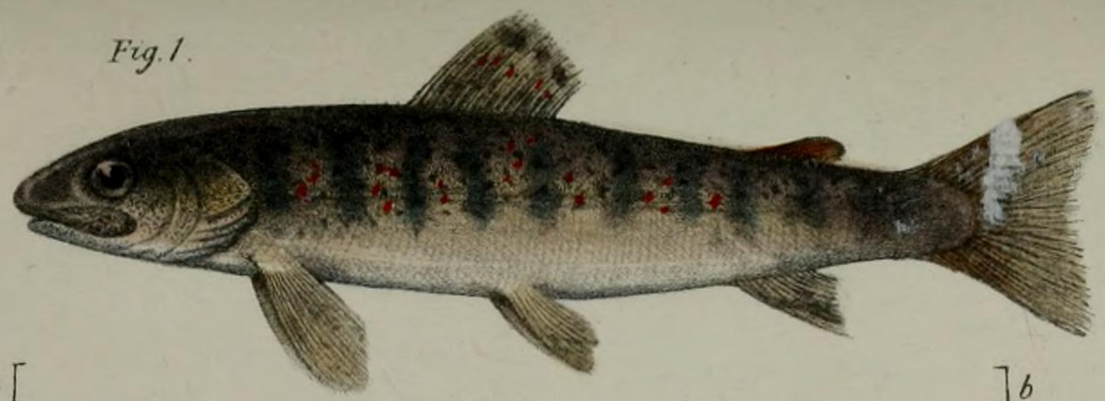
Fig. 1.



a [ ] b

Fig. 2.

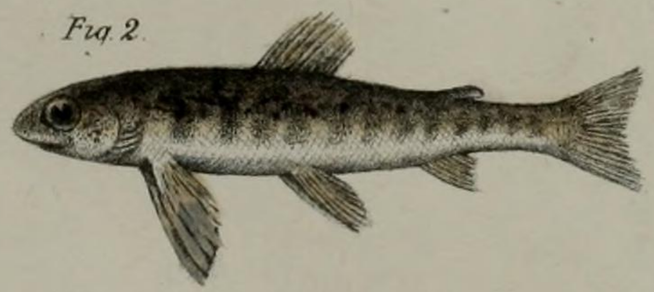


Fig 3.

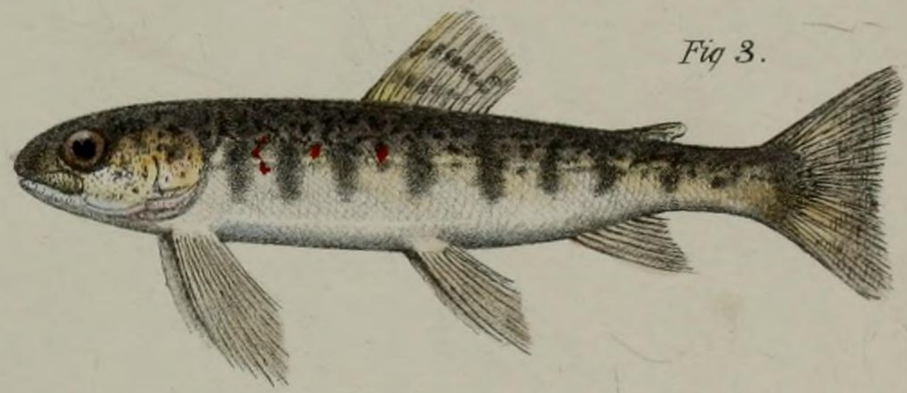
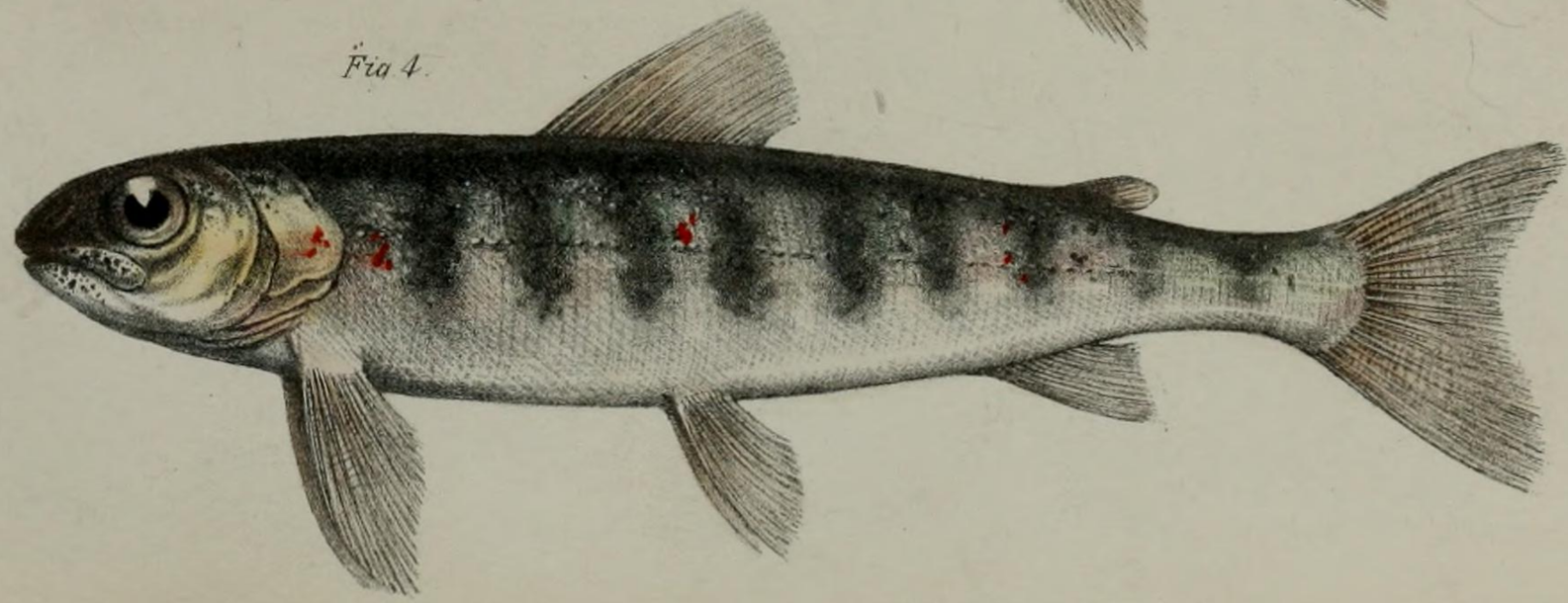


Fig 4.



C. Berjeau del et lith.

M. & N. Hanhart imp.

SALMONOIDS.

than their brethren, had been dragged out. The fishermen, well knowing that these were not indigenous fish, made a shrewd guess at the nature of their capture, and, on the 22nd of October, brought them to the Salmon Commissioners, who at once pronounced them veritable Smolts*.

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

4. Additional Memoranda as to Irregularity in the Growth of Salmon. By James Murie, M.D., F.L.S., Prosector to the Society.

(Plate II.)

Preliminary Notice.

When I communicated to the Society some observations in connexion with the supposed arrest of development of the Salmon (see P. Z. S. 1868, p. 247), I purposely held back memoranda in support of the view therein enunciated. Having, as it were, registered the data occurring within my own ken, my further intention was to institute a series of experiments, with the object of crucially testing the truth or fallacy of the doctrine.

Unforeseen circumstances happened, depriving me of that auxiliary assistance necessary for the fulfilment of the requisite conditions. But it is probable that other parties may be favourably placed to try the issue of experiments, to set the matter at rest; hence I make note of what seems a feasible plan.

I propose that some one resident close to a Salmon river should obtain a quantity of impregnated and undoubted *Salmo-salar* ova—some of this to be forwarded, and deposited in the tanks at the Gardens, where, after hatching, careful notes of the growth and changes &c. are to be made; due precaution also to be taken that batches of the young fish shall be placed under varied circumstances, *i. e.* as respects the size of the reservoir, food, &c.; on the other hand, the

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

remainder of the ova left in charge of the correspondent to receive widely different treatment—hatching to be carried on in the open air, and the tiny fish, once out, confined in a pond. Reared to the Smolt condition, when the migratory restlessness occurred, some might be marked and allowed to go seaward, the condition of those left behind being noted. During the second or third season, as the case might be, others to be allowed to depart, whilst a few are permanently retained in the pond.

Three years or less from the commencement of the experiment, in the event of a marked grown Grilse or Salmon being caught, specimens from the Society's tanks, the open-air pond, and it to be rigidly compared side by side. In the intervals specimens of the progressive ages and stages to be preserved in spirits, and, as apparent changes take place, figures and annotations thereon duly registered.

The result of experiments conducted somewhat in the above fashion would, I consider, conclusively prove whether or not Salmon are temporarily or definitely arrested in their development when retained for a considerable period in fresh water. At all events all chance of the denial of the parentage of the fish would be obviated.

Or, again, if the breeders of Salmon, say at the stock-ponds in Perthshire, could be induced to fertilize the ova of a full-grown Salmon, and transmit the same to the Society, I venture to say the ova would be attentively watched during the process of hatching, and afterwards the phenomena and stages of growth duly recorded. Furthermore, could the bodies of the parents, male and female, be likewise transmitted to London for identification, all possibility of error would be prevented. As appears plain from what has happened with those already reared in the Zoological Gardens, it is of the utmost importance that the parents should bear witness of the ova being those of genuine *Salmo salar*.

It is, indeed, much to be desired that some such well-attested observations should be pursued; for notwithstanding the asseverations of several trustworthy observers, subsequently to be cited, there still remains a lurking suspicion that error of data may have crept in.

I urge therefore upon pisciculturalists, and such as are interested in solving a physiological, or, rather, zoological problem of high value, the benefit science would derive from the authentication or denial of the alleged circumstantial evidence. This is my plea for intruding the above suggestions and further memoranda upon the Society. I trust that this second notice may stir up those at home, or fish-rearers abroad, to follow out the investigation.

I may premise that I have not entered on the task in a controversial mood, but to incite further research on the matter. Moreover it is possible those interested in the question may wish to refer to the data, be they merely asserted or be they proven, concerning the rearing and detention in pure fresh water for so long a period of fish considered to be Salmon.

It may be pardonable on my part, then, to examine more narrowly than heretofore the grounds of opinion, favourable or adverse, especially as the whole matter is one involving biological laws of the

highest consequence as regards the determination of species, supposed transition of allied forms, and questionable hybridity.

With these remarks I proceed to reproduce my previously suppressed discussion of facts and published data.

Affirmation.

I. *The historical evidence.*—What points to the truth of this (*i. e.* that the fish described are Salmon) has already been given (see P. Z. S. 1868, p. 247); but it undoubtedly contains a weak point; otherwise the whole matter were settled. While the ova received in the Gardens on the 8th January, 1863, may have, as related, veritably undergone all the subsequent changes ascribed, this does not prove their being in the first instance ova of *Salmo salar*. Messrs. Buckland and Bartlett assume them to have been so, and add validity by stating that the size and appearance of the ova convinced them of their genuineness; for the ova of the Great-Lake Trout differ sufficiently to be recognized by the naked eye.

As a sequel to the heretofore described specimens, it is most important to note that one of the fish produced from the ova of the Rhine Salmon, hatched in the Gardens in February, 1863, died on the 1st December, 1867. It was sent to Mr. Frank Buckland, who found on examination that it was a pregnant female. He states that 117 ova, nearly ripe, were present in the abdominal cavity, lying perfectly loose therein. This female weighed 4 oz., and measured $8\frac{1}{2}$ inches in length. Mr. Buckland believes "that, had this fish lived another fortnight or three weeks, these ova would have been quite fit to be deposited in a nest, after the fashion of an ordinary full-grown salmon that had made its two or three journeys from the fresh water to the sea" *.

II. *External resemblances to Salmon.*—It can hardly be denied that, so far as external appearance is concerned, the fishes bear the stamp of young Salmon in the Parr condition. This applies more especially to that figured as No. 1 (Pl. xxiii. P. Z. S. 1868); the other, No. 2 (*l. c.*), is more brindled and spotted than is commonly the case in the Parr; but this in part may be due to the nature of its habitation. The form of the bodies, the relative dimensions of snout to head, head to body, shortness of maxillary, colour of adipose fins, dentition, shape of caudal fins, and contour of præoperculum all agree with *Salmo salar*, and not with other species of *Salmo*.

III. *Published statements and experiments.*—Reference to a few of the better substantiated cases of Salmon reared and continuously kept in fresh water may be interesting at this juncture.

1. Yarrell (Brit. Fishes, vol. i. p. 172, 3rd edit. 1859) mentions that a Scottish landed proprietor in 1831 put some Salmon-fry into a freshwater pond. These were taken out in 1833, to all appearance

* See an account of this interesting specimen in 'Land and Water' for Dec. 7, 1867, vol. iv. p. 320. Preserved in spirits as a preparation, this same fish was shown at the Meeting the evening the former paper was read. It now forms one of the series in the Museum of Fish-culture at the Horticultural Gardens.

Salmon. They weighed from 2 to 3 lbs. each; their flesh was pale in colour.

2. The same acute naturalist has published a separate volume 'On the growth of Salmon in Freshwater' (1839), wherein six coloured illustrations of fish of the natural size, at various stages during the first two years of their growth, are given. The specimens figured show very well the progressive growth and change of dress with age. Yarrell remarks that there is a comparative deficiency of general growth in the older specimens. One of the largest measured 14 inches long and weighed 14 ounces.

3. Lloyd states that near Katenberg there is a salmon-fishery. "These salmon are bred in the lake, and, in consequence of cataracts, cannot have access to the sea." They are small in size and inferior in flavour.

4. I may as well here quote the opinion of another eminent Scandinavian pisciculturist, Prof. Rasch, of the Christiania University. Writing to an English friend *, among other matters he says, "The assertion of some of your countrymen that the Salmon cannot be acclimatized so as to become entirely a freshwater fish is quite at variance with the results of experiments we have made in Norway. Some years ago Hetting hatched out numbers of Salmon-ova, which he subsequently turned loose in the Tyri-fiord; and during the last two years fish have been caught in that lake, resembling in every respect 'Salmon proper.' It is impossible for them, as you know, to return thither, even should they succeed in reaching the sea.

"As regards acclimatizing Salmon to fresh water, our enclosures at Greffsen† are too small. But if in larger pieces of water it be only possible to prevent their first migration to the sea after they have assumed the Smolt dress, they will readily accustom themselves to their freshwater home. And should the water be a very large lake, such as Ladoga, Werner, Peipus, and as rich in nourishing food, the freshwater Salmon will then attain about the same size as the Salmon of the sea."

5. Mr. George Anderson, of Glasgow, communicated the following authentic case to the 'Field' (see 23rd and 30th June, 1866)‡. This gentleman obtained in 1862 about thirty specimens of Salmon parr from the well-known Stormontfield Salmon-ponds §. The fish, as he observes, were then two years old, but had not put on the Smolt dress preparatory to migration.

Twenty-nine of the Parr were placed in a freshwater pond well supplied with Minnows and other food. In June 1866 the pond

* Who, under the initials "N. R. B.," has published the letters in 'Land and Water,' vol. i. pp. 221–245 (March 31st and April 7th, 1866).

† An establishment close to Christiania.

‡ I am indebted to Mr. Charles Darwin for calling my attention to this interesting notice.

§ A pretty sure guarantee that the fish were the young of *Salmo salar*, as it is not at all likely that the trained eyes of Mr. Buist and other experts would be deceived in them—nor, indeed, that ova specially destined to stock the river Tay, and not, as in Huningue, exported, should be chosen from other than pure-bred Salmon.

was run off, when three good-sized Salmon were found to have survived; these were bright, lively, and healthy, but ill-grown. One of these specimens sent to London weighed 15 oz., measured $14\frac{1}{2}$ inches in its greatest length, and had a girth of $6\frac{1}{2}$ inches. The head was $3\frac{1}{8}$ inches from the snout to the extremity of the operculum, and appeared large enough for a 5-lb. fish.

It is greatly to be regretted one of these three unusually interesting specimens was not preserved in spirits and forwarded to the British Museum.

6. Lastly, I shall advert to an account, by Mr. Frank Buckland, of a "Salmon that had never seen the sea"*. This specimen was obtained from the river Wye in 1862, in the Parr condition, and transferred to a pond through which a streamlet of water ran. Four years afterwards it was taken out as a Salmon 11 inches long.

IV. *Irregularity of growth.*—The life-history of *Salmo salar*, as all admit, is a most extraordinary one. The exceeding rapidity of their growth between their descent to and return from the sea is marvellous. But there are still two points as remarkable, viz. that a retardation of development is far from uncommon; and, on the other hand, causes occasionally ensue seeming as it were to stimulate and quicken the usual accession of growth. Since Shaw's experiments on the growth of Salmon-fry †, other observers have noted, and, in fact, it is now universally known to all those practically conversant with artificial Salmon-culture, that of the first year's Smolts only some migrate seawards, while many of them remain behind in the fresh water. In the second year it also occasionally happens that in some fish no desire of migration ensues; but the accession of migratory instinct takes place in the ensuing season, or even later. In other words, some Smolts ripen earlier than others, and those remaining behind, which are slower in their seasonal migratory instinct, remain apparently stationary as to growth. The cause of the retardation of the migratory stimulus, so far as I am aware, has not been satisfactorily accounted for; but clear evidence exists that the young self-detained Salmon are little or no larger than their brethren a year or two younger. Their development is more or less retarded for the time being—but not necessarily continuously so; for as soon as migration occurs, the usual growth concomitant with a sea-water visit takes place. Here, then, we have, from natural causes, retention and arrest of growth of young Salmon in a comparatively healthy condition in fresh water for two years or more. If such a fact or premise be granted, it seems to follow, as a necessary consequence, that if Salmon arrived at the Parr condition be prevented from migrating, they either remain stunted or increase in magnitude in a very diminutive ratio compared with their fellows that have spent a season in the sea-water.

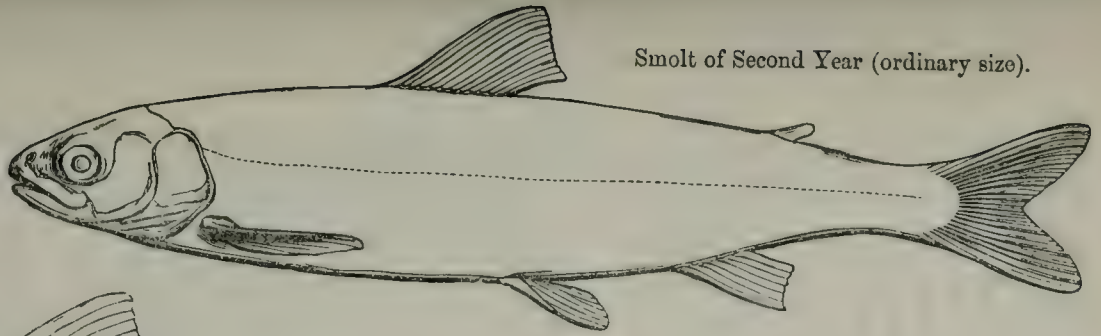
Regarding increase of size generally, and also unusual accretion of growth, in Salmonoids, this, as most authorities agree, is greatly, if not entirely, dependent on the abundance or scarcity of food,

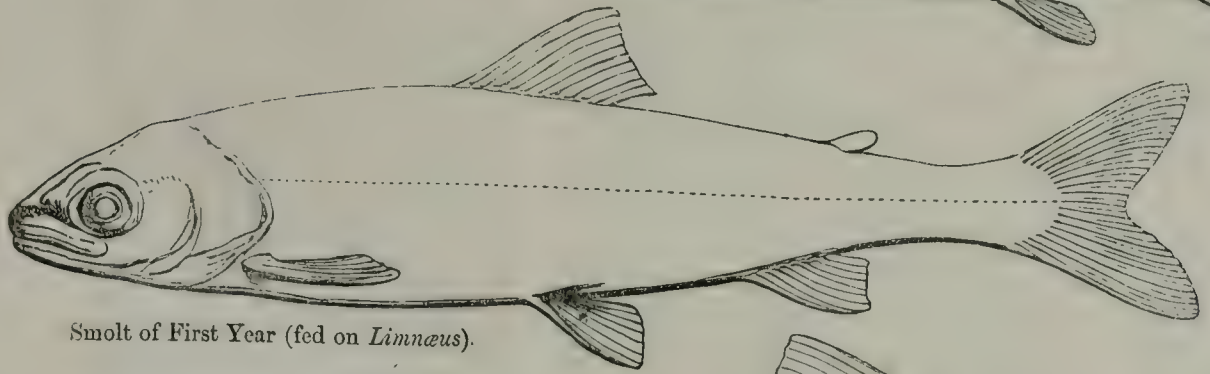
* Figured and described in 'Land and Water,' vol. i. June 2, 1866.

† Trans. Roy. Soc. Edinb. vol. xiv. &c.

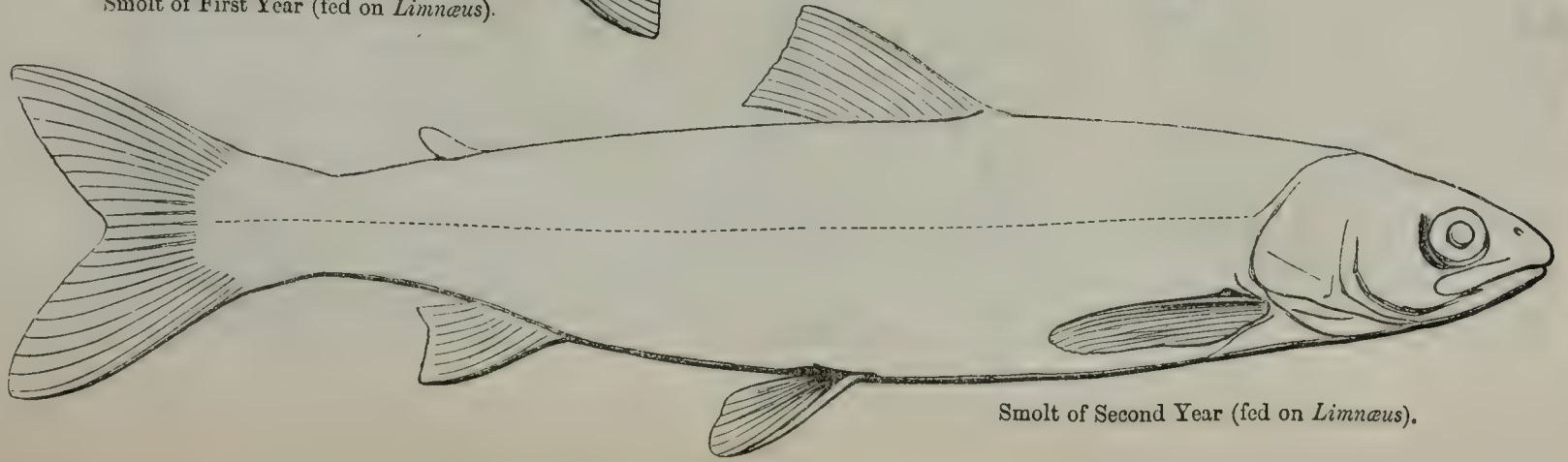
Young Fry.

Smolt of Second Year (ordinary size).





Smolt of First Year (fed on *Limnæus*).



Smolt of Second Year (fed on *Limnæus*).

and the extent of the water in which they abide. Many facts might be adduced in support of this ; but one of recent occurrence may serve the purpose of illustration*. The experiments at Stormontfield, in Perthshire, already adverted to, are too well known to need further comment ; suffice it to say that there can be little doubt of these ponds containing the produce of genuine *Salmo salar*. On the 20th of May 1868, at the above piscicultural establishment, "Peter of the Pools" (the *nom de plume* of an experienced Salmon-rearer) observed great variation in the size of the smolts of the same age—some of the two year-old fish being fully a fourth larger than others, and their bodies proportionally plump. This increased growth was found to be dependent on their feeding on molluscous animals ; for in the pond which the large Smolts inhabited vast quantities of *Limnæus peregra* had taken up their abode among the aquatic plants†.

Negation.

I. *Not true Salmon?*—I had Dr. Günther's permission to state that in his opinion the specimens reared in the Gardens (*cf.* P. Z. S. 1868, p. 247) are not true *Salmo salar*, as he considers their history a doubtful one, and furthermore, in some respects, they disagree with the characters assigned by him to that species. He justly lays stress upon the weak point that the ova may or may not have been the produce of a female *Salmo salar*, and may or may not have been impregnated by the milt of a male of the same species. He thinks that among the immense numbers of Salmon-ova yearly sent off from the hatching-establishment at Huningue on the Rhine, there is likelihood of mixture occasionally occurring in the transit, and also that fish which are not true Salmon may be mistaken for them and thus error arise. The chance that fortuitous circumstances might give rise to the last-mentioned error has already to some extent been admitted. It is well to remember, however, that Salmon-ova are distinguishable from those of the Great-Lake Trout, with which they may have been most readily confounded, by their greater size and deeper yellowish tint.

Now as regards constant characters defining the species, and thereby, by the absence of such, excluding the imperfectly developed specimens from being considered as representatives of *Salmo salar*, Linn., I shall take three into consideration—the number of the vertebræ, of the cæcal appendages, and of the scales ; the other six characters which Dr. Günther considers trustworthy in the classification of the Salmonidæ are not so applicable in the present instance. A tabular view, moreover, may be more readily appreciated ; hence I place in series the formulæ appertaining to true Salmon, our two specimens, and such forms as are the most likely to have been introduced into the Gardens and mistaken for Salmon. The formulæ are

* See 'The Field,' June 13, 1868.

† Through Mr. Tegetmeier's interest, the proprietors of 'The Field' have kindly permitted me the use of their woodcuts illustrating the phenomenon here cited (see p. 35).

taken from Dr. Günther's catalogue; but the upper and lower transverse or oblique series of scales are expressed here in separate columns, and the numbers within brackets are extremes incidentally noted in his description of typical specimens in the collection.

TABLE A.

	Vertebræ.	Pyloric appendages.	Scales.		
			Horiz. series immediately above lat. line.	Transv. series.	
				Dorsal fin to lat. line (obliquely).	Lateral line to ventral fin (obliquely).
Salmo salar	59	53–70	120	22–26	19–22
—— ——?, Zool. Soc. spec. No. 1.	59	48–50	120–122	19 (21?)	18
—— ——?, Zool. Soc. spec. No. 2.	60	.....	120	22	.....
—— trutta	59–60	[46] 49–61	120 [117]	24–26 [30]	36–34 [22]
—— cambricus	59	39–47	120–125 [117–130]	27 [25–28]	38–40 [20–24]
—— fario gaimardii	59–60	33–46	120 [124]	27–30 [26]	[22]
—— —— ausonii	57–58	38–47 [51]	120 [117–127]	26–30 [23–31]	[21–27]
—— carpio (Lake Garda)	.....	40–50	123	.....	.....
—— remanus (Lake Geneva)	57–59	45–52	115–128	26–28–36	.....
—— rapii (Lake Constance)	59–60	48–54	120	27–35	.....
—— lacustris (Lake Constance)	60–61	60–61	120	26–30	.....

Tested by the number of vertebræ, the doubtful specimens in question may either be *S. salar* or any other of the species enumerated, excepting *S. fario ausonii*.

The numerical excess or diminution of the pyloric appendages points in the present case to the probability that the two fish are not Salmon. The numbers 48–50 are considerably below the minimum of *S. salar*, but come within the range of the Central-European Lake Salmonoids—to wit, the four last mentioned in the table; likewise *S. trutta*.

One of the most constant characters is said by Dr. Günther to be the size and consequently relative numbers of the scales. In our specimens the horizontal series of these, 120–122, does not exclude the notion of their being Salmon; neither does it show if they are, or are not, specifically separate. The numbers, however, do not tally with the minimum or maximum of several of the species (*vide* Table A), and in this rather agree than otherwise with *S. salar*.

Of the transverse or, rather, somewhat oblique series of scales superior to the longitudinal medio-lateral line, and counted in a row from the dorsal fin to the said lateral line, one specimen (that designated No. 1, P. Z. S. 1868, p. 251) possesses nineteen, possibly more, as shall presently be explained; the other specimen (No. 2, *l. c.*) twenty-two. The latter number is given by Dr. Günther as the numerical minimum of *S. salar*; the former falls three short of it. Hence, as regards this differentiating character, No. 1 apparently

is not a Salmon. It must be borne in mind, moreover, that in my previous communication I stated that the number of scales counted in the specimen was not rigidly accurate, those given as transversely inclined to the long axis of the body being decidedly under rather than above the precise amount. I say so advisedly; for on reexamining specimen No. 1, and taking a linear row of scales slightly in advance of the point previously chosen, and therefore more in accordance with Günther's plane of obliquity, I find that twenty-one or twenty-two (?) are definable. But howsoever this may be, the penultimate column to the right of the table here given (p. 37) conclusively demonstrates that, even in limited numbers of scales, the dubious specimens in question agree less with the undernoted species of *Salmo* than with *S. salar*.

Lastly, this remark applies with still greater force to the scales counted linearly from the lateral line to the ventral fin, with the *proviso* that those of the lake fishes of mid-Europe are unrecorded.

II. *Uncertainty of the species.*—Upon this point it need only be said that, if not *Salmo salar*, it is most remarkable, and fatally telling to the denial of parentage, that the fish correspond to none of the European types, either in size, markings, or other distinguishing characteristics. Had therefore a mistake happened as to the recognition of the ova, this would have ultimately rectified itself in the development of the specific characters applicable to adult piscine form.

III. *The question of hybridity.*—As respects hybridity, which Dr. Günther suggests may be the case with those specimens reared in the Gardens, it becomes rather an important item of deliberation. On what grounds can it be assumed we have hybrid fish to deal with, granting, for the time being, no set line of demarcation proving their identity with a single specific form can be given?

1. The produce of different species may have been fertilized at the Rhine fish-hatching establishment.

2. Instances of hybrids among certain of the Salmonidæ are stated to be of no uncommon occurrence.

3. Our specimens possess resemblances to none of the well-established forms, but have appearances indicating intermediate origin.

As experiments prove, the fertilization of the ova of one piscine form with the milt of another distinct species is beyond controversy exemplified in hybrids between the Salmon and the Trout. It is needless therefore to shirk the reasonable contingency of intermixture of breed having accidentally or intentionally supervened. Against such a circumstance it can be advanced that, so far as is known, the authorities at Huningue did not with intent form a cross breed and transmit the impregnated ova of such to this country as pure *Salmo salar*. Moreover, to the practised eyes of Buckland and Bartlett, the ova were those of Salmon; and the period of hatching coincided with that of that fish rather than with that of the Great-Lake Trout, Charr, Salmon-trout, or Common Trout, received in the beginning of the same year, 1863. This fact also tends adversely to the presumption of accidental hybridity.

Dr. Günther himself professes to have been sceptical concerning hybrid Salmonoids under natural conditions, until convinced, through the Rev. Augustus Morgan, of a cross between the Sewin (*S. cambricus*) and the River-trout (*S. fario*)*.

It is said "These hybrids are so numerous in the Rhymney and other rivers of South Wales, and so variable in their characters, that the passage from one species to the other may be demonstrated in an almost unbroken series, which might induce some naturalists to regard both species as identical." They retain the migratory impulse seawards, and are sexually developed in the autumn,—when young, are like Trout—when older, Sewin. On their first ascent from the sea they are slightly smaller, but closely resemble Sewin. On their second migratory return they are darker and redder than either supposed parent. These equivocal hybrids, W. Peel, Esq., of Taliaris Park, retained for years in a freshwater pond, where they grew from 15 to 18 inches long, but remained sterile. Males preponderate.

It is not stated precisely on what evidence these fishes claim hybridity, more than that they bear resemblances to both species. Indeed, from Dr. Günther's own descriptions, the Sewin characters preponderate. If, therefore, Siebold's observations, checked by Widegren's subsequent data (viz. that some individuals of every Salmonoid species are very late in being sexually developed, or have as it were a longer temporary immaturity, and during such period differ from those normally developed), be applied to this instance of hybridism, it may on such grounds be maintained that the said hybrids are after all nothing but retarded examples of *S. cambricus*.

Taken in this light, these so-called hybrids offer coincident analogies to the retarded conditions assumed to occur in *S. salar*, and notably in those two specimens which have formed the basis of the present paper.

It seems to me also a legitimate inference that the two fishes reared in our aquarium are Salmon, inasmuch as they differ in a far greater degree from all other European species than from *S. salar*. Indeed, as is broadly admitted in the British-Museum Catalogue, p. 3, of the genus *Salmo*, "The almost infinite variations of these fishes are dependent on age, sex and sexual development, food, and the properties of the water;" hence this very same reasoning which demonstrates peculiarities in the two Salmonoids and brood in question, logically points to their immaturity, retardation, or masking of the normal adult characters of the species. If their entire growth has been prejudicially influenced by continuous retention in fresh water, so may a defect or abnormal number of scales (two transversely) and pyloric appendages (three or four) be but the concomitant effect of unnatural development.

Suppose, again, our oft-quoted Garden specimens were a cross breed between any two well-known species, freshwater or marine, there remains still a wide loophole of doubt why they have remained so very small-sized. No European species whatever, to my know-

* See B. M. Cat. of Fishes, vol. vi. p. 8.

ledge, are so stunted when full-grown. Thus it follows that either lessened dimension is a result of hybridity, or the two specimens a distinct species *per se*.

In a conversation with my colleague Mr. Bartlett concerning this same question of hybridism and the size of the offspring, I received such information, based on his long experience among animals, that I think it worthy of incorporation in the present paper. From it some hints applicable to fish may be derived, or at least borne in mind, in discussing piscine forms.

His proposition is, "That among all hybrids of vertebrated animals there is a marked increase of size." In no instance coming under his observation has the offspring been smaller than both its parents. In other words, it is always larger than the lesser-sized parent; that is, supposing inequality of dimensions between the parents to exist.

Among Mammals the following examples may be cited:—

1, Hybrids between Horse and Ass; 2, the Common Zebra and Common Ass; 3, Burchell's Zebra and the Common Ass; 4, the Wild Ass (*Equus onager*) and the Zebra; 5, the Bactrian and Common Camel; 6, the Alpaca and Llama; 7, the Yak and Zebu; 8, the Barbary and Red Deer; 9, the Rhesus and Bonnet Monkey; 10, the Black-fronted and Yellow-cheeked Lemurs (*L. nigrifrons* and *L. xanthomystax*); 11, Bennett's and the Rufous Kangaroo (*Halmaturus bennettii* and *H. ruficollis*).

Among Birds:—

12. Hybrids between the Common Canary and the following, viz. the Greenfinch, the Goldfinch, the Linnet, and the Siskin.

13. Among the Galinaceous Birds, hybrids between the Common Pheasant and the Silver Pheasant, the Gold Pheasant and the Bar-tailed Pheasant; also hybrids between the Common Pheasant and the Common Fowl, the Guinea-fowl and the Black Grouse.

14. Hybrids between the Black Cock and the Wood-grouse; in this case the offspring is termed *Tetrao medius* because of the constancy of this very peculiarity as regards size.

15. Of Struthious Birds one cross only has come under Mr. Bartlett's notice, namely a hybrid between the Great-billed and the Common Rhea. Curiously enough, this offspring was larger than either of the parents.

16. Among Waterfowl a very large number might be adduced as evidence; but the subjoined may suffice:—Hybrids between the Common Goose and the Chinese species, the Canada, the White-fronted, and the Barnacle Goose (indeed cross breeds amongst various sorts of Domestic and Wild Geese have many times been observed by him); hybrids between the Common Wild Duck, the Wigeon, the Pintail, the Teal, and the Muscovy Duck. These and other instances of Waterfowl have frequently come under his notice; and in all cases the afore-mentioned law applies.

As respects fishes, authentic observations upon hybrid progeny are meagre; but I may quote some experiments made at Stormontfield.

In November and December 1857 provision was made for hatching

in separate compartments the artificially impregnated ova of:—1, Parr and Salmon; 2, Grilse and Salmon; 3, Grilse pure; 4, Salmon pure. It was found, when the young of these different matches came to be examined early (in April 1859), that the size of each kind varied a little, Mr. Buist*, Superintendent of Fisheries, informing us that:—1st, the produce of Salmon with Salmon are 4 in. in length; 2nd, Grilse with Salmon $3\frac{1}{2}$ in.; 3rd, Grilse with Grilse $3\frac{1}{2}$ in.; 4th, Parr with Grilse 3 in.; 5th, Smolt from large pond 5 in."

Unfortunately these experiments do not apply to the instance in point, hybridity; but they show that intercrossing between the, so to speak, imperfect form though sexually developed fish and the mature individual gives rise to diminished offspring; whereas two mature specimens produce young which, at least in their earlier stage, are of larger growth. The result, though seemingly disparaging to what Mr. Bartlett has stated of mammals and birds, is in reality not against it; for his remarks have reference to the adult hybrid and not to the juvenile condition.

Addenda.

Whilst I have freely used data tendered by friends, it is right for me frankly to state they do not concur in the sum total of my deductions; for these therefore I am alone responsible. It gives me pleasure, though, to make known some of their views, as evincing both concord and disagreement with those held by myself.

The following is a report of a statement by Mr. Buckland, which I immediately wrote out and obtained full liberty to publish.

"Salmon-ova are generally deposited from the middle of December until the middle of January.

"Young fish of the first year may be observed in the spawning-streams about May. In July and August they are as big as Minnows. The mothers risk their own lives for the safety of their progeny; they make every effort to get to places where food is abundant for their young. Some of those hatched, say, at Christmas put on the Smolt coat in the following spring; but the great majority of these young fish do not go to the sea till the spring of what may be considered their second year. They have then attained the dimensions of a Sprat.

"If a shoal of Smolts be examined whilst they are passing down, some will be seen to be only of the size of Minnows, whereas others will be quite as large as Sprats; the little ones are those of the first year's brood, the big ones of the second year's series.

"Some Smolts remain to the third year; but these differ very much from their brethren, their residence in the fresh water giving them quite a Trout-like appearance. These latter are found as long as 5 or 6 inches, and are called 'Heppers' in the west of England. They are beautiful fish, with well-developed Parr-markings, and much more common in the west of England than in the north of England. It is possible that these 'Heppers' remain in the upper

* A writer in the 'Illustrated London News,' April 19, 1862.

waters because no suitable floods occur for them to come down; and hence they are obliged to stay an extra year in fresh water. It may be that these fancy Parr-markings are a provision of nature for concealment when in the young state.

"There is good evidence of a second migration of Smolts in the month of September. This is quite a new fact; but Mr. Buckland is fully inclined to believe it, because he is of opinion that as yet *no universal law can be defined as respects migration of Salmon.*

"Nature seems to anticipate the deaths of a large number during their migratory ascent and descent, so that a Salmon river, like Jacob's ladder, has fish most months of the year, some going up and others going down. If nature sent all the Smolts of the first year into the sea in the spring of the second year, some accident might happen and all be destroyed.

"It happens instead that the crop of full-grown Salmon becomes due about the fifth year from those reared in the first year; thus a certain number are always coming into condition.

"As respects the return of Grilse, these are equivalent or *pro rata* to the descent of the Smolts. It is not at all a likely circumstance, from what is known of the return numbers, that the large quantities which as Smolts arrive in the sea in the spring of the second year will ascend in July and August of the same year. But there can be no question that they sometimes do so, if Sir William Jardine's remarks on Salmonidæ be consulted.

"Furthermore, it is a curious circumstance that in 1867 no Grilse came back from the sea throughout the entire United Kingdom. Concerning this fact a consultation was held at Mr. Buckland's rooms, and among those present were several experienced Scottish netters. The opinions expressed were very diverse, and may be arranged numerically thus:—

"1. Some held that the fish had never been hatched.

"2. Some concluded they never went down.

"3. Others believed the fish were all destroyed in the sea.

"4. Others conceived that the deficiency of return Grilse was caused by an unusual natural phenomenon unknown to man, yet wide-spread.

"5. Several parties expressed themselves that the fish would return early in the summer and autumn of 1869; and, strange to say, they did come back in enormous numbers at the time specified. Indeed the Irish fisheries in 1869 have far surpassed most of the previous seasons, and particularly in the vast preponderance of Grilse compared with Salmon. Some of the Grilse were large; but the majority were not much, if any, larger than their ordinary dimensions.

"In estimating the value of a Salmon-fishery, the calculation ought to be based upon an epoch of five years, or a *quinquennial* period. A generation of men is counted by thirty years; so in like manner a generation of Salmon ought to be estimated at five years. Some say, however, nine years; but the law of probability is rather in favour of five years.

"The term arrest of development of the Smolt, Mr. Buckland thinks, is not a scientific term. Nature has ordained that the fish should not grow more than a certain size in fresh water; that is to say, there is a maximum of growth and size in the Smolt. The transmutation of the Smolt into a Salmon takes place in the sea. Here, for the first time, we find that wonderful provision (which Mr. Buckland lays great stress on), the storing of fat on the pyloric appendages. Smolts have no fat on the pyloric appendages; but Grilse have. Non-migratory Salmonidæ have no pyloric fat; but Sea-trout possess it.

"The reason why Smolts will never become Salmon in fresh water has some relation to this development into the superior from the inferior stage of organization. This stage is not necessary for life. Salmon will live a long time in fresh water in the inferior condition, yet never pass over the line of demarcation between the two stages, unless conditions for the perfection of the secondary form be present. This is shown in the fact that nature actually orders a new coat for the creature when it passes from the one condition of things to the other.

"If the migratory instinct is impeded by human intervention, the dress assumed at such times disappears, and the fish (by a happy provision of Providence) continues to wear its Parr-coat, which, as the fish gets bigger, becomes increased in intensity. The 'Heppers' already spoken of exemplify this.

"The arrest of development is a term, therefore, which can only strictly be applied to Salmon in the sea, inasmuch as the arrest is simply the first natural stage of the progressive series of growths. Such stages of Salmon-growth have a parallel in the changes of insect-form: thus egg =ovum, caterpillar =parr, chrysalis =Smolt, and the butterfly =Salmon, may be said to be the analogous stages whereby insect and Salmon pass from the imperfect to the perfect condition."

Among what I have classed as addenda comes, as undernoted, a Table of dimensions (B). In the first notice (P. Z. S. 1868, p. 253) I was only able to give in detail those of specimen No. 1; but No. 2 has died since, and thus permitted its linear measurements to be taken. I have placed alongside these five other specimens, four of which are nearly similar in length, and the other that of a full-grown fish. These are specimens described individually by Dr. Günther in his Catalogue, and have been chosen by me to illustrate the proportional sizes and relations of the parts of the body to each other in an immature Salmon, a Sewin, a quasi-hybrid, a *S. nigripinnis*, and a fully developed *S. salar*. As the fractions used in the Catalogue are chiefly given in fourths, eighths, and sixteenths of an inch, I have converted these into decimals, enabling comparison between my two specimens and them more readily to be drawn therefrom.

Columns I. and II. relate to the Society's specimens, described in the previous paper.

Column III. relates to a young male Salmon (Parr), from the

Kulder (a rocky mountain-stream joining the river Tyne, in Northumberland), with the testicles fully developed.

Column IV. to a Sewin, or Bull Trout (*S. cambricus*) from the Rhymney. A male in the Smolt state, before going down the sea.

Column V. gives the admeasurements of one of the so-called hybrids between the Sewin (*S. cambricus*) and the River-trout (*S. fario*). "A young female from the Towey, caught in the month of August."

Column VI. gives those of a male specimen of the *S. nigripinnis*, with testicles well developed. "From Llyn Gadr, caught in the month of August."

Column VII. gives those of a perfect-conditioned male Salmon from the river Tweed.

Table B.

	I. Zool. Soc. spec. No. 1, Proc. 1868.	II. Zool. Soc. spec. No. 2, Proc. 1868.	III. Salmon-parr, B. M. Cat. p. 21.	IV. Sewin, Smolt, B. M. Cat. p. 45.	V. Hybrid? B. M. Cat. p. 57.	VI. *S. nigripinnis*, B. M. Cat. p. 99.	VII. *S. salar*, ad., B. M. Cat. p. 16.
	in.	in.	in.	in.	in.	in.	in.
Total length	6·5	7·6	6·5	6·87	7·50	8·00	46·0
Greatest depth of body	...	1·2	1·43	1·37	1·50	1·62	11·50
Length of the head	1·4	1·2	1·37	1·43	1·56	1·75	10·50
Least depth of tail	...	0·6	0·56	0·56	0·62	0·75	3·33
Distance from end of snout to eye	0·3	0·45	0·37	0·37	0·37	0·37	4·50
Length of maxillary bone	0·6	0·75	0·43	0·56	0·62	0·75	3·75
Distance between eye and præopercular angle	...	0·5	0·37	0·50	0·50	0·62	3·33
Greatest width of operculum	...	0·4	0·37	0·37	0·37	0·37	2·12
Greatest depth of operculum	...	0·75	0·43	0·50	0·50	0·56	3·0
Distance between occiput and origin of dorsal fin	...	1·75	1·62	1·87	1·75	1·87	14·0
Distance between end of dorsal and root of caudal fin	...	2·40	2·06	2·31	2·5	2·87	15·0
Length, base of dorsal	0·9	0·85	0·75	0·75	0·75	0·87	4·66
Greatest height of dorsal	1·2	...	0·87	0·81	1·00	1·12	4·50
Length of pectoral	1·2	1·3	1·25	1·00	1·25	1·37	5·50
Distance between roots of pectoral and ventral	1·6	1·8	1·62	1·87	2·00	2·00	12·5
Length of ventral fin	...	0·9	0·87	0·75	0·87	1·12	4·66
Distance between root of ventral and origin of anal	1·2	1·15	1·0	1·00	1·37	1·37	10·5
Length of the anal	0·8	0·8	0·56	0·43	0·56	0·62	3·33
Length of longest caudal ray	...	1·1	1·06	0·87	1·12	1·25	6·00
Length of middle caudal ray	...	0·55	0·43	0·56	0·56	0·62	...

Between the Society's two specimens there is a close agreement, the head of No. 1, however, being proportionally and absolutely the longest. The Parr (III.) corresponds to both, the main disagree-

ment being in the less depth of the operculum, and smaller size of the dorsal and anal fins.

The Sewin, excepting in a smaller ventral fin, is almost intermediate between the three foregoing. The hybrid (?) varies in proportional dimensions little from the preceding; the head may be considered a trifle longer than in them, as also the distance betwixt the dorsal and caudal fins, betwixt the pectoral and ventral fins, and betwixt the ventral and anal. Considering that the specimen of *S. nigripinnis* is a shade larger fish, its admeasurements wonderfully harmonize with the five already mentioned.

What, therefore, appears to be elicited is that, *pari passu*, the fishes No. 1 and No. 2, fully four and five years old respectively, are almost identical in the relative proportions of their bodies with what may be assumed much younger Parr, Sewin Smolt, hybrid Sewin, and the so-called *S. nigripinnis*.

Taking column VII. into consideration, and contrasting it with III., the relative growths of the several parts of the Salmon's body to each other (from the Parr to the adult condition) are proved to be unequal in ratio. The total lengthening of the body, in the instances cited, is $=7$ times. The depth of the body increases $\times 8$. The head elongates $\times 7{\cdot}6$. The least depth of the tail has an increment $= \times 5{\cdot}9$. The distance from the end of the snout to the eye enlarges $\times 12{\cdot}1$ times, or in the male the anterior segment of the face is proportionally excessively developed, a fact not at variance with the proportion between adult male and female Salmon. The maxillary bone grows in length $\times 8{\cdot}7$. The distance between the eye and the opercular angle increases nine times from the Parr to the adult stage as a Salmon. The operculum widens $\times 5{\cdot}7$, and its depth becomes $= \times 7$. Betwixt the occiput and the dorsal fin the intervening space lengthens by $\times 8{\cdot}7$, and that betwixt the dorsal and caudal fin 7·2 times. The elongation basally of the dorsal fin is $= \times 6{\cdot}2$, and its height $= \times 5{\cdot}1$. The pectoral fin lengthens $\times 4{\cdot}4$; but the increase of distance between the roots of the pectoral and ventral fins is $= \times 7{\cdot}7$. The elongation of the ventral fin proceeds to $\times 5{\cdot}3$ times, whereas the distance between the root of the ventral and the origin of the anal fin becomes $= \times 10{\cdot}5$. The anal fin grows 5·9 times as long, the longest caudal ray $\times 5{\cdot}6$.

The above data are of course only approximate, as from the comparison of only two specimens it would be unfair to draw conclusive deductions; but, taken for what they are worth, computation gives the following general results:—

1. The average measurements of the development of the body, head, occiput to dorsal fin, dorsal to caudal, and pectoral to ventral fins are as 7·44 to 1.

The amount of divergence between the ventral and anal fins, 10·5 to 1, is much greater than the foregoing maximum and minimum, an anomaly possibly dependent on sex.

2. The ratio of increase of the maxillary and the eye to that of the operculum averages 8·85 to 1.

3. The average elongation of the fins is as 5·26 to 1.

4. The depth of the body and root of tail differ as regards augmentation, the former being as 8 to 1, the latter as 5·9 to 1.

5. Between the width and depth of the operculum, respectively 5·7 and 7 to 1, the horizontal to vertical increase is inversely to what obtains in the body.

Availing one's self of these considerations, and comparing specimens I. and II. with III. (Table B), it will be seen, more especially in the older fish, II., that the maxillary bone and distance from snout to eye are proportionally larger than in the Parr. The same may be said as regards growth of the operculum, more particularly its depth. The distance between the ventral and anal fins is also sensibly greater. Thus those parts which in the adult, *cæteris paribus*, show the greatest relative accretion are, curiously enough, in the Salmonoids reared in fresh water, the parts which have most increment. From this it follows that whilst a general arrest of development, retardation of growth, or whatsoever the term used, has occurred from the altered physical circumstances, still the proportional magnitude of the parts has kept pace with that of a normally developed adult Salmon favoured by visits to the sea.

General Conclusions.

The main fact at issue—Can *Salmo salar* live for series of years in fresh water without access to the sea?—if not settled beyond cavil, has, I venture to think, in this and the preceding paper, been tolerably well substantiated. At least the evidence of many observers has been given; so that it remains for those who discountenance the view to show the fallacy of the data, and prove on evidence as reliable that the contrary is the true state of the case. This does not interfere with the necessity of further experiments being tried. For my own part, I am quite willing to bow acknowledgment to whichever side the truth lies on—though, after an impartial consideration, I cannot escape or reason away the strong presumptive allegations positively confirming the opinion. To me they are reasonable, because based on what, in homely parlance, are deemed everyday occurrences. The principle in the life-history of the Salmon which seems at variance with its customary habits is in reality not so; what takes place as a general rule is here but temporarily departed from. In the physical constitution of animals, the limits assigned to the well-being of the individual are not so rigidly exact as a mathematical problem; hence, to judge rightly, we must know all, or be prepared to confute abnormal phases of existence. In the present instance the choice of credence lies between testimony harmonious with laws regulating the primary growth of Salmon, and suppositions framed on circumstances we have but an imperfect knowledge of, unless it be satisfactorily shown that the statements of such a truthful observer as Yarrell, or the instance recorded by Anderson, are fictitious or egregiously false.

Those who deny that some Salmon, few or many, can permanently accommodate themselves to a freshwater residence for a comparatively

long period, seem to have lost sight of the value of several important points and consequent deductions.

1. That, in the natural condition, Salmon-fry do not all attain vigorous adolescence at the same period; still more so is their irregularity as regards perfect maturity.

2. That the periodical accession of the migratory impulse does not affect all alike, either as to time or season.

3. That those which do remain behind in the rivers for two seasons or more grow, relatively speaking, no larger than their juniors in age.

4. That the very fact of their abnormal retarded growth may account for several peculiarities as to organization, which divergence from the type has been put down to specific difference or hybridity.

5. That the admission of the uncertainty of the species (reared in the Gardens) strengthens the presumption of their being *S. salar*, when it has been demonstrated that their characteristic affinities are closer to that than to any other form.

6. That the belief in the hybridity of Salmonoids under natural conditions is, as yet, based on data less stable than the assertion that Salmon can abide long in fresh water: hence such an argument presents feeble opposition.

7. That not only does an occasional lengthened stay in fresh water accord with known habits, but, inversely, a more than ordinary protracted stay in sea-water occurs at times. In the instance mentioned (*anteà*, p. 42), the majority of the return Grilse had grown no larger than those sojourning only a few months in the salt-water. This circumstance tells weightily in support of a temporary cessation of growth happening equally when Salmon dwell longer than the normal period either in the river or the sea.

8. That the fact of Salmon periodically tenanting sea and stream does not absolutely enforce migration under immediate penalty of death. The bodily improvement consequent on the change, however, is tantamount to its being needful to their ample development; *ergo*, causes checking the migratory impulse are coincident with the abeyance of growth.

9. That marine fish, other than migratory Salmonoids, have survived freshwater confinement.

10. That numerous instances can be adduced showing that fish of several sorts remain relatively feeble or thrive vigorously, according to limited space and nourishing food being withheld or granted to them. Salmon offer no exception.

11. That in well-attested cases fish confined to tanks are predisposed to variability—this notably in the Cyprinidæ, which present no very distant family relationship to the Salmonidæ, whence it may be assumed that such phenomena in the latter would be likely to supervene.

12. That in animals which exhibit peculiar phases of transformation or rapid changes at epochs of their life, exemplified in some Echinodermata and Insecta among invertebrates, and certain Batrachia* among vertebrates, physical agents play an important part in

* *Vide* Higginbottom's experiments (Phil. Trans. 1850, p. 434, pl. 32).

the retardation or hastening of development. So, therefore, temporary arrest of growth in Salmonoids is but an expression of the same law; and it is worthy of special note that Salmon-ova preserved in ice are hatched later than when placed in a more suitable temperature.

13. That the proportional growth of head to body &c. of Salmonoids confined in fresh waters bears a diminished, though steady, ratio to that between Parr and adult Salmon. Thus it would seem that the same disposition as to the growth of parts is manifest, but antagonized or hampered by the unnatural conditions extant.

14. That solid evidence is published of sexually mature male SalmonParr being frequently met with in natural conditions. Experimentally, milt from such has impregnated Grilse-ova, the brood resulting showing diminution of early growth compared with Salmon-milt and ova, Grilse with Salmon, and Grilse with Grilse. It may be conjectured, therefore, that the produce of the former parents would be much more likely to evince variation as regards development and migratory instinct than would fry derived from full-formed fish.

15. That such legitimate though unequal unions should peradventure happen, may very plausibly be assumed to be the case, rather than that hybridism between specifically different forms, spawning at separate dates, does often ensue.

The above fifteen points, even when sifted and divested of extraneous remarks and unguarded assertions, still form a compendium which materially urges the following convictions:—(α) That though as a rule Salmon necessarily spend periods of their life in sea-water, circumstances may conduce to this being postponed temporarily or indefinitely. (β) That a very appreciable arrest of growth is the consequence where retention to a limited area of water obtains.

I leave it as an open question, whether *S. salar* may not vigorously grow and multiply in extensive lakes and running streams, though, I may add, the preceding convictions prepare the mind for that belief.

Respecting the term "arrest of development," which my friend Mr. Buckland holds can only significantly be applied to a Sea-salmon, and in itself is not scientifie, I entirely disagree with him. I grant the phrase is one seldom if ever used by ichthyologists or in practical natural history; but in pathological anatomy, and the kindred subject of malformations or teratology, it is of great import. The celebrated Russian embryologist Wolff suggested the term, and the no less famous comparative anatomist J. F. Meckel followed, and first used the expression (*Bildungshemmung*) commonly adopted by succeeding writers on malformations—a sufficient guarantee for its scientific accuracy.

The dwarf formation, abnormal diminutiveness, or retardation of growth that affects the Salmon in question is essentially due to a congenital or acquired arrest in the growth or development of the organs or system generally. Growth may be checked either in the embryo condition or subsequently to birth; and the latter appears to be the case with the fish under immediate consideration. That is

to say, after the fry have reached a certain grade of maturity and bulk, causes (nature of food and retention in a limited volume of fresh water) induce malnutrition or derangement of nutrition, hindering normal growth. Had the Salmonoids gone to the sea and returned stunted, the term "arrest" would still be partially applicable, inasmuch as normal evolution from the embryonic to the full-formed animal would have been interfered with, or remained stationary short of completion. The phrase would be equally a happy one, viewing the development of Salmon as a series of stages of progressive growth, as Mr. Buckland puts it; for as some physiologists limit "growth" solely to increase of size, and "development" to structural change*, the idea of progressive advance in the Salmon would sanction the "arrest of development" as a most suitable term.

Should future researches support the facts and views it has herein been endeavoured to establish, obviously many species at present adopted in the nomenclature of the genus *Salmo* may require material modification. For doubtless it would follow that the same fish, under different grades and shades of development, has been distinctly and separately named, as, indeed, H. Widegren† has already attempted to show, and has partly been supported and opposed by Malmgren‡ and Günther. The geographical distribution of the group as now understood might need revision. It would likewise strike at the root of living transitionary species, and be the clue whereby a path through the labyrinthine variations of the Salmonidæ would lead to a better knowledge and study of the group. Assumed hybridity of Salmonoids must necessarily require a much broader body of evidence, and more vigorous scrutiny of data, than has hitherto been accorded it. Although it may be said that fish-spawn presents far greater accessibility to the fecundating influence of the milt of a different species than does the union of the germinal products of higher Vertebrata, still the line of demarcation must rest sharply somewhere; otherwise no such thing as specific identity would be recognizable in the produce; instead of hybrids being rare, or in the minority, as now obtains, they would soon be in overwhelming majority, and reduce the present faint distinctions of the Salmonidæ to a chaos.

On the other hand, can it be that in this variability from a common stock we have tracings of the elimination of natural species? Has the inherent organization, permitting some individuals to survive changed conditions, alone the utility of preserving the race, or does it carry with it the elements of structural variety, whereby ultimate scission from the primary type is effected?

There are not wanting able defenders of views of an entirely opposite character; but in whatever direction the opinion leads, the force

* See some pertinent remarks thereon in Darwin's 'Animals and Plants under Domestication,' vol. ii. p. 389.

† Œfvers. Vetensk. Akad. Förhandl. 1863.

‡ Kritisk Œfversigt af Finlands Fisk-Fauna: Helsingsfors, 1863. Translated, Wiegm. Archiv, 1864, and reviewed, Record of Zool. Lit. 1864, p. 178, by Günther.

of Professor Agassiz's * expressions (himself adverse to the transmutation theory) cannot be denied. In treating of the relations between animals and plants and the surrounding world, he says, "And yet, without a thorough knowledge of the habits of animals, it will never be possible to ascertain with any degree of precision the true limits of all those species which descriptive zoologists have of late admitted with so much confidence into their works. And, after all, what does it matter to science that thousands of species, more or less, should be described and entered into our systems if we know nothing about them!" . . . "Then we may learn with more precision how far the species described from isolated specimens are founded in nature, or how far they are only a particular stage of growth of other species; then we shall know, what is yet too little noticed, how extensive the range of variation is among animals observed in their wild state, or rather, how much individuality there is in each and all living beings."

No decided answer can be given to the questions at issue while so much of the commoner facts in the life-history of the Salmonidæ are conjectural. Every scrap of information based on accurate observations is needed to unravel the phenomena, whether dependent on reasons physiological or physical, teleological or pangenetical.

EXPLANATION OF PLATE II.

Illustrations of the variable growth of Salmonoids in tanks of fresh water.

Fig. 1. Young of the Great-Lake Trout (*Salmo lacustris*?), being one among others reared from a batch of ova from Huningue, near Basle, and presented to the Society by Mr. Frank Buckland, 9th or 10th March, 1869. The specimen was nine months old, having been hatched about the middle of March; and the drawing was taken immediately after death, on the 15th December, 1869, natural size, *i. e.* 3·3 inches long. A few of the same brood were somewhat larger, others smaller.

Fig. 2. A young Salmon (?) from Rhine ova, received as above. Length 1·95 inch; natural dimensions: sketched 14th December, 1869.

Fig. 3. Another specimen of the same batch of Salmon (?), and corresponding to fig. 2 in age, viz. about 9 months. Natural size, =2·7 inches, and, as in fig. 1, figured immediately after death.

The brackets, respectively lettered *a*, *b*, between the preceding figures, indicate the length (3·1 inches) of one of nine good-sized specimens of the same brood of Salmon (?), which died on the 6th October, or somewhere betwixt 6 and 7 months old. Had they lived until the middle of December, doubtless they would have grown as large as the Great-Lake Trout here represented.

Fig. 4. Salmon (?) from Rhine ova, fully 2 years old, which, like the above, was reared and retained in the Society's freshwater aquarium at the Regent's Park. Hatched February 1866, died 14th April, 1868.

The figure, natural size and colour, taken immediately after death, shows the assumption of the silvery Smolt-coat, indicative of the migratory impulse.

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* An Essay on Classification (London, 1859), pp. 85, 86.