XXIII.—*On the Growth of Grilse and Salmon.* By Mr ANDREW YOUNG, *Inver-shin, Sutherlandshire.* In a Letter addressed to JAMES WILSON, *Esq., F.R.S.E.* Communicated by Mr WILSON.

(Read 9th January 1843.)

THE history of the habits and development of the salmon has been for ages a subject of dispute, even among men of science and experience. The general theory which prevailed regarding its earlier stage of existence was, that the spawn deposited in the autumn or beginning of winter, produced by development the smolts which were seen descending to the sea in the course of the next ensuing spring.

In regard to its after state, some supposed that the smolts which descended the rivers in spring or early summer returned as grilse that same season. Many doubted this theory, and maintained that it was impossible, or very improbable, that they should return so speedily in that greatly enlarged condition; their only argument, however, being founded on the unlikelihood of such a rapid growth.

Others, again, have maintained the opinion that the grilse is a distinct species of fish, closely allied to, but not identical with, the true salmon, and that in the so-called condition of grilse it has attained to its ultimate state. In fact, this has been asserted not only by naturalists, viewing the subject somewhat vaguely as one with which they had no great acquaintance, but also by practical, that is, professional fishermen, whose opinions, from their more enlarged experience, were supposed to carry greater weight. But till recently all these various opinions were uncertain and unsatisfactory, in so far as they were founded upon supposition, without proof or trustworthy experiment.

But in regard to the first, or, as I may call it, fresh-water state of the fry of salmon, Mr JOHN SHAW of Drumlanrig, several years ago commenced, and some time ago concluded, a series of most sagacious and well known practical experiments, which settled that part of the subject. I lately visited Mr SHAW's experimental ponds, and carefully examined his various specimens, from the ova to the smolts, and I am perfectly convinced of the accuracy of the results, and of the correctness of the general conclusions which he has drawn. This I believe would have been my opinion, judging simply from Mr SHAW's explanations; but I am happy to say (and think it my duty so to do), that my own more recent experiments, undertaken upon similar principles, though not for such a length of time, have led to the same results. I have as yet gone no further than to a period corresponding to Mr SHAW's first season; but this decidedly confirms Mr SHAW's principal discovery, by confuting the idea entertained by our ancestors, that the fry became smolts during the first spring after the ova were spawned. All my confined specimens are still in the state of parr, exactly as described by Mr SHAW, with this difference, that their dimensions are somewhat greater; and I therefore

anticipate that a larger number will become smolts in about a twelvemonth after their first spring, than was the case with those observed in Dumfriesshire. This may possibly arise from their being with me so much nearer the salt-water, of which I find the influence on salmon, in all its stages, to be most remarkable. I conceive, however, that the question of the true history of this important species, from the egg to the smolt, has been set at rest. To connect that early state with the grilse, and the latter link with the adult salmon, is therefore the object of the present communication. My long continued superintendence and control of some of the finest and most productive salmon fisheries in Scotland, and the peculiar position I occupy, as residing almost within a few yards of the cruives upon the noted river Shin, afford me advantages which I trust I have not altogether neglected.

I have now made many experiments on these fish, taking up the subject where it was necessarily left off by Mr SHAW ; and I find, that, notwithstanding the slow growth of the parr in fresh water, such is the influence of the sea, as a more enlarged and salubrious sphere of life, that the very smolts which descend into it from the rivers in spring, ascend into the fresh waters in the course of the immediate summer as grilses, varying in size in proportion to the length of their stay in salt water.

Thus, in the months of April and May of the year 1837, I marked a great number of the descending smolts by making a peculiar perforation in the caudal fin with a pair of small nipping irons constructed for the purpose ; and in the months of June and July I caught a considerable number on their return to the rivers, all in the state of grilse, and varying from 3 lb. to 8 lb., according to the time which had elapsed since their first departure from the fresh water, or, in other words, the length of their sojourn in the sea.

Again, in April and May of the present season (1842), I marked a number of descending smolts, by clipping off the dead or adipose fin upon the back, and carefully replacing them in the river. In the course of June and July following, I caught them returning up the river, bearing my peculiar mark, and agreeing with those of 1837, both in respect to size, and the relation which that size bore to the lapse of time. Two of these smolts, as marked last spring, and which I caught again as grilse, I have transmitted to the care of Mr GOODSIR, College of Surgeons, in whose hands they may be seen for the satisfaction of the curious or the sceptical.

I have no doubt that many who argue on supposition, not on facts, may ask, how, when salmon from the ovum to the smolt are so slow of growth, their advance from the smolt to the grilse should be so rapid ? In regard to this, I can only state the fact as I have repeatedly ascertained it ; and it is not the less a fact, although some of the final causes which produce it may be uncertain or obscure. My own opinion is, that it is owing to their change of domicile from

fresh to salt ; and in proof of this I may refer to the following fact, that, with the exception of the early state of parr, in which the growth is admitted to be slow, salmon actually never do grow in fresh water at all, either as grilse, or in the adult state. All their growth in these two most important later stages takes place during their sojourn in the sea. Not only is this the case, but I have also ascertained that they actually decrease in dimensions after entering the river, and that the higher they ascend the more they deteriorate, both in weight and quality. In corroboration of this I may refer to the extensive fisheries of the Duke of Sutherland, where the fish of each station of the same river are kept distinct from those of another station, and where we have had ample proof that salmon habitually decrease in weight in proportion to their time and distance from the sea.

I have also instituted another series of experiments for the purpose of shewing the relationship of the grilse and adult salmon, and connecting, as it were, these two final stages with each other. In the spring of 1841 I marked a number of spawned grilses soon after the termination of the spawning season. I took a net and coble, and fished the rivers for the purpose ; and all the spawned grilse of 4 lb. weight were marked, by putting a peculiarly twisted piece of wire through the back fin. They were immediately thrown into the river, and of course disappeared, making their way downwards with the other spawned fishes to the sea. In the course of the next summer we again caught several of these fish which we had thus marked with wire as 4 lb. grilse, grown, in the short period of four or five months, into beautiful full-formed salmon, ranging from 9 lb. to 14 lb. in weight, the difference still depending on the length of their sojourn in the sea.

Again, in January 1842, I repeated the same process of marking 4 lb. grilses which had spawned, and were therefore about to seek the sea ; but, instead of placing the wire in the back fin, I this year put it in the upper lobe of the tail or caudal fin. On their return from the sea we caught them, salmon as before. Two of these fish, marked as grilse on the 29th of January, and weighing at that time 4 lb., were caught as salmon on the 4th and 14th of July, weighing respectively 8 lb. and 9 lb. They were transmitted, at your request, to the care of Mr GOODSIR of the College of Surgeons, for preservation by that gentleman, in whose hands they may now be seen, in confirmation of my statements on the subject of the salmon's growth.*

I may here state, that the motive which first induced me to mark both grilse and salmon was the desire to ascertain whether the fish of a river were a breed peculiar to that river alone ; that is, whether the same individuals, after descending to the sea, returned to their original spawning grounds, or whether, as many supposed, the main body returning shorewards from their feeding grounds in distant parts of the ocean, and progressing southwards along the coasts of Scotland, were thrown into, or encouraged to enter, estuaries and rivers by various accidental circumstances, and thus, that the numbers obtained in these estuaries and

* The specimens above referred to are now in the Museum of the Royal Society.

rivers depended mainly on wind and weather being suitable to their upward entrance at the time of their nearing the mouths of the fresher waters.

To settle this point I commenced, in 1836, to catch and mark all the spawned fish I could obtain in the course of the winter months during their sojourn in the rivers. We frequently fished all the pools of a river with net and coble ; and, as soon as we drew the fish ashore, we made a peculiar perforation in their tails with the nipping-irons, and threw them back into the water. In the course of the following fishing season we caught great numbers of them after their return from the sea, each in its own river with its distinctive mark.

We have also another proof of the fact, that the different breeds or races of salmon continue to revisit their native streams. You are aware that the river Shin falls into the Oykel at Invershin, and that the conjoined waters of these rivers, with the Carron and other streams, form the estuary of the Oykel, which flows into the more open sea beyond or eastwards of the bar, below the Gizzen Brigs. Now, were the salmon which enter the mouth of the estuary at the bar thrown in merely by accident or chance, we should expect to find the salmon of all the various rivers which form the estuary of the same average weight, for, if it were a mere matter of chance, then a mixture of small and great would occur indifferently in each of the interior streams. But the reverse of this is the case. The salmon in the Shin will average from 17 lb. to 18 lb. in weight, while those of the Oykel scarcely attain an average of half that weight. I am therefore quite satisfied, as well by having marked spawned fish descending to the sea, and caught them ascending the same river, and bearing that river's mark, as by a long continued general observation of the weight, size, and even something of the form, that every river has its own breed, and that that breed continues, till captured and killed, to return from year to year into its native stream.

I may now mention that I commenced marking grilse, with a view to ascertain that they became salmon, so far back as 1837, and have continued to do so ever since, though never two years with the same mark. The result in respect to growth in each of these earlier years corresponded exactly with what I have given in more detail regarding the years 1841 and 1842.

The following lists are extracted from the note-book in which I have carefully recorded the peculiar marks, the periods of marking, the weight at each period, the time of the recapture, and the increased weight.

List of Smolts marked in the River, and recaptured as Grilse, on their first ascent from the Sea.

Period of Marking.	Period of Recapture.	Weight when Retaken.
1842, April and May.	1842, June 28.	4 lb.
... ..	... July 15.	5 lb.
... ..	 15.	5 lb.
... ..	 25.	7 lb.
... ..	 25.	5 lb.
... ..	 30.	3½ lb.

List of Grilse marked after having Spawned, and recaptured as Salmon, on their second ascent from the Sea.

Period of Marking.	Period of Recapture.	Weight when Marked.	Weight when Retaken.
1841, February 18.	1841, June 23.	4 lb.	9 lb.
... .. 18.	 25.	4 lb.	11 lb.
... .. 18.	 25.	4 lb.	9 lb.
... .. 18.	 25.	4 lb.	10 lb.
... .. 18.	... July 27.	4 lb.	13 lb.
... .. 18.	 28.	4 lb.	10 lb.
... March 4.	 1.	4 lb.	12 lb.
... .. 4.	 1.	4 lb.	14 lb.
... .. 4.	 27.	4 lb.	12 lb.
1842, January 29.	1842, July 4.	4 lb.	8 lb.
... .. 29.	 14.	4 lb.	9 lb.
... .. 29.	 14.	4 lb.	8 lb.
... March 8.	 23.	4 lb.	9 lb.
... January 29.	 29.	4 lb.	11 lb.
... March 8.	... Aug. 4.	4 lb.	10 lb.
... January 29.	 11.	4 lb.	12 lb.

In the year 1841, we marked a few spawned salmon along with the grilse. We marked both kinds in the back fin, but the salmon with copper wire, and the grilse with brass wire. I perceive by my lists, that a salmon marked on the 4th of March, returned and was captured on the 10th of July, with an increase of 6 lb., having grown in that time from 12 to 18 lb. In 1842, however, we marked no salmon; all were grilse of 4 lb., and were marked in the caudal fin. In the course of both seasons we caught far more marked grilse returning with the form and attributes of perfect salmon than are recorded in my lists. In many specimens the wires had been torn from the fins, either by the action of the nets or other casualties; and although I could myself recognise distinctly that they were the fish I had marked, I kept no note of them. All those recorded in my lists returned, and were captured with the twisted wires complete,—the same as the specimens transmitted for your examination.

I think that the preceding facts, viewed in connection with Mr SHAW's observations, entitle us to say that we are now well acquainted with the history and habits of the salmon, and its rate of growth from the ovum to the adult state. The young are hatched during a period which admits of considerable range, according to the temperature of the season, and the character of special places. Their growth in the early state of parr is extremely slow, and the silvery aspect of the smolt is not assumed till at least the lapse of a year from the time of hatching. The great mass of smolts descend to the sea during the months of April and May, but not the whole, because the varying range of the spawning season carries with it a somewhat corresponding range in the assumption of the

first change, and the migration of the smolts towards the sea. They return as grilse during the summer and autumn of the same season, their increase of size depending on the length of time which has elapsed between their departure from and return towards the river water. Such of these grilse as escape the snares of the fishermen and other enemies, spawn that same season in common with the salmon, and after spawning, both the one and the other redescend into the sea in the course of the winter or ensuing spring. They all return again to the rivers sooner or later, according as they had previously left it, after having spawned, early or late. The grilse have now become salmon by the time of their second ascent from the sea. All these changes and conditions I have verified by special experiment, as well as by general observation, from the egg to the smolt (the parr inclusive), from the smolt to the grilse, from the grilse to the salmon; and I am perfectly satisfied with the accuracy of the conclusions come to, and which I have here endeavoured to explain.