our indigenous estuary or fresh-water fish ever show in a spring fresh: these fish were unmistakeably strangers. Those who saw this school of fish state that they were small, not above five or six inches in length, and silvery; there can, therefore, be little doubt that these fish were Smolts proceeding to sea.

In October, 1872, a school of large fish were seen a mile below New Norfolk by several residents; and on the same day a man named Rousell, at work near the Falls, 4 miles higher up, was attracted by splashing sounds, ran to the river bank and saw a shoal of large silvery fish making their way over the falls, cutting the water (to use his own expression) like scythes. When questioned about these fish, Rousell (who is a very intelligent man) said they were half as long as his paddle,—that is between 3 and 4 feet—and that he was certain the shoal contained not less than 30 fish. Two days afterwards these fish, or a similar shoal, were seen by a man named Ware, 6 miles farther up the river.

At the end of October, 1872, a flood came down the Derwent; and a resident high up the river reported shortly after that during the flood he had seen a large school of fresh-water Mullet jumping above the surface,—a circumstance never before observed during a fresh in the Derwent in October; and it is, therefore, more than probable that this was again a school of Smolts on their way to sea. This was followed in the early part of November by the capture in the salt water of the Lower Derwent of two Smolts of about the same sizes respectively as those taken in 1869. On careful examination the largest proved identical in the most minute external particular with that preserved in 1869. All three are now preserved in the Royal Society's Museum. Since the capture of these Smolts information has been given to the Commissioners that many others had been taken by the seine-net men during the last 3 years, and that they had concealed the fact fearing that the use of seine nets might be prohibited altogether, or their operations confined to still narrower limits.

A belief was very prevalent, till the capture of the Smolts in October last, that the fish taken in 1869 were hatched from the last batch of English ova, and the apparent non-capture of any specimens in the seasons of 1870 and 1871 tended to strengthen that belief; but it is absolutely impossible that the fry hatched in 1866 (when the last eggs were received from England) could have survived till the end of 1872 and have retained the Smolt form without exhibiting some signs of the unnatural retardation in their development; therefore, as the captured Smolts exhibit all the characteristics of vigorous health, it is certain that one species of migratory Salmon has bred in Tasmanian waters.

The cost of the experiment since October, 1869, amounts to £855 2s. 11d., from which should be deducted the sum of £107 10s. received in respect of Licences to fish for Trout, and the sum of £20 for ova sold to non-contributing Colonies.

RETURN of the Distribution of Ova and Fry from the Breeding Ponds, River-Plenty, during the Years 1869, 1870, 1871, and 1872.

OVA.

Salmon Trout.

	1869.	1870.	1871.	1872.
Launceston	600	750	400
NEW ZEALAND	200	..	..
Ballarat	100	..	..

Brown Trout.

VICTORIA (Ballarat)	1800	1000	3300	5500
Launceston	1500	1000	1000	600
Gipps' Land .....	..	2000	..	4500
NEW ZEALAND	2600	4000	..	3100
NEW SOUTH WALES .....	..	..	..	500
Lake Echo .....	..	550	..	..
East Coast Rivers .....	..	..	..	500
Chudleigh .....	..	..	600	5100

FRY.

Salmon Trout.

Swansea .....	..	..	..	20
River Derwent .....	..	450	..	..
Huon River .....	..	500	70	81

Brown Trout.

Tasmanian Lakes .....	..	1000	..	..
River Plenty	1850	3140	..	..
VICTORIA .....	..	..	700	510
River Huon .....	..	..	650	..
Southport	400	..	400	..
River Lachlan	1100	1400	..	..
Guy Fawkes Rivulet	200	500	80	..
Brown's River	200	500	..	..
River Derwent	2000	..	1000	..
Bagdad Rivulet	300	..	500	..
Swanport	200	..	..	..
Lachlan River	200	..	..	..
East Coast River	200	..	..	..
Port Esperance	150	..	400	..
River Jordan .....	..	..	1050	250
Peppermint Bay	50	..	..	..
Port Seymour	100	..	50	..
Kermantie River	339	..	..	200
River Styx	800	1200	500	700
Russell's Falls .....	..	1000	..	..
Swansea .....	..	..	..	180
Mountain River .....	..	300	..	400
Lake Echo .....	..	..	500	..
River Ouse .....	..	..	1000	..
Back River .....	..	..	400	..
Clarendon, River Derwent .....	..	200	..	..
Woolpack, ditto .....	..	100	..	..
N. W. Bay .....	..	200	..	..
New Town Creek .....	..	50	..	..
Coal River .....	..	400	..	..

JAMES M. CLARKE, *Secretary Salmon Commissioners.*

1 June, 1873.