SALMON AT THE ANTIPODES

SIR SAMUEL WILSON

SALMON AT THE ANTIPODES.

TROUT POND AT ERCILDOUNE.

SALMON

AT THE ANTIPODES

BEING AN ACCOUNT OF

THE SUCCESSFUL INTRODUCTION

OF

SALMON AND TROUT INTO AUSTRALIAN WATERS

BY

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LONDON

EDWARD STANFORD, 55, CHARING CROSS, S.W.

—

1879

PREFACE

TO THE SECOND EDITION.

This paper originally appeared in the Annual Report of the Zoological and Acclimatization Society of Victoria for the year 1878. It is here reprinted in a separate volume for the convenience of those who are not Members of that Society.

The object of the writer of the paper was, by giving in an easily accessible form the main principles of the Art of Pisciculture, to be of some service to those who may desire to promote the scientific cultivation of our waters, with a view to the increase of our food fishes, and thereby to provide in Australia

the fresh attractions of the sport afforded by salmon and trout fishing; also to place on record what has been done in the attempt to introduce the Salmon into Australian waters. Should this attempt prove successful —which time alone can show—the knowledge of this result will be in itself an ample reward to the writer for all his exertions, which, from the very interesting nature of the work he had undertaken to accomplish, were to him a labour of love.

December, 1878.

PREFACE

TO THE THIRD EDITION.

THE substance of this work in a slightly different form, under the title of "The Californian Salmon," was originally published in the Transactions of the Zoological and Acclimatization Society of Melbourne for the year 1878, and a second small edition was reprinted in Victoria. In publishing this third edition in England, the desire of the writer is, by giving in a plain and simple form an account of his experience and of the main principles of the art of fish-hatching as far as it relates to salmon and the different varieties of trout, to be of some service to those who may desire

to follow this very interesting pursuit; and he ventures to hope that the history of the various attempts which have been made to introduce the Salmon into Australian waters may not be without interest to English readers.

Athenæum Club, London,
June 16, 1879.

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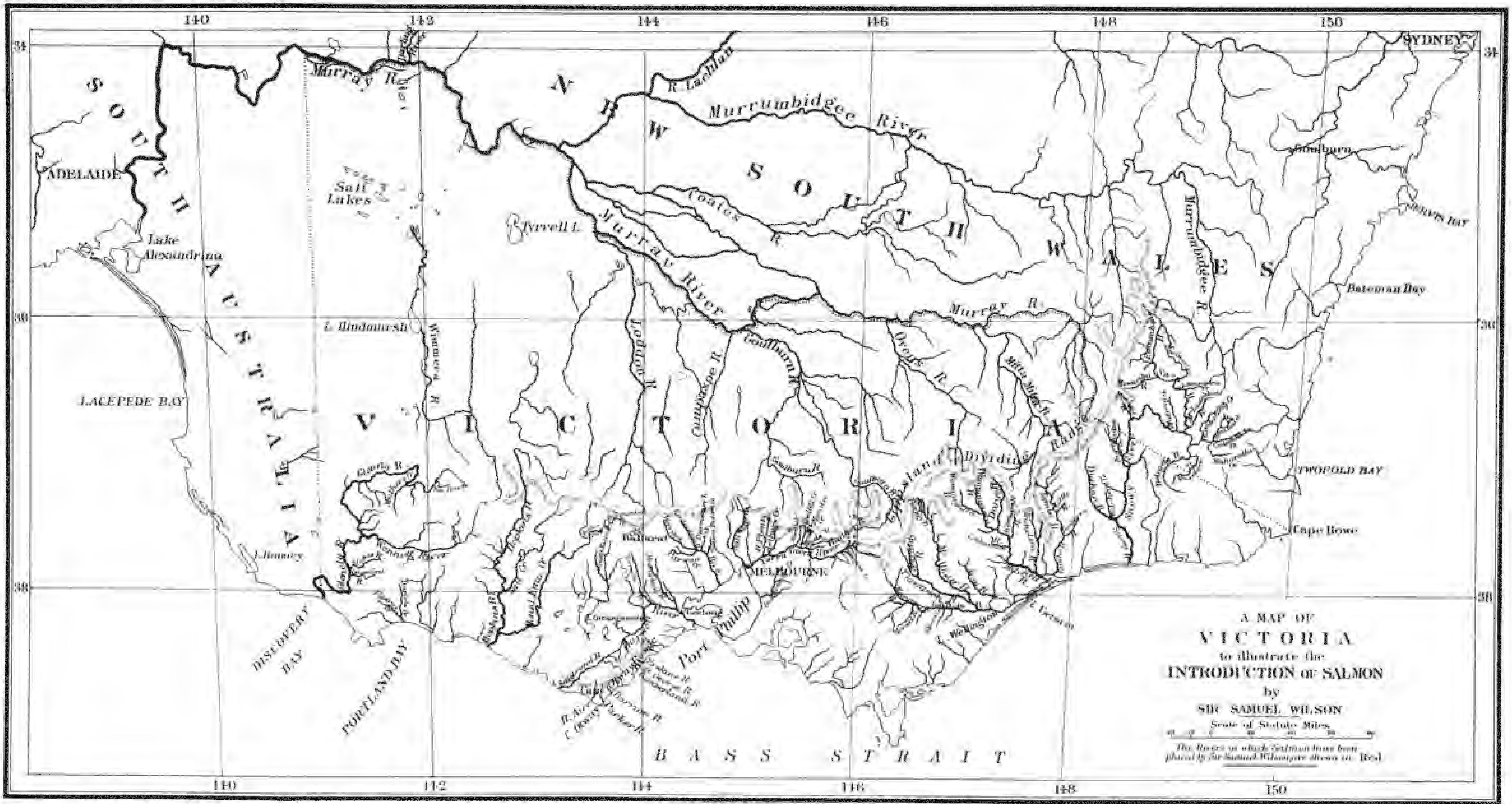
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SALMON AT THE ANTIPODES.

CHAPTER I.

PISCICULTURE.

It is only within a very recent period that the science of fish culture has become known, so as to be of practical use for the multiplication of our food fishes, although the keeping and feeding of fish in artificial ponds and basins has long been practised, and wealthy Roman citizens in ancient times did not consider their establishment complete without their fish stews, to keep up a constant supply for the table. According to Diodorus Siculus, fabulous returns were realised from Lake Mœris, in Egypt, an artificial fish-pond, constructed by the predecessor of Sesostris.

Oysters were successfully cultivated in Lake Avernus, near Naples, a reservoir since dried up by volcanic upheaval, and afterwards at Lago Fusaro, where the industry has been continued up to the present day. The artificial care of eels and other fish has been pursued successfully near Venice, at a lagoon about 140 miles in circumference, called Comacchio, where very extensive works have been constructed, and arrangements made for the care of eels from the time they leave the sea as tiny worms, till they are ready for market. But in all these instances there was no artificial fecundation of ova, and fish culture, as now understood, was then practically unknown.

The first discovery of the possibility of the artificial impregnation of fish ova was made in the fifteenth century, by a monk named Pinchon, the record of which was disinterred three centuries later by the German naturalist Jacobi, who described accurately the method practised by Pinchon. But the subject does not seem to have been then taken up, and the discovery of Pinchon remained practically unknown, until, in 1840, two fishermen named

Remy and Gehin, in a valley of the Vosges, after years of patient watching and intelligent reasoning from the facts observed by them, at last discovered the secret, and found that the impregnation of the ovum took place after its exclusion from the ovaries, and when deposited in the gravel, and that the natural process could be imitated artificially, thus giving a certain and easy method for the propagation and increase of any kind of river fish.

The story of the perseverance and patient endeavour, by which this discovery was made, has a strong element of romance. Concealing himself in the tall grass by the side of the stream, or in the overhanging branch of a tree by day, and by night when the full moon favoured his object, sustained against fatigue, cold, and hunger, by that enthusiasm which has aided so many noble efforts, Remy desisted not from his pursuit, until he had wrested from Nature the secret which had been so long withheld, and which was destined to confer a lasting benefit upon the human race.

It has often happened, in scientific pursuits,

that a discovery has been made simultaneously by two inquirers, who have arrived at the result by totally different methods. In 1848 the celebrated French naturalist, M. De Quatrefages, on scientific grounds, brought before the Academy of Sciences at Paris the subject of the artificial impregnation of fish ova; and, in a paper read before that body, asserted the possibility, by the artificial fecundation of the ova of fishes, of propagating them to any extent that might be desired. His statement was at first discredited, but the publication of his paper brought out the fact that the process which he had advocated on theoretical grounds, and from an anatomical examination of the generative organs, had actually been reduced to practice by a poor fisherman of Bresse. The Academy appointed a committee to inquire into the matter, which found the facts to be as stated.

In 1843 Remy had addressed a letter to the Prefect of the Vosges, of a portion of which the following is a translation, taken from a paper by Professor C. A. Joy, on fish culture :—

"Joseph Remy, fisherman, of the Bresse, to M. the Prefect of the Vosges.

"Sir,—I have the honour to inform you that, in consequence of the numerous experiments which I have made, I have succeeded, after much care and trouble, in hatching an immense quantity of trout eggs, the young of which, healthy and well-formed, will be suitable for re-stocking the rivers. I deem it to be my duty to make known to you the means by which I have arrived at this fortunate result. . . . At the season of spawning, in November, when the eggs appear at the vent of the trout, by passing the thumb and pressing gently against the vent of the female without doing her any injury, I cause the eggs to fall into a basin of water; after this I seize the male, and by operating in the same manner cause the milt to flow upon the eggs until they have become opaque. As soon as this operation is completed, and the eggs have become clear, I dispose them between coarse grains of sand in the bottom of an iron box, pierced with a thousand holes. I placed one of these boxes in a spring of fresh water, the other in the

river Bresse, in a spot where the current was only slight. Towards the middle of February the eggs in the spring commenced to hatch, while those in the river did not change until the 20th of March. . . . In hatching, the young, the tails of which first appear, are white, elongated, lean, with large heads. They move immediately, and appear, by their action, to swim with pleasure; every day they change colour, and assume the tints of the large fish; the body becomes round, and fills out. I have retained a quantity of these little creatures, in order to be able to reproduce them at pleasure. It appears to me that a discovery of this nature, especially at a time when the rivers are nearly deprived of fish, in consequence of the drought of last season, is worthy of the attention of the Government.

(Signed) "J. Remy."

Remy was awarded a bronze medal and 100 francs, by a local scientific body, for his discovery, which would have remained in obscurity but for the paper of M. De Quatrefages, which brought the matter before the whole scientific world. Remy and Gehin

received a pension from the Government of 200 dollars per annum, and the former was granted a small monopoly in the sale of tobacco.

The question was warmly taken up by M. Coste, Professor of Embryology at the *Collège de France*, who contributed greatly, by his labours and researches, to place the science of pisciculture in the position to which it has since attained. In England, the importance of the subject has also been warmly advocated by Mr. Frank Buckland, Mr. Francis, and some other ardent pisciculturists, and at Stormontfield, on the Tay, an extensive salmon-rearing establishment has been erected. At Galway, the Messrs. Ashworth have stocked with salmon some large rivers and lakes extremely well suited to this fish, but which they had been prevented, by a natural barrier, from reaching in their ascent from the sea. At Huningue, in Alsace-Lorraine, a very extensive fish-rearing establishment has been in existence for many years, from which hundreds of thousands of fish were distributed annually to stock the French rivers and lakes. The work is still continued by the Govern-

ment of Germany, into whose possession the establishment has fallen.

But the greatest triumph of pisciculture is the transfer and acclimatization of the salmon and trout, from the northern to the southern hemisphere, through the heat of the tropics. This has now been successfully accomplished by the aid of ice and steam; the one to keep down the temperature, and thereby delay the hatching process, and the other to shorten the time required for transit.

In the United States of America also, great things have been done in fish culture by Livingston Stone, Seth Green, Norris, Ainsworth, and others, and several large establishments exist for fish cultivation. A fish commission has been appointed by the Government, of which the Hon. Spencer F. Baird is president, and, with a liberality and generosity which does infinite credit to the Great Republic, they freely supply ova of the salmon, trout, and coregonus, or whitefish, not only for their own rivers, but also—in hundreds of thousands—to stock the waters of Australia and New Zealand. The efforts of the Commission have, in the States, resulted

in a manifest increase of the fish supply in rivers where the produce had been rapidly diminishing, and the benefits which will follow their labours cannot be easily estimated.

In fish culture, the hatching of the fish is not the only difficulty that has to be overcome. In many places, high dams or waterfalls prevent the fish from ascending the rivers to spawn, and a contrivance, called a *fish ladder*, has been invented, by which salmon or other sea-going migratory fish can ascend the rivers to fresh spawning grounds. The fish ladder is simply a series of small pools, like steps of stairs, with an opening for the fish to get through, and a place where they can rest before ascending the next step. The invention has proved exceedingly useful, and it has enabled the owners of suitable waters to stock with salmon many rivers and lakes, which were formerly inaccessible to migratory fish.

CHAPTER II.

FISHING.

In Badham's "Ancient and Modern Fish Tattle," an amusing, quaint, learned, and delightful book, there are many curious facts illustrative of the art of fishing. "Fish," he says, "being more distinguished for the size of their heads than for the amount of brains lodged in them, and affording an easier capture than either beasts or birds, fell early victims to the crafts and assaults of their arch-enemy, man;" and he goes on to quote early writers from Habakkuk and other sacred authorities down through Homeric stanzas and Oppian's verses on the same subject. Suetonius speaks of gold and purple nets to charm the fish to a sweet death. History tells of Antony and Cleopatra's love for the sport, and how the latter played a cunningly devised trick off upon her admiring triumvir when he was unsuccessful in angling, by sending down a

diver to fasten a fish upon his hook, which first delighted him with his apparent success, but afterwards caused him to feel annoyed with his inamorata for bringing him into ridicule.

From the earliest records down to the days of Isaac Walton and our own times, angling has been practised and enjoyed as being a most delightful sport. Sir Henry Wotton calls angling "an employment for idle time, which was not then idly spent; for angling after tedious study was a rest to his mind, a cheerer of his spirits, a diverter of sadness, a calmer of unquiet thoughts, a moderator of passion, a procurer of contentedness, and begets habits of peace and patience in those who practise it." In ancient Rome the artificial fly was used as a bait, and fish-hooks of hardened bronze and of steel have been disinterred from the buried ruins of Pompeii. Martial refers to fish "decoyed and caught by fraudful flies," and Ælian describes the construction of the same by instructing the angler—

> "Around the hook a chosen fur to wind,
> And on the back a speckled feather bind."

The same writer describes the art of angling as practised in the river Astræus in Macedonia, by which a speckled fish was caught by a fly made in imitation of the *hippurus*, a certain buzzing, wasp-like insect, of which these fish were fond. Arrian, in his history of India, tells of a nation of ichthyophagi residing on the Persian Gulf, who not only lived entirely on fish themselves, but even fed their cattle upon it. Their dress was made of fish skins, and their huts were supported by beams and rafters, made from the skeletons of the leviathans of the deep. This wretched people occupied a tract of country devoid of vegetation, and, being entirely dependent upon the fish they could manage to catch, were in a constant state of hunger and misery.

Fishing has been practised from a remote period for the food supply obtained by it, and as the calling of a class of the population; but angling for the love of the sport was the result of civilization, and, as Badham says, "was an after-thought not likely to occur till the world was well peopled, and different states sufficiently prosperous and advanced in civilization to spare supernumerary hands, and allow the

wealthier sons to follow less necessary arts than the primary ones of war and tillage. The Greeks and Romans, civilized beyond the rest of the world, soon became enthusiastic sportsmen." The delight of salmon fishing is so great to many from the health and amusement which it affords, that, although it is obtained by costly and laborious exertion, the passion for it leads to an increasing demand for the fishings at still higher rentals; so much so that the average cost of a salmon, taken by the rod on the Tweed, is calculated at from £3 to £5, although the same fish could be bought in the market for one-fifth of the money. It is said by enthusiastic salmon fishers that the delight experienced in the first tug of a salmon, when newly hooked, is a sensation more exquisite than any other sport can afford. That the gentle craft is not more practised in Australia, is owing partly to the fact that men are there all workers, who have little time to spare for pleasure or sport, and partly that the rivers do not contain the best kinds of sport-giving fish. As time advances and population increases, a leisure class will appear, and field sports, but especially angling,

will, no doubt, become a favourite amusement of a section of the population, during their holidays and times of recreation. Let us hope that when that time comes the rivers of Australia may be plentifully stocked with those members of the finny tribe, of the family of the *salmonidæ*, which are best calculated to give sport to the angler, as well as to please the fastidious palate of the epicure, when served on the tables of our prosperous citizens; and that these fish may become so abundant as to be within the reach of every class of the community, and add materially to the food supply of the fast increasing population.

CHAPTER III.

THE INTRODUCTION OF ENGLISH SALMON INTO THE SOUTHERN HEMISPHERE.

The introduction of the English salmon into the waters of Australasia has been frequently attempted, and many failures have been made, and much money spent, in the endeavour to accomplish this object.

The reason that the introduction of this fish into Australia has been considered so important is not far to seek. The Australian rivers are already stocked with native fish of pretty good quality, and not to be despised from a gastronomic point of view, but there are no representatives of the anadromous or migratory species found there. Hence the salmon is particularly valuable, as its feeding grounds are in the unlimited extent of ocean washing the shores of the Australian continent, and they bring far inland the wealth of

nourishing food which they have collected in the depths of the ocean; and as they consume but little in the rivers, these are not impoverished by this temporary addition to their scaly inhabitants. When we consider that almost every plant and animal useful as food to the British race, which has taken possession of Australia, has been introduced there, it is evident that many more species may yet be found eminently suitable to the climate and circumstances of the country.

No less than ten different shipments of ova of the *salmonidæ* have been sent from Britain to Australia and New Zealand.

The first attempt to send out salmon to Australia was made in the *Sarah Curling*, in February, 1860. It was superintended by Messrs. J. A. Youl and Edward Wilson, and it was intended that the fish should be hatched out on the voyage. Very complete arrangements had been made by the Salmon Commissioners appointed by the Government to receive the salmon fry in Tasmania, and Baron von (then Dr.) Mueller was entrusted with the care, transhipment, and forwarding of them from Melbourne; but this, like many subse-

quent attempts, resulted in a complete failure, although some few fish hatched and were carried alive into the tropics.

The second effort which was made to introduce the salmon into Tasmanian waters, was a shipment by the *Beautiful Star*, which sailed from London in March, 1862; but this attempt was also a total failure.

In January, 1864, the first successful shipment was made by the *Norfolk;* in January, 1866, that by the *Lincolnshire* was also partially successful. In January, 1867, a shipment to New Zealand was made by the *Celestial Queen;* also, in December, 1868, by the *Medora;* in January, 1873, by the *Oberon;* and in January, 1875, by the *Timaru*, from Glasgow. In January, 1876, a joint shipment was sent by the *Durham* to New Zealand and Australia, which was partially successful in New Zealand; and in January, 1878, by the *Chimborazo*, which was also a partial success, some of the fish surviving both in Australia and New Zealand.

CHAPTER IV.

THE FIRST INTRODUCTION OF THE SALMON INTO AUSTRALIA.

The first successful attempt to introduce the salmon into Australia was made in the year 1864. A hundred thousand salmon and 3000 trout ova were shipped on board the *Norfolk*, packed in moss, in 200 boxes. The trout ova were collected by Mr. Frank Buckland and Mr. Francis, and the fish hatched from these are the parents of all the trout now in Australia and New Zealand, except those from the shipment lately received from England by the *Chimborazo*. The trout ova by the *Norfolk* were taken from fish in Admiral Keppel's preserves in the Itchen, and sent as a present to Mr. Youl by Mr. Buckland. Mr. Francis also collected a lot of trout eggs for the same shipment.

The salmon ova were obtained by Mr. J. A. Youl, C.M.G., from the Severn, the Ribble, the Tyne, and the Tweed; and under his personal care and superintendence they were put on board the *Norfolk*. To Mr. Youl is due the credit of the discovery of the proper mode of packing the ova for transmission on a long sea voyage, by placing them in moss and charcoal, in wooden boxes placed below the ice in an ice-house. The boxes containing the ova were placed in an ice-house made to receive them, and were surrounded by 32 tons of ice. The ship sailed on the 21st of January, 1864, and the voyage occupied 77 days. The undertaking was a joint affair between the Victorian Government, represented by the Acclimatization Society, and the Salmon Commissioners on behalf of the Government of Tasmania. The greater portion of the ova were forwarded to Tasmania, reaching Hobart Town on the 20th April. Arrangements had been made by the Salmon Commissioners appointed by the Tasmanian Government, and a hatching apparatus was ready for the reception of the ova. On the boxes being opened, only

one-third of the eggs were found to possess any vitality, and out of these only 3000 fish were hatched, notwithstanding that Mr. Ramsbottom, the son of the noted pisciculturist of that name, had charge of them, and gave them every care. The temperature of the water in which they were placed for hatching was from 46 deg. to 49 deg., and they were afterwards put into a small pond, where they remained for some time. On the pond in which the salmon fry were placed being examined, it was found that a further loss had taken place, and the number remaining was estimated at about 500 fish. After a time, as the period of their expected migration to the sea approached, it was thought desirable to liberate them, and about the end of the year 1865 those remaining were allowed to find their way into the river Plenty. These were the first salmon introduced into Australasian waters.

A portion of the brown trout also were hatched out successfully, producing 320 fish, many of which died. About 30 were liberated in the Plenty; and though only six pairs reached maturity and spawned in the

ponds, the progeny of these have been distributed over many rivers and streams in Tasmania, Victoria, and New Zealand, and they are the progenitors of all the brown trout in those colonies. Up to the present time, however, it is understood that no salmon ova have been obtained there, although a few undoubted specimens of the *Salmo salar* have been caught at various times in the river Plenty. A considerable quantity of salmonoids of various weights up to 18 lbs. or 20 lbs. have also been caught, which were supposed to be the true salmon, but which appear to have been a species of sea trout, having pink flesh, like the *Salmo salar*. One of these was sent over to Melbourne, and on being scientifically examined by Professor McCoy, was pronounced to be a fine specimen of the *Salmo eriox*, a migratory species, of considerable commercial value. The ova had doubtless been taken and sent, by mistake, with the salmon ova, the two fish having a strong resemblance to each other. It was not intended that this fish, which is commonly known as the "bull trout," should have been introduced there, both the *Salmo*

salar and *Salmo trutta* being much superior fish. All doubts about the *Salmo salar* having been successfully established in Tasmania have finally been set at rest by a specimen sent to Melbourne in 1877, which Professor McCoy identified as a true salmon, although only of small size, being about four pounds in weight.

The small number of ova left in Melbourne —about 3000—out of the shipment by the *Norfolk* produced a few hundred fry, many of which, however, disappeared mysteriously in the hatching boxes. A small remnant of these were taken to the Upper Yarra, and 300 live salmon were stated to have been liberated successfully on that occasion, in a tank made to keep them for a time; of which number about 120 were afterwards placed in the Badger Creek, a tributary of the Yarra; but up to this time none of these fish, or of their progeny, have been caught, and there is no evidence to show that they have survived to propagate their species.

A fourth attempt was made to introduce the salmon into Tasmania, and another shipment of ova was sent by the *Lincolnshire*,

which arrived in Melbourne on May 1, 1866. The Government liberally granted the s.s. *Victoria* to convey the eggs to Tasmania, which was successfully accomplished by Commander Norman, under the superintendence of Mr. Ramsbottom. The hatching resulted in 6000 salmon and 1000 salmon trout. In Victoria, the acclimatization of this fish was given up as being impossible of accomplishment, and the attempt was looked upon by many as a useless expenditure of money; as it was thought that the temperature of the rivers was too high to suit the salmon, which is generally found in rivers which are partially frozen in the winter.

CHAPTER V.

THE FIRST INTRODUCTION OF CALIFORNIAN SALMON OVA.

Having, in early life, obtained some knowledge of the great value of the salmon from a commercial point of view as a food producer, as well as for the noble sport which it affords, I determined that another effort should be made for its introduction into Australia, and, in 1874, Mr. Le Souef, the Honorary Secretary to the Victorian Acclimatization Society, at my request, through Mr. Williamson, the Secretary of the Acclimatization Society of San Francisco, ordered 25,000 ova of the Californian salmon. I had learned that this species was capable of withstanding a much higher temperature than the English salmon, and would probably suit the climate much better. The ova arrived in due course; but, the supply of ice having failed on the

voyage, the fish had hatched out, and, of course, perished for want of their natural element; and on the box being opened, the ova were found to have become a putrid mass. Another shipment of 25,000 was asked for from Mr. Williamson, who wrote promising to forward them, but, from some unexplained reason, they were never received.

CHAPTER VI.

THE SECOND IMPORTATION OF ENGLISH SALMON OVA INTO VICTORIA.

Up to the year 1875 there was no proof that the salmon had been established in Tasmania, although some enthusiasts declared that they were, without doubt, to be found in the Plenty river.

At that time, the Government of New Zealand had determined to attempt the introduction of the salmon into that colony, where the rivers and climate are exceedingly well adapted for this fish; and, learning this intention, I offered to join in a shipment of 200,000 ova, one-half for Victoria. My proposal was agreed to, and, under the joint care of the celebrated naturalist, Mr. Frank Buckland, and Mr. Youl, C.M.G., both of whom are enthusiasts in pisciculture, a shipment was made by the *Durham* in the year 1876, which

arrived in Melbourne after a passage of 63 days. It was found, on examination, that about two-thirds of the ova had perished, and, owing to the unusually hot season, the hatching proved a complete failure, although ice was freely used. They were divided into four lots, one of which was placed in hatching-boxes in the ice-house at Melbourne; one at Geelong, under the care of the Geelong Fish Acclimatizing Society; one at Ballarat, under the care of Dr. Whitcombe, who undertook the charge; and one at Ercildoune. Out of the entire shipment landed in Melbourne only five fish were hatched, which were from the lot sent to Ercildoune. The temperature of the water during the hatching was from 60 deg. to 65 deg., and, although there was a large quantity of ice used, the high temperature was undoubtedly the main cause of the failure. With the moiety which went to New Zealand, a more favourable result was obtained, and 1500 fry were liberated in the Aparima river, being the produce of this shipment. That greater success was attained in New Zealand was doubtless owing to the low temperature of the rivers there, the fish having

been hatched under a rill of water, at a temperature of only 50 deg. Fahrenheit.

The enormous loss of ova in these shipments appeared to me to be owing, in a great measure, to the eggs having been shipped immediately after impregnation. It is well known by pisciculturists, that in this stage the principle of life in the egg is most easily destroyed, whereas, at a later period, when the embryo has reached a further stage of development, the ovum will bear an amount of shaking and rough usage, that would inevitably be fatal to it at an earlier period. To test this point, I telegraphed to my London agents, Messrs. Robert Brooks and Co., to have a few hundred ova forwarded in the ice-house of the Peninsular and Oriental Company's mail steamer; the ova to be obtained from the fish-rearing establishment at Stormontfield, on the Tay, and to be in the stage when the eyes are visible, as at this period they can be carried with the greatest safety. My telegram arrived too late, however, for that season.

CHAPTER VII.

THE SECOND IMPORTATION OF CALIFORNIAN SALMON OVA.

This was very disheartening, but I still determined to persevere, and contemplated going myself to California, to superintend the packing and transit, so as to insure a more successful result with another shipment; but, seeing in the papers that the New Zealand Government intended to import a large quantity of the Californian salmon ova, I applied to Mr. Firth, the President of the Auckland Acclimatization Society, to order for me 50,000 ova for Australia, to come at the same time as those for New Zealand. He very courteously agreed to do so; and in due time the shipment arrived by the Californian mail steamer, and was forwarded by Mr. Firth, with every care, to Sydney. From

Sydney the ova were forwarded by Mr. Barker, my agent, kindly assisted by Mr. Webster, and arrived in Melbourne safely.

On the arrival of the ova at Sandridge they were removed, and taken by train and waggon, well packed on an elastic cushion of straw, and opened at the spring on Ercildoune estate, where the hatching-boxes were ready for their reception. On the pads covering the ice being taken off, a layer of moss, fresh and green as if newly gathered, was to be seen covering the ova. On this being removed, the eggs were visible through the thin net-like web which covered them, and at once it was evident, to my great delight, that they were in splendid preservation, and far advanced in hatching, the eyes of the young fish being clearly visible.

The ova were packed in layers in a box or ice-chest, about three feet by four, and about two feet in depth. They were placed between two pieces of mosquito net, about 7000 in each layer, with a cushion of moss about two inches deep between each two layers, and also above and below the ova. Six inches of ice was placed over the eggs, and

the bottom of the box was pierced with holes, to allow the escape of water from the melting ice. The ice was renewed every twelve hours on the voyage from Sydney to Melbourne. The box had an inner lining, enclosing about four inches of sawdust, to act as a non-conductor, and which answered the object sufficiently well.

The weak points in the packing were the use of cotton net, which rots and gets mouldy, while the moss remains green and fresh; and also that the ova were too closely packed together. For a short voyage this matters little, but in a long distance the difference is great, as when one egg loses vitality it soon decays, and the byssus, or fungus, which quickly forms, attacks all the ova within reach; these ova adhere to each other, and although little altered in appearance, invariably perish in the hatching.

With little loss of time the ova were transferred to the gravel of the hatching-boxes, which had been prepared with great care, by being screened to insure a uniform size, and by boiling, to destroy insect germs which might be injurious to the ova. All

were got into the hatching-boxes the same evening, except one layer of about 7000, which were left under the ice until next morning. About 6 per cent. of dead eggs were taken out at once, but many were adhering in clusters, most of which I knew could not live, but which looked healthy enough at the time.

The next morning over 100 young salmon were hatched, and they were lively little fellows even at that early stage of their existence. When touched with a feather, they would start off and swim round in a circle, and settle down again amongst the gravel. On the remainder of the ova being transferred to the hatching-boxes, numbers of young fish were found to have hatched out during the night, and during the day 400 or 500 made their appearance.

The ovum of the Californian salmon is larger than that of the British species. The young fish is about an inch long. The umbilical sac attached to it, containing the yolk of the egg, is of a clear, transparent red colour, and seems quite as large as the egg from which it has emerged. This sac contains

the food of the young salmon for three or four weeks, and is gradually absorbed, becoming smaller as the young fish grows.

The hatching process is effected simply by placing the ova on a layer of gravel, over which a stream of water is allowed to run. The temperature of the water is a most important point, and I selected a spring from its being of a uniform degree of cold, and from its freedom from sediment, which, by settling on the eggs, would interfere with the supply of oxygen necessary for their vivification. As the supply from the spring is limited, being only four to five pints per minute, I had a pipe laid down from the creek to supply two filters, the water from which is used to increase the stream. The water from the pipe can be shut off entirely when its temperature is too high, but, so far, the difference has not been great between the water from it and that of the spring. The temperature of the spring is 55 deg., and the pipe supply has risen on hot days to 62 deg., but the young fish did not seem to suffer in the slightest, and those in the warmest water are the furthest advanced. The hatching went on favourably, but a large

number of the eggs arrived at a certain stage and failed to produce live fish. Sometimes after a struggle the head would appear, and the little creature would perish in the effort to emerge from the shell. In others, after the eyes were plainly visible, the living principle became extinguished, as shown by the ovum becoming white or opaque. The fish which were hatched, however, were strong and healthy. For a time the dead eggs picked out were over 3000 a day, and prospects were rather gloomy, but circumstances proved that it was more to the conditions to which the ova had been subjected before their arrival that the losses were attributable, than to their treatment after landing.

The total shipment was supposed to be 50,000 ova, but from a rough count the number received was estimated at 55,000. When the eggs were unpacked, one layer of about 7000 ova was put in each hatching box. The combined stream runs through the boxes from 1 to 8, the first boxes getting the fresh, cool water, and having the best chance, the water heating 2 deg. in passing through the boxes

in hot weather. When the hatching was nearly finished, a very marked difference was observable in the number hatched in each box. No. 1 had only about 1000 live fish out of 7000 eggs. These eggs were on the top, nearest the ice. The next layer, in No. 2, had probably 3000 fish out of 7000 ova. No. 3 was the best of all, and there were probably 6000 live fish out of 7000 ova. Nos. 4, 5, and 6 were pretty equal, and hatched over 50 per cent. The eggs in No. 7 hatched out much earlier, but the percentage of loss was above the average. Box No. 8, received the lowest layer of eggs, which hatched out very quickly, having the warmest water, and produced probably 5000 fish.

It will thus be seen that the different lots of eggs, when treated exactly in the same way, varied very materially in the number hatched, showing that the causes of this difference were to be looked for in the treatment of the ova when first taken, or in the mode of packing, rather than in their management after their arrival in Australia.

After the young fish were fairly hatched but

few losses occurred, probably not 50 in the whole number. Of the ova only about 500 remained to hatch on the 24th, and that day, although the hottest of the season, did not appear to injure the *alevins*, as the young fish at this stage are called. The number of live fish is now about 28,000, which is a not unsuccessful result. Had the ova arrived a week earlier, probably three-fourths could have been saved. If they had been a week later, probably they would have been a mass of putrefaction from the fish hatching out, as happened with the first lot of 25,000 Californian ova which I had brought over three years previously.

Success, in most things, is the result of good arrangements, made with a thorough knowledge of the subject, and combined with favourable circumstances, where these are beyond control. The result in this case shows what a narrow line may lie between success and failure.

This shipment of ova had been obtained from the McCloud river, a tributary of the Sacramento, in Shasta county, California. They were obtained from the United States

Fisheries Commission, of which the President is the Hon. Spencer F. Baird; and although my application was made with the condition that a proportion of the cost of the shipment should be paid by me, the United States Government, with a noble generosity worthy of all praise, presented them free of charge; a very handsome present indeed, for which I made due acknowledgments on behalf of the colony. Mr. Firth, who interested himself in forwarding them from New Zealand to Sydney, and who incurred some items of expense, declined to furnish an account of the same, and I now take this opportunity of thanking him for his generosity.

I had prepared myself for the undertaking, and obtained a good knowledge of fish culture, by reading all the books I could obtain on the subject, including the writings of Frank Buckland, Francis, Livingston Stone, Norris, and also the papers on fish culture which have been published in the proceedings of the *Société d'Acclimatation* of France. I also gained much practical knowledge, by having under my care, while hatching, several lots of *Salmo fario* and *Salmo trutta*, and was better

able, after the experience thus obtained, to undertake the care of the Californian salmon ova, during their hatching and distribution in the Victorian rivers.

CHAPTER VIII.

THE CALIFORNIAN SALMON.

The Californian salmon (*Salmo quinnat* of Richardson, or *Salmo lycaodon* of Pallas) is, according to Günther, of the sub-class Teleostei, of the order Physostomi, of the family of the Salmonidæ, and genus Oncorhynchus (Suckley, "Ann. Lyc. Nat. Hist." 1861, p. 312).

It belongs to the anadromous or migratory species of the salmonidæ. It is not intended to give here a scientific description of the fish; it is distinguished from the Atlantic species, however, by having more than 14 rays in the anal fin, while the *Salmo salar* has less than that number. This salmon is found on both the American and Asiatic shores of the Pacific (Günther), a species believed to be identical with it (*S. Japonensis*) having been found in Japanese waters (Pallas).

The name "*Quinnat*" is that given to this fish by the Indians, and it signifies "glittering," in reference to its silvery lustre. The name of a Welsh salmonoid "*Gwyniad*"—also in reference to the shining appearance of that fish—has a curious resemblance to the Indian word, and the coincidence is a problem for philologists to solve.

This salmonoid, similarly to the trout, salmon, salmon-trout, the grayling, and probably even the *Coregonus*, has, in its young state, the transverse bands or parr marks, clearly distinguishable, and they gradually disappear after a certain stage in the development of the fish, this being a family feature of all the salmonidæ, in an early stage of their existence.

The quality which the *Salmo quinnat* possesses, and which makes it peculiarly suitable to the Australian streams and rivers, is its power of resisting high temperatures without danger, and even with apparent comfort. The habits of this species differ somewhat from those of the *Salmo salar* in its period of spawning, the ova being deposited in summer and hatched out in the autumn, in-

stead of being developed in winter and hatched in spring, as in the Atlantic species. In its native rivers the *Salmo quinnat* usually hatches out in October, after a period of incubation of about 60 days, at a temperature of 48 deg. to 50 deg.; the time of hatching being extended or shortened by a lower or higher temperature of the stream in which the ova are placed. It is an ascertained fact that, in ascending the rivers for the purpose of depositing their spawn, the fish have to pass through waters at a temperature of 76 to 80 deg., and as few of the Victorian rivers attain to a higher temperature than this, there is a very strong probability that they will prove admirably suited to this fish. The average size of the Californian salmon when full grown is about 20 lbs., but specimens have been caught of 40 to 60, and even 100 lbs.' weight. It is a handsome fish, having a silvery lustre even at a very young stage, which the *Salmo salar* does not attain, until it becomes a smolt. It has not the elegant contour of the English salmon, and the grain of the flesh is somewhat coarser, but it is nearly, if not quite, equal to it in

quality and flavour when in prime condition, and the flesh is firm, sweet, rich, juicy, and high coloured. It also gives good sport with the artificial fly, but the most killing bait in fresh water is the salmon roe. In its native waters on the Sacramento river, a little snow falls occasionally near the sources, but the climate is mild and warm in summer, and very similar to that of the seaward slopes of the great dividing range in Gippsland, and near Cape Otway.

The Californian salmon frequents bays and inlets, where the water is deep, and spends most of its time in the ocean. There are no salmon in the rivers during the winter months, from November to March, corresponding with May to September in Australia.

There are three ascents of this fish up the rivers each year. The first is in spring—corresponding with September and October in Australia—when the largest fish go up to spawn. This takes place at the head waters of the streams, in the months corresponding with January and February. The adult fish all die after spawning, so far as has yet been observed. There is a second ascent of fish

in the season corresponding with February in Australia, but the fish are of inferior quality. The third run is of smaller fish, in the corresponding month with April, being probably the grilse going up to spawn for the first time.

In a work entitled "The Naturalist in British Columbia," by John K. Lord, some interesting facts are given about the *Salmo quinnat* in the tributaries of the Columbia river. He states that in the Fraser river, "in June and July, salmon ascend this stream in incredible numbers, filing off, as they work up-current, into every rivulet, filling even pools left on the prairies and flats by the receding floods. About a mile from my camp was a large patch of pebbly ground, dry even at the highest floods, through which a shallow stream found its way into the large river. Though barely of sufficient depth to cover an ordinary-sized salmon, yet I have seen that stream so filled, that fish pushed one another out of the water high and dry upon the pebbles. Each with its head up-stream, struggled, fought, and scuffled for precedence. With one's hands only, or, more easily, by employing a

gaff or a crook stick, tons of salmon could have been procured by the simple process of hooking them out. . . . At the end of this pebble stream was a waterfall, beyond which no fish could by any possibility pass. Having arrived at this barrier to all further progress, there they obstinately remained, and weeks were spent in watching them; but I never, in a single instance, saw one turn back and endeavour to seek a more congenial watercourse, but, crowded from behind by fresh arrivals, they died by the score, and, drifting slowly along, in time reached the larger stream. . . . The Indians say all the salmon that come up to spawn die. . . . Why there should be this marvellous waste of salmon in the rivers of the north-west I am somewhat puzzled to imagine." This writer states that the salmon die where they have only to ascend 200 miles in one river, while they ascend over 1000 miles in another with the same result, and gives his opinion that the fish die "from sheer starvation," as the salmon "never feed after leaving salt water." He also states that, in the Fraser, he tried in every way to coax them to take the fly, but was in no instance successful,

and no salmon he had seen caught in fresh water had any trace of food in its stomach or intestinal canal. In salt and brackish water, however, they take the bait freely. The river becomes quite offensive from the quantity of dead fish floating down the stream. An increasing population will, no doubt, remedy this evil before long by reducing the numbers of this wonderfully prolific fish within bounds, and restoring the balance which has been upset by its vigorous vitality.

Enormous quantities of the *Salmo quinnat* are tinned, and also preserved in casks with brine. It is stated that, in 1875, 16,000,000 lbs. of tinned salmon were prepared for exportation, on the Pacific coast of the United States, besides a large quantity cured otherwise. If sold at the rate of eightpence per lb. this would amount to over £533,000, as the annual produce of only one branch of the preserving industry.

The fact here stated, that the Californian salmon is nearly, if not quite, equal in quality, for the table, to the English variety, is contrary to several statements that have been made to me. In fact, one gentleman went so

far as to say that he was sorry that the Californian fish had been introduced at all, as it was so much inferior, for sport and for the table, to the English salmon. I have made careful inquiries on this point, and the result has been quite satisfactory. Three different gentlemen from Victoria who had good opportunities of comparing the two, gave it as their opinion that the Californian salmon was quite equal in flavour to the English species.

It has also been maintained by several good authorities that the former will not rise to the fly, but the information furnished by Dr. Hector, from the reports of the United States Fisheries Commission, from which I have obtained some of the facts mentioned, expressly states that the Californian salmon gives good sport with the artificial fly. I can at any time, at my salmon ponds, show any one curious in the matter how readily they will rise to flies which are put on the surface of the water. It is probable that an abundance of other food will prevent both salmon and trout from rising readily to the fly, and until the rivers are well-stocked with fish, fly-fishing may not prove very successful; but,

whatever the variety of salmon, it is likely that the habits and even the flavour of the fish will soon come to be what the climate, food, and other circumstances will make them. It is a known fact that, in some of the Scottish rivers, certain tributaries produce much finer trout than others; the difference being so marked that an experienced fisherman will, at a glance, tell the stream in which the fish has been caught.

After this work was in type, I found in the January number of the proceedings of the *Société d'Acclimatation* for the year 1878, a short paper by M. Raveret-Wattel on the Californian salmon, which gives some valuable information, a portion of which I have translated for insertion here. M. Raveret-Wattel states that:—

"Besides having well-marked specific characters, the Californian salmon is distinguished from the Atlantic species by some differences in its habits, but above all by a special aptitude for living in a much warmer climate. We know indeed that the *Salmo salar*—of which the abundance in the North gradually diminishes as we go South, beginning say

from 55 deg. of latitude—descends but little beyond 42 deg.; which explains its absence from the waters of the Mediterranean—the Straits of Gibraltar being about the 36th parallel—and also in America from the streams falling into the Gulf of Mexico.

"The *Salmo quinnat*, on the contrary, is abundant about 35 deg. of latitude, and is found beyond 30 deg., which gives good reason to think that it may be acclimatized in the valley of the Mississippi. . . .

"The Californian salmon will bear very great heat without inconvenience. In July and August it is seen in great shoals on the San Joaquin, which river it ascends to a distance of about 100 miles through the warmest valley in California, where the temperature of the air, rarely below 75 deg. at noon, is often up to 104 deg. As to the water of the river, it reaches sometimes 82 deg. at the surface, and 80 deg. near the bottom. No other species of migratory salmon lives in latitudes so far South as this one. Mr. Redding, of the Californian Fish Commission, states that in July and August, when salmon are most abundant, the mean temperature of the San

Joaquin river is 79·7 deg. During the same period the mean temperature of the Sacramento, calculated over ten years, is 73·4 deg.

"A point equally important is that this species does not suffer although the water may be somewhat impure; it ascends the Sacramento and San Joaquin at the precise time when the waters are most affected by the washing of minerals, and seems to feel no inconvenience.

"The time of spawning of this salmon is prolonged excessively, contrary to that of the *Salmo salar*, and seems to last nearly six months of the year. It is known that the period varies according to the locality, being earlier in proportion to the distance from the sea, and near the source of the rivers. Thus in the upper waters of the Sacramento the spawning takes place in the end of June or the beginning of July; 30 miles lower down the stream it is observed to take place in July and August, and the farther down the river the later is the time of spawning. At the junction of the McCloud river with the Sacramento, or about 180 miles from the sea, it does not take place till the end of August, or

early in September; lower still at Tehama, the season is October and November. In some of the streams which fall into the sea north of the Sacramento, such as the Eel river and the Russian river, the spawning takes place in winter, or in December, January, and February.

"Not long since, all the tributaries of the Sacramento were visited every year by prodigious numbers of salmon, which came there to spawn. The Pitt or Upper Sacramento, the American, the Feather, and the Little Sacramento had magnificent spawning beds; but since the extension of mining, the washing of minerals has nearly destroyed the spawning grounds of the American and Feather rivers.

"The Pitt and the Little Sacramento, with their tributaries, have alone escaped this injurious effect of the gold-workings, and keep all their primitive wealth of fish-life. The spawning grounds of the McCloud river, an affluent of the Pitt, which has its source at Mount Shasta, are of considerable extent. It is to the banks of this river, in the midst of Indian tribes 'of a doubtful sympathy for the pale faces,' that Dr. Livingston Stone goes

every year during the month of August, to collect the eggs of the *Salmo quinnat* for the purpose of stocking other streams, and acclimatizing this fish in other waters; the work being under the care of the Fish Commission of the United States. The distance from civilization, and above all the presence of the Indians, have so far protected this region from the invasion of *prospectors* for gold.

"The waters of the rivers constantly fed by the melting snows are not troubled by the washing of minerals, and are suited admirably for the salmon which literally crowd there in the spawning time. According to Livingston Stone, it is not by thousands but by millions that he can collect the eggs, and, although so many are taken to stock other waters, it has no appreciable effect on the number of the fish in the river.

"The ascent of salmon in the McCloud river commences in March, and lasts till October, some few arriving even in November; but, when the rains of winter commence, the salmon all disappear till the following spring.

"In the principal branch of the Sacramento, the ascent takes place at a different

time. The earliest salmon commence to ascend in November, and they increase in numbers till March. They are then very abundant, and continue so till the beginning of June. During that and the following month the numbers diminish. In August they again increase, but diminish gradually till November, at which period they return to the sea; just at the time when the younger salmon of about a year old commence their first ascent. There is also in this river, in considerable numbers, a large trout commonly called the 'salmon trout' of the Sacramento.

"The habits of the Californian salmon, at the time of spawning, are in all respects similar to those of the ordinary salmon, but with the former the eggs are much less abundant. In specimens of equal size there is a difference of nearly one half in the number of eggs; thus, while in the *Salmo salar* there are generally about as many thousands of eggs as the fish weighs in pounds, the *Salmo quinnat* only produces about 500 eggs to each pound weight of the fish. . . . The time of incubation is about 40 days, and in another month the umbilical sac is

absorbed. The *alevins* are more lively and precocious than those of the *Salmo salar*. At a year old they attain a length of 6 to 8 inches; the second year they double in size, and at four years they often measure 24 inches in length. When full grown they may weigh 67 lbs., but 22 lbs. is about the average weight of the great part of those that are caught. They decrease in weight during the time they are in fresh water, and their appearance then alters greatly. They do not seem to take any nourishment while in fresh water. It is stated by Mr. Vincent Cooke, of the Oregon Packing Company, that, out of 98,000 salmon caught in the Columbia river in 1874, three only were found with some traces of food in their stomachs, and these seemed to have quitted the salt water very recently.

"At the time when they leave the sea to ascend the rivers, they scarcely differ from the Atlantic salmon, and are beautiful fish with silvery scales, while the two sexes differ little in appearance. Up till the month of June they keep in good condition, and retain their delicious flavour, which is exactly similar to that of the ordinary salmon. But

after this time they begin to get thinner, become less elegant in form, lose the changing tints of their colouration, and the scales appear larger and rougher. As to the flesh, it is already noticeably deteriorated in quality. The nearer the spawning time the thinner they become; their silvery lustre gives place to a deep olive-green colour, and the scales become imbedded in the skin, which gets thickened and spongy.

"The two sexes are then easily distinguished. The females have their abdomens distended with ova; the males, on the contrary, are thin and narrow; their heads are long, and compressed laterally.

"They have, according to L. Stone, a somewhat ferocious look, caused by the expression of the eyes, and the presence in the jaws of formidable rows of enormous pointed teeth, sometimes half an inch in length.

"As the season advances, these characters become more marked up to the time of spawning, when both sexes become so weak and emaciated that many of their number die of exhaustion.

"On account of the length of many of the

Californian rivers, the salmon have to travel each year considerable distances in their periodical migrations, and they must often surmount numerous obstacles to reach their spawning grounds. In the McCloud river, the source of which is 3500 feet above the sea, they have to ascend rapids for a length of 30 miles. In the Snake river, the sources of which are eastward of the Great Salt Lake, the journey that they have to make is about 1000 miles.

"In general, when they leave the sea to ascend the rivers, they remain for some time in the brackish water where the river joins the sea. The fishermen believe that the change destroys the numerous parasites which become attached to their body during their sojourn in the sea. . . . They soon, however, begin to ascend the rivers, where they are immediately set upon without mercy, by the whites at first, and afterwards, higher up in the Indian territory, by the red-skins, who during a part of the year live entirely on this fish.

"The *Salmo quinnat* can be caught very well with the fly, like the trout or the ordinary salmon. Its own eggs make also an excellent

bait. But, as salmon-fishing in California is oftener followed as an industry than simply for sport, it is principally by means of immense fixed nets that they are caught, which completely stop the passage of the fish at certain points known to be most frequented by the salmon. This happens, for instance, near the limit of the salt water in the Rio Vista and Oregon river, where the quantity of fish caught is enormous. Extensive works have been erected for preserving the salmon in tins, which are afterwards exported to Europe, where they meet with an advantageous outlet. In 1874, the preserving works on the Columbia river preserved more than 22,000,000 lbs. of salmon, in addition to the local consumption, which might be estimated at 11,000,000 lbs.' weight of fresh and salt fish, which would make 33,000,000 lbs. of salmon, the produce of one year from a single river, and since then the numbers have increased.

"The works are on the bank of the river, upon which are sometimes seen heaps of 1200 to 1500 fish. According to the practice in Germany and Holland, they kill the salmon by giving it a blow on the head, instead of

allowing it to expire when landed from the net. After having been washed in a basin prepared for the purpose, the fish are laid on immense tables, where workmen with large knives cut off the head with a single stroke. With a second cut they open it up in all its length, and then remove the entrails. In some establishments the head and other offal are not utilized, but in others they extract from them an oil of considerable value."

The paper then goes on to describe the process of preserving the salmon in tins, which is exactly similar to meat preserving as usually practised, and states that:—

"In the fisheries of Oregon alone, this industry occupies not less than 10,000 workmen, and during the last season the exports of preserved salmon have risen to a million sterling.

"We may ask if such destruction is not likely soon to ruin the fisheries. Already a remarkable diminution has taken place in the number of the salmon, and the Fish Commission has taken steps to prevent their wholesale destruction. Some fish-hatching establishments have been instituted to re-stock the

different streams with salmon fry, to take the place of those netted for consumption. . . . One of these, on a branch of the Columbia river, has an apparatus capable of hatching at one time 20,000,000 eggs."

From this it will be seen that energetic efforts are being made by the Government of the United States to maintain in their rivers the supply of salmon, which from too close fishing has been diminishing for some years.

It would be interesting to know in what rivers the salmon are found as far south as 30 deg., as stated here by M. Wattel. Should the statement be correct, as to their reaching so far south, the fact will have an important bearing upon the question of the acclimatization of the Californian salmon in rivers having high temperatures, not only in Australia but also in Europe, South Africa, South America, and possibly even in India.

CHAPTER IX.

IS THE CALIFORNIAN SALMON SUITABLE TO THE MURRAY RIVER?

No attempt has yet been made to place any salmon in the Murray river, but a few trout have been liberated in one of its tributaries by the Acclimatization Society. It is not at all improbable that the Californian salmon would succeed very well there, if once established in sufficient numbers to bid defiance to the dangers of the annual journey to the sea. The upper waters of this river and its tributaries have splendid spawning grounds, and never-failing streams of pure and cool water, which would be admirably adapted either for this fish or the brown trout.

As the acclimatization of the Californian salmon in the Murray and its tributaries would, if successful, benefit in pretty equal proportions the three colonies of New South

Wales, Victoria, and South Australia, they might unite in the undertaking, and contribute £1000 each to stock this splendid stream with, say, a million of salmon. It may be said that the climate is too warm for this fish, but an examination of the map will show that the mouth of the Murray is in latitude 35½ deg., while its head waters and southern tributaries are between 36 deg. and 37 deg., and they reach altitudes of several thousand feet above the sea. Let us now inquire where is the home of the *Salmo quinnat.* The mouth of the Sacramento is in latitude 37½ deg., or two degrees farther from the equator than the mouth of the Murray, and the main course of the river is from the north, running southerly, but its waters reach a temperature of over 76 deg. in summer, which is probably as high as that of the Murray. The San Joaquin branch of the Sacramento reaches south nearly as far as to the 35th parallel, or half a degree nearer the equator than the mouth of the Murray, and its waters reach a temperature of 80 to 84 deg. (S. Baird). Mr. B. B. Redding states, in a report to the Hon. Spencer Baird, that the salmon remain for weeks and months in

the San Joaquin river, in a climate much warmer than that of Florida or the Mississippi; and they might, he thinks, be successfully introduced into the Gulf of Mexico, and possibly into the Rio Grande. Seeing that the brown trout has adapted itself so well to temperatures so much greater than any it could ever have experienced in England, it is not unreasonable to suppose that the Californian salmon, which has been proved to be so hardy in Victoria, should have sufficient adaptability to circumstances to enable it to live and thrive in a climate and temperature so nearly similar to that of its native rivers.

A new danger to which the salmon would be liable in the Murray is the risk of being devoured by the voracious Murray cod (*Oligorus Macquariensis*), but a swift, active, and powerful fish, like the salmon, has little to fear from a comparatively sluggish swimmer such as the Murray cod, and it is even probable that the scale may be turned the other way, and that the salmon might be well able to hold its ground against the native fish of the country.

The distance from the sea to the spawning

beds is certainly great, but not farther, I believe, than the salmon go in ascending some of the great American rivers.

In the report of Professor Spencer Baird, the United States Commissioner of Fish and Fisheries, for the year 1875, it is stated that, in the tributaries of the Columbia river, "1800 miles from its mouth, the salt-water salmon come in myriads to spawn. . . . The large king salmon or *chowichee*, and the red salmon, *hoikoh*, are according to Mr. Dall, taken as far up theYukon river as Port Yukon, 1400 miles from the sea. . . . From these facts we may infer that the instinct of location is probably sufficient to attract a colony of fishes as far inland as the head waters of the longest river, whenever their home has been once established there. . . . The vigorous strength and the energy exhibited by the Californian salmon during its migrations up the Sacramento and Columbia rivers, afford the evidence that its capacity for a long migration from the sea to its spawning grounds is unsurpassed by any species of fish known. Wherever the Californian salmon, in the process of artificial propagation,

has come under the hands of the fish culturist, it is acknowledged to exceed all other species which are propagated, in hardiness, in tenacity of life, and in freedom from tendency to disease. It possesses a most vigorous vitality, and when slaughtered at the canneries where it is preserved, is said to 'bleed like a bull'" (Nordhoff).

I would strongly recommend that the three colonies interested should take united action, and import 500,000 or 1,000,000 of the ova of this valuable fish, to be placed in the head waters of the Murray and its tributaries. Some suitable hatching ground could be selected near Albury, in the Howqua or Delatite, or in some stream high up in the mountains, where cool springs could be found, fed by melting snows, to provide admirable hatching-rills, where the young fry could be nursed past the dangerous stage of their existence. Should the three colonies join in the proposed undertaking, and the experiment prove successful, each would derive a pretty equal share of the benefit. South Australia would have the fishing at the mouth of the Murray, where the salmon would be caught

in the best condition, and Victoria and New South Wales would benefit pretty equally on each bank of the river; while the fishing in the Murrumbidgee, on one side of the border, would balance that in the Goulburn on the other. Should the Darling waters become stocked with this fish, the preponderance of advantages would rest with New South Wales.

If this proposal be adopted no time should be lost, as, from the present abundance of fish in the Sacramento river, ova can be procured in any quantity, and the United States Fisheries Commission are most ready and willing to share with other nations the immense advantages which they enjoy, in the abundance of fish of the best kinds with which their lakes and rivers are stocked. Should the fish soon become scarce, which is very probable, and the Fisheries Commission be obliged to retain all the ova procurable for increasing the supply in their own rivers, it is possible that great difficulty might be experienced in obtaining a large quantity of ova for a purpose of this kind.

But, it may be said, why not wait the result

of the late experiment? and if the Californian salmon succeeds in Victorian rivers, ova can be obtained to stock the Murray, Murrumbidgee and Goulburn. To this argument I would reply that life is too short, the time to wait is too long, and that even should the Californian salmon prove as successful as we could expect it to be, ova could not be obtained easier, or at less cost, than they now can from California. The fact of this fish having been so very successfully introduced is an assurance that the money it is proposed to expend in the undertaking would not be thrown away.

In a recent number of *Nature*, a valuable scientific publication, Mr. George Francis, in a paper dated Adelaide, May 11th, 1878, stated that the river Murray had that season been very low, and the water unusually warm. The stream running into Lake Alexandrina was very slight, the temperature of the water being 74 deg. The surface of the lake on calm days rose to 76 deg., and the bottom temperature was 73 deg. In a stiff breeze the water stood at 72 deg. As these temperatures are lower than those which are

found in the waters of the Sacramento river, in all probability the Californian salmon would be well able to stand the heat of the waters of the Murray. The summer of 1877–8 was unusually dry and hot, and it is probable that the volume of the stream of the Murray had reached its minimum, and the temperature of the water its maximum, when these observations were made, and that a more unfavourable time for testing it could scarcely be found. These facts constitute a strong argument in favour of the undertaking, which I would earnestly recommend to the favourable consideration of the Governments of the three colonies which are interested in the matter.

CHAPTER X.

COLLECTING THE OVA.

The ova of salmon, trout, and of many other fish, when deposited in the natural gravel beds, in nests made by the fish, which are called *redds*, can be collected and carried to a distance, to be used in stocking other waters. This is the plan adopted at Huningue, the great French fish-rearing establishment, which has now, however, changed owners, having been included in the territory ceded to Germany after the last war.

The ova, when received at Huningue, are placed in artificial hatching-beds, until the process of incubation has advanced to a certain stage, which is found by practical experience to be the safest time to subject the eggs to the rather rough usage to which they are sometimes liable, in being forwarded long distances. When the hatching has pro-

ceeded till the embryo is clearly visible in the egg, they will bear being transported to long distances without injury. When the ova are about to be deposited in the natural way in the *redd*, the female fish excavates a hollow by fanning away the loose gravel with her tail fin. It is well known that divers can lift stones under water, in building submarine walls for piers, docks, etc., which they could not move on land, on account of their weight being less in water by the weight of the bulk of water which they displace, and this principle enables the salmon to excavate their *redds* in loose gravel, in a strong current, with little difficulty.

The *redd* can be easily recognized by those familiar with its appearance, being simply a mound containing about a barrowful of gravel, thrown up into a little heap, with a hollow or furrow at the upper side, where the work was finished. When fish are spawning, it is no unusual thing for other fish of the same species to lie in wait, and devour the eggs in a wholesale way, and many of the ova are carried away by the current into deep water, where they cannot be hatched out and must perish.

Many ova are never impregnated, and the enemies and dangers to which they are exposed are legion. The water may become too low, and leave the eggs to perish; floods may tear up the gravel and cover them over with mud; frogs, lizards, water-rats, snakes, and numerous kinds of fish find a dish of ova a dainty feast. When the young salmonoid is hatched and reaches the *alevin* stage, it is equally exposed to perils of similar kinds, and at every stage from the ovum to the adult salmon, dangers encompass it and snares surround it. We may readily perceive the advantages of protecting these delicate and helpless young creatures, at least until they are in a measure able to provide for their own safety.

The ova of salmon and trout, when deposited in the natural *redds*, can be collected by using a hoop-net, made of fine netting. This should be held in the current below the *redd*, while the gravel in which the eggs are embedded is turned over with a spade. The gravel falls to the bottom immediately, but the ova, being lighter, float a little way with the current and get caught in the net, and can then be placed

in damp moss and taken to the hatching-boxes. It is not very safe to keep them long in still water, although they may be retained in this way for a short time. It is well to renew the water occasionally, or to have it aërated, to prevent injury to the ova.

But, as collecting the ova from the natural spawning-beds is attended with great difficulty, a plan has been adopted, of netting the fish when they are ready to spawn, and by careful manipulation obtaining the ova from the female, and fertilizing them with the seminal fluid, taken in the same way from the male. A little practical experience teaches the operator to know when a female fish is ripe for spawning, the eggs having then left the ovaries, and descended into the abdomen, where they remain ready to flow out with a slight pressure, like shot from a shot-belt. The same operation is repeated with the male fish, and the milt is well stirred up with the ova, which at first are covered with a glutinous matter, which makes them adhere to each other. After standing for a little while, they will separate easily, and are then ready to be placed in the hatching apparatus. The opera-

tion of taking the eggs requires to be performed with great care, so as not to injure the fish by rough usage. They are very difficult to hold, and if the gills be injured, or the skin broken, it is almost certain to result in the death of the fish.

An apparatus has been described to me, invented, I think, by Mr. Howard, the curator of the New Zealand hatching establishment, which obviates to some extent the danger of hurting the fish in taking the ova. A sort of sloping table is used, the top of which is about two feet six inches long and nine inches wide. To the lower side of this a small net is tacked. The fish is laid upon the table, which is padded, and the net is brought over it, and fastened by hooks so that the fish cannot struggle much, or hurt itself. A shelf is fixed below, to support a pan so placed as to catch the ova, and by passing the fingers with a gentle pressure along the belly towards the vent, if the fish be ripe, the operation can be successfully accomplished in a few seconds, and the fish may then be returned to the water without injury. Where trout are kept in ponds, this method may be adopted success-

fully, and it is highly recommended by Mr. Howard, who has used it with success in New Zealand.

A plan has been invented in America, by which the ova of trout kept in artificial ponds, can be taken without catching or handling the fish, and thereby preventing the losses which are unavoidable in manipulating them. The invention is called Ainsworth's Spawning-Race, and it has been patented in the United States. It consists of a wooden box about two feet wide, and of the same depth, in which wooden trays are set, having wire netting in the bottom, and containing coarse gravel to allow the ova to fall through easily. The box is placed in the bed of the stream, where the water enters the pond in which the trout are kept, and the water is made to flow over the gravel with a rapid current, having a depth of 12 inches at the lower end, where the water enters the race, and gradually getting shallower towards the upper end. Beneath the trays containing the gravel, a revolving belt on two rollers is placed, with a handle above water, by turning which, and by the action of two small bevel wheels, the

rollers and belt revolve. The boxes holding the gravel are each two feet square, and the bottom is made of wire netting of half-inch mesh. It is necessary that the fish should not be able to get past the spawning-race, or have any other gravel beds to spawn in. The trays are filled with coarse gravel, which the fish mistake for the natural river bed, and the ova when deposited fall through, and are caught on the revolving belt, which is made of fine wire netting. A few turns of the handle bring the ova to one end, where they are caught in a pan, placed there for the purpose. If the race be covered, the ova may even be taken while the fish are spawning, without disturbing them. I have tried this race, but my fish did not spawn in it. In the Botanical Gardens at Ballarat the spawning-race was more successful, however, and a quantity of ova was obtained from some trout kept in a small pond, and afterwards hatched out successfully. A full description of this spawning-race, illustrated with plates, will be found in "Domesticated Trout," a very valuable work on fish culture, by Dr. Livingston Stone. Another way of obtaining ova from

fish retained in artificial ponds, is by making a race laid with suitable gravel, and after the fish have spawned, shutting them off by a screen and taking the ova, which may be done by lowering the water. This is the plan which has been very successfully adopted by the Tasmanian Salmon Commissioners, at the salmon ponds at New Norfolk.

In a report dated April 5, 1875, addressed to the Hon. Spencer Baird, by Dr. Livingston Stone, the mode of obtaining salmon eggs in the McCloud river is described. A bridge was formed across the river, resting on triangular wooden piers, moored with cables and then filled with stones; in the spaces a grating of poles was placed, one inch and a half apart, and securely fastened; when this was completed, the salmon were prevented from ascending the river, and were netted in immense numbers and the ova obtained from them.

The scene is thus graphically described by Mr. Stone: "about four o'clock in the afternoon, a few days after the passage of the salmon was obstructed, it was announced that they were making their first assault upon the

dam. The whole camp collected upon the bridge to witness the attack. It was a sight never to be forgotten. For several rods below the bridge, the salmon formed one black, writhing mass of life. Piled together one above another, they charged in solid columns against the bridge and dam, which trembled and shook continually under their blows. Not daunted by their repeated failures, they led attack after attack upon the fence, one column succeeding as another fell back. Encouraged by their numbers, and urged on by their irrepressible instinct, they entirely disregarded the observers on the bridge, and struggled at their very best to pass the unwonted obstruction. Finding the fence impassable, many fell back a little, and tried to jump the bridge. This several succeeded in doing, sometimes violently striking the men on the bridge in their leaps, and sometimes actually jumping between their feet.

"For an hour and a half this fierce assault continued, when, exhausted by their efforts and discouraged by many failures, they fell back to a deep hole just below the rapids, arrested for the first time, since the McCloud

formed its channel, in their progress up the river. The Indians who were watching their movements were wild with excitement over the scene. . . ."

In this pool "they had their natural habitat and surroundings, and the whole volume of the McCloud river for a water supply. . . . When any were wanted, it was only necessary to extend the net around them and haul them in. Once or twice no less than 15,000 lbs. of salmon must have been inclosed in the net. They formed a solid mass reaching several yards from the shore, and filling the net two or three feet deep. If I should say 20,000 lbs. I do not think it would be exaggerating. . . . One much-disputed point about the McCloud river salmon was settled this year by the presence of the dam. The vexed question has been whether the salmon ascending the McCloud river to spawn, ever returned to the sea. . . . The fact has been proved this year that the spawning salmon do not return to the sea. The proof is this: our dam formed an impassable barrier to the return of the salmon which had ascended the river to spawn. Tens of thousands, not to say hundreds of thousands,

which would perhaps be nearer the truth, passed the line of our barricade before it was completed. Not one of these salmon passed that point on their return to the sea. If their habit had been to return seaward after spawning, they would have crowded to the upper side of the barricade, as the ascending salmon did two months previously; but instead of this, not one was observed to even show the least disposition to pass it, although thousands floated down dead, against the dam."

Mr. Stone is convinced that the salmon have no natural disposition to return to the sea, and that they all die after spawning. At the end of October, he says, "a live salmon can hardly be found in the whole length of the McCloud river anywhere." In the season when this report of Mr. Stone was written (1874), the total number of salmon eggs taken in this river by him was 5,752,500, at a cost of seven shillings per thousand.

The collecting of salmon eggs for shipment to Australia and New Zealand is graphically described by Frank Buckland, the celebrated pisciculturist, in the following letter, which appeared in *Land and Water* of January 12, 1878:—

"Salmon-egg collecting is one of the most difficult—and, I may say, dangerous—tasks that fall to my lot; nevertheless I have gone at it once more. The Government authorities of New Zealand having expressed by telegram to Sir Julius Vogel, agent-general in London, their desire to have a further consignment of salmon ova sent them this spawning season, I told Sir Julius that I would do my best for them, though it was late—very late—this year to hope for much success.

"The ship chosen to take the eggs is the *Chimborazo,* a big steamer, sailing from London direct to Melbourne, the eggs to be there transhipped to New Zealand. The *Chimborazo* is to leave the port of London on January 21. I pass over for the present the various arrangements made by my friend Mr. Youl for packing the eggs in the ice, and proceed to relate my adventures since last Monday.

"In the collection of salmon eggs, as in every other matter, the great rule is to 'take for granted you will find nothing anywhere,' therefore I go fully prepared for all eventualities. It is a difficult task, and requires the

forethought of many previous days to get a 'spawning kit' together. Here is a list of my kit:—1. Nets. On this occasion I took with me one long, heavy trammel, and two smaller trammels. 2. Two landing nets, one gigantic fellow, the other smaller. 3. Tins, viz. one big spawning tin and two egg-carriers. 4. Box of bottles for eggs. 5. Ten wooden boxes to pack the eggs by the river-side. 6. Two sacks of sphagnum moss. 7. Glass catchers to pick up the eggs, and a glass contained just 1000 eggs. 8. Coil of the best rope and string. 9. Lady's wicker travelling-basket for holding live salmon. 10. Wading trousers and diver's india-rubber dress. 11. Ordinary luggage.

"Thus equipped, I started on Monday last for Newcastle—wrote all the way in the train, of course. Arrived at Newcastle, took train to Chollerford, where my friend, Mr. John Ridley, chairman of North Tyne committee, had kindly made all the arrangements for me. The next morning, a drive of eleven miles to Bellingham, and thence by train to Reedsmouth. We dressed ourselves in the station, and proceeded to find the head of

the Tyne salmon-watchers, Sergeant Harbottle, the water bailiffs, and my man, Mr. Edon, who had gone on before us. The main river of the North Tyne was too heavy for us—no net could possibly stand; so Harbottle had judiciously made his first shot in the river Reed, just above her junction with North Tyne. He had marked several pair of spawners down on this bed, and hoped to get the lot for me. Ridley and I came up just in time to see our assistants with very long faces. It appears that they had, though the water was then running rapidly, got the net across and some fish in her. Just as they were bringing her round she caught on a rock, and immediately rolled 'leads over corks.' Just at that moment there came a heavy spate from above. The men on the bank could not hold the net, and she straightened herself out beautifully, letting every fish in the net, of course, escape. Mr. Edon, however, managed to secure three half-spawned fish, from which he got a few eggs. We then packed up the wet nets and the kit on to a cart, and marched off to a shallow in the North Tyne, about a mile above, where we thought we might have luck.

"During our walk there a regular winter's storm came on; the telegraph wires sung out their music as if laughing at us, and away far in the north was a great jet-black, angry-looking cloud, showing that a heavy storm was gathering upon the moors and great hills that separate England from Scotland. We had no time to lose, as we knew the rain from this cloud would soon send North Tyne down in a heavy spate. Turning off the highway, we passed down a hill to the river bank, and then the cart with the nets, etc., went across the river, and I waded over—not very pleasant work in a rapid, rising river, with great, rolling, slippery boulders under one's feet. However, we got to the island, and determined to fish the stream on the other side of it. There was great difficulty in getting the net across, the stream was so rapid. At last Harbottle and six men got her over, and then, beginning some 60 yards above, the trammel was run down-stream to her. Great was the excitement when we quickly perceived, from the bobbing of the corks, that the fish on the spawning bed were 'masked in the trammel. She's a beautiful net is my trammel, though

some find fault with her. She's like bird-lime to a fish; let her once touch a fish's fin, and she has the rest of him pretty quickly. Down came the trammel right on to the net below in true orthodox style. Round with them both on to the bank. Three fish. Instantly I was on to them, as they kick about in the water. First, male; second, female; third, male. The males fine, big fish, with red coats on them, as though they were going to a Horse Guards' parade, and beaks on the lower jaw enough to frighten one. The female, alas! had not an egg in her; all done spawning long ago.

"While I examined these fish the river spared us not, and I observed that a bank of pebbles on which I had been packing eggs was covered with water. We were all, therefore, only too anxious to be off, as a long stay on a desolate island for a winter's night, in the middle of the North Tyne, was not a pleasant prospect. Several of the party, therefore, got into the cart: the more the safer, as the cart would be heavier in the stream, and less likely to tip over. As I was waterproofed up to my neck, I walked behind in the water, holding the

cart-tail with one hand, the precious egg-can with the other. The man whipped up the horse, and he managed to drag his heavy load across the river, the old cart (up already over the axles in water) rolling about like a ship at sea as the wheels tipped up over the boulders below.

"At last we got ashore all right, and the cart went back for the nets, etc., and the other men, some of whom waded, others rode across. Mr. Ridley had brought with him a curious-looking basket, made by the peasants in Germany, very handsomely worked in wicker. This basket he carried on his back, like a Parisian *chiffonnier*. We laughed at his basket, but we did not laugh now, and he produced therefrom a capital luncheon, beer, etc. As we sat on the bank, we saw the North Tyne gradually rising. Lap, lap, came the little side-waves at our feet. Gradually the island on which we had been standing became smaller and smaller, and at last down she came with a mighty rush; the stones which, a few minutes before, had caused the ripples and the rushes so dear to salmon fishers, quickly ducked their heads under water, and where

there had been a loud resounding rapid before, now was a swift, deep stream, running like oil. This sudden spate was caused, of course, by our friend, the black storm, on the hills. In this part of Northumberland spates come on very quickly, owing to the mountains being so steep, and the moors being so much more drained than they were in former years. With the spate in the river came the storm upon us —a regular spiteful gentleman, fresh from the caves of Æolus—iced rain, sleet, and snow. I was cold—very cold—but I would not let it be seen. I felt my wet suit of waterproof gradually freezing, and becoming like a suit of armour, especially about the arms and throat; so we packed up, and walked away as fast as we could under a railway arch, where I managed, with the help of a water bailiff, to get off the same frozen dress; and then for a walk—I hate walking—into Bellingham. As we went along, a blacker cloud came over, and it began to snow; not in nice heavy flakes, but little sharp spikes, the size of peppercorns. The howling wind drove these along like shot from a volley of infantry.

"At last we arrived at Bellingham, and on

our way home a regular heavy winter snow-storm was on, and kept on all night. The next morning everything, from the distant hills down to the window-sills, had put on a white nightcap. My friend Ridley examined, with the telescope, from his lawn, the river tumbling over Chollerford dam in the distance, and at once concluded it would not be of the least use to try, certainly not to-day—maybe many days—as all that snow had to melt and come down off the hills into the river in the form of water. 'Besides, Buckland, you're a fortnight or three weeks too late to get the run of spawning salmon off the redds.' 'Yes,' I said, 'I know that; but when Sir Julius and the New Zealanders say, "Go and try," of course I must go and try.'

"So I packed up, waited half a day at a country railway station, and got that night to Carlisle, to try what my old friends the salmon in the Caldew had to say."

It is at the coldest time of the year that the spawning takes place, and the necessary work when netting the rivers and manipulating the fish, with the thermometer below freezing point—sometimes up to the armpits in water

—even if in a waterproof dress, is no easy or pleasant task, and requires an amount of enthusiasm in the cause of acclimatization, and energy in carrying out the undertaking, that few men possess. To Mr. J. A. Youl, C.M.G., and to Mr. Buckland, the colonies owe a debt of gratitude for their exertions in the cause. To Mr. Youl is, I believe, due the honour of being the first to make the discovery that the eggs of salmon and trout could be kept alive in ice long enough to enable them to reach the antipodes: and the first, and many subsequent shipments of salmon ova were collected and sent out by him, or under his personal care and supervision. Mr. Youl did not refrain, although his fingers were numbed with cold, worn and bleeding by contact with the sharp masses of ice, until his task was accomplished. Both he and Mr. Buckland have been unsparing in their labours to achieve the desired object of stocking the waters of Australasia with the king of fish. After years of patient observation of facts, leading up to a final result, and notwithstanding hardships endured in collecting the eggs, or in packing boxes of ova in ice, with the

thermometer far below freezing point—labours sustained by that enthusiasm which deadens the sense of pain—each new attempt finds these two brothers in unity of purpose, *par nobile fratrum*, again with renewed enthusiasm —often under very discouraging circumstances —repeating their toilsome task.

CHAPTER XI.

FISH-HATCHING.

We will suppose that the ova have been obtained, and properly impregnated; the hatching process next claims our attention. The eggs must not be exposed to a dry atmosphere, under penalty of their destruction. In still water they will perish for want of the necessary supply of oxygen, which all living things require to sustain the vital principle. In moist air, or in a current of well-aërated water, the process of incubation will go on favourably. Although salmon and trout eggs are usually hatched out in a stream of water, this object can be attained equally well in moist air; and if kept in moss, with a slight drip of water to keep up the supply of moisture, and if the temperature be not too high, they will hatch out equally well without being put in water at all. It must be remembered, how-

ever, that the moment they are hatched they become fish, and, like most other fish out of water, will die immediately if not restored to their natural element. As an illustration of this fact, when the shipment of Californian salmon ova which I received in 1877 was opened, it was found that some of the eggs had hatched out some time before, and that the fish had perished. Some had just hatched and others were on the point of hatching, and these were placed in a stream of water in the hatching-boxes, and they lived and will grow, I hope, to be 50 lb. salmon in the Gellibrand and Snowy rivers, where they were liberated some time afterwards.

CHAPTER XII.

HATCHING FISH OVA IN MOIST AIR.

As the mode of hatching in moist air has not been tried, as far as I can learn, at any of the great fish-hatching establishments in Europe or America, there may be reasons which do not occur to me which might hinder its success, but there are several advantages which the plan possesses over that usually adopted. Those who have succeeded in hatching the eggs of any of the salmonidæ will know that one of the great dangers to which the life of the embryo is exposed is from the sediment which is deposited from the water—however pure it may seem—which is used in hatching. With a low temperature the time of incubation is lengthened, and this evil is then greater. Even filtering will not entirely prevent it, and where a strong current is used, no efficient filtering apparatus can be arranged

to obviate this difficulty, which cannot arise under the moist air system. Another advantage of the latter plan is, that any injurious substance which may get into the water accidentally, and which might destroy the ova, could not affect them in air. The simplicity of the arrangements required for hatching in air is another great advantage, as compared with the elaborate apparatus required under the ordinary system, and a low temperature is much more easily maintained in an air-chamber than with a stream of water.

The Californian ova above referred to were, on their arrival, found to be packed in netting in a box, between layers of moss, over which a few pieces of ice were placed, and the box had been kept in an ice-house with a uniform temperature of 32 or 33 deg. Of these ova 94 per cent. arrived in good condition, and over 50 per cent. hatched out successfully, the hatching having commenced at once when they were placed in the water, and having gone on without interruption till all were hatched, the incubatory process having been almost completed in the moist air of the ice-chamber.

CHAPTER XIII.

FISH-HATCHING IN A CURRENT OF WATER.

The natural way in which the eggs of trout and salmon are hatched, is by the action of a current of water flowing over them, and the ova of the salmon, salmon trout, and sea trout, as well as of all the other varieties of river and lake trout, are deposited by the parent fish in natural gravel beds in shallow parts of the streams and rivers, where the current runs swiftly. In cold latitudes, where the rivers are often frozen over in winter, the shallows having a rapid current are seldom frozen, and the constant supply of atmospheric air necessary, as well to the development of the ova as to the existence of the fish, is kept up by the running water, which by rippling over the rapids gets aërated, and maintains the necessary supply of oxygen, which is obtained from

its contact with the atmosphere, and is essential to the vivification of the ova.

It probably happens sometimes that ova which are covered with gravel may, by the subsidence of the stream, be left above the level of the water; and if the gravel in which they are embedded continues sufficiently moist, these eggs may hatch out safely, and the *alevins* may reach the water immediately after being hatched; but this must be a very exceptional case, and I cannot imagine such a delicate creature as a newly hatched salmon, if buried even to the depth of an inch or two, unless it be in very coarse gravel, being able to find its way out.

The parent fishes, if of the migratory species, ascend from the sea into the same rivers in which they were reared, with almost unerring instinct; it being a very rare thing to find a salmon, bred in one river, ascending another river to spawn. Having found a suitable spawning place, which is generally sought for at or near her own place of birth, the female fish excavates a hollow by the motion of her tail, acting as a fan upon the gravel, which is termed the *redd*. The male,

meanwhile, hovers about, and makes furious attacks upon any other male that may come near, and severe wounds are given and received, often leading to fatal results. When the *redd*, or nest, is partly formed, the female deposits her eggs in the hollow or trough which she has formed, and the male fish remains close alongside, quivering with excitement, and sheds his milt or spermatic fluid over the ova, which become fertilized by the process. The female covers up the ova by fanning the gravel over them in the direction of the current with her tail. This process is repeated day after day, until all the ova are deposited, the fishes retiring into some sheltered pool to rest after each effort. When the spawning is over, the fish become thin, poor, and unfit for food, and many of the males, and some females, die of exhaustion. In fact, it is asserted, that where salmon have to make very long and fatiguing journeys to deposit their spawn, as happens in some of the American rivers, that they are never known to return to the sea. When the period of spawning approaches, the male salmon has a cartilaginous excrescence on the point of his under jaw, which, like the

antlers of the deer, grows with great rapidity at this time. This protuberance is common to nearly all the varieties of salmon and trout, but is developed to a much greater extent in the salmon, and especially in the *Salmo quinnat*, or Californian salmon, found on the west coast of North America. The horny excrescence turns upward, and is sometimes several inches in length; in some cases a corresponding hollow is formed in the upper jaw, the protuberance being occasionally developed to such an extent as to prevent the fish from feeding, and causing it to die of starvation. In the *Salmo salar* it is less prominent, and still less so in the trout, and it gets partially absorbed after the spawning season, to reappear again when the next spawning time returns.

The ova that have been deposited in the gravel of the river bed, or those that escape the dangers to which they are exposed from their many natural enemies, remain for a period ranging from 50 to 130 days, before hatching. The period of incubation varies, according to the temperature of the water. It has been found that salmon or trout ova

will hatch in about 50 days, in water at a temperature of 50 deg.; every degree above or below this temperature shortens or lengthens the time of incubation by five days. They would eventually hatch out, even if the water of the stream were at freezing point, but if once subjected to a temperature much below 32 deg., it is said that their vitality is destroyed.

The ova of the *Salmo salar*, when from a ripe fish in the best condition, are almost exactly a quarter of an inch in diameter. They are nearly globular, and of a transparent pink colour. Those of the *Salmo quinnat*, or Californian salmon, are considerably larger, and are about one-third of an inch in diameter. They are very easily measured in this way: take a board and place it in a sloping position, and lay a foot rule on its side, with the graduated edge on the side next the highest part of the board. Place a few eggs above the rule on the board and cause them to run together, and then count the number which lie opposite three or four inches, and find the average number to the inch. One lot of English salmon ova that I measured were exactly four to the inch, or a quarter of an inch in

diameter. The eggs in another lot were nine to two inches, or two-ninths of an inch in diameter. The number of ova deposited by a female trout or salmon is about 1000 to each pound weight of the fish. Different fish vary greatly in the proportionate number of ova to the size or weight of the fish. Mr. Frank Buckland, in his valuable work on "Fish Hatching," gives the result of careful calculations of the number of eggs which different kinds of fish are found to contain. A jack of 4½ lbs. weight had 42,840; a perch of ½lb. 20,592; a roach of ¾lb. 480,480; a brill of 4 lbs. 239,775; a turbot of 8 lbs. 385,200; and a cod of 20 lbs. 4,872,000. From the enormous quantity of ova produced, it will be seen that if anything near these numbers were to come to maturity, both rivers and seas would become, as *Punch's* Irishman said, "stiff wid 'em;" and as we do not find this redundancy of fish life, there must be an enormous waste, or loss, of both ova and young fish. In fact, the proportionate numbers of ova to the size of the fish may be taken as an indication of the risk to be run by the fish, which an actuary might calculate from these data. It has been estimated from close ob-

servation, that out of 1000 salmon eggs left to be hatched in the natural way, only one is allowed to reach the marketable stage, when the fish is fit for the table, as a grilse or an adult salmon. When a female salmon or trout is spawning, other trout and salmon lie in wait, and devour the ova greedily. In fact, ova are a most killing bait, and their use is prohibited in England as being unsportsmanlike. Eels, lizards, snakes, and birds devour them; droughts and frosts may cause them to perish; and when the young fry is hatched, it is still more liable to danger, as it is extremely helpless in its *alevin* state. Notwithstanding all these perils, were it not for the engines of destruction brought against them by man, the rivers would swarm with salmon and trout, as has been the case in former times in Scotland, and is still so in some of the American rivers. If man has destroyed, however, science has given him the means to replace, and where only one in a thousand has come to maturity naturally, one in five may do so with artificial hatching, and rearing.

The most approved mode of hatching salmon and trout, is to place the ova on fine

gravel in shallow boxes, and allow a brisk current to flow over them. The dead ova must be removed, or they soon generate a byssus or fungoid growth, which is fatal to any live ovum which it touches. This fungus grows with such rapidity that in a few hours it extends its thread-like arms and catches any living egg within reach, inevitably causing speedy destruction of the vital principle. Another danger in hatching is the slimy deposit, which falls even from the purest water, if not well filtered. The remedy for this is a good filtering arrangement, and the use of a garden watering-pot to wash the ova with a brisk shower, when any deposit becomes visible. The slime is injurious in preventing the proper supply of oxygen, required by the egg to vivify the embryo, from reaching it, and if the deposit be allowed to remain long on the ovum, it causes certain death to the embryo. The temperature of the water is another very important point, and the coolest water is to be preferred, as fish hatched in cold water are said to be more robust than those hatched at higher temperatures. A good spring, if not impregnated with any injurious mineral substance, is the best, as the tempera-

ture varies little, and the water is generally free from sediment. Any good water will do, however, even if muddy, provided some pure water can be used occasionally, to enable the attendant to see the ova, and by the very frequent use of the watering-pot to wash off the sediment. I have known trout ova hatched out very successfully by Mr. Richmond, at Learmonth, in water raised by a windmill from the lake, which was so muddy that neither ova nor fish could be seen in it until a few buckets of rain water were poured into the hatching-boxes—which was done daily to make the ova or fish visible, so that dead eggs or fish might be removed. These ova were within a few days of hatching, however, when placed there.

I will now describe the hatching-boxes, which I have used with success, and which are very convenient, and in every way suitable. They are about 6 feet long by 18 inches broad, and 6 inches deep. They are made of three-quarter inch pine boards, covered outside with zinc, and the joints soldered, so as to be water-tight. At the end is an overflow spout made of zinc, a foot in width,

which conducts the water from one box to the other, and which, by being spread out in a thin sheet, gets aërated by being brought into contact with the atmospheric air. On the bottom of these boxes two or three inches of gravel is placed, so that the water runs an inch in depth above the ova, which are distributed over the gravel. The gravel should be about the size of split peas; if larger, the *alevins* bury themselves in it, and when they die cannot be seen, and when decaying will foul the water. If the gravel be smaller, when the watering-pot is used the shower drives it about too much, and buries the ova, and when any die they will produce the dangerous byssus, with the risk of injuring healthy eggs. A shallower box than that mentioned would suit the hatching better, as half an inch of gravel is sufficient—the object of using the gravel being to retain the ova in their places, and to keep them from drifting about with the current, too much motion being injurious to them. When the fish are hatched, however, more depth is required, as the young fish soon become lively, and may jump out of the hatching-boxes, and a deep bed of gravel is useful

to catch and cover particles of food, or the shells and *débris* of hatched eggs.

The hatching of salmon and trout ova requires constant and extreme care and attention. Cleanliness is most important in everything connected with both the ova and the young fish. Pure water is also of great importance, as a very slight thing may destroy a whole batch of eggs. In hatching English salmon, the lower the temperature of the water during the period of incubation the stronger the young fish are likely to be, and 40 to 45 deg. is said to be most suitable. But in no part of Australia are the streams long at these temperatures, even that of the springs rising at 2000 feet above the sea being about 51 deg.; and, unless the ova can bear much higher temperatures than the authorities on the subject seem to think possible, there is little hope of the English salmon succeeding in the Australian climate. The brown trout or *Salmo fario*, however, which in England is found in the same streams with the salmon, bears the temperature of our streams admirably, and the ova hatch out successfully at a temperature of 55 to 60 deg. without any great loss.

The best place to select as a site for the artificial hatching of these fish is undoubtedly at a spring, where the temperature of the water is little influenced by atmospheric changes. The water should be free from mineral taint, and of considerable volume, so as to insure a good current. The ova are generally spawned at the time when the temperature of the streams is at its minimum, and it is therefore very desirable to have the command of both spring and brook water, so that either or both can be used if desired. When salmon ova are sent from England to the Southern Hemisphere, they arrive before the end of summer, or about the 20th of March, when the water still retains a high temperature, being the effect of the solar rays, and, unless a spring with a low temperature be at command, the water may be found up to 65 deg. on a hot day, being high enough to make any chance of success very doubtful. Even if ice be used, the difficulty of keeping the temperature sufficiently low, both night and day, for a lengthened period, is found to hinder the success of the experiment. The Californian salmon ova arrive at a better time,

or about the 20th November; and although the summer has then set in, the water of the streams has not yet been greatly raised in temperature, and, the hatching-out going on with great rapidity, the young fish have made very considerable growth before the great heat of summer sets in. This fish having different habits from the *Salmo salar*, and spawning about the end of summer, the young fry are better able to resist a high temperature, which, if injurious to the ova in hatching, is certainly, up to a certain point, favourable to the growth of the young salmon.

It is a well-ascertained fact, that trout in cold streams or ponds do not grow at the same rate as those of the same age in warmer waters.

In hatching English fish, I should recommend that water be used of as low a temperature as can be procured, whether from spring or brook. With Californian salmon 60 deg. is not at all dangerous to the ova, but higher than this is probably unsafe; 55 to 57 deg. I have found to answer well with them, and the fry will live in water having a brisk current up to 70 deg., or even to 75 deg. But

a much lower temperature in dull, sluggish running water would be dangerous, and the young fry have perished at once, when suddenly placed in water at 80 deg.

My hatching apparatus was erected at a small spring, trickling down an oozy hollow, and rising out of the side of a volcanic hill. To collect the water and protect it from the sun, and from pollution by cattle, I formed a stone drain about three feet in depth down the channel, and collected the water in a small dam, which was filled with loose stones and turfed over. The water comes through the dam in a galvanized-iron pipe, and is not exposed to the sun or to the open air until it reaches the hatching-boxes. It is perfectly pure and free from sediment. The temperature when I first tested it was constant for some months at 53 deg., which was very suitable for fish-hatching. From some unknown cause, which, as the spring rises from the side of an extinct crater, is probably due to volcanic action, it has risen to 62 deg. in summer, or 60 deg. in winter, but the heat is now lessening. The supply is only five pints per minute in summer.

In the stream which runs close by, and which is supplied by numerous springs, a constant current runs at all times, and I have by dams, one above another, retained in its channel, the flood waters which would otherwise run to waste, so as to keep up the supply in the dry season. The channel of the brook is a rocky glen or gorge, and in some places the stream runs underneath large rocks and into cavernous recesses, which lowers the temperature of the water, even in very hot weather, most remarkably. I have found the water at the surface of the dam 79 deg., and flowing over the sluice gate at this temperature, but it was reduced in a distance of 200 yards, lower down the glen, at the hatching-boxes, to 57 deg. The bottom temperature of the dam also, during all the early part of the summer, keeps very low, being 55 deg. at five feet beneath the surface, while the stream from springs running into the dam was 80 deg., and the surface stratum of water in it of the same temperature. On making the discovery that there was this difference of 25 deg. between the top and bottom temperature, I arranged to draw off the water from the bottom of

the dam, instead of allowing it to overflow at the sluice-gate, and thus, by maintaining a lower temperature in the hatching-boxes, contributed greatly to the success of my undertaking.

The water of this stream is dammed up by a little stone and cement work under a rock, and carried by a two-inch galvanized-iron pipe, which is covered with a hay-rope wound round it to protect it from the sun and to keep down the temperature. The hatching-boxes are seven in number; and in addition to them I had a stone and cement race constructed on the ground, divided down the centre, and so arranged that the water would circulate with a gentle current through all the boxes, up one side of the race and down the other. There are little miniature waterfalls from one box to another, to aërate the water, which finally flows through four small ponds fitted with gratings to retain the young fish, when they are sufficiently advanced to require this precaution, and covered with netting to keep off shags and cormorants. The water of the brook being muddy, I had a very elaborate filtering arrangement erected,

which, however, was of little service, as it filtered but a small quantity of water, and I found it better, as the hatching was going on rapidly, to dispense with filtering and make use of a larger stream. The hatching-boxes are at different levels, beginning at four feet above the ground, and going down to two feet, a fall being required from one to the other. Each box is set perfectly level, and the current is regulated by the depth of gravel.

Many experiments as to the best mode of fish-hatching have been tried, and a very efficient apparatus has been invented by the late M. Coste, the great French pisciculturist, consisting of a zinc or iron japanned trough, having movable frames fitted with glass rods, between which the ova lie suspended, allowing any sediment or particles of hatched eggs to fall through, so that they may be cleaned out without disturbing the eggs. This hatching-box obviates the difficulty that has been experienced, of a fungoid growth which is apt to form on wooden hatching-boxes, but it is more suited for an amateur to hatch out a few ova, than for hatching large numbers.

An American discovery, of the advantages to be obtained by the use of charred wood for hatching-boxes, has solved the problem most satisfactorily, it having been found, after a long and severe test, that no fungus appeared on the carbonaceous surface. In one of the hatching-boxes, by way of experiment, I placed a bottom of ribbed glass, but found, after trying this and also a charcoal bed, that nothing suited so well as fine gravel of a dark colour. If the gravel be of a light colour, the dead eggs are less easily seen, from their colour being also white. It is better that the hatching-boxes should be three to four feet above the ground, for convenience in picking out the dead eggs, and for examination of the fish and eggs from time to time. The stone race being on the level of the ground necessitates the kneeling posture in examining them, which becomes very irksome and inconvenient, as the young fish cannot be seen so well, and dead ones may be left in the race, thereby fouling the water, to the injury of the live fish.

The hatching-boxes were each secured at the ends with fine screens of perforated tin.

These must be smaller in the perforations than the finest perforated zinc that I could obtain, which I found would let young fish go through. I first tried woven screens of copper wire, but finding the deaths amongst the ova to increase rapidly, I suspected that something was wrong, and had tin ones inserted instead. I found that I had unwittingly, by the combination of zinc and copper, constructed a galvanic battery, which, no doubt, was destroying the ova. I found that M. Coste had on one occasion made the same mistake, which he described in a paper sent to the *Société Imperiale d'Acclimatation*, and which suggested this as the possible cause of the loss which had occurred. The boxes should also be divided by a screen into two parts, to prevent the young fish from crowding to the end where the water enters, which they are eager to do.

The boxes must be kept carefully covered, so that not a crevice may be left where a bird, mouse, snake, or lizard could enter, as they would make short work of either ova or *alevins* if once they gained access to them. A portion of the cover should be of perforated zinc, to

admit light, which, although not needed during the process of hatching, is essential to the health of the young fish when hatched.

The boxes being all in their places, and the water running well from one to the other throughout, and the screens fitted in their slides, the gravel may be put in them. It should be well washed, and, if river gravel, it should be boiled, so as to kill any eggs of water insects that it may contain. It must first be carefully screened to the right size, one screen taking out the larger gravel, and another the sand and fine gravel. When it is ready, it must be spread smoothly and evenly over the bottom, to such a depth as will leave from half an inch to an inch of water over it, according to the supply. The current should be brisk, but not strong enough to carry away the eggs, as rest is essential to the development of the embryo. When the gravel has been put in the boxes, they are then ready to receive the ova. If these have been packed in snow or ice, they should not be at once placed in water that may be much warmer, but the water should be brought down to, say, 40 deg. by the use of

ice, or some other means of preventing the injurious effects of the shock caused by a sudden change of temperature. Then the ova may be distributed equally in the boxes, and a small stream of water turned on, to bring up the temperature by degrees to that of the water in which they are to be hatched. It is very dangerous to expose the ova to dry air of a high temperature, and they should be placed in the hatching-boxes, moss and all, as the moss can be easily picked out afterwards. Care must be taken not to keep them for any great length of time in still water, as it is likely to kill the embryo, and where water is abundant, a good current should be maintained. A stream of 15 or 20 pints per minute would serve to hatch 50,000 ova, with an occasional shower from the watering-pot; and the water should be made to fall some distance, or be forced through a small aperture under pressure, to aërate it thoroughly. With a stream of four or five pints per minute, 1000 ova may be hatched, or even two or three times that number. But much depends on constant care and attention to minute details, which readily suggest themselves to the attendant.

The moss, and any foreign substance, having been removed, the attendant should use a pair of pincers made of wire about the size of knitting-needles, with the ends turned in a circle with the opening about the size to hold an egg, to pick out dead eggs. The ova should be distributed evenly over the gravel by using a feather from a goose or turkey's wing. A little practice will enable this to be done without touching the eggs, simply by causing a current over them, as, being but little heavier than water, they are easily moved about in it. One thousand eggs can be hatched to the square foot of space in the hatching-boxes, but double this space is better, and after the fish are hatched, much more room and an increased current of water are required to do them justice.

In a new fish-hatching institution lately established by Livingston Stone, a mode of hatching was adopted with success, which greatly economizes space in the hatching-race. The eggs were placed, 10 or 12 layers deep, in baskets made of galvanized wire, and the current was made to rise up through them from below. The baskets were placed

across the current in the hatching-race, and no gravel whatever was used. When hatching was about to commence, the ova were removed to a hatching-race, where they had sufficient room to insure their proper development. This plan was adopted to enable Mr. Stone to hatch out a large number of eggs which he had obtained, but for which he had not been able to get proper appliances made in time to hatch in the ordinary way. The upward current keeps the eggs partially afloat, and a slight motion of the baskets brings the dead eggs to the surface. The plan is useful in bringing eggs intended for transit to a distance to the proper stage of development. The establishment is on a branch of the Columbia river, in the Oregon territory, where the fisheries had been found to be getting less productive.

When a white speck, however small, appears in an egg, it is a sign that the embryo within will die, and speedily the whole egg becomes white and opaque. Dead eggs must be removed as soon as possible, as, if this be not done, the fatal byssus soon appears, and if not removed, spreads from egg to egg, destroying all it touches.

The healthy impregnated ovum of the salmon is of a deep pink colour, and consists of a horny outer shell, which is filled principally with a semi-transparent, viscous fluid, resembling the albumen of a hen's egg, in which may be seen floating the yolk, of a pink colour, and some oil globules of a deeper pink. On closely examining the egg against the light a spot is visible, resembling a light seen through a fog, and this is the embryo of the fish within. After a time a white line appears dimly, curved round inside of the shell, which is the outline of the fish; the bright spot becomes more definite in outline, and a faint dot appears, which is the eye of the fish. After a few days the head and both eyes may be seen dimly, and the egg may be seen to roll about in the current, without apparent cause. At this stage the ova will bear transport better than at any other time, and it is most difficult to move them with safety during the earliest stages of the incubatory process. The knowledge of this fact is of great importance to those engaged in pisciculture.

After the eyes of the young fish are plainly

visible, only a few days will elapse before some of the ova will be hatched out. If the egg be examined at this stage against a strong light, by looking through it the movements of the embryo can be plainly seen inside the semi-transparent shell. At last the interesting process of the development of a living fish from a minute germinal spot floating in albumen, is completed; the young fish becomes too large for its prison, and the shell bursts open, liberating the captive. Where there are many ova hatching out, the observer may be fortunate enough to see this very interesting phenomenon take place before his eyes. Sometimes the head comes out first, and the shell adheres to the sac for a time, till a last grand effort frees the young *alevin*, which lies panting with the exertion and the novelty of its position, vigorously exercising its lungs, or, rather, the breathing apparatus in its gills, which performs the same office.

At first a few fish will hatch during two or three days, and then the great bulk of them will come, the whole being hatched in about 10 or 12 days; and some unimpregnated ova,

in which no fish exist, will remain good and sound to the last.

During the time of hatching, the watering-pot should be freely used, and indeed all through the time of incubation, when sediment becomes troublesome. When the hatching is going on, the empty shells and *débris* of the eggs are by this means washed away and get collected against the screens, when they can be removed. The current of water should now be increased a little, and a slightly higher temperature is not objectionable. The *alevin* stage of the fish is the least troublesome time in the rearing of young trout or salmon. They do not require any food, and are little liable to loss at this period. A little very fine earthy gravel should be spread over the coarser gravel in the hatching-boxes, to cover up and deodorize any particles of decaying eggs which may be in the gravel. Of course, all dead fish should be removed at once, as decay sets in very speedily. Every second day, a sprinkling of fine volcanic earth, or good loam, not of an adhesive nature, is very beneficial, and it should be scattered over the surface of the water. The shower should be

used two or three times daily, and everything should be kept scrupulously clean. The *alevins* collect in clusters in corners sheltered from the current, and lie on their sides closely packed together, like herrings in a barrel, sometimes taking a start and going about for a foot or two.

The appearance of the newly hatched fish is not the least like that of a salmon. There appears a mass of transparent pink gum, with a thin body attached to it about three-quarters of an inch in length. This is the body of the fish, and the large, shapeless head and enormous goggle eyes are very remarkable. The dorsal, or back fin, seems to extend the whole way from the head to the tail. The body and umbilical appendage seem larger than the egg they have just emerged from. The sac is elongated and tapers slightly, and contains the food required by the fish during its *alevin* stage. As the *alevin* grows, the sac gradually diminishes, until it is quite absorbed. At this stage the fish is perfectly formed, the continuous back fin having divided into the dorsal, adipose, and caudal fins, and the body having become developed, in proportion to the

head, into a perfectly formed and shapely fish.

When the umbilical sac is absorbed, the young salmon is called a parr, and already the transverse bars may be seen on the sides of the fish, which continue to distinguish the parr until it reaches the smolt stage. These bars are common to most, if not all, the varïeties of trout and salmon, which at this early stage are very similar in appearance, and are most difficult to distinguish from each other. The migratory species, however, have a larger number of bars than the non-migratory.

Although the *alevins* do not require much, or any, food until the umbilical sac is absorbed, it is wise to begin to offer them some a little before that stage is reached by the earliest hatched amongst them; otherwise, should they get ravenously hungry before food is offered, some may get too weak, and perish without being able to partake of the unaccustomed food, or they may gorge themselves, causing illness, heavy losses being the result. The food which it is most convenient to use, and which answers exceedingly well, is the

liver of sheep or other animals, boiled and grated on a nutmeg-grater, then rubbed into the consistency of cream with a little water, by the use of a table-knife on a board. In this way the particles are made fine enough, so as not to choke the young fish. The meat must be perfectly fresh, and should be prepared frequently; and care should be taken that not too much is given at a time, as it decays very speedily, and will foul the water. Other food is recommended by some, such as eggs, sour milk, and the minute roe of sea fish; but liver is easily obtained, and is, on the whole, more convenient than any other food.

Earth should be used at least every second day, a little being sprinkled all over the hatching-box, and the fish will be found to disperse themselves over every inch of the box, hunting about for something they find in it, and seeming to enjoy it greatly. It probably contains microscopic insects invisible to the unaided human eye. Whether it be the variety of food obtained from the earth, or some mineral constituent in it that they require, certain it is that the use of earth is a most important part of their treatment. It

also acts as a deodorizer and purifier of any decaying or fæcal matter which may be in the gravel.

The shower should also be continued two or three times daily, and two or three small sods, with the grass on them, are useful to supply a little vegetable diet. The food should be given three or four times a day at first, in very small quantities. It is stated that a fish eats one-hundredth part of his weight daily, and this rule may give some indication of the quantity of food to be given.

CHAPTER XIV.

THE LIBERATION OF YOUNG FISH.

JUST before the *alevins* lose their sacs, and while they require but little food, is a good time to transport them, especially where the distance to their destination is great. At this stage they are much more easily carried than when they grow to a considerably larger size; and many think that, by being early accustomed to face danger, they are more likely to come successfully through the perils they have to encounter, than if trained to come for their food, and partially domesticated, without having any knowledge of the dangers that they must encounter when liberated in the open waters. Where salmon can be retained in ponds until they attain the smolt stage, and put on their silvery coat preparatory to commencing their migration to the sea, and where every care is taken of them, it would, no

doubt, be more in their favour, and a larger number would probably survive, than if they had been earlier exposed to all the perils of the river; but if they had to be transported to a distance before being liberated, the risk of loss, with fish of the size that they would then have attained, would more than counterbalance the loss from their early liberation.

CHAPTER XV.

TRANSPORT OF LIVE FISH.

The transport of live fish to long distances has been a most difficult problem, until it was discovered that the main want of the fish was atmospheric air, or the oxygen contained in it. It may seem strange, at first sight, that fish should need air, when they always live in the water, and still more so that they cannot rise to the surface, and obtain the needed oxygen from the air that is so easily within their reach. It is found in practice, however, that few river fish will live long in a vessel of still water, unless there be a current running into it. It is true that pond-fish can do so, but they have the faculty of sucking in air at the surface of the water, as may often be seen in the glass globes in which the golden carp are usually kept.

An interesting experiment is detailed in

Land and Water, in which a number of adult specimens of salmon, perch, black bass, etc., were conveyed from the Atlantic to the Pacific Ocean, from New York to California.

The fish were carried in a waggon fitted up expressly for the purpose, and belonging to the United States Fish Commission. Round the waggon are ranged tanks to hold the fish, of a convenient size for moving about in transit. Each has a siphon of india-rubber, to allow the water to be drawn off and renewed, when necessary, without disturbing the fish.

A special arrangement provides for aërating the water during the journey. On one of the axles of the waggon is fixed a wheel, which, by means of an endless belt, drives an air-pump, which is worked constantly while the train is in motion. The air is forced into an india-rubber tube having a branch to each tank, each branch being fitted with a stop-cock, to regulate the supply of air. By the aid of this ingenious arrangement, more than 150 breeding fish, of nine varieties, were carried without serious loss across the American continent. For the sea fish, a supply of sea-water was sent from California

to meet them, to renew the water on the journey, and was found of great service.

In China, live fish are carried to market on barges and boats down the rivers and canals, in tanks into which a constant shower of water is allowed to fall from a bamboo pierced with holes and connected with another tank, which is replenished from time to time. The water, by being brought into contact with the air, gets aërated, and so keeps the fish supplied with oxygen, and in a healthy state. An eye-witness was surprised to find that, after the great care that was taken of the fish on the journey, when they reached their destination they were taken out of the water, and pitched into a boat in the most careless way, to be carried off to the market for sale.

The great secret of success in transporting live fish safely, is to keep the water in which they are carried at the same temperature as that to which they have been accustomed, by using ice if necessary; and to have the water constantly and thoroughly aërated. For all the varieties of salmon and trout, a low temperature in transit is much safer than a comparatively high one. At 50 to 55 deg. the risk

is little, if other important matters be carefully attended to. In the winter season, and with small numbers, it is comparatively easy to transport them to any reasonable distance, but in summer the risk is enormously increased.

The plan that I adopted, with great success, was to put the fish into cans resembling the milk-cans used by dairymen for carrying their milk. A perforated lid, besides the cover, was used to prevent the fish from being carried out with the current, when changing the water; and the cans could be placed under a tap or stream, if necessary, during the journey, without the fish being able to get away. The cover was also perforated, to give a free supply of air. In the transit of fish, as already stated, the most important point is to keep up a constant supply of air in the water. It is found that water is composed of rounded globules, which admit of a certain quantity of air in the interstices. Fish require oxygen, which they respire by their gills, which fulfil the functions of the lungs in the mammalia. When all the air (the quantity of which is very limited) which is contained in a vessel of water has been deprived of its

oxygen by being inhaled in passing through the gills, the fish must become suffocated, as certainly as would a human being, if shut up in a close box without fresh air. Certain fish do not suffer in this way; but active fish, such as salmon and trout, which are accustomed to highly aërated water in the rapid rivers or the seas which they frequent, perish very quickly if confined in a small vessel of water without a current. The remedy is to give a supply of air at intervals, and the simplest and most effective method of attaining this object is by using a strong pair of bellows, and an india-rubber tube about two feet in length, to force the air to the bottom of the fish-can.

The tube should be corked at the end, and pierced with a number of minute holes with a fine wire made red-hot, so as to bring the air into contact with as large a surface of water as possible. When fish turn on their sides, and are perishing for want of air, a few strokes of the bellows act upon them like magic, and they immediately recover. In practice, I used the bellows every 15 minutes, although less frequently would probably have done equally

well; but it is better to err on the safe side.

In the transport of fish, the danger increases greatly with high temperatures. In distributing the Californian salmon, I kept them at the temperature at which they had been hatched, and to which they had afterwards been accustomed, which was 55 to 57, and occasionally up to 60 deg., and I am satisfied that my doing so contributed greatly to the successful result which was attained.

Plenty of room in the cans is also very important, as fish will go safely in small numbers, when they would perish if crowded. It is easy to keep the temperature down to any point that may be desired, by the use of wet covers to the fish-cans, and by having a supply of ice packed in sawdust, to use on the journey.

A bucket in which to wash the ice is necessary, also a thermometer, and a small net to pour the water into when liberating the fish, so as to be able to count them, and to ascertain if any have died. The net is also of great service, when the water is changed on the journey. This I should not recommend

to be done on a journey of 18 or 20 hours' duration, if the fish have plenty of room, and no food be given to them; but in a long journey the water gets foul, and should then be changed. Good water from a spring or running creek, free from mineral taint, is the best, or rain water if good, but changing the water is somewhat dangerous; and the temperature should be carefully attended to, so as to prevent a too sudden shock to the fish. A lower temperature than 50 deg. for salmon or trout is unnecessary in transit, and if too low it may even be dangerous, though higher than 60 deg. should be avoided. Before placing the fish in the fresh water, its temperature should be brought as near as possible to that from which they have been taken, or the water brought to the desired temperature by pouring in fresh water slowly. Fish do not seem to suffer by being poured out with the water from one vessel to another; and by the use of a small net made by stretching some mosquito netting over a hoop of wire, the fish can be transferred from one can to another, and their number ascertained, by only allowing a few to go on the net with a little water

at a time, and then allowing them to spring off the net, into the vessel placed ready to receive them.

Tobacco smoke is most injurious and poisonous to salmon fry in transit, especially if the bellows be used while the air is impregnated with it. The essential oil of tobacco is a volatile essence known as nicotine. It is a deadly poison; and when air filled with tobacco smoke is forced into the cans, the nicotine is condensed and remains in the water, causing certain death to the fish, should the quantity of the poison be sufficient. Even the fumes and smoke from the locomotive may in some cases prove dangerous. I have had losses occur where the cause could not be traced; and it is singular that only a part will sometimes die, and the remainder seem unaffected. Motion of the vessel, however violent, does not seem to hurt the fish, at any rate after the first few miles of the journey, and, in fact, rather tends to benefit them, by the aëration of the water caused by its splashing about in the cans.

In sending off the different lots of fish to their destinations I gave written instructions

to the attendant in nearly the following form :—

1. Keep the water thoroughly aërated by using the bellows every 15 minutes.
2. Keep them in water of the same temperature as that to which they have been accustomed. This can be effected by means of ice.
3. Use the water in which they have been reared, and keep everything clean about them.
4. Take out all dead fish at least once a day, as they putrefy quickly and foul the water.
5. Give them a fresh supply of the same water if possible, or of water equally pure, every 24 hours, and give but little food in transit.
6. Tobacco smoke will surely kill them.
7. Turn out about 20 or 30 in one place in shallows, and do not subject them to a too sudden change of temperature.

Abundance of space in the cans is of great importance, especially for large fish. Two thousand *alevins* have been carried success-

fully in a 10-gallon can, but 150 mullet, about six inches long, could not be kept alive in the same vessel, although about 30 would travel safely. Fish differ greatly in this respect, some dying at once when caught in a net. Perch and carp can be carried in wet grass or in moss for hours without injury, and in Germany are taken to market in this way, and if not sold, brought back to the ponds alive and well. Crayfish or lobsters will live out of water for a very long time, and may be taken hundreds of miles by giving them a drink occasionally. I have taken Murray lobsters from Echuca to Longerenong on the Wimmera river, being a distance of about 300 miles, a great part of the way by coach, with little loss. Flounders can be carried in water with little risk; also whiting, bream, and mullet; but sand-eels, garfish, and trevale are very difficult to transport alive.

CHAPTER XVI.

THE THIRD IMPORTATION OF ENGLISH SALMON OVA TO VICTORIA.

The experiments made to introduce the English salmon to Victoria not having been very conclusive, I was still desirous of making another experiment on a small scale to test the point, and learning that the s.s. *Chimborazo* was bringing a shipment of English salmon ova for the New Zealand Government, I considered that it would be a good opportunity of ascertaining whether the English salmon could be successfully hatched and reared in Victorian waters, so I telegraphed to Sir George Grey as follows :—" Can you spare 3000 salmon ova, ex *Chimborazo*, for experiment here? Will pay cost." The reply came promptly to the following effect :—" You are welcome to 3000 salmon ova from the *Chimborazo*. We cannot accept payment."

This very generous offer on behalf of the New Zealand Government I at once determined to accept, although, as I had joined with them in half the cost of a previous shipment by the *Durham*, I expected that my present request would have been granted on the same arrangement of my paying a proportionate part of the cost of the shipment. On the arrival of the *Chimborazo*, I found that the boxes containing the ova were carefully packed in the icehouse beneath the ice, and that between two and three feet of ice still remained over them. The total number of ova shipped was about 50,000, and they were packed in 55 boxes. There was also a box of the ova of the common trout. On the ice being removed the boxes were handed up, and the lids of some of them having been damaged, Mr. Howard, who came over from New Zealand to take charge of the ova on their transhipment into the *Alhambra*, examined the eggs by lifting up the moss covering them, and it was at once evident that the great bulk of those in four of the boxes so examined had perished, as very few healthy ova could be seen. He handed over to me three other

boxes, with the remark that he did not think they were worth taking away. I had them placed in a larger box with ice above them, and took them direct to the ice-works, where I opened them in the ice-room, at a temperature of 32 deg. The boxes were differently packed. One, with a Y on it, was packed by Mr. J. A. Youl, and had, in addition to the moss, a layer of charcoal at the bottom; the other two had been packed by Mr. Frank Buckland. I picked out the ova that appeared healthy, and counted the whole of the ova in these two boxes, and found that only 270 ova remained showing any signs of vitality, out of a total of about 1500. On the other box being opened I was delighted to find the ova bright, transparent, and of a fine pink colour. I could only find four dead ova, and did not further disturb the box. These ova were much larger, approaching in this respect to the Californian ova, and had evidently been taken at the right time from a "ripe" fish in the best condition. The other two boxes contained smaller-sized ova, of a paler colour and more irregular in form, being in many instances oval-shaped, and wanting in the bright look of healthy ova.

Their appearance reminded me forcibly of my unfortunate shipment of 100,000 eggs by the *Durham*, from which only five fish were hatched.

It may be remarked that I should not "look a gift horse in the mouth," but it is only at the end of a long voyage that defects in the mode of sending fish ova can be seen and pointed out; and it is for the benefit of all who are interested in pisciculture that the actual facts should be made known, so that errors may be discovered and avoided in future. Whether the American pisciculturists are more experienced, or the American salmon ova are less delicate, there is no doubt that the Americans have been more successful in their shipments of ova, and that our English friends may learn something from them as to the *modus operandi* which has given such satisfactory results. From the Californian ova being usually on the point of hatching on their reaching Melbourne, it is evident that the hatching process is advanced to a certain stage before they are shipped, which enables them to stand the voyage better, and gives the opportunity of rejecting before shipment

any eggs which may perish or remain unimpregnated. It is my opinion that until this plan be adopted, no future shipments of English salmon ova can be sent, with any hope of results being obtained that will be anything like satisfactory. The voyage is now so much shortened by the great speed of the new line of fast steamers, that there is no danger of the ova hatching out on the voyage, even if the incubation be advanced to the stage when the half of the time required has elapsed.

The damage done to the broken boxes did not injure the ova; one of these boxes, also, had a Y on it, and the ova in it were no better than those in the others, showing that the difference was more in the ova than in the packing.

On account of the high temperature of the waters at the time, I thought it better to leave the boxes of ova in the icehouse for two or three weeks—where the process of incubation would proceed slowly—until the heat of summer was over, when they were taken to Ercildoune and placed in the hatching-boxes there.

On examination of the ova, it was found

that only about 200 looked as if likely to hatch, these being all out of one box which had been packed by Mr. Youl. After about a fortnight these commenced to hatch, and about 150 fine healthy young fish were the result. These seemed to thrive well for a time, but after a few days became unhealthy, and commenced to die off without apparent cause. On a close examination I found that some iron pipes had been laid to carry the water through a dam, and these had been coated over with tar, as is usually done to prevent corrosion. I had this water at once cut off, and used only the spring water, which I had before refrained from using on account of its high temperature. The fish continued to die, but a few seemed to improve. They all continued to grow rapidly. Even those that showed evident tokens of being fatally attacked grew larger every day. The first symptom of the ailment was a small white spot on the umbilical sac; after this appeared the fish became dull and sluggish, and swam round in a circle. The white speck increased in size, and in about a week generally proved fatal. A few survived, and of these some

healthy specimens of the *Salmo salar* were still alive, and doing well when I last heard from Australia. They made rapid growth, and at about six months old, were nearly two inches in length, and very thriving and healthy. I shall try to keep these fish in the ponds at Ercildoune until they are of the age to spawn, in the hope that some fertile ova may be obtained from them. This small number could not, at any rate, be expected to do much in stocking a river, taking into account all the dangers to which they would be exposed, and the experiment of retaining them in fresh water may give some very interesting and valuable results.

CHAPTER XVII.

EXPERIMENT OF M. COSTE IN KEEPING SALMON IN FRESH WATER.

In a note to the *Société Imperiale d'Acclimatation* of France, dated March 4, 1859, by M. Jules Cloquet, the statement is made that salmon have been found to propagate their species in artificial ponds of fresh water. The details are of so much interest that I have made the following translation for the benefit of English readers:—"I have the honour to make known to the society a discovery which, it appears to me, is destined to exercise a marked influence upon the future progress of pisciculture in our rivers. I refer to the reproduction of salmon in artificial ponds securely enclosed, in which the fish, shut up from the time of hatching, have never been able to migrate to the sea. This discovery has been made at Saint Lucufa, near Saint Cloud,

in one of the domains of the Emperor, where for several years M. Coste has carried out, under the eyes of his Majesty, some extensive experiments. The little pond which has been the scene of this curious phenomenon is situated in the hollow of a shady valley, and is only about two and a half acres in extent. Its depth is about 20 feet at the embankment, while the depth decreases gradually towards the other end, the bottom being well covered with vegetation. The water is pure and always cold, being supplied by springs from the slopes around, and is sufficiently abundant to form a cascade at the point where it overflows the reservoir. Three years ago this pond was empty while some repairs were in progress, and when the bank was closed the water soon accumulated so as to fill the reservoir. M. Coste placed in it some trout of a year old, which he had placed temporarily, under the surveillance of the Emperor, in a little pond of about six feet square. These trout are now four years old, and are 19 to 22 inches in length. In April and May, 1857, several thousands of young salmon, placed for hatching at the *Collège de France*, two months

before, were liberated in the pond with the trout; and these young salmon, notwithstanding the enemies they had there already, have succeeded so well, that when the pond was netted last month by order of the Emperor, and in the presence of their Majesties, there were caught, in a single draught of the net, more than 220 pounds' weight. These fish are now 22 months old, weigh on the average about a quarter of a pound, and are 10 to 12 inches in length. M. Coste found, to his great surprise, that all these fish were ready to spawn. The females had their ova matured, and some of their eggs were taken and artificially impregnated at the time. I have seen these eggs, and the embryo is so far developed that they will hatch out in a short time. The possibility of the reproduction of the salmon, in ponds where they are closely shut in, is, then, a fact acquired by science. It is shown here in a manner so general that it cannot be looked upon as an exception, and if nothing comes to interfere with this great experiment, the result must be yet more striking next season, when the fish have attained to a larger size.

"From this experiment, it appears also that the first spawning of the salmon takes place at 18 months old, the same as that of the trout, and that the number of eggs of the first spawning is about 200. If these ova are less highly coloured than those of large fish caught in the open waters, this is probably from the flesh of the young salmon not having yet acquired the tint that it would have at a greater age. This removes the last objection that has been made to the raising of salmon in close ponds; but to succeed in this industry, it is necessary to know how to choose conditions favourable for carrying it out."

In the experiment here described, it would have been much more satisfactory if the trout had not been present in the pond, and, singularly enough, no mention is made of their having been caught in the net with the salmon. I have tried to ascertain the final result of this interesting experiment, but have failed to find in the Transactions of the Society any further reference to it. All the authorities agree, however, that salmon detained in fresh water beyond the time of their migration to

the sea, have their development checked, and grow but slowly, and the possibility of obtaining matured ova from them before they go to the sea is a curious scientific fact, rather than a discovery of much practical value. It might, however, be of some utility, where a small number of sea-going fish were retained for the purpose of securing a further supply of ova, for their reproduction before being themselves liberated.

CHAPTER XVIII.

THE IDENTIFICATION OF SALMON AND TROUT.

When the soldiers of Cæsar, in their victorious march upon Gaul and Britain, reached the banks of the Garonne, the saltatory motions of a fish new to them, making his ascent from the sea, obtained for him the specific name that his habits so well justify to the present day, as may be well seen in any river where salmon abound, this fish being able to leap 10 or 12 feet high in ascending waterfalls on the way to its spawning ground. The *Salmo salar* is admittedly the king of fishes; but there are princes and nobles of the family, which bear such a close resemblance to him, that the identification of individuals is in some cases a matter of great difficulty.

The genus *Salmo* presents such diversity of form, caused by differences in food, climate, circumstances, and the quality of the water

of the streams and rivers in which the specimens are found, that the ichthyologist sometimes finds the determination of the identity of individual specimens of the genus a most difficult problem to solve. The difficulties are greater also from the development of the sexual characters materially changing the appearance of the fish at certain seasons, the colour differing most markedly at the breeding season, and in the males the cartilaginous protuberance, which is then formed on the under jaw, completely alters their appearance. Added to this is the ascertained fact that many, if not all, of the species are capable of hybridization, and the hybrids have in some cases been found to be capable of propagating their kind, and of again crossing with the pure race. Hence it is not improbable that there are intermediate forms, connecting—in many cases—the different genera, and rendering identification difficult, if not impossible. The crosses between the salmon and the trout are of rare occurrence in their natural state, but by artificial impregnation this has often been effected. I have failed, however, to find any record of hybrids

from this cross having been proved to be fertile.

There are certain characters which are found to be constant in numbers of individuals, and which are relied upon for identification of the species. These are:—the form of the bones of the cheek and jaws; the size, arrangement, and permanence, or otherwise, of the teeth; the form and development of the fins; the size of the scales indicated by the number of rows above and below the lateral line; the number of the vertebræ, and of the pyloric cæca, which are sac-like appendages to the main gut, which is short and simple.

There are other characters, which are found to be variable, and little reliable as a means of identifying the species, such as the number of the fin rays; the colour, form, size, number, and position of spots and bars, or parr-marks. Although the parr-marks, or transverse bars, are common to all the individual species of the genus, it has been observed that the migratory species have two or three more than the non-migratory kinds. The males attain brighter colours than the females as the spawning season approaches, while the

young of the different migratory species put on a coat of silvery scales, which covers the bluish transverse bars, before they commence their migration to the sea.

The colour of the bottom of the water in which the fish live, as well as that of the water itself, influences greatly their appearance and markings, and, like the chameleon, they have the power, to some extent, of changing their colour in accordance with their surroundings.

The size of the fish is also a very variable character, and cannot be relied upon as a guide to its identification. It is well known that the size of trout depends on the amount and quality of their food, and the extent of the feeding ground available.

It is stated by Günther that the *Salmo fario*, when it inhabits a small mountain pool, with scanty food, never reaches a greater weight than eight ounces; while in a large lake or river, where food is abundant, it attains to a weight of 14 or 16 lbs. It has been found by dissection that these overgrown fish are usually barren, and hence such large specimens, from their well-known

ferocity towards the young of their own species, are very objectionable amongst breeding fish.

The salmonoids that have been introduced to Australian waters, including those of Tasmania, are the *Salmo salar*, *Salmo trutta*, *Salmo fario*, *Salmo eriox*, and the *Salmo quinnat*.

The *Salmo salar* has larger scales than any of the other salmonoids, and the number of rows above and below the lateral line is a means of identifying this fish. Its form is the most elegant and symmetrical of any of the genus; and its speed and power in the water, whether for swimming or leaping up waterfalls, on its toilsome ascent to the spawning beds, are most remarkable. It attains to a length of four or five feet. It has a single longitudinal row of teeth on the *vomer*, or bony plate in the roof of the mouth, which are gradually lost at an early age, except three or four commencing from behind and coming towards the front of the mouth. The dorsal fin has 14 rays, the anal 11, the pectoral 14; the vertebræ number 59 to 60; the pyloric appendages are 53 to 77. The parr has 11

transverse bars. There are 11 or 12 rows of scales transversely from behind the adipose fin, or rayless back fin near the tail, forward to the lateral line. The young of the first and second year are called "parrs;" after they assume the silvery coat, in 12 to 24 months, they are called "smolts," in which stage the scales are very easily removed, and come off on their being handled. On their return from the sea they are called "grilse." After spawning the female is called a "kelt," and the male a "kipper."

The form of the bones of the opercular, or valve-like plates covering the gills and forming the cheek-bones, affords a useful guide to identify the species, the posterior margin of those of the salmon forming nearly a semicircle, which differs in form in the other species.

The salmon trout, or *Salmo trutta*, is a small variety of salmon, the flavour of which is considered by many to equal that of the true salmon. This fish, in different stages, is often taken for the *Salmo eriox*, with which it has been confounded by some otherwise good authorities. The parr has nine or ten

cross-bars, and it is known as the "orange-fin" of some rivers. In its grilse state it is called "whitling," "hirling," or "lammas-man." Its flesh is of a rich pink colour in the best specimens, and it attains a length of two to three feet. It is supposed to be capable of living altogether in fresh water, although a migratory fish, and a number of them have been detained in a pond at New Norfolk, in Tasmania, for about 12 years. All the original stock have died out, but a number of breeding fish of two generations, descended from them, are still retained, but evidently degenerate and wanting in vigour; and although they pair and deposit their spawn regularly every year, their progeny are delicate and difficult to rear, through having been so long deprived of access to the sea.

The fin rays are:—dorsal, 13; anal, 11; pectoral, 15; vertebræ, 59 to 60; pyloric appendages, 49 to 61, *rarely less*. In the grilse state, the top of the dorsal and pectoral, and the hind margin of the caudal, fins are black. The hind margin of the gill-cover is obtusely rounded. It has a single row of teeth on the vomer, sometimes pointing

alternately to the right and left, which soon disappear, except three or four on the front of the vomer. It has 14 to 15 scales in an oblique line forward, from behind the adipose fin to the lateral line. There are 24 to 30 rows of scales above, and about 22 below the lateral line.

Of the *Salmo fario*, or river trout, there are two varieties in Britain (besides the various lake trouts, such as the Loch Leven trout—*S. Levenensis*—which is celebrated for its fine flavour; *S. ferox*, or large lake trout; and several other species). Of these two varieties of the *Salmo fario*, one, the *Salmo fario ausonii* of Günther, sometimes attains to a length of over 30 inches, and weighs over 20 lbs. It is found in the southern parts of England, in Sweden, and on the continent of Europe. It has 13 to 14 rays in its dorsal fin, 10 to 11 in the anal, and 13 in the pectoral; it has 57 to 58 vertebræ, and 38 to 47 pyloric cæca. Its dentition is the most perfect of any of the genus. The body of the vomer has a double row of strong teeth, either opposite or alternate, which do not become lost, as in the migratory salmonoids,

but remain through life. This is the case with all the varieties of *Salmo fario*, whose teeth serve as one of its main distinguishing features. There are 26 to 30 rows of scales above and 21 below the lateral line, and 15 in an oblique direction, from behind the adipose fin forward to the lateral line.

The other variety is much smaller, and inhabits the Scotch and Irish rivers, and some of those in the northern counties of England, both forms being found in Shropshire. The smaller variety is called by Günther the *Salmo fario gaimardi*. It has 59 to 60 vertebræ, and seldom exceeds 15 inches in length. It is the small burn trout of the Highland streams, rarely weighing more than a pound to a pound and a quarter. It has not yet been introduced into the Southern Hemisphere, but the Council of the Melbourne Acclimatization Society has taken steps to obtain, through Mr. Frank Buckland, a shipment of the ova. It is likely that this fish, from its smaller size, would suit Australian streams better than the larger variety; but as, in Britain, it is a more northerly form, it is doubtful whether it may stand the climate so

well in Australia, owing to the high temperature to which it would be subjected.

The "brown trout," or *S. fario ausonii*, is of exceedingly rapid growth, equalling in this respect, if not excelling in its early stage, that of the salmon, and it has the faculty of adapting itself to very different conditions. It does well in the creeks and rivers of Victoria; it thrives in a still pond, where there is little or no current for many months in the summer; and it is able to live in the brackish water of the estuaries of the Tasmanian and New Zealand rivers, when it becomes so changed as to puzzle the *savants* as to its identity. It then becomes, to some extent, migratory, as it is obliged to ascend into fresh water to spawn. This adaptability to circumstances, and its great size, rapid growth, and prolific nature, besides its power of enduring high temperatures, render it exceedingly valuable wherever it has been introduced.

The *Salmo fario* never assumes the silvery garb of the migratory kinds, although at the approach of the breeding season its colours become more brilliant and lustrous.

The *Salmo eriox* (*L. Sys. Nat.*), or *S.*

cambricus of Günther, is a migratory fish, usually known as the "bull trout." It is similar in habits to the salmon, but its flesh is paler in colour and inferior in quality. It is known as a "pink" or "orange fin" in its parr state. It is the "sewin" of Wales, the "grey trout" of some rivers, and the salmon-peal of others. While the *Salmo salar* has 22 to 26 rows of scales above the lateral line, and the *Salmo trutta* 24 to 26, the *Salmo eriox* has 27, and the *Salmo fario* 26 to 30 (Günther). It is not quite equal in size and in rapidity of growth to the salmon, and is less symmetrical, and apparently not so well formed for speed, or with such fine lines, as that fish. It attains to a length of three feet. The *Salmo eriox* has 14 rays in the dorsal fin, 11 to 12 in the anal, 16 in the pectoral. The ventral fin has 9 and the caudal 19 rays; the numbers being constantly the same in these two fins, in all the British species enumerated. The vertebræ are 59 in number, and the pyloric appendages are 39 to 47, *rarely more*. The scales in the smolt stage are very deciduous. There are 14 rows in an oblique direction, from behind

the adipose fin forward to the lateral line, and 20 to 22 below that line. The authorities differ curiously about the identification of this fish. Günther has not been able to obtain specimens of it from Scotland, and seems to consider it indigenous to Wales and the South of England. He thinks it "quite possible" that the typical specimen figured in Yarrell's "British Fishes," "belongs to *Salmo trutta;*" and the Salmon Commissioners of Tasmania are of the opinion that the *Salmo eriox* has not been introduced into that island.

The *Salmo quinnat* has a very distinctive mark from all the other salmonoids imported into Australia. In this fish the anal fin has from 15 to 17 rays, while in each of the three other imported species it has only 11 to 12. The dorsal fin has 13 rays. The vertebræ are 66 in number, and the pyloric cæca 155.

Amid the confused and doubtful distinctions which it has been attempted to found between the different species of the salmonidæ, it is hard to find the way, which is rendered yet more difficult by the many hybrids between the different species. The power of adaptation to circumstances being strong in the genus,

many apparently new species have probably been formed by accidental hybridization in the first instance, and the new form has been fixed by breeding to the same type over a long period; the new race, from being exposed to somewhat altered conditions, becoming apparently a distinct species.

In a preface to the sixth volume of the Catalogue of the fishes in the British Museum, Dr. Günther, the great ichthyologist, remarks: — "The salmonidæ and the vast literature on this family offer so many and so great difficulties to the ichthyologist, that as much patience and time are required for the investigation of a single species, as in other fishes for that of a whole family. The ordinary method followed by naturalists in distinguishing and determining species is here utterly inadequate; and I do not hesitate to assert that no one, however experienced in the study of other families of fishes, will be able to find his way through this labyrinth of variations without long preliminary study, and without a good collection for constant comparison. Sometimes forms are met with so peculiarly and so constantly characterized, that no ich-

thyologist who has seen them will deny their specific rank; but in numerous other cases, one is much tempted to ask whether we have not to deal with a family which, being one of the most recent creation—no fossil true *Salmo* being known—is composed of forms not yet specifically differentiated."

CHAPTER XIX.

THE GROWTH AND DEVELOPMENT OF THE SALMONIDÆ.

The salmon, the trout, and sea trout, in their early stages, grow at nearly the same rate for the first year, the sea trout being rather more advanced. In each of the three varieties mentioned, however, the rate of growth is most unequal in individuals of the same age. If 100 ova of brown trout be taken from the same fish, and hatched out at the same time, at 12 months old some of the young fish will have grown to eight inches in length, while others will not have reached four inches. The same curious difference in the growth of individuals has been observed in salmon and salmon trout.

In no other animal is the difference in the rate of growth of specimens of the same age, and subject to the same conditions, so marked as in the salmonidæ.

When the *alevins* of trout or salmon leave the shell, they are about three-quarters of an inch in length. In about three or four weeks the yolk-sac is absorbed, this result being hastened by a higher temperature, or retarded by a lower one. The young salmon then becomes a parr, and soon the parr-marks can be distinguished; and at three months old, when about two inches in length, these marks are clearly developed. At six months old, the parrs have attained to an average length of three inches, some having reached four inches; at nine months old, their length is four to five inches; and at twelve months, some will have reached seven to seven and a half inches; while the bulk of them remain about five to five-and-a-half inches long, and some, even then, are not over three inches. At this stage a transformation takes place in the migratory species. The salmon parr puts on a coat of silvery scales, covering the parr-marks, which can still be seen on removing the scales, which are loosely attached, and come off easily on handling the fish.

This change takes place immediately before the fish begins its journey to the sea, and the

fish is then called a "smolt." It will then endeavour to leap over any obstacle that may be in the way, in its efforts to get off to the sea, and will even leap out on dry land and perish, in its instinctive desire to reach the ocean.

The smolts begin their journey at about 12 months old, or a little over that time; but here a singular fact has been discovered. Only one-half of the salmon parrs assume the smolt dress, and migrate to the sea in the first season, the remaining half staying another year in the fresh water, and going down to the sea at about the same time of the succeeding year. It has been found that the early migrating fish include pretty equal numbers of both sexes. The female parrs have never been found in fresh water with fully developed roe, but the male parr is sexually matured, and it is no unusual thing to see a male parr of six inches in length waiting to impregnate the ova which are being deposited by a salmon of 15 or 20 lbs. in weight.

In England, the salmon smolts commence their descent early in May, about which time the young salmon of that year are bursting

their shells. The parrs which remain in the river for a second year grow very little during that time, and do not assume the smolt dress until near the time for migrating to the sea in the following spring. It is believed that the smolts which commence their journey to the sea in May, return to the rivers to spawn in four or five months after reaching the sea, having attained a weight of 4 or 5 lbs.; while their brothers and sisters of the same age remain in the river, as parrs of two or three ounces in weight. The young salmon, on its first return from the sea, is called a "grilse;" after it has deposited its spawn, it falls off in condition, and is then unfit for the table, and loses greatly in weight. It returns to the sea, and on its next ascent, in the following season, is called a "salmon," and will then weigh 10 or 12 lbs. It is believed that the transformations and habits of the *Salmo trutta* and *Salmo eriox* are similar to those of the true salmon, but these fish do not attain to the same size.

The *Salmo salar*, when detained in fresh water, has its growth greatly checked. In Scotland, some salmon fry, three to four inches

long, were put in a pond in April, 1831, some of which were caught in the summer of 1833, 2 to 3 lbs. in weight. The flesh was of the best colour, but rather pale.

From experiments made by Mr. Shaw, who was head keeper to the Duke of Buccleuch at Drumlanrig Castle, the rate of growth of the salmon has been clearly ascertained by marking the smolts with silver wire, or by notches on the adipose fin, to identify them on their return from the sea, and many disputed questions about the salmon have thus been set at rest.

It was for a long period believed that the parr was a distinct fish from the salmon, although the absence of ova in any individual instance was a strong argument against this supposition.

Salmon increase in size every succeeding year, and it was no uncommon thing at one time to get salmon of 30 lbs. weight, but few of that size are now caught, as they are killed long before they attain to this weight. They have been caught 40 lbs., 50 lbs., 60 lbs.; and one of the enormous weight of 83 lbs. is recorded.

The *Salmo fario ausonii*, or large brown trout, grows to about six inches in length in 12 months, and specimens of seven or eight inches long may be produced in that time by high feeding. In two years they will measure about 14 inches, and weigh 1 lb.; in three years, about 3 to 4 lbs.; in four years, about 4 to 5 lbs.; and in five years they will weigh 6 or 7 lbs.; and I have caught two of that age, at Ercildoune, which weighed 11 lbs. each. Their growth is influenced greatly by the space they have to roam over, and the quantity of food which is available. Heat stimulates their growth, and warm water will produce larger fish than cold. A large pond will also produce larger fish than a small one. Fish artificially fed, and well cared for, will grow much faster than those that have to seek their food in the natural way. The largest trout that there is any record of having been caught in Victoria is one of about 15½ lbs., which came out of Lake Learmonth; but in Tasmania brown trout of over 20 lbs. have been taken.

Salmon and trout that are well fed will usually spawn at about the age of 22 months;

but some trout will spawn when they are only about a year old.

The hybridization of the different species of salmonoids has been tried successfully, and the hybrids are found to be fertile in every case where they have been observed.

In a paper read before the *Société d'Acclimatation* of France in September, 1877, by M. Rico, director of the establishment of pisciculture of Ruisseau (Seine-et-Oise), details are given of a remarkable experiment, in which the eggs of the *ombre-chevalier*—a salmonoid inhabiting several of the Swiss lakes, with habits similar to that of the *Salmo fario*—were fecundated with the milt of the salmon trout. These ova were hatched in January, 1873, and the *alevins* had grown rapidly, being, at the age of six months, three inches and a half long; at 22 months, averaging seven inches; at 34 months, 11½ inches; and at 42 months, over 13 inches. The females of this new variety produced eggs at the age of 22 months; but as the males had already shed their milt, that of a male trout was used to fertilize the eggs, and these were hatched successfully; the *alevins* made more rapid

growth than trout of the same age, and continued to thrive in a way that indicated a robust constitution. This is an instance of the ease with which even dissimilar kinds of salmonoids can be hybridized, and the progeny not being unfertile indicates a near relationship between the two species. In these experiments, what is called the "dry" system of fertilization of the ova was practised—that is, the ova and the seminal fluid were brought in contact in a pan, without being immersed in water. This system, which was first discovered in Russia, has produced a larger percentage of fertile eggs than the old method of fertilization in water.

On the 1st of August of the year 1878 I examined the different small salmonoids in my ponds at Ercildoune. The Californian salmon had been some time previously divided into two lots, and placed in two small ponds, the larger sized fish in one and the smaller in another. Both lots were regularly fed with liver in the same way. I measured the largest and smallest in each lot, and found in one that the largest fish was four inches and three quarters in length, and the smallest three inches and a half. In

the other lot the largest was four inches and a quarter long, and the smallest three inches. These fish were then about eight months old, but those that I retained were the largest and best fish, or there would have been a much greater difference in their sizes.

These fish were silvery white on the belly and sides, and had 11 or 12 bluish parr-marks very clearly distinguishable. The back had three rows of very dark green round spots, about 18 in number, and numerous small greenish-brown spots above the lateral line. The pectoral, ventral, and anal fins were white in colour; the caudal, dorsal, and adipose fins were dusky on their outer margins.

The young *Salmo salar* from the ova presented by Sir George Grey and brought in the *Chimborazo* when four months old were an inch and a half in length, and showed the parr-marks distinctly. Their growth was then very slow from the low temperature of the water, the spring at which they were placed having been swamped by surface water and the temperature reduced to 47 deg.

I carefully examined the salmonoids bred from Tasmanian ova. They were caught in a

net and drafted into two well-marked varieties; and probably one of these could be again divided into two kinds, although, until further developed, it is difficult to do so with certainty.

The largest variety is a gray-coloured trout, with no red spots, excepting one faint row along the lateral line. These fish have made much more rapid growth than the others of the same age. The largest specimen measured eight inches and a quarter, and the smallest five inches and a quarter. The parr-marks were slightly distinguishable only in the smaller specimens. The pectoral, ventral, and anal fins were yellow; the dorsal had three rows of black spots, the caudal had a black margin, and the adipose fin was of a pink colour on the tip. A specimen sent to Professor McCoy was pronounced by him to belong to *Salmo trutta*. The fin rays are—

D., 12; A., 10; P., 13; pyl. cæc., 63.

There are 14 rows of scales from behind the adipose fin forward to the lateral line, and 25 rows above the lateral line. None of these fish had, up to the end of 1878, commenced to put on their silvery coat.

The smaller Tasmanian salmonoids measured from three and a half to five and a half inches. The dorsal fin had two or three rows of bright-red spots, intermixed with a few black ones; the adipose fin was of a deep-red colour; the caudal fin had red tips slightly tinged with black at the extremities; the pectoral, ventral, and anal fins were yellow. There were 11 to 13 parr-marks plainly distinguishable. On the sides and back were many bright-red spots, intermixed with black ones. Two of this size, which had assumed the silvery coat at about ten months old, were unfortunately carried away by a flood. They were of more elegant form than the others, and distinct in appearance. Their length was about five inches. The scales did not appear to be deciduous. The parr-marks were almost covered by the silvery scales. The dorsal and caudal fins had a dingy margin. These two fish had been placed in a small pond by themselves, that their development might be easily observed. Some of these fish are probably *Salmo fario*, and a few may prove to be *Salmo salar*, as the two silvery fish which escaped probably were. The warmth of the

water, together with high feeding, have caused a rapid development and growth of these fish, especially the *Salmo trutta*, which are much farther advanced than fish of the same age in England; although the milt in the males which were examined was not yet developed. The Tasmanian fish above referred to were about 11 months old when examined on the 1st of August, 1878.

It is a curious circumstance that while Australians are endeavouring to introduce the different varieties of the salmonidæ at the antipodes, none of which existed there naturally, this family of fishes, so valuable to the human race, has been threatened with extinction in the Old World by a new disease which has attacked the salmon and trout in some of the rivers of Scotland, and in the north of England. It is stated that the same disease has also appeared in California. It is said to be caused by a fungoid growth of an orange colour, called *saprolignia ferox*, which attacks the fish and eats its way to the bone, speedily causing the death of the fish. Pollution of the rivers from manufactories, and overstocking, have been assigned as causes of this pest.

The drainage of the country has greatly lessened the minimum flow of the streams, which is doubtless injurious to the fish, and may predispose them to the disease. It is unlikely, however, that this disease could be carried with the salmon ova to Australia.

CHAPTER XX.

AQUICULTURE.

WATER is one of the natural elements which, next to the air we breathe, is of the most importance to the human race. It makes an easy highway for civilization to extend her bounds to the remotest corners of the earth. As a source of power it is invaluable; as a fertilizing agent it is of the utmost benefit to all kinds of animal and vegetable life; but it is from the point of view of its value as an element for the habitation and cultivation of useful fishes that we would at the present time wish to deal with it. In this aspect it becomes mainly important as furnishing a healthy, nourishing, and very welcome and delicious addition to our food supply.

It is asserted, as an undoubted fact, that an acre of water, well stocked with fish, will produce a far larger amount of food for man

than the same extent of best land, and with a far less expenditure of labour; and it is only in old countries, such as China, where the population has overtaken the food supply of the land, that the waters are cultivated as they ought to be, and that fish becomes a main element in the daily food of the mass of the people. With the possibility of obtaining, by scientific aids and appliances, such valuable results from the waters of our streams, rivers, and lakes, and even from the seas which wash our shores, the subject of aquiculture is deserving of our earnest attention. The enormous fecundity of all kinds of fish renders their increase and multiplication easy; and the question of how to turn to the best account this bounty of nature is a study worthy of the highest intellectual powers, and will well repay those who devote their time and attention to it, by results of a kind valuable to the nation.

M. Eugene Simon, who acted as French Consul in China, gives some interesting information as to the extent to which aquiculture is carried on in China, and we should not be above taking a lesson even from the

"heathen Chinee," whom it is the fashion in these days to despise.

M. Simon, in describing the manner in which the waters of China are utilized, states that their fertility is so great that "the streams and rivers, the lakes and canals, with which two-thirds of China is covered, literally swarm with fish, butchers' meat being no more indispensable. It is impossible to form an idea of their fecundity. It is not only in the watercourses that the people fish, but in the rice-fields, and in ponds which retain water for a time after heavy rains; and if we add that there are varieties of fish which increase so prodigiously that they spawn twice in one month, you would not be surprised that fish is sold for one penny per pound, and the most costly at fivepence or sixpence. They fish with nets of all sizes and dimensions, with ground-lines, with tridents, and with cormorants. Fish is the habitual nourishment of about 350 millions of inhabitants, and remains always abundant."

Many of the curious and valuable fish found in China would, no doubt, be worthy of introduction elsewhere. In a recent number of

Nature, reference is made to "M. Dabry de Thiersant, a French *chargé d'affaires*, who has been instrumental in introducing a number of Chinese plants and animals into his native country, and has made arrangements for the importation in quantities of the sitz, one of the most valued fish found in Chinese waters. The fish belongs to the carp family, and when fed on aquatic plants in ponds attains with great rapidity a weight of about 40 lbs. During the past three years, experiments which were made on the fish in the *Jardin d'Acclimatation* have shown it to be well adapted to a European climate; and, as it increases rapidly, it is to be hoped that within a few years it can be introduced extensively throughout Europe." Let us hope that Australia also may soon obtain this valuable fish. We have at command there, however, many useful varieties, which, by a little care and attention, might be multiplied immensely, such as the carp, tench, perch, and trout.

Of desirable fish to introduce and acclimatize in Australian waters the gourami is one of the best, and is said to be most excellent for the table. Some specimens were taken

out there some years ago, by Mr. Joshua, from Mauritius, and arrived in a healthy state; but from some cause unknown, probably the coldness of the water, they all perished the first night after being landed. This fish requires a warm climate, and would probably succeed in the lagoons of the northern parts of Victoria, and in Riverina.

The *Coregonus albus*, or whitefish of the North American lakes, is a fish of great value for the table. It is called the gizzard fish of Canada. It rarely exceeds a foot and a half in length, and a weight of 5 lbs. From its small mouth, it is not dangerous to other fish, its food being insects, larvæ, etc. It is well worthy of introduction, and would succeed best in the colder districts of the colony.

There is an Egyptian fish called the binny, which is most highly esteemed in that country. It is found in the Upper and Lower Nile, where it is very abundant. It is celebrated for the excellence of its flesh, and a proverbial saying attributed to the fish is—"If you know a better than I, do not eat me." There are fishermen at Syout and Kené, who have no

other occupation than fishing for the binny. M. Geoffroi St. Hilaire has identified this fish with the famous *Lepidotus* of the ancients, which, according to Strabo, was the only fish which, together with the *Oxyrhyncus*, was worshipped as sacred all over Egypt. The binny grows to about 20 inches long, but specimens of three feet in length are not uncommon. It is remarkable for the silvery lustre of its scaly coat, which distinguishes it from all the other fish of the Nile. It is one of the cyprinoids, allied to the barbel, and would be a most valuable acquisition in Australia.

In the great Australian salt lakes a vast field is open for a grand experiment in the introduction of the most valuable kinds of sea fish. This idea occurred to me more than three years since, and I determined, should the experiment seem likely to prove successful, to make the attempt to introduce sea fish into Lake Corangamite, which is the largest lake in the colony of Victoria, having an area of about 50,000 acres. I proposed the matter to Mr. J. H. Connor, who formerly represented that district in the Legislative Assembly, and

who had gone to much trouble in conveying various kinds of fresh-water fish to stock the streams and lagoons near Colac; and I offered to pay the cost of an experiment with the desired object in view. He very heartily entered into my scheme, and, as a preparatory measure, obtained from the Government analytical chemist, Mr. Johnson, an analysis of the water of Lake Corangamite. Samples were taken at three different places, which, however, did not vary much from each other. The water contained some earthy impurities which were not taken into account, and the following soluble salts. One imperial gallon yields :—

	Grains.
Chloride of sodium (common salt) ...	1280
Sulphate of sodium	43
Carbonate of sodium	35
Total	1358

Mr. Johnston states that, in his opinion, "this water can be safely trusted not to injure a great variety of fish, the foreign substances present being of the most innocent nature."

This analysis being encouraging, Mr. Connor started with a lot of various kinds of sea fish from Geelong, a proportion of

which reached Corangamite alive, and seemed to enjoy being liberated in their new home. I then placed a further sum at Mr. Connor's disposal, to enable him to place a larger number and a greater variety of fish in the lake. Six different trips were made; and although many died on the way, a large number of fish of a size that indicated the prospect of their soon spawning, were placed in the lake. Mr. Connor wrote to say that he wished to bear the cost of the first trip; but, as he had given his personal care to the experiment all through in the most generous way, I did not think that he should bear any part of the actual outlay. The first lot was placed in the lake on the 3rd of June, 1876, and the last lot on the 25th of June, 1878. The result of this most interesting experiment is not yet known, as, in a lake twenty miles in length, a few fish are not easily found again. There is abundance of food, however, in its waters, including a small shrimp and a kind of whitebait (*Galaxias attenuatus*), which is found in myriads coming up to spawn in its tributaries; and as the water of the lake has been proved by chemical analysis to differ

little from sea water, and to contain nothing deleterious to fish life, it is highly probable that the attempt will be successful. The fish included in the experiment, and liberated alive, have been the following :—

Name of Fish.	Number liberated.
Whiting—*Sillago punctata*	9
Flounder—*Pleuronectes Victoriæ* ...	47
Mullet—*Dajaus Diemensis*	108
Bream—*Caranx Georgianus*	12
Crayfish—*Astacus*	8
Trevale—*Neptonemus Travale*	
Roughy—*Arripis Georgianus*	1
Salmon trout—*Arripis truttaceus* ...	27
Flathead—*Platycephalus Richardsoni* ...	25
Gurnet—*Trigla polyommata*	4
Oyster—*Ostrea*	384

Some trevale and sand-eels died on the way, being very difficult to carry. I accompanied the fish, and saw them liberated on the last occasion ; and, with a few exceptions, they soon recovered from the effects of the journey. The oysters were of several varieties. About 350 live fish were placed in the lake out of about 1000, being a loss of two-thirds on the journey. This loss was mainly caused by putting too many in some of the cans, and from the want of the bellows in the earlier ex-

periments, to aërate the water. Some of the kinds experimented upon could not be taken there alive. On the last occasion I watched with particular attention one trevale, which had a can to itself, but which, with every possible care, died before reaching Corangamite. Oysters can, of course, be carried to any distance in safety. Those deposited in the lake were placed in a most favourable spot, on both sides of a ruined stone wall running about half a mile into the water, where the loose stones will afford good holding ground for the spat, should the oysters live and deposit their spawn there. A portion of them were also put in some rocky ground on the west side of the lake. The numbers of fish given are those that were placed alive in the lake out of three lots, details of some of the other trips not being obtainable. A few carp, perch, trout, and Californian salmon I have also placed in some of its tributaries, which may, at some future time, become of value, and it will be most interesting to watch the result.

It is stated by residents in the neighbourhood, that the waters of Lake Corangamite

have been gradually rising for the last ten years. This is, no doubt, owing to the extensive works by which many swamps and marshy places have been freed from surplus water and drained, so as to become better fitted for pasturage. This increase in the quantity of water in the lake, should it continue, will inevitably cause its waters to overflow into its natural outlet in the Barwon river. Hitherto the evaporation over its large surface has balanced the drainage flowing into it, so that no overflow has occurred; but should its waters rise so as to overflow every season, the amount of salt carried away would necessarily cause the water of the lake to become fresher every year, and it would be interesting to know whether the sea fish introduced there could adapt themselves to the gradual change from salt to fresh water, which would then take place.

The oyster-fisheries of Victoria, that were once productive, have now failed almost entirely, and that colony is dependent upon other places for supplies of that delicious bivalve. Why should not scientific culture restore the productiveness of the old oyster-beds, and with

the knowledge so easily attainable, and by the aid of tiles and fascines, establish fresh beds on suitable parts of the bays and indentations of the coast-line ?

The more careful protection of small and immature fish, and a close time, rigorously enforced, to protect migratory fish during the spawning season, would save valuable kinds, such as the delicious fresh-water herring, or grayling (*Prototroctes maraena*, Günther), now threatened with extinction, and would allow of the natural increase, which is now prevented to a great extent by a wasteful system of killing small fish, and of netting breeding fish on the way to their spawning grounds.

An attempt made in 1877 to introduce the Californian salmon into France proved unsuccessful. Two hundred thousand ova were sent from America, but on their arrival they were found to have perished. Another experiment made in 1878 also failed, but it is to be hoped that a renewed effort will be made to acclimatize this valuable fish in the rivers of France.

The waters of the Mediterranean have no salmon in them, and probably the *Salmo salar*

would not live in the high temperatures of that sea, but it is extremely probable that the Californian salmon would be well suited to the European rivers which debouch into its waters. During the last season 300,000 eggs of this fish were imported by the German Fischerei-Verein, and on their arrival 25,000 of them were found to be in good condition. A portion of the fish hatched from these ova were put into the tributaries of the Danube, and the remainder into those of the Rhine. There are many rivers and streams falling into the Mediterranean, in France, Italy, Austria, Spain, and Portugal, which might be found well suited to the Californian salmon, and the attempt to introduce this valuable fish would be well worthy of the attention of the Governments of the countries interested. The Rhone and its tributaries should be especially well suited for this experiment; also the Po and Adige in Italy, the Ebro and Guadalquiver in Spain, and the Tagus and Guadiana in Portugal, besides many other minor streams of little note, but from which valuable results might be obtained.

In the United States of America the subject

has been warmly taken up by an enlightened Government, and enormous numbers of fish have been hatched artificially and afterwards liberated, greatly increasing thereby the annual results of the fisheries, which had been gradually diminishing, and which tended towards the extinction of the most valuable kinds. The matter is necessarily the business of the Government, as no individual can be expected to breed fish on a large scale, and to liberate them in open waters, where he cannot hope to reap the benefit resulting from his labours.

In Canada and Nova Scotia, establishments for the restocking of the waters by the artificial incubation of fish have been in operation for some time.

In a letter received from Sir Robert Officer, chairman of the Tasmanian Salmon Commissioners, very encouraging accounts are given of the success of the salmonidæ introduced into that colony. He says :—"I have just had the pleasure of receiving your note, in which you ask for a further supply of ova, and in reply I beg to assure you that everything in our power will be done to meet your wishes.

We have this season the prospect of a very large produce of ova and young fish, both in the ponds, and in the Plenty river adjoining, as well as in the other tributaries of the Derwent. The rills connected with the ponds, and the bed of the Plenty for several miles of its course, may be seen thickly studded with the *redds* of the fish, in which will be found, I doubt not, the whole three species of salmonidæ in vast numbers. The Plenty is but one of the many fine streams connected with the Derwent, in which it is scarcely to be questioned that the same promising state of things at this moment exists. The spectacle is one that would delight you to behold."

The fish-breeding establishment of Stormontfield on the Tay, and that at Oughterard in Galway, have produced valuable results. Norway and Sweden have their fish-hatching establishments; Russia and Denmark have theirs at Nikolskoi and Viborg. Germany has now obtained Huningue, and Austria has a piscicultural establishment at Salzburg. Italy has for ages cultivated her lagoons at Comacchio and elsewhere. While all these nations have learned the value and profit to be realized

from the cultivation of their waters and seas, shall Australia remain inactive? The same enterprise which has in a few years raised noble cities where formerly, under the shadow of the eucalyptus and casuarina, only a few bark *mia-mias* of a native race were seen, can and will advance in the culture of the waters of that new continent, until, as knowledge extends, the rivers, streams, lakes, and seas shall teem with the scaly denizens of the deep.

CHAPTER XXI.

THE VALUE OF SALMON FISHERIES.

It is undoubtedly in the cold regions of the North that we must look for the home of the salmon. Sir John Ross, in his Arctic explorations, found salmon so abundant that he could buy 100 lbs.' weight from the Esquimaux for a knife, and enormous quantities were consumed by this people, one having been observed by him to dispose of a stone weight at a meal.

Few nations have been so highly favoured as Scotland in respect to their salmon fisheries, but unfortunately, for want of proper legislation to protect the spawning fish, the value of the fisheries has greatly diminished; and should there not be greater attention paid to this question, and sufficient protection given to the fish, there is a risk of the extinction of the salmon in some of those rivers where they formerly abounded.

In Norway, salmon are also extremely abundant; and in the rivers of the Pacific seaboard of North America, the salmon fisheries are wonderfully productive, the rivers in these countries not having been closely fished till recently. The extension of railways and of rapid steam communication by sea has, by bringing the salmon rivers within reach of markets, caused that fish to become scarce, and, like the deer and other wild game, it would no doubt soon disappear altogether, unless protected by wise legislation.

In a work entitled "The Salmon," by Mr. Alexander Russel, it is stated that the annual value of three Scotch fishery districts, "the Tay, the Spey, and the twin rivers entering the sea at Aberdeen, amounts to nearly £40,000; and from the reports of the Irish Commissioners we learn that in 1862 three Irish railways conveyed 900,000 lbs. of salmon, being equal in weight and treble in value to 15,000 sheep. In Scotland, the Tay alone furnishes annually about 800,000 lbs., being equal in weight and treble in value to 13,000 sheep. The weight of salmon produced by the Spey is equal to the weight of mutton annually yielded

to the butcher by each of several of the smaller counties."

According to the same authority, the value of the Irish fisheries has been stated semi-officially at £200,000 a year. The fisheries of the Duke of Richmond on the Spey are worth about £13,000 annually, and the right to fish in a river often lets for a larger rental than that of a considerable extent of land on each of its banks. In Great Britain a salmon fishery is as saleable a property as houses or land, and is often held by as ancient a title.

In the Oregon territory of the United States, the produce of the fisheries is worth £700,000 or £800,000 annually, and the exports of preserved salmon from the Columbia river and its tributaries in 1877 were so much increased as to be estimated at a value of a million sterling.

It is evident, therefore, that if the experiment of introducing the salmon into Australian waters should prove successful, very valuable pecuniary results may follow in a not very remote future, besides the sport which will be afforded, and which is not the least of the advantages to be expected from the undertaking. There are good grounds for the belief

that the introduction of the salmon is not merely a curious scientific experiment, but that there is a prospect of its proving useful, in adding materially to the food supply of the people.

CHAPTER XXII.

THE DISTRIBUTION AND LIBERATION OF THE CALIFORNIAN SALMON FRY.

When the salmon fry had nearly advanced to the stage in which the umbilical sac is absorbed, I found it necessary to make arrangements for their liberation without delay. While yet in the *alevin* stage, no food is required, and they need less room in the cans in which they are conveyed, than when they have grown to a larger size.

I had many applications for a portion of the fry, for various rivers and streams, from shire and borough councils and from private individuals; and after collecting as much information as possible concerning the various rivers and streams in the colony, I came to the conclusion that the Gippsland rivers, and those streams running into the sea near Cape Otway, were the best suited

for the purpose. The Yarra river also, notwithstanding that its waters are sometimes poisoned by the noxious refuse from many factories, will, I think, prove well suited to the Californian salmon, as their descent and ascent would probably take place after a flood, which would have purified the few miles of the river near Melbourne most dangerous to them; and a swift-swimming fish, that can go 30 miles up the stream in a day, will pass through the most dangerous part of the river, opposite Melbourne, in a few hours. It is impossible to foresee the result of experiments of this kind in a new country, and under new conditions. We have instances of animals introduced here succeeding in the most wonderful way, and of others which seemed to promise equally well, but which have utterly failed, so that the test of experiment is the safest guide.

It is only about 60 years since that a salmon of 20 lbs.' weight was caught in the Thames, near Windsor, notwithstanding that the sewage from millions of people living on its banks was allowed to flow into it; and salmon fry have been re-introduced into

that river by Mr. Frank Buckland within the last few years, with some prospect of success.

The following account of the successful conveyance of the first lot of about 4000 salmon fry from Ercildoune to the Gellibrand river, a fine stream running into the sea some miles to the westward of Cape Otway, was sent by me to the *Argus* of December 20th, 1877, on my return from the trip, which was to me one of great enjoyment:—

"I have just returned from the Cape Otway ranges, where I have been distributing the first lot of the young salmon in the fine streams of that district. I placed the fish in four cans, each capable of containing about ten gallons of water, about 2000 fish in each can, at about two p.m. on Monday. The fish were lifted from the hatching-boxes with a small net, and placed in a pan containing water, which was poured into the cans from time to time, the fish being carried along with the water. A current was kept up in the cans by a stream from a hose, and syphons from one can to the other, the cans being at different levels.

"At half-past four it was time to start for

the railway station. The cans were placed in the express waggon, and protected from the sun and air by thick, padded covers, and the temperature slightly lowered by placing pounded ice in the water. The water in the cans was aërated every 15 minutes by using a pair of bellows and a piece of india-rubber tube, corked at the end, and pierced with small holes, to bring the air which was forced into the water into contact with as large a surface as possible. Fortunately, the weather, though warm, was not oppressive, and it was not difficult, by the occasional use of ice, to keep the temperature of the water from rising, and this ranged at from 54 deg. to 58 deg. throughout the journey. On my arrival at Geelong, Mr. Le Souef was waiting to take charge of two cans containing about 4000 salmon, intended for the Upper Yarra. These, on being examined at Geelong, were found to be strong and lively. On reaching the Barwon at Winchelsea, 200 were given to the station-master, who started off in the moonlight to put them in the river, about 200 yards off. At Birregurra station Mr. Strachan, the occupant of Sir C. Sladen's Ripplevale

estate, took charge of a small can containing 500 of the fry, to place them in the upper waters of the Barwon river. On reaching Colac, at 12 p.m., the cans were transferred to an express waggon, and we at once started for the Gellibrand river by moonlight, so as to lose no time, and to get through in the cool of the night. The road was a pretty good bush track for some miles, till we reached the forest, but as we penetrated further it became more difficult for a wheeled vehicle to get along, owing to fallen logs, ruts, stumps, and the steep ranges and gullies which had to be crossed. At daybreak we reached a hill just above the channel of Love's river, which is the first tributary of the Gellibrand. As the descent was very steep, and much encumbered with fallen timber, we camped and waited for daylight, much enjoying a bush meal by the light of an enormous fire. Our pioneers then cleared a practicable track, and after some difficulty we reached the bank of the stream, and on examination found the salmon were alive and well. A few hundreds were distributed up and down the river in shallows, and a few

hundreds more in a small creek falling into Love's or Porcupine river. Following down Love's river, a few hundred more were liberated in a beautiful stream called the Trout river. The creek was swarming with a native trout (*Galaxias*), which is said to be peculiar to this stream. It is a pretty, spotted fish, growing to about six inches in length, and said to be of excellent flavour. These trout are not at all shy, and will rise to the fly, and afford good sport. I tried to get a specimen, but, having no proper appliances, did not succeed. I was somewhat alarmed at the prospects of the young salmon amongst so many strange fish, and, after liberating 20 or 30 in a little pool, I sent the men up the stream to distribute the rest of the lot, and sat down to watch how they would get on in their new home. On being turned out, the parrs at once turned up-stream bravely, and swam about, examining curiously what must have seemed very new to them. There were about a dozen native trout about three inches long in the little pool, and the young salmon showed their high breeding in entering the society of these strangers in the most self-

possessed manner. The trout, on seeing the strangers come near, darted away as if startled, but after a little they returned; and finding the salmon coming beside them again, one turned and darted at an intruder, who soon showed that he was thoroughbred as far as speed was concerned, by quickly getting away out of danger, and I came to the conclusion that the young salmon would soon be able to take care of themselves.

"After a few hours of very heavy work, through a dense scrub of mimosa, melaleuca, and ferns, underneath the tall stems of the forest gums, we reached the bank of the Gellibrand river about ten o'clock, and liberated the remainder of the fish, partly in a fine creek on the south side of the valley, and partly in the main river. The stream was running with a clear and rapid current, about 20 yards wide, and is greatly encumbered with fallen timber, which bridges the channel over in many places. The temperature of the water was 60 deg. Fahrenheit. The river banks are lined with eucalypti of an enormous height, straight and round as if turned in a lathe, up to 200 feet without a branch. Un-

derneath are giant fern trees, Dicksonias, alsophyllas, and splendid todeas, with brushwood, climbers, and ferns six or eight feet high, and very difficult to penetrate. The soil on the river flats is good enough for anything, and the wonder is that it is not already occupied.

"The fish were netted out of the cans, and at the last the water was poured through a net that any dead fish might be seen. In one can there were nine dead, and in the other 10, being a loss of 19 in all out of 4000, or less than one-half per cent. This result is exceedingly satisfactory."

The fish taken charge of at Geelong by Mr. Le Souef were liberated on the same day, the following particulars having appeared in the *Argus*:—

"The deposit of salmon fry in the head waters of the Yarra was successfully carried out yesterday morning (December 19, 1877). Four cans were despatched from Ercildoune on Monday, and divided at Geelong into two lots. One lot was sent westward, and two cans were brought on to Melbourne. They reached Spencer Street station at 11 p.m., whence they were taken by Mr. Le Souef, the

hon. secretary of the Zoological and Acclimatization Society (accompanied by Mr. Purchas, one of the vice-presidents), to the Badger Creek. The party travelled all night, and reached Coranderrk, at the junction of the Yarra and the Badger, at seven a.m. The fish were carried in two large cans not unlike, in shape and size, the vessels commonly employed by milk-vendors. By the application of ice, the temperature of the water was kept low, and air was injected at intervals by means of a pair of bellows and a perforated india-rubber tube. Mr. Le Souef's party halted a short time at Coranderrk, where additional assistance was obtained, and then drove more than a mile further up the creek. The Badger is a stream which enters the Yarra on the north side, and is the next tributary above the Watts river. No introduced fish have hitherto been placed in the creek, and it is inhabited by no more dangerous residents than the black-fish. Trout were put into the Watts some years ago, and they have since been caught there in considerable numbers. Cod frequent the Yarra below the Watts, but the Badger is perfectly free from inhabitants

likely to prove unfriendly to the young salmon. Two places, about a quarter of a mile apart, were selected for the deposit of the fry, and the operation of ladling them from the cans into the stream was successfully got through before ten o'clock. The fish were in splendid condition, for not more than two dozen (out of several thousands) were found dead. As soon as the fry were liberated, they showed themselves to be lively and strong, and swam about in little shoals, with their heads up-stream, evidently pleased with their new quarters. They averaged about two inches in length. A clear mountain creek like the Badger may be regarded as an excellent nursery. Should the grown fish be able, when they set out for the sea, to pass through the foul water which fills the river in the neighbourhood of Melbourne, a problem of great importance will be happily solved. It is believed that, with the assistance of a seasonable freshet, which they will probably wait for, the salmon will make their way easily into the bay. Similarly, a freshet will help them up again when they want to return to the head waters of the river. So much more important must it be to

domesticate the salmon close to the metropolis, than in the distant rivers of Gippsland, that the few thousand fry risked in the present experiment may be considered well laid out. If success crowns the undertaking, the river will become well stocked in the course of a few years."

The following is a very interesting letter from Mr. Arthur King, who very generously undertook the task of conveying 4000 salmon fry to the Latrobe river. That he was not more successful was certainly from no want of care or attention on his part, as his letter shows that he did not shrink from any hardships in carrying out his undertaking. I had intended to have accompanied Mr. King, but my Parliamentary duties prevented my doing so.

I inspected the fish at Spencer Street, on their arrival from Burrumbeet, and saw at once that they were not doing well, and that many were dead, and others floating on their sides in a sickly state. I at once concluded that they had not had sufficient air, and on trying the bellows and tube, found them to work but poorly, although they were not

altogether inefficient. I then used the garden syringe vigorously for ten minutes, but did not see the usual revival take place, which generally follows when the fish have been suffering from want of oxygen, and I could not make out the cause. I am satisfied that there was no want of care in aërating the water in transit. It appeared, however, that the train was very crowded, and some six or seven passengers had got into the van with the salmon cans, and that they were smoking while the bellows were being used. I am quite certain that the nicotine poison in the fumes of the tobacco, and nothing else, was the cause of the loss of these 2500 salmon fry.

"*December* 27, 1877.

"My dear Sir,

At 11 p.m. on Thursday, 20th December, two cans, containing about 2000 each of the young salmon, were received by myself and a friend (Mr. Elliot), who volunteered to assist me in taking the salmon to the sources of the Latrobe river.

"Unfortunately, when they reached Melbourne (as you yourself saw), the fish appeared

to have suffered on the journey from Ercildoune, in consequence of a defect in the bellows used to infuse fresh air into the cans. Garden syringes had, happily, been provided, by your instructions, in case of accident to the bellows apparatus, and by their means, as well as by the use of the defective bellows, the water had been aërated.

"We started from Melbourne in one of Messrs. Cobb and Co.'s express waggons, and reached Oakleigh at a quarter-past one a.m. on Friday, the 21st. Syringes were used throughout the journey, in order, if possible, to revive the fainting fish.

"An express train having been provided by the Government, the fish were taken on to the Bunyip, which was reached before three a.m.

"In the train sedulous efforts were used, both with the bellows and tube, and with syringes, to aërate the water in the cans, and a considerable number of dead fish were removed.

"At three a.m. a start was made from the Bunyip in one of Messrs. Cobb and Co.'s four-horse coaches, I using one syringe, and Mr. Elliot another, occupying the whole time in

aërating the water as well as we could while the coach was jolted on the road. The Latrobe river was reached at the crossing-place to Walhalla, about five miles from Shady Creek, on the Gippsland road, at eight o'clock in the morning.

"The night had been cool throughout, and the temperature in the cans had never exceeded 53 deg. Fahr. There was, therefore, no need to use the ice, which had been supplied liberally by the Melbourne Ice Company, in aid of the experiment.

"The river temperature was found not to exceed 55 deg. in the warmest place.

"The anxious time had arrived to ascertain how many fish were left alive, after so many had been removed when dead. The journey had been hastened, so as to give a chance to some of the fish to reach their destination alive.

"Counting them carefully, we placed 1500 live fish in various parts of the river.

"Each lot was about 100 in number, and as the little swimmers found themselves at large in their new home, they moved about as if wonderingly, but not in fear, and then

gradually took their course in the shallows near the bank, in every case making their way up the stream.

"The river was clear, and running with a strong current over a sandy bed, through a valley overhung with immense gum trees, blackwood trees, and other growth. Fern trees were growing near the stream.

"Mr. Needham, one of the few residents in the neighbourhood, met the coach on its arrival, and kindly assisted in carrying the cans and placing the fish in the river. He stated that the only fish caught in that part of the river were fine black-fish and a few eels. The swift-swimming salmon have, therefore, nothing to fear from such sluggish neighbours.

"In passing various watercourses, I found the residents in the neighbourhood anxious to have some of the fish left at each; but as there was a doubt whether the sea could be reached by the fish, if left at such places, I was compelled to carry all which could be kept alive to the Latrobe river, which was their original destination, and about whose ample stream I had no doubt at all.

"Throughout the journey the utmost friend-

liness and interest was shown by railway officials, by the *employés* of Messrs. Cobb and Co., and by all the people who were met on the road.

"Mr. Roden, to whom every turn in the road has long been familiar—who drove the first woman along it, and the first baby—himself drove the coach from the Bunyip, rendering all possible assistance, and taking pleasure in driving the first salmon to the Gippsland waters.

"I am, etc.,

"ARTHUR S. KING.

"The Honble. Sir Samuel Wilson."

The following account of the liberation of a portion of the salmon fry in the Wannon and Glenelg rivers will be of interest (*Argus*, January 5):—

"*Shire of Kowree, Council Chambers, Harrow,*

"*December* 27, 1877.

"The Honble. Sir Samuel Wilson, Ercildoune.

"SIR,

"I have the pleasure to inform you that the consignment of salmon you so kindly placed at the disposal of the shire were liberated in splendid condition. I left about

30 with Mr. Brayshay, at Hamilton, who had undertaken to place them in the head waters of the Wannon. On my way through Cavendish, Mr. O'Connor deposited 25 in the Wannon at that place. At Balmoral, Mr. Lang assisted me to distribute about 200 in various suitable spots in the Glenelg. The remainder of the fish were dispersed here and there above and below Harrow, where the arrival of the little strangers received a welcome in true Christmas style, their arrival having been anxiously waited for. A breakdown on the road near Cavendish caused many hours' delay, but thanks to the excellent apparatus supplied, and to your very lucid written instructions, furnished me by Mr. Learmonth, I succeeded in transporting them over 60 miles of rough road, with the loss of only three fish, one of which I found dead at Balmoral, and two at Harrow. The last batch were placed in the Glenelg at eight p.m. on Christmas Day. They seemed as lively and active as at starting from Hamilton, but appeared ravenously hungry. A small white moth, having accidentally fallen into the water, was vigorously attacked, and

carried to the bottom of the bucket with almost lightning rapidity, every time he floated to the surface. The next meeting of our shire council takes place on Wednesday, 2nd prox., when I am sure the councillors will be glad to learn the so far success of this portion of your efforts to improve the piscatorial resources of the colony.

"I beg to remain,

"Your most obedient servant,

"J. S. MACKENZIE,

"*Secretary and Engineer of Kowree Shire.*"

Mr. J. H. Connor, in the letter from which the following extracts are given, furnishes some interesting details concerning the streams near Cape Otway, in which a portion of the salmon fry have been successfully liberated. They were taken to Apollo Bay and Blanket Bay by the Government steamer *Pharos*, on her way to supply the lighthouses in that neighbourhood with stores, for which purpose this vessel is required to go there occasionally. He says:—

"We divided 250 of the fry into four small fish-tins of water, reducing the temperature

well with ice, and proceeded across the windings of the Burrum Burrum River from the sea inland. . . . We liberated the first 65 fish at a point in the river about three miles from the sea; and I may here state that the river runs inland from 10 to 15 miles. It is well and closely shaded with trees of different kinds, and undergrowth. The water is very cold and clear, running over a gravelly bed; just the river, I believe, that will prove to be most suitable for the acclimatization of the salmon. The young fry seemed to enjoy their new home immensely, and quickly headed up the stream, in regular marching order. We followed the course of the river for about four or five miles, and liberated 185 more of the fry (250 in all) at different places in the stream.

"The land near to the river, and fronting the bay, appeared to me to be capable of growing almost anything; and the green clover paddocks are a pleasing sight in themselves at this season of the year. Altogether, I much liked the rather wild and romantic look of the country at and around Apollo Bay, and I venture to say that it will some day be

a place of importance. In our absence, while liberating the fish, the crew of the *Pharos* had landed the stores, so that we were, on our return, enabled to at once proceed to Blanket Bay, where we arrived about 11 o'clock the same morning. . . . We were, without delay, rowed to the shore in the large boat of the *Pharos*, and carried on shore by the sailors, when we at once divided the fish into four fish-tins, largely supplied with iced water, and rolled the tins round with rugs and canvas. Messrs. Stephenson and Walls had, at their own expense, provided pack-horses, all ready . . . and we started for the Aire river. The journey through the bush was very difficult and trying. We crossed the Parker river at about two miles inland from the sea, and took advantage of its delightfully cold and clear water to replenish our fish-tins; and we also placed the tins themselves in the stream for half an hour, at the same time liberating in the water 12 of the young fish. The reason that we did not put more in the Parker is that the falls in it near to the sea are very steep, and the stream is very much blocked up with timber. The fish will

have no difficulty in getting to the sea, but I fear they will not succeed in returning. We reached the Aire at a point near to its junction with the sea. Here a boat had been provided, in which we rowed up the river, with the fish-tins covered with wet rags, the day being very hot. Mr. Walls recommended that we should go up the Ford river, a tributary of the Aire, which we did, and liberated 60 of the young fry in it. We then rowed up the Aire for about four or five miles, and liberated the remainder of the fish, about 175, making in all 247 in the Aire, the Ford, and the Parker rivers, only losing four fish from the total number of 500 received at Ballarat. The Aire river is 20 to 30 yards wide about a mile and a half from the sea, and continues a good width for about two or three miles inland. It is, however, liable to be barred, in certain seasons, with the sand washing in from the ocean. Only recently Messrs. Stevenson and Walls scooped out a passage for its accumulated waters to get to the sea, and thereby considerably reduced the depth of the river, and drained a large extent of swampy land adjoining it. The scenery along the

banks of the stream is beautiful to look at, but the water in the river itself is much warmer than the waters of the Parker or the Burrum Burrum. . . . Altogether, I believe that the experiment to acclimatize the salmon in these rivers will prove to be a success."

The following appeared in the *Argus* of January 19, 1878, and is an account of my trip to Gippsland with the salmon fry intended for distribution in the rivers flowing from the Great Dividing Range known as the Australian Alps, some of which run direct to the sea, and others into the great lakes which receive many of the Gippsland streams, and have their embouchure by the Reeves river, through a shifting sand-bar, into the Pacific Ocean :—

"I had originally intended to have taken the fish intended for Gippsland, and more especially those for the Snowy river, by sea, and had postponed making any arrangements for stocking these rivers, until the return of the Government steamer *Victoria* from her cruise, which I understood was to terminate about Christmas, 1877. An application made by the Zoological and Acclimatization Society to the

Government, for the use of the *Victoria* to take the salmon to Gippsland, had been very favourably received, and on seeing her arrival reported in the *Argus*, I at once wrote to the Commissioner of Trade and Customs, asking that arrangements might be made, as soon as convenient, to send the fish to the entrance to the Gippsland lakes, and to the mouth of the Snowy river, and that the steam launch of the *Cerberus* might be taken, to go through the surf and ascend the Snowy river with the young salmon. Not receiving any reply in a few days, I had an interview with the Hon. Mr. Lalor, who then stated that the *Victoria* could not be sent on this trip, as there was no money to pay the officers and men, on account of the political difficulties between the two Houses of Parliament, and that Captain Stanley, the commander of the *Victoria*, did not consider it safe to land near or to enter the mouth of the Snowy river, unless in very calm weather, as the coast is unsheltered, and a dangerous surf from the Pacific Ocean breaks upon the long stretch of the littoral line known as the Ninety-Mile Beach, near the mouth of the Snowy river. I had an

interview with Captain Stanley, who pointed out the risk of being detained for days, if high winds should blow landwards on that coast, and the danger to the lives of his men should a landing be attempted in such circumstances; and it became evident that the idea of getting the *Victoria* to transport the fish must be abandoned.

"I then applied to the Gippsland Steam Navigation Company, and with great liberality they at once offered to convey the fish free of charge, by any of their steamers, to the lake's entrance, or to any point on their usual route. They also expressed their intention to send a small steamer soon, on an exploring expedition to the Snowy river, which could take the fish at the same time. This very liberal offer I at first intended to accept; but on inquiry I found that many days might be occupied by the trip, and the difficulty of keeping the fish alive for such a long period, together with the risk of windy weather, which might cause further delay, caused me to decide upon taking them overland.

"I then applied to the Minister of Railways, who showed every desire to assist me, and

placed the whole department at my service in the most liberal manner. As it is necessary in the transit of salmon that no delay should occur, I asked for a special train to run during the night, and to go over the contractors' lines as far as practicable.

"I found, on inquiring of Mr. Higinbotham, the engineer to the Railway Department, who kindly offered to assist me, that only four miles of a gap was left in the whole line from Oakleigh to Sale, the rails being laid all the rest of the way. I then applied to the contractors, asking for permission to run a Government train over their uncompleted lines, to convey the salmon fry, which request they at once and most readily granted. They also gave their personal attendance during the night, and furnished men to assist in carrying the cans, and also riding-horses where required. The Railway Department, not having a spare engine to do the work, asked the contractors for the use of their engine on hire, which was most readily granted; and Messrs. Fishbourne and Morton and Messrs. Noonan, with great generosity, not only carried the salmon and a large party over their own line,

but Messrs. Noonan's engine went also all the way to Sale over the Government line, free of any charge to either myself or the Government.

"I arranged with Messrs. Robertson and Wagner to send an express waggon to carry the fish-cans over the four miles of a gap between the ends of the completed railway lines, and also to convey the salmon from Sale to Bairnsdale.

"The conveyance of the salmon beyond this place—which is the furthest point to which Cobb's coaches run—I left to be arranged by the Bairnsdale shire council. However, the day before that fixed for starting, I had a telegram from the secretary to the shire, to the effect that it was 'impossible' to take the salmon by the route I had indicated, and advising me to go by steamer.

"I decided, however, to endeavour to carry out my original plan; and accordingly, on January 13th, 1877, at a quarter-past five p.m., I left Ercildoune with about 2700 salmon fry, all of which were intended for distribution in the Gippsland rivers, except a small number left at Meredith in passing, which were successfully placed in the Moorabool river.

"Soon after leaving Burrumbeet, I noticed that the fry showed symptoms of being sickly, by turning on their sides; and, notwithstanding every care, it soon became evident that a serious loss would occur. At Lal Lal I partially changed the water in one can, which seemed to be the worst, but could not see any improvement, and a number of fish were evidently dying, and my project to take a proportion of the fish to the Snowy river seemed little likely to be realized. With every care and attention that could be devised, and after having, as I thought, mastered all the difficulties attending the transit of these fish, I had the sickening feeling that I could do nothing to prevent the loss of possibly the whole of the lot, and that, after all the trouble I had given to so many people, I should have put them to this inconvenience without any good result. As the night wore on I observed a little improvement, however, and those that remained alive showed plainly that they had recovered from whatever had sickened them. I have not been able to account satisfactorily for this loss, but think it may have been caused by feeding the fry immediately before

starting, to prevent the necessity of doing so in the night, and thereby spoiling the water; and by the fish, from their increased size, owing to their rapid growth, probably requiring more space in the cans than I had given them. The motion of the waggon immediately after their being fed, and the vibration of the train, may have sickened them. It is somewhat curious, however, that out of over 20 lots of fry, serious loss should have occurred only in the two going to Gippsland, and in both cases between Burrumbeet and Melbourne.

"On arriving at Melbourne, Mr. Le Souef was waiting with an express waggon and a spring van (carrying two boxes of ice), to convey the fish to Oakleigh railway station. An express train was waiting there on our arrival, and soon we were on our way at a good rate of speed. On arriving at Buneep, Messrs. Fishbourne and Morton's engine was attached to the van containing the fish, and we sped on through the forest in the darkness.

"Mr. Le Souef was desirous of going through to the Snowy, but owing to the roads being bad, I thought it better not to have too large a party. Mr. O'Brien, of Swan Reach, had

joined the train at Oakleigh, and most kindly offered to drive me through to my destination in his buggy, with three good horses. This offer I gladly accepted, as, in case of accident to the express waggon, it provided a means of saving the fish. Besides his being a most capital whip over very bad roads, his pleasant companionship made the journey a very agreeable one.

"We arrived at the end of the rails without accident, although, from the line being unfenced, and from there being facing points of sidings in various places, and also from the fact of the clearing being insufficient, there was really some danger in running at the rate of 40 miles an hour under the circumstances. The trees along the line are high enough to reach—should any fall—not only the rails, but right across the line so as to touch the trees on the other side, and unless a much wider space is cleared, accidents must occur, during high winds, from fallen trees obstructing the trains.

"The lamps of the express waggon appeared in a few minutes after we reached the unfinished portion of the line, and soon the fish-

cans, ice, etc., were transferred to it. And here I would express my sense of Messrs. Robertson and Wagner's generosity and public spirit, in not only giving the gratuitous use of their horses and coaches, but in the care and trouble they took to send out their road inspector, Mr. Roden, to find a practicable route, and to drive the salmon over this very difficult portion. To get his waggon there, it had to be carried some distance, and lifted over logs and stumps three feet high.

"The first peep of dawn appeared in the east as we left the railway, and the increasing light helped us over the difficulties of the way. More than once the vehicle was on a balance, with two wheels in the air; but willing hands were ready to prevent an upset, by holding on to the waggon, and pushing it up the steep ascents that had to be surmounted. After some heavy work in getting through the forest, and along the railway line, we reached the Little Moe; and on ascertaining by tasting the water that it was good, I examined the cans, and changed the water in those in which there were dead fish. We could then see the smoke of the other train at a distance, coming up to meet us.

"I poured out the water through a small net, which detained the fish, and the living ones drafted themselves out very speedily, by leaping off the net into a can ready placed to receive them. On the dead fish being counted, there were about 950, leaving between 1600 and 1700 fish which were lively and well. From this point onward, all the way to the Snowy river, only four fish died out of the number left, being a much better result than I had expected; and although they were much fewer than I wished to send, there were still enough to stock the rivers they were intended for, in a way to give the experiment a fair trial.

"It was sunrise when we again started, and although the engine seemed near, it took a long time to get up to it, owing to the bad roads; and the waggon was at last forced to stop, the fish-cans, ice, etc., being carried about half a mile to the railway. A party had come out by the train from the Moe to meet the salmon, and, although the hands of some were more used to the pen than to carrying burdens, by their willing assistance we got the fish safely into the Government van

attached to Messrs. Noonan's engine, and steamed away at a rate of speed that promised an early arrival at Sale. The train for Melbourne was to start at eight o'clock, and the station-master at the Moe telegraphed to delay it 15 minutes, till the arrival of the express. However, the powerful engine we had dashed along at such a good rate, that we were in Sale at 25 minutes to eight o'clock; and on reaching the station, I was received by the mayor and council of Sale, and the secretary and councillors of the shire of Avon, and three hearty cheers were given in honour of the event by those assembled on the platform.

"According to arrangement, vehicles were in waiting to convey the salmon. Some 250 went to the Avon river, in charge of Messrs. Little, Lloyd, and Bolden, and the mayor of Sale, with Dr. Macdonald and Messrs. Bushe and Topping, started with 250 more for the Macalister river. Without delay, after leaving written instructions how to act, a start was made with the remainder for Bairnsdale, some 42 miles off. The fish stood the journey well, being attended to every 15

minutes, fresh air being injected, and ice being used, as required, to maintain a temperature of 55 deg. The thermometer, unfortunately, got broken here, but another was provided at Bairnsdale. The weather became very hot during this part of the journey.

"At Bairnsdale, Mr. Howitt, P.M., and Mr. Goold, the president of the shire, were waiting to receive us. The former volunteered to accompany us on horseback to the Snowy river, and, from his thorough acquaintance with the district during the many years he has spent there, no one could better act as guide. A more pleasant companion I would not desire to travel with, and his readiness of resource in an emergency is invaluable in an expedition over such rough country as we had to travel through. It will be remembered that Mr. Howitt went as leader of the relief party sent to learn the fate of the ill-starred expedition of Burke and Wills, and that he accomplished the object of his mission most successfully. His son Charlton, a fine active lad of 13, also rode with us, and rendered good service on many occasions.

"The Mitchell river flows close past Bairns-

dale, and enters Lake King some miles below that place. Being desirous of knowing the temperature of its waters, while counting over the fish intended for it, I asked Mr. Goold to ascertain the surface and bottom temperature of the river. He reported 75 deg. at the surface, and 74 deg. at 11 feet deep. At the time I thought there must be some mistake, but afterwards I had good reason to know that it was quite correct, and a very much higher temperature than I could have desired for the salmon. Without delay, the waggon provided by the shire for conveyance of the fish started for Bruthen, on the river Tambo; and as Bovill, who had come from Ercildoune in attendance on the fish, seemed quite exhausted by want of sleep, I left him behind, to wait my return, and went in the waggon to look after my charge. Mr. O'Brien remained to get some fresh horses, and to feed those he had brought on, and, after some time, he and Mr. Howitt and Charlton overtook us; and Bovill, not liking to be left behind, and feeling stronger after dinner, had come on also.

"We had now left the plain country, where,

at intervals, splendid wheat crops, and well-grassed paddocks, with most substantial fences and stocked with fine cattle, showed the wealth of Gippsland; and we entered the interminable forest of the mountain slopes facing seaward, which extends, without a break, all the way to the New South Wales boundary.

"We stopped at the Nicholson, a fine stream, shaded over by wattles and gums, and running briskly over gravelly fords, into long reaches of deep water. The temperature of the water was here 72 deg. After bringing up the water by degrees from 55 deg. to about 70 deg., to prevent a too sudden shock to the salmon, we liberated a few at a place, in sheltered parts of the current, and in shallow water. There were plenty of young fish in the stream, smaller than the salmon parrs, which proved that there was a good chance for them. The high temperature did not seem to inconvenience the salmon, which headed up-stream, and darted about, evidently enjoying the change.

"The roads became much more difficult to go over, being through a dense forest, and across

deep gullies and high ranges, timbered with a number of different kinds of eucalypti, a variety of Banksia, and a casuarina new to me, and an undergrowth of wattles, dogwood, etc. We arrived at Bruthen about six o'clock.

"The Tambo runs past this place, which is most picturesquely situated, and is surrounded by an amphitheatre of mountain ranges, which seem quite near; and the river winds through alluvial flats, of moderate extent, but of magnificent soil, as the fine crops show very clearly. I expected to have found the water of this river much colder than that of the Mitchell, as we were so much nearer the mountains, but on reaching the stream I found, to my surprise, that it was 75 deg. The water was running swiftly, with a murmuring sound, over a beautiful bed of clean gravel, and was clear, and pleasant to the taste, the stream being 60 yards wide. Two hundred were liberated in the fords here, and they found shelter amongst the gravel from the strong current, which carried them downwards.

"The road beyond Bruthen towards the Snowy river is bad to travel over by daylight, but much worse by night, and Mr.

Howitt advised that we should remain at Bruthen till dawn, and take some rest.

I had prepared a box for a portion of the ice, with perforated zinc inserted in the ends, but it was now nearly empty of ice. We sank this amongst the gravel in the current, and, after equalizing the temperature, poured the salmon, and the water which they were in, out of the cans into the box. The fish evidently enjoyed the change from being in the cans, to a rapid current in a natural stream, and leaped high out of the water in a way I never saw them do before. One got over the box, jumping over six inches high, and swam quickly away; and many leaped much higher, but fell back again. The box was fitted with a close lid, which prevented risk of loss in the night. The current, being strong, carried the fish against the perforated zinc, and kept them there. To lessen the current a wall of loose stones was built round the box, and some placed on the top of it. The fish were fed with grated liver, the lid closed, a rope was tied round it, and fastened to the wheel of the waggon, to prevent its being carried away by a sudden rise in the

river; and after doing justice to our dinner, we retired to very comfortable quarters, with the understanding that we should start at the first peep of dawn.

"Early as I was next morning, I found Mr. Howitt and Charlton before me at the river, in the grey dawn. They had examined the fish, and were just returning to tell me that they were as lively as possible, except two that had got pinned against the zinc by the force of the current, and which were suffocated. I had been very anxious during the night, as I did not anticipate these high temperatures, and I kept waking up, thinking of the salmon. The test was a very severe one. These fish had never before experienced higher temperatures than 60 deg. to 62 deg., and were out of iced water at 55 deg., besides being very young and tender. Should any large portion of them be found to have perished from the heat, it would be of little use, I thought, going further, and the experiment must fail. The news brought by Charlton set my fears at rest; success now seemed certain, and soon we were on our road to the Buchan, the nearest tributary of the Snowy river.

"The road became more difficult as we advanced; deep gullies, with bad crossing-places, alternated with steep hills and bad sidlings. It was found necessary to tie up one or two wheels in going down the precipitous slopes, and occasionally all hands assisted in getting the waggon, with the load, up the steep ascent of some range. A spring was found to be broken in the express waggon, and we stopped to repair it as well as we could, and lessened the quantity of water in the fish-cans, to lighten the load.

"On starting again, a splinter-bar of the buggy broke, in making the ascent out of Stony Creek. The waggon was not delayed, and by the aid of a sapling, some rope, and Mr. Howitt's skill as a bushman, we were soon on the way again.

"It was thought at first that if the fry were put into the Buchan, a tributary of the Snowy, they would find their way there in time, and so accomplish the desired object; but I felt that my undertaking would be incomplete, if I did not get a portion of them placed in the Snowy river. On inquiring we obtained a guide, who promised to conduct us by a

near way, but a bad road, to the Snowy river, near to its junction with the Buchan.

"Two bullock teams were camped on the road, and the drivers were sitting smoking on a log after eating their dinner. As we passed them Bovill got the bellows and tube and commenced blowing into the cans. One bullock-driver started to his feet with a face of astonishment, and an untranslatable exclamation. I fancy we must have been taken by him for a party of escaped lunatics, come over the mountains from the Beechworth Asylum. Both men stood looking after us till lost to sight in the windings of the road. The incident afforded us a good hearty laugh for some time after.

"We came to the Tara Creek, on the watershed of the Snowy—a beautiful small stream of water clear as crystal. It did not taste well, however, and I could not see a single fish after examining it for a long distance, and did not liberate any fish there. After a very rough road, we at last arrived at a hill close to the Buchan river, and from this point the fish were carried on horseback, in small cans, over very precipitous country; and 200 were

liberated in the Buchan, a beautiful stream of good clear water, with beds of clean gravel and small fish in shoals. Our horses were led, and slid down the sandy bank into the stream on their haunches. Only a high hill now separated us from the valley of the Snowy river.

"On ascending the slope, our guide had the can with the fish (about 400) before him on the saddle, and I rode close behind. Suddenly the sandy bank gave way, just as he had surmounted the last ascent, and horse, rider, and fish-can were rolling in the sand. I dismounted in a moment, and ran to save the fish, expecting to see them scattered about on the sand; but although the water had partially escaped, none of the fish were lost, as the perforated top of the can was fastened with a hasp. Thus, within the last mile, the object of our journey was nearly being frustrated. I carried the fish the remainder of the way.

"On arriving at the top of the ridge the Snowy river lay at our feet, but it looked muddy and turbid, as if in flood from recent rains in the hills. It has every indication of

being a rapid mountain stream, subject to heavy floods, which are said to rise 60 feet in a night. There is an island of boulders and water-worn pebbles at its junction with the Buchan, of some 30 acres, completely denuded of soil by the strength of the current. Not liking to put the fish in the muddy water, I carried them to the junction, and wading through the Buchan, I liberated them some distance below the junction, but in the clear water of the Buchan, which did not intermingle for a considerable distance with the muddy waters of the Snowy river—just as is seen at the confluence of the Rhone and the Arve, near Geneva, where the blue waters of the lake unite, but do not mingle with, the muddy waters brought down by the melted snows from Chamounix. I got rather chaffed for wading into the water unnecessarily, but wet clothes did not seem of much consequence at the moment, and the strong heat of the weather soon dried them.

"Mr. Howitt went to make some geological examinations of the pebble and boulder drift, which contained specimens of many varieties of rocks, all rounded and water-worn; even

large blocks of over two feet in diameter had apparently been rolled down by the force of the current in times of flood. The channel of the Snowy river is probably 300 to 400 feet wide, and near its confluence with the Buchan runs between high, steep ranges. It is more than twice the width, and has three or four times the volume, of the Yarra, and runs swiftly over pebbly shoals and rocky rapids. It is said to be often muddy from rains in the hills, but is generally bright and clear. There is a waterfall about 25 miles above the junction, about 12 feet high, but it is not an abrupt descent, and salmon could ascend it easily. There is no other barrier that I could hear of. It is well stocked with fish of good quality. The temperature of its water, to my surprise, was 73½ deg. Higher up the river, no doubt, it is much cooler, and I wished greatly that the salmon could have been first taken there. The Buchan was half a degree warmer, or 74 deg., and this stream seemed to me better suited to salmon than the Snowy, although they will, in my opinion, do well in both rivers. It has been stated that the Californian

salmon goes through waters in its native country up to a temperature of 85 deg. in safety. In the Avon the fry perished at 83 deg. In a brisk current they will live at temperatures that they could not bear in still water, and in all the Gippsland rivers a good stream runs throughout the driest summer. The present season has been exceptionally dry and hot, and my journey took place a few days after midsummer, in the very hottest season of the year.

"After having a short rest and a pot of tea, we retraced our steps and patched up the damaged buggy, pushing along rapidly, and at about ten o'clock on Saturday night reached Gibb's at Stony Creek, and next day Bairnsdale, where I parted with regret from Mr. Howitt and his son, and Mr. O'Brien. The buggy broke down completely, and was brought on by a bullock dray. As Parliament was to meet on Tuesday, I was obliged to travel through the night, to catch the train at Sale at eight o'clock on Monday morning, and arrived in Melbourne about ten o'clock on Monday, having travelled about 600 miles, over the worst roads in the colony, in a remarkably short time.

"I would especially refer to the liberality of Mr. C. Umphelby, on behalf of the directors of the Ice Company, who supplied, free of charge, all the ice required for more than 15 different trips. On this, as on many previous occasions, the Victoria Ice Company has rendered good service to the cause of acclimatization, for which they deserve the thanks of the community.

"The Minister of Railways most freely gave every assistance in his power, and the ice, the fish-cans, and an attendant were allowed to travel free in all cases, and three special trains were provided for the Gippsland road.

"But for the great interest taken in the experiment by all engaged in it, the same amount of success could not have been attained. And now it only remains for Nature to do her part, to have, in a few years, should fortune favour the experiment (as it has hitherto done in a most remarkable manner), results which will provide a new sport to make the colony more attractive, and a new source of profit, in the rivers and seas of that portion of the island continent of Australia.

"The rivers and streams in which the salmon have been placed, include all streams of any note extending into South Australia on one side, and into New South Wales on the other. The rivers included in the experiment are the Glenelg, at three places 100 miles apart; Darlot's Creek, near Portland; the Hopkins, the Fiery Creek, Lake Burrumbeet, and Emu Creek; the Gellibrand and its tributaries, the Erskine, St. George, and Cumberland, at Loutitt Bay; the Aire, Barrum, Ford, and Parker, at Cape Otway; the Barwon, at Winchelsea and Birregurra; the Werribee, the Saltwater river, the Yarra, the Latrobe, the Macalister, the Avon, the Mitchell, the Nicholson, the Tambo, and the Snowy rivers."

It is important to know that the salmon have been placed in streams that afford a good promise of successful results. The Cape Otway streams are all highly spoken of, by those who know them, as being most suitable. The Aire river, about six miles west of Cape Otway, has a wide estuary, into which flow three tributaries from a tract of country of a semi-alpine character. There are extensive forests of the beautiful evergreen beech (*Fagus*

Cunninghami), many of the trees being splendid specimens from four to five feet in diameter. There are many beautiful spots in these ranges near the base of Mount Sabine—waterfalls and rapids, with fern trees 50 feet in height.

Near Loutitt Bay there are clear, cool streams, with pebbly bottoms, coming direct out of high ranges. Mr. Edward Hayes, who carried some of the salmon fry on pack-horses over almost inaccessible country, and liberated them successfully, speaks in high praise of these streams as being most suitable for salmon.

The Gippsland rivers are splendid streams, which never fail in the driest seasons. The Avon is one of the best streams flowing into the lakes; its tributaries are most suitable for fish-spawning, being extremely clear, with a rocky and pebbly bottom.

The Mitchell, and its principal tributaries, the Dargo, Wentworth, Wonnongatta, and Morocco, take their rise from the great dividing range, and receive the drainage from the melting snows of a watershed having a very large area.

Mining operations having now all but ceased on these streams, their waters are bright, clear, cold, and rapid, and they are free from all enemies to the young salmon.

One thousand salmon fry were sent to the Hopkins river, near Warrnambool, by sea, and were taken there by Mr. Hickling. In his report he says:—"I got down with the fish very successfully, and liberated them in excellent condition in the Cudgee Creek. I am sure they will do well, as the temperature (on 27th December) was only 57 deg., and—dry as it is—there is now a splendid stream of the purest water. The temperature of the Hopkins was 64 deg.—no doubt cooler in the shady pools and shallows—but this was after the great heat of Saturday; however, the fish did not appear to be at all inconvenienced by the change from the cool tank to the warmer river. I am confident they will be heard of again."

In distributing the young salmon, it was not found convenient to delay the fish so as to count carefully the large number sent off at once—in one case 8000; but the number was estimated approximately by

counting out 100 into a bucket, and afterwards netting about the same number as near as could be guessed, and noting the number of hundreds put in the cans. The later lots, being smaller in number, were counted with care, and, when all were counted, a very considerable loss was found to have unaccountably taken place; but it was found that lizards and snakes had made their way into one of the hatching-boxes, and no doubt they had devoured many of the *alevins*. One snake was caught inside of the cover of wire-netting put over the hatching-race, and killed; and a lizard was found with a *Galaxias* five inches long, which it had dragged out of the water, and which was still alive.

An objection has been made to my dividing the salmon into different lots, as it is supposed that they would have had a better prospect of success if a large number had been placed in one river. From the fact of six pairs of breeding trout having only been retained in the ponds at New Norfolk, and that these, with 30 more turned into the river, are the parents of all the trout in the Australian colonies, it will be evident that by dividing

the salmon the chances of success are greatly increased. It is impossible to tell which river may prove best suited to them; but when all the rivers in the colony of any note have been tried, if at all suitable to the climate, the fish must succeed in some of them, and I had so many applications for a portion of the fish, that I could not well refuse to send a few to each river.

Even from Tasmania I had a request for a few of the fry to put in the Mersey, and sent off 200 there; but from some cause, which I could not ascertain (possibly *mal-de-mer*), all but seven fish perished during the sea voyage, and these, I fear, will never be heard of again, although they were safely liberated in that fine stream, the Mersey river. I hope that my Tasmanian friends will be more fortunate the next time that a similar attempt is made.

The Zoological and Acclimatization Society acknowledged their indebtedness for services rendered, by awarding medals to Sir George Grey, K.C.B., Premier of New Zealand; the Hon. Spencer Baird, President of the Smithsonian Institute, Washington; the Hon. Mr. Woods, M.L.A., Minister of Railways in Vic-

toria; Mr. J. H. Connor, Mayor of Geelong; Mr. Howitt, P.M.; Mr. O'Brien; Messrs. Robertson and Wagner; and the Hon. Mr. Murray Smith, M.L.A., Chairman of the Victoria Ice Company, for their valuable assistance in carrying out the experiment.

I would here express my grateful appreciation of the warm interest in the undertaking shown by the public and the press, but especially by the *Melbourne Argus*, while the experiment was in progress. I also had very kind and, indeed, in some cases, far too flattering expressions of acknowledgment from Shire Councils and from Angling Societies, and a most kind recognition of my exertions by the Council of the Zoological and Acclimatization Society. The Société d'Acclimatation of France have also, in a truly cosmopolitan and generous spirit, awarded to me their gold medal of the first class, to mark their appreciation of the importance of the undertaking which I had accomplished successfully. And to one and all I would offer my most hearty thanks for the kind feeling shown in connection with my undertaking, which has been so far successful,

thanks to the good fortune which, under the blessing of Divine Providence, has attended the experiment, and to the able assistance that many have so freely rendered to promote that result.

FINIS.

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LONDON: PRINTED BY EDWARD STANFORD, 55, CHARING CROSS, S.W.


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