

tenth morning from that they look for the appearance of the palolo; but the extra lunar month sometimes puts them wrong. Others watch with equal success, for the indication of the season, the sinking below the horizon of various constellations, commencing with Orion.

I should mention that there is a second appearance of palolo each year, occurring a month after the first, consisting of such worms, probably, as were not sufficiently mature to spawn in October—or, it may be, of another species.

The palolo is by no means confined to Samoa and Viti. Our Samoan missionaries in the Gilbert Group have informed me that they also are found at those atolls. One of the missionaries caught some of both the grey and green varieties there. The worms are found near the outer reefs, in from 4 to 8 feet of water. The natives of the Gilbert Islands hold that the palolo is a production of the coral—grows out of it; they call it “Te Nmatamata,” *i.e.* the Glistener. It appears there in *June* and *July*. How is this? Why there in June, but here in October? Perhaps it may be because those atolls are nearly on the line, while Samoa is 14° more to the south.

Samoa, May 14th, 1881.

P.S.—If the above calculations and statements are correct, the palolo should appear in Samoa on October 15th or 16th, 1881, October 5th or 6th, 1882, and October 25th or 26th, 1883.

Observations on British Salmones.—I. Trout.

By FRANCIS DAY, F.L.S.

[Read March 16, 1882.]

At the early part of 1880 I exhibited some Salmonidæ before the Linnean Society*, in order to demonstrate how local causes may induce temporary or even permanent changes among members belonging to this family of fishes. The first example I showed was an American charr (*Salmo fontinalis*). The specimen was nine inches in length, of good condition, and with brilliant colours; it had been reared by the late Mr. Frank Buckland in his tanks at the Horticultural Gardens, South Kensington, from eggs received direct from Lake Huron. He presented some of the fry to the authorities of the Westminster Aquarium soon after that institution was first opened; and the example under consideration was the last survivor, having met with its death in October 1879, when

* For brief notice of which see the ‘Proceedings’ of the Meeting 5th February 1880, p. lii.

it was kindly sent to me by Mr. Carrington, F.L.S., the naturalist in charge. Here no question respecting the parentage of the fish could arise, no crossing with European trout could have occurred; but a single glance at the specimen sufficed to show great differences from what may be considered to be its normal form. The head had much elongated in proportion to the length of its body; and the very form of the subopercle had changed, being twice as long as deep, instead of nearly square, as observed in this species when in a state of nature. I had also two other examples of this fish reared from eggs derived from the same source; they were turned out in Cardiganshire in 1876, and captured in the middle of 1877: in them the head was not elongated, and the form of the subopercle was normal. It appeared to me that these facts were very suggestive: certain unnatural conditions had caused unnatural changes of certain parts; and it did not appear improbable that, were other examples similarly reared, they might in like manner differ from the primitive stock. Neither could I see why, if such forms were transferred to ponds or streams, they should not retain such abnormal variations through succeeding generations or return to what normally existed among their ancestors.

I also showed four examples of young salmon (*Salmo salar*) reared by Mr. Frank Buckland from eggs received from Huningen, and which were collected from salmon captured for this purpose from below the falls of Schaffhausen. As year after year passed by, and these fish were still retained in the comparatively small amount of fresh water which was sufficient to fill the tanks in the Horticultural Gardens, the same results developed themselves which have usually attended the retaining of salmon parr in freshwater ponds. The lanky half-starved body became identical with that of *Salmo gracilis*, Couch, and *S. argenteus**, Günther. As this subject has been well treated of by Dr. Murie†, I do not propose considering it further at this time.

Since the period (1880) first alluded to, I have received extensive collections of Salmonidæ, more especially from Sir Pryse Pryse, of Gogerden, Cardiganshire, a beautiful variety‡ obtained for me in Yorkshire by Mr. G. Brooks, F.L.S., Loch-Leven trout from our late Secretary, Mr. E. R. Alston, examples from Waterford and elsewhere; while I have visited the Eastern counties, the museums of the North and Scotland, personally captured examples

* Drawing exhibited.

† Figure exhibited.

† Proc. Zool. Soc. 1868, p. 247, pl. xxiii, and 1870, p. 30, pl. ii.

in Gloucestershire and in Cornwall (*S. cornubiensis*), irrespective of investigating the beautiful series in the British Museum.

The various forms indigenous to this country, and usually considered as pertaining to the genus *Salmo*, have been thus divided:—

(1) *Trutta*, Nilsson; *Salmo* and *Fario*, Cuvier. Salmon.

Anadromous forms, possessing at some period of their lives deciduous teeth on the vomer, which teeth are usually shed commencing from behind forwards.

(2) *Salar*, Cuvier. Trout.

Freshwater non-migratory forms, possessing at some period of their lives teeth on the vomer which are to a certain extent deciduous, the shedding of which commences from before backwards.

(3) *Salvelini*, Nilsson. Charr.

Freshwater non-migratory forms, in which the vomerine teeth are restricted to the head of that bone.

The remarks which I have to make will refer to the second group or subgenus of the genus *Salmo*, or *Fario*, our freshwater non-migratory trout, respecting which I will commence by observing that (excluding the Loch-Leven trout) we have only one form, the *S. fario*, Linn.,—*S. ferox*, Jardine & Selby, *S. nigripinnis*, Günther, *S. stomachicus*, Günther, *S. gallivensis*, Günther, and *S. orcadensis*, Günther, being simply varieties which, due to local circumstances, have developed certain changes, some of which appear at first sight to be permanent, others to be transitory.

If we examine into the history of these fishes as given by our various British authors, we find as follows:—

Donovan, in his 'British Fishes' (1802–1808), refers to the common trout (*Salmo fario*), which he observed was subject to many varieties, differing in appearance according to the season of the year and also the nature of the water it inhabited. He commented on a *form* existing at Llyndivi, a lake in South Wales, where it was termed "Coch y dail" (it was marked with black spots as large as sixpences); to a crooked-tailed variety in the Eynion, a river not far from Machynlleth, as well as to its being found in the Snowdon lakes; to the Gillaroo trout of Ireland, remarkable for the great thickness of its stomach, though it does not differ in other respects from the common trout; and, lastly, to some in the Scotch lakes that are very differently coloured *externally* from the common sort, and which he suspected might be a distinct species. He next alluded to the variation of trout

in *size*,—referring to the Fordwich form in Kent, which attains nearly to the weight of salmon; to the Buddaghs of Lough Neagh, in Ireland, some of which weighed nearly 30 lb. He finally drew attention to the *colour internally*, or that of the flesh, remarking upon having taken both the red and the white kind at the same season in two contiguous streams in Cardiganshire, one of which invariably produced the red and the other the white variety.

Turton admitted into the 'British Fauna,' 1807, the common trout and the parr. Fleming, in his 'History of British Animals,' recognized the same, remarking of the Gillaroo variety that when it feeds on shellfish the coats of its stomach acquire a thickness causing it to resemble the gizzard of birds. Jenyns, in his 'Manual of British Vertebrate Animals,' 1835, recorded the common trout with its variety the Gillaroo; the great lake-trout, *S. ferox*, which he believed to be identical with the *S. lacustris* of Berkenhout. Yarrell ('History of British Fishes,' 1836) at first admitted the parr or samlet, the common trout, and great lake-trout, and, in a later edition, the Loch-Leven trout. Parnell, in 1838, in his prize essay on the Fishes of the Firth of Forth, gave the same as Yarrell did. Jardine, in his 'British Salmonidæ,' figured the great lake-trout, the common trout, and varieties. Thompson ('Natural History of Ireland,' 1856) gives the common trout, including the Gillaroo, which variety he recorded having met with in most freshwater races, and the great lake-trout. White, in the 'List of the Specimens of British Animals in the British Museum' (1851), enumerated the common trout and the great lake-trout.

In 1865–66 Dr. Günther bestowed a large amount of research upon this family of fishes, and brought together a beautiful collection of specimens in the British Museum; and if I am unable to agree with his conclusions, it must be remembered that the Tasmanian experiment, so fatal to the validity of his reputed species, did not commence until subsequent to the publication of vol. vi. of the 'Catalogue of the Fishes in the British Museum.' In it, in 1866, he described the following forms:—*Salmo levenensis*: vertebræ 57 to 59, cæcal appendages 49 to 90*. *Salmo fario*, var. *fario*: vert. 59–60, cæc. pyl. 33–46; var. *ausonii*: vert. 57–58, cæc. pyl. 38–47. *Salmo ferox*: vert. 56–57, cæc. pyl. 43–49.

* These numbers are distinctly recorded in the pages of the sixth volume of the 'Catalogue of the Fishes in the British Museum,' by Dr. Günther, as existing in specimens present in the collection of that institution,

Salmo stomachicus: vert. 59-60, cæc. pyl. 44. *Salmo gallivensis*: vert. 59, cæc. pyl. 44. *Salmo orcadensis*: vert. 56-57, cæc. pyl. 50. *Salmo nigripinnis*: vert. 57-59, cæc. pyl. 36-42. The foregoing show an extreme range as follows:—*S. levenensis*, vertebræ 57-59, cæcal appendages 49-90; the remaining six, enumerated as species, vertebræ 56-60, cæcal appendages 33-50. In the year 1880, Wallace, 'Island Life' (p. 321), on the authority of Dr. Günther, introduced these forms as distinct species, observing, "They are in fact, as Dr. Günther assures me, just as good and distinct species as any other recognized species of fish;" while Dr. Günther, 'Introduction to the Study of Fishes' (p. 644) reiterates, with but slight variations, his conclusions come to in 1866. Thus, as in the former work he observed "that at least some of the species interbreed, and it is probable, although at present not confirmed by direct observation, that such hybrids mix again with one of the parent species, thereby producing an offspring more or less similar to the pure breed" (Catal. vi. p. 3), he asserts in his later work that "some of the species interbreed, and the hybrids mix again with one of the parent breed, thus producing an offspring more or less similar to the pure breed" (Introd. Stud. Fish. 1880, p. 631). This exceedingly interesting conclusion, unfortunately, is unsupported by reference to the results of any experiments or observations made by competent individuals, leaving one in doubt as to whether it is an opinion founded upon conjecture or fact.

From our very earliest authors on ichthyology down to the present period, the existence of hybrid fishes has been insisted upon; and of late years artificial propagation has clearly proved that such can occur; but it is open to grave doubt whether among the Salmonidæ they are as numerous in a wild state as some authors would have us believe; while, so far as my inquiries tend, the fertility of hybrids still remains to be proved*. Experiments have been instituted to test this question of hybrids; and Professor Rasch, in 1867, recorded the result of his investigations. He found that the ova of the sea- and river-trout are developed regularly whichever form were the parent, and the offspring are fertile; that, of the ova of the charr fertilized by the milt of the trout, 30 to 40 per cent. are developed, but many young fish perish after being hatched; trout-ova fertilized by the milt of the charr gave only 10 per cent. developed, and many of the young were misshapen; salmon-ova fertilized with trout-

* Professor Rasch refers to the ova of a hybrid between a trout and a charr.

milt yielded 40 per cent. of young fish, but none if the milt of the charr were used; that the ova of a hybrid between a trout and a charr could not be fertilized with trout milt. I saw at Berlin lovely hybrids between trout and charr, but was unable to obtain satisfactory evidence that such were fertile forms.

I will now briefly record the results which I have arrived at in testing the interesting conclusions, given in Dr. Günther's 'Catalogue,' as to what constitutes a species of trout. I took first what are termed *constant characters*, as the number of the vertebræ as well as of the cæcal appendages, as they appeared to be considered among the most important factors in affording a guide to specific differences. I obtained leave from Mr. Elwes to use his trout-preserves at Colesbourne, on the summit of the Cotteswold Hills, where no new races of trout have been introduced, and consequently the original local form remains unchanged. According to Dr. Günther's investigations, the variety of brook-trout termed *S. fario*, distributed in the northern parts of Europe and Scotland (Catal. vi. p. 59), has vertebræ 59-60 and cæca pylorica 33-46; whereas the variety *Ausonii* is stated to possess vertebræ 57-58 and cæca pylorica 38-47. The latter "is found in Central Europe and the southern parts of England" (vi. p. 59). Certain varieties of distribution are alluded to; and it is asserted that the northern form "extends as far southward as Shropshire, where both forms are met with." I captured a considerable number of trout at Colesbourne, which from its locality should have produced the variety *Ausonii*, and found that they had the number of vertebræ stated to belong to that form, or 57-58, but that their cæcal appendages were 34-39, or appertaining to the northern race. This rendered it clear that reliance could not be placed on these figures; the proposed formula of vertebræ and cæcal appendages were not found correlated at Colesbourne on investigation, and therefore could not be depended upon as invariable in other places. The next locality from which the examples came that I minutely investigated were from Cardiganshire, already referred to; and here again an anomaly was found. The number of vertebræ were from 57 to 60, but the cæcal appendages from 35 to 44. Tabulated, they would be as follows:—

<i>Salmo fario</i> , northern form (Günther),	Vert.	59-60,	cæc. append.	33-46.
„ southern „ „ „	„	57-58,	„	38-47.
„ from Gloucestershire	„	57-58,	„	34-39.
„ „ Cardiganshire	„	57-60,	„	35-44.

The foregoing results threw strong doubts upon the validity, first, of how the species had been subdivided, and, secondly, as to their distribution; while, if the number of vertebræ in all the seven forms of non-migratory freshwater trout inhabiting our islands merely varies between 56 and 60, I possess examples from one locality (Cardiganshire) in which they differed from 57 to 60, and in an example of the same variety from Penzance I have only found 56. Dr. Cobbold likewise gives an instance of a Scotch trout (*S. fario*) that he examined, and which had only 56 vertebræ. It is evident that too much stress has been attached to the number of vertebræ in trout; and no confidence can be placed on such as affording evidence of specific difference.

We thus arrive at the remarkable fact that the form considered by Dr. Günther as *S. fario* may possess from 56 to 60 vertebræ, which are exactly the extreme limits he ascertained existed among all the freshwater non-migratory trout of the British Isles.

Then, as to the number of these bones which are present, some other facts should not be overlooked. This family of fish is exceedingly prone to affections of the spinal column. Occasionally two small vertebræ take the place of one large one, as if a division had occurred; while in others may be observed an abnormally large one, as if two had coalesced, as shown by the normal number of hæmal spines for two vertebræ being present. Dr. Günther, in his interesting volume, even instances a case "where three vertebræ were united."

The number of cæcal appendages has been adduced as a character which may materially assist in fixing a species; and if unexpected variations occur, their cause, it is asserted, may be found in the partial confluence of the cæca. Dr. Günther gives the extreme limits of variation in his six species of non-migratory freshwater trout (excluding the Loch-Leven) as being between 33 and 50. But it appears to me that the difficulty does not appear so much in discovering variations, as in determining within what fixed number they exist in a given form: thus in Gloucestershire I found them at least from 34 to 39, and in Cardiganshire from 35 to 44. The question first requiring solution is, whether the number of these appendages is persistent or inconstant, and whether change of climate and food may occasion any variation.

I must here refer to the Tasmanian experiment, wherein it appears that the common brook-trout of the Thames and the

south of England has so altered since its introduction into the waters of the Antipodes that the breed has increased in size, while, food being abundant, certain organic changes have occurred. Dr. Günther, in an interesting manner, ignores the facts thus obtained by observing that "it is a fact that numerous cross-breeds have been introduced into and reared in Tasmania, which must more or less interfere with the character of the pure breeds" (Introd. p. 642). Neither does this view agree with his theory that "the hybrids mix again with one of the parent species, thus producing an offspring more or less similar to the pure breed" (*l. c.* p. 631)*. I therefore prefer accepting the statements of Mr. Allport and Mr. Arthur, more especially as their correctness as to whence the ova came is capable of being verified, and with respect to this I have been at some considerable pains. The trout-ova (1200 to 1500) sent by Buckland in 1864 came from fish taken "in a branch of the Itchen which runs through the garden of Admiral Keppel, at Bishopstoke, near Winchester" (Buckland, *Brit. Fishes*, p. 317); while the readers of the 'Field' have been informed, upon what appears to be reliable evidence, that the remainder, which were sent by Mr. Francis Francis, were obtained from brook-trout inhabiting streams that are affluents of the Thames.

To obviate errors, I will trace as briefly as possible the whole of this interesting experiment (except as to the collection of the ova, which has already been referred to)—when the eggs were sent out, and what became of them. From at least 1200 to 1500 trout-ova were despatched in the ship 'Norfolk,' which left Falmouth on January 28th, 1864, anchored at Hobart Town on April 20th, and on the 21st reached the ponds, about 300 trout-ova arriving alive. In Mr. Allport's account, "on the 8th day of February, 1866, the ship 'Lincolnshire' left Plymouth bound for Melbourne, having on board about 103,000 ova of salmon (*Salmo fario*†) and 15,000 ova of sea-trout (*S. trutta*), stowed in an ice-house," reaching Hobson's Bay on the 30th April, 1866 (see *Proc. Zool. Soc.* 1870, p. 23); but he alludes to the ova

* Examined from a different point of view, it may be asked to what original breed of British freshwater non-migratory trout have these fish reverted, if the British-Museum Catalogue is correct that none, except the Loch-Leven, have more than 50 cæcal appendages? for the Otago ones (New Zealand, distributed from Tasmania) show as many as 54.

† This probably means *S. salar*, but may refer to both.

subsequently as those of the salmon. Anyhow, any trout-ova received came from Mr. Francis Francis, who obtained them from an affluent of the Thames. On July 3rd, 1866, the first pair of trout matured in Tasmania had the ova and milt taken from them. "The ova shipped to Tasmania consisted of three* batches of eggs, supplied through the kind offices of Mr. Frank Buckland and Mr. Francis Francis," and were obtained from the localities alluded to. Mr. Arthur† informs us that the first successful trout-hatching in Otago occurred in October 1868, from 800 ova obtained from the natural spawning-beds of *S. fario* in Tasmania; these and a second lot the subsequent year formed the whole of their original stock, some of which were first liberated in the streams in November 1869.

As these New-Zealand fish are clearly descendants from our brook-trout (*S. fario*), it is evident that they might be expected to correspond in structural characters with their ancestral stock. But results show that they have not done so. Without entering minutely into Mr. Arthur's interesting paper, which should be studied in the 'Transactions' of the Society in which it was published, I will restrict myself to his conclusions. Scotch trout, according to Stoddart, show a yearly increase of about one third of a pound in weight; while in Otago they grow so rapidly and are so fat that they have reached an average yearly increment of from 1 lb. to $2\frac{3}{4}$ lb. Already the various streams have stamped the trout with local peculiarities: in some they are plump almost to deformity; their proportions are not constant, neither are their colours; while examples are said to have been seen up to 20 lb. in weight. What is of extreme interest, however, is, as already remarked, that these fat fast-growing fish have not the number of cæcal appendages of their ancestors, but with increased necessities, due to a superabundant supply of food, they have augmented in number—not varying between 33 and 47, the extreme limits Dr. Günther assigns to the *Salmo fario*, but from 43 to 54; while among the entire six British species he described (Loch-Leven trout not included) he limited these appendages to between 33 and 50. Thus the brook-trout, transported to a climate where food is abundant, has taken on structural changes affording a most conclusive proof that the

* Buckland says he believes Mr. Francis Francis sent some trout-eggs obtained from Hungerford at the same time as his were forwarded.

† Transactions of the Otago Institute, July 9th, 1878.

number of cæcal appendages is no more a criterion of species than are the number of the vertebræ. Had these New-Zealand examples been submitted to Dr. Günther prior to 1865, they would undoubtedly have formed at least another new species for the British-Museum Catalogue; while his views, as given in his late work, appear to have undergone but little, if any, modification*.

Respecting the form of the preopercle, the size of the head, and the dentition, wide differences exist in this fish, in accordance with age, sex, and other causes, and which do not call for a detailed examination in this place. I will therefore pass on to variations in colour—first, internally, and, secondly, externally.

The flesh of trout may be of a red or of a white tint, due, it has been frequently shown, to the food which the fish consumes. And this difference in the food may be consequent either on necessity or choice. Thus, in one river, as at Alresford in Hampshire, crustaceans may be obtained in the lower portion of the stream, not so in the upper; in the former the cooked fish cuts pink, in the latter nearly white. It would also appear that, even if the necessary food for occasioning the pink appearance is present it does not follow that the fish selects it, as there are rivers in which some of the brook-trout are red while the others are white, both forms being in good condition and equally excellent when served at table. Reverting to the *Salmo fontinalis*, or American charr, which undergoes the same changes in this country as *S. fario* does in New Zealand, what do we find? The young, as I observed, have been turned out and acclimatized here, and with the following result as regards this question. Those which have been liberated in the streams in Cardiganshire are, as food, observes Sir P. Pryse, “very good, the flesh having a peculiar gamboge colour, and rich;” while Mr. Francis Francis tells us, respecting others from Sir James Maitland’s, in Perthshire, that their condition left nothing to be desired: they were fat and firm; the flesh was of a beautiful pearly white (‘Field,’ March 11th, 1882). A subsequent correspondent (Coracle, ‘Field,’ March 18th, 1882) states that he has also seen it in this fish perfectly

* It is difficult to admit that all non-migratory trout not agreeing in their fin-formula, their number of vertebræ, and cæcal appendages with the descriptions given in the British-Museum Catalogue, are to be termed hybrids. It seems more rational to surmise that Nature’s limits of variation are more extensive than those admitted by Dr. Günther.

pink. It is clear, from the foregoing differences in colour in the flesh of an unquestionably single species of *Salmo*, that it may be pearly white, perfectly pink, or of a gamboge colour, but equally good for the table, the fish being in good condition in all the several forms.

The external colours of these fish (omitting such as are due to age, condition of health, or the breeding-season) vary in a very wide manner, in accordance with the localities they inhabit, the nature of the soil or bottom of the water, the rapidity or the reverse of the current, the extent and depth of the water, as well as the food, light, and temperature. Clear water in rapid rivers or lakes, especially when the bottom is pebbly, often contains somewhat silvery fishes with black X-shaped marks. Many experiments have been made, showing how rapidly one of these fishes may change colour. "Put a living *black* burn-trout into a white bason, and it becomes within half an hour of a light colour. Keep the fish living in a white jar for some days, and it becomes absolutely white; but put it into a dark-coloured or black vessel, and although on first being placed there the white-coloured fish shows most conspicuously on the black ground, in a quarter of an hour it becomes as dark-coloured as the bottom of the jar, and consequently difficult to be seen" (St. John, 'Natural History and Sports in Moray,' p. 25). All practical anglers know how trout of very different colours may be captured from contiguous streams, or from ponds into which they have been introduced, from what they were when originally placed there. "Unquestionably," observes Stoddart ('Angler's Companion,' 1847, p. 3), "there exists no species of fish which, judging of it by the external marks, holds claim to so many varieties as the common fresh-water trout. In Scotland almost every lake, river, and streamlet possesses a breed peculiar in outward appearance to itself." Jurine, respecting the fishes of the Lake of Geneva, observes that the common trout, salmon-trout, lake-trout, river-trout, the alpine trout, &c. are all referable to differences of sex, age, season, the nature of the water, food, light, &c. (Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève).

If some trout esteem food which causes their flesh to be tinged with red, while others in the same water appreciate a different sustenance, and consequently are not thus tinged, if the Gillaroo eats shells, occasioning thickening of the middle coat of its stomach,

while such diet, as a rule, is rejected by the common variety of *Salmo fario*, it appears to point out that the tastes of some differ from those of their companions; while it is a well-known fact that certain forms of food promote fish-growth more rapidly than others. Mr. Stoddart gives the result of an interesting experiment on trout:—"Fish were placed in three separate tanks, one of which was supplied daily with worms, another with live minnows, and the third with those small dark-coloured water-flies which are to be found moving about on the surface under banks and sheltered places. The trout fed on worms grew slowly, and had a lean appearance; those nourished on minnows (which, it was observed, they darted at with great voracity) became much larger; while such as were fattened upon flies only, attained in a short time prodigious dimensions, weighing twice as much as both the others together, although the quantity of food swallowed by them was in nowise so great."

If a trout, normally belonging to a small race, as *S. cornubiensis*, is transferred to a reservoir or lake where food is plentiful, it attains a size to which it never reaches in its ancestral stream, showing capacity for growth to be inherent, and called into action by luxuriant living. In Scotland the largest examples are in lochs, so also in Wales and Ireland—although occasionally a large one may be found existing in a sluggish stream, especially if such passes over a rich soil. Should food be plentiful, a brook-trout may attain to many pounds weight in suitable localities—in fact, to as large a size as the great lake-trout, which I hold to be merely a form of *S. fario* which indulges in luxurious living or cannibal propensities.

The first so-called species which I propose alluding to is *Salmo nigripinnis*, Günther, 1865, or *S. cornubiensis* as described by Borlase, Artedi, &c., and which for many reasons may be considered the young of *S. ferox*. I have been most liberally supplied with specimens from Cardiganshire, through the kindness of Sir Pryse Pryse; and among them is one form which was alluded to by Barrington, in the 'Transactions of the Royal Society' for 1774, as the "Hog-backed Trout of Plinlimmon," which Dr. Günther, as I believe correctly, considered identical with his *S. nigripinnis*. My example is a peculiarly interesting one, as showing a link between *S. nigripinnis* and *S. ferox*, pertaining partially to one form and partially to the other. The

following are the differences noted in the British-Museum Catalogue :—

Salmo nigripinnis.

D. 14, A. 12, P. 13, L. l. 120–125, Cæc. 36–42; Vert. 57–59.

Head small. Preopercle with an indistinct lower limb. Snout not much produced in males. No mandibular hook observed. Head of vomer with a transverse band of teeth, on body generally a single series. Female mature at 7 inches. Largest example observed, 16 inches.

Salmo ferox.

D. 13, A. 10–11, P. 16, L. l. 125, Cæc. 44–49; Vert. 58–59.

Head of moderate size. Preopercle crescent-shaped, without any angle (or distinct lower limb). Snout much produced in males. Mandibular hook when spawning. Head of vomer small, toothless; body with a double or zigzag line of teeth. Caudal truncated at 18 inches, in larger examples rounded. Female mature at 14 inches. Largest example observed, 31 inches.

These reputed two species have been found residing in nearly or quite the same localities* in England, Scotland, Wales, and Ireland. The size of the specimens is important, as modifying the conformation of the opercular pieces, as well as of the fins, the character of the scaling, the proportional diameter of the eye, and the existence, or the reverse, of teeth on the head of the vomer, so frequently partially or entirely absent in the non-migratory freshwater trout, more especially after attaining to a large size. The teeth being present on the head of the vomer in the smaller (*S. nigripinnis*), but absent from the same place in the larger ones (*S. ferox*), is merely symptomatic of edentulation due to age. The same argument applies to the mandibular hook, it being well known that among the Salmonidæ this production is absent in young males, as may be readily observed in the parr which possess milt ready for exudation and which has been stated so long ago as by Willughby, and proved by Shaw, to be capable of fertilizing the ova of the salmon. The number of pectoral rays is of no consequence, as I find, even in the British-Museum specimens, examples of *S. nigripinnis*, *S. ferox*, and *S. fario* possessing from 13 to 15.

The foregoing leaves the following as Dr. Günther's primary reasons for dividing these two so-called species :—*S. nigripinnis* has D. 14, A. 12, head of the vomer toothed, and generally a

* Wallace ('Island Life,' p. 322) observes that it is not found in Ireland, but acknowledges Dr. Günther as his informant; while Irish examples exist in the British Museum, and that habitat is admitted in the 'Introduction to the Study of Fishes,' as well as in the British-Museum Catalogue.

single row along the body of that bone; caudal fin with pointed lobes. *S. ferox*: D. 13, A. 10-11; no teeth on the head of the vomer, but a double row along the body of the bone; caudal fin truncated*.

The example of the "hog-backed trout" (which I exhibit) has D. 14, teeth on the head of the vomer, and a distinct lower limb to the preopercle, thus belonging to *S. nigripinnis*. Likewise A. 11, a double line of teeth along the body of the vomer, and the caudal fin truncated, which is given as diagnostic of *S. ferox*.

I have likewise six smaller examples of *S. nigripinnis* in which teeth are present on the head of the vomer and in a zigzag line along the body of that bone; the caudal fin in the smallest has pointed lobes, which have become rounded in larger specimens; the caecal appendages varied from 35 to 44. In some of these fish the posterior margin of the preopercle was rounded, and had no distinct lower limb. The maxilla was much feebler than seen in some other local races of brook-trout, which was remarkably the case on comparing it with a beautiful Yorkshire variety sent me by Mr. G. Brooks, F.L.S.; but among these Yorkshire specimens I found great differences to exist.

I now determined to go to Cornwall and ascertain whether the *S. cornubiensis* really differed from a young *S. nigripinnis*; and the first thing I ascertained at Penzance was, that the little brook-form, if placed in large pieces of water, attained to several pounds in weight. I obtained a considerable number which externally only differed from *S. nigripinnis* in colour, the parr-marks of the young stage being continued throughout life in these small trout taken from the streams. The brook-trout from the Cotteswolds has as weak a maxilla as the *S. nigripinnis*, although it is clearly a typically-coloured *S. fario*.

Salmo orcadensis, Günther, 1865.—In the 'Catalogue of the Fishes in the British Museum,' vi. p. 91, it is observed that "Sir J. Richardson mentions this trout in the Fauna Bor.-Amer. Fish. p. 142, referring it to the 'Frith-trout;' but this appears to have the maxillaries feebler and the scales smaller." In examining this question, we undoubtedly find that in the third edition of Yarrell's 'British Fishes,' edited by Sir J. Richardson, allusion is made to the Loch-Stennes trout under the head of the

* "The caudal fin (in Salmonoids) especially undergoes considerable changes with age, and dependently upon the sexual development. Young specimens of all species have this fin more or less deeply excised." (Günther, Cat. vi. p. 5.)

grey trout, *Salmo eriox*. At vol. ii. p. 236, it is stated, "Mr. Low says it is found in the Loch of Stennes, Orkneys." But this is not, I think, the form Dr. Günther terms *S. orcadensis*; for at p. 288 (Yarrell, *l. c.*) it will be seen that another race of trout is recorded as existing at the Orkneys, and which is considered *S. ferox*. "The Rev. Mr. Low, 'Fauna Orcadensis,' mentions a trout of 36 lb. weight or more, which, along with the common trout, occurs both there and in Zetland." Thus it clearly appears that three forms were considered to exist in the Orkneys—the grey trout, great lake-trout, and common trout. Now Low expressly said that there are salmon in the sea, although he had only heard of four instances of such; and three (if they were salmon) were killed and brought on shore by otters from the sea, and picked up subsequently by the country people; while the fourth stuck in a mill-wheel, and was caught by the miller. In his time (prior to 1795) Low had been informed of a salmon-fishing that had formerly existed at the mouth of the Loch of Stennes, and of heritors who had such a fishing in their charters, the old people still showing a place where cruives were placed; but such had long since been given up. Vast quantities of salmon, he continues, were caught in the rivers of Caithness, which are right against and only separated from the Orkneys by the Pentland Frith, and from thence he supposed the stragglers came.

It will thus be seen that probably *S. orcadensis*, Günther, a non-migratory form of trout from Loch Stennes, is identical with the "large trout" mentioned by Low as existing in that locality, and which has been referred to *S. ferox* by Yarrell and Richardson. Dr. Günther most justly compares his examples to *S. nigripinnis*, to which he observes "it is very similar," but distinguished from it "by a broader and stronger maxillary, larger scales on the tail, and a greater number (50) of caecal appendages." The same author, and also Thompson, found 49 in the great lake-trout.

About two years since I obtained from Waterford two examples of trout exactly similar in shape &c. to the types of *S. orcadensis*; they are respectively 13 and 14 inches in length. Some of the spots on the head are ocellated, as seen in freshwater forms; whereas others are X-shaped, as is frequently perceived in such as are taken in the sea. The teething is complete, having a row across the head of the vomer, and a double zigzag line along the body of that bone.

It now becomes necessary to consider the relationship existing between *S. nigripinnis*, *S. orcadensis*, *S. ferox*, and *S. fario*. Among our earlier British ichthyologists we find that Berkenhout (Sym. 1795, p. 79. sp. 3) termed the "great lake-trout" *S. lacustris*, supposing it to be identical with the continental variety; but of late years differences have been asserted to exist between the British and foreign race. Jardine and Selby termed ours *S. ferox*, as will be seen in the 'Encyclopædia Britan.' (edition vii., art. "Angling," p. 142) and in the 'Edinburgh New Philosophical Journal' (xviii. p. 55), the specific name having been chosen to characterize its size and voracious habits. I have already alluded to Jurine's opinion of the specific identity of all these forms in the Lake of Geneva; and it would be but reasonable to expect that if the British *S. fario* under favourable conditions could attain the size of *S. ferox*, the continental *S. fario*, which is the same species, would, under like conditions, also arrive at being a great lake-trout. Collett (1875) in Norway, Feddersin in Denmark, Moreau (1881) in France, can only see in the numerous races of freshwater trout varieties, and not species; while the last author (vol. iii. p. 534) places among the synonyms of *Trutta* (or *Salmo*) *fario*, "La Forelle du Lac Lëman, *Fario Lëmanus*;" and at p. 536 observes, "La *Truite féroce*, *Trutta ferox*, Valenc., des eaux du Foretz est une simple variété de la *Truite ulgaire*, et nullement une espèce particulière."

Although these authors have, in my opinion, been perfectly correct in their views, still there existed this fact, that Dr. Günther had given structural differences existing among the specimens in the British Museum, showing that *S. ferox* possessed 56 to 57 vertebræ and 43 to 49 cæca, while *S. fario* had 57 to 60 vertebræ and 33 to 47 cæca. I have, however, now shown that examples of *S. fario* may have from 56 to 60 vertebræ, and likewise from 33 to 54 cæca, thus overlapping the entire amount of variations as described.

What differences have been brought forward to differentiate *S. ferox* from large examples of *S. fario*? Sir William Jardine stated that "the dorsal fin contains 15 rays, and appears to be constant in that number;" and that "in form it is generally shorter proportionally and deeper than large specimens of *S. fario*." Sir J. Richardson distinguished between the great lake-trout and brook-trout by the size it attains. The tail "in adults is perfectly square, or might even be described as slightly rounded

at its extremity ; in the young it is slightly forked, and appears to fill up gradually as the fish advances in age." The relative position of the fins is different ; the number of rays in the dorsal varies from 2-4/11 or 13 to 15 ; and the scales along the lateral line are of a different form. Thompson observes that he found from 33 to 49 cæca in various examples of *S. ferox* from 12 to 17 inches in length.

I possess undoubted examples of the common brook-trout having from 13 to 15 dorsal rays ; while as to the caudal fin being square in adults, so it is also in large examples of the brook-trout. Yarrell (ed. 3, i. p. 281) gives an illustration of a large Thames trout (a locality not frequented by *S. ferox* according to authors), in which the caudal fin is as rounded as in any examples of great lake-trout of similar size. It was a male, 28 inches long, having a hooked lower jaw, while it weighed 11 lb. The comparative length of the head and height of the body are almost identical with what obtains in an example of *S. ferox*, 20 inches long, from Llanberris, and which is in the British Museum. I examined a few years since a specimen (which is still preserved) of trout, weighing upwards of 13 lb., taken from a large sheet of water at Alresford in Hampshire, which is well stocked with coarse fish. This was one of about a dozen that some years previously had been transferred from the contiguous stream, to which they could not subsequently obtain access. It is believed that in such situations trout do not breed, but, if food is plentiful, they attain to a large size. Without a history of whence this fish came, I maintain that no ichthyologist could be certain whether it is or is not a great lake-trout.

"The trout," says Dr. J. Davy, "when it feeds principally upon fish must be extremely active and strong ; consequently, from its predatory mobile habits, acquires large teeth, large fleshy fins, thick skin, and great pectoral fins for turning. When it feeds on shell-fish, it gets the stomach of the charr and its colours as in the Gillaroo trout."

A race of trout found in Ireland has from time immemorial been known as the Gillaroo, distinguished by the thickness of the middle coat of its stomach. The first mention of this fish is in a paper by the Hon. D. Barrington, read at the Royal Society, December 23, 1773, when he observed "there are no exterior marks by which the species on the table can be distinguished from the common trout." The fishermen observed that "the

largest Gillaroo is $12\frac{1}{2}$ lb.; the smallest 2 lb. There is a red Gillaroo and a white; the last is the smallest and the better eating. It is white with black spots on it; the red Gillaroo is red with black spots on it."

Trout, as already remarked, are exceedingly liable to variation, whether such is due to local or constitutional causes. Some of these abnormal productions would seem to be hereditary; in others the same exciting cause continuing in action occasions the same results as in previous generations. Giraldus Cambrensis, lib. iii. c. x., the traveller and Archdeacon of Brecon, who attended Baldwin, Archbishop of Canterbury, in a progress through Wales in 1188, tells us of trout existing in the lakes of Snowdon which possessed only one eye. The Fischau, near Mandorf in Germany, was reputed to contain blind trout (Fr. Ern. Bruckmanni Epist. Itin. xxxvi. Wolfenb. 1734, p. 10). A deformed race of trout is asserted to exist in a small loch in Inverness-shire near Pitmain: among them there appears to be an arrest of development in the upper jaw, giving their heads a slight resemblance to those of bulldogs, due to the projection of the lower jaw (Encyc. Brit. 7th ed., art. Ang.). In Loch Islay is a race of tailless trout. At Malham Tarn, in Yorkshire, the trout are distinguished by a deficiency or malformation of the gill-covers. On Plinlimmon, and in adjacent parts of Wales, are "hunch-backed" trout, having deformed vertebral columns, as already alluded to. There are likewise races in which some local cause has set up local action, as of the stomach alone. This variety, due to the food it indulges in, has the muscular coat of its stomach thickened, which abnormal structure has been reproduced in succeeding generations. For it must not be assumed, because in certain examples we are unable to find *Limnæa* and other shells, that the fish has never consumed any; they may have been digested, or it may have varied its food, or the shells may have been temporarily unobtainable. But prior to considering this modification as of a specific character, it may be worth while to ask whether such is solely restricted to the Gillaroo, which, in the British-Museum Catalogue, vi. 1865, is termed *Salmo stomachicus*, Günther.

Thompson ('Natural History of Ireland,' iv. 1856) justly observes that "the coats of other species of *Salmones* than *S. fario* (of which *only* the Gillaroo is set down as a variety) become muscular from the same cause. I have seen *S. ferox*, from different localities, with a muscular stomach; and these examples

were called Gillaroo trout by persons who distinguish these from the ordinary state of the fish, believing them to be a distinct species." Sir Humphry Davy remarked that if they are the common trout which have gained the habit of feeding on shell-fish, "they have altered in a succession of generations. The common trout of this lake have stomachs like other trout, which never, as far as my experience has gone, contain shell-fish; but of the Gillaroo trout I have caught with a fly some not longer than my finger, which have had as perfect a hard stomach as the larger ones, with the coats as thick in proportion and the same shells within; so that this animal is at least now a distinct species, and is a sort of link between the trout and charr, which has a stomach of the same kind with the Gillaroo, but not quite so thick, and which feeds at the bottom in the same way." Sir J. Richardson observes:—"We may here note the existence of a strongly-marked and peculiar variety, called the Gillaroo trout of Galway. It is remarkable for feeding on shell-fish, in consequence of which (it is supposed) the coats of the stomach acquire a great degree of thickness, from which peculiarity it is sometimes called the *gizzard trout*." Sir H. Davy remarks that "the charr of the lakes of Southern Austria feeding similarly (to the Gillaroo trout) have a like thick stomach."

I must confess being unable to understand by what process of reasoning any ichthyologist who considers the common trout and the great lake-trout distinct species can admit that, if both *Salmo fario* and *S. ferox* have thickened walls to their stomach, the first is to be constituted a distinct species as *S. stomachicus*, whereas in the latter it is merely to be deemed a variety.

Salmo gillivensis, Günther, 1865, or *S. estuarius*, Knox ('Zoo-logist,' 1855, xiii. p. 4662), is similarly coloured to freshwater forms; while the young (in the National collection) so exactly resembles the *S. cornubiensis*, that it is impossible to doubt their specific identity. Knox's example had 60 vertebræ, similar to the number present in the British-Museum specimen.

The last British form which I propose briefly alluding to is the Loch-Leven trout, *Salmo levenensis*, that appears, at least from the specimens I have examined, to possess a considerably shorter head than any of the varieties of the freshwater non-migratory brook-trout; while the number of its cæca has been observed to vary from 49 to 90. This appears to be probably a descendant from some marine form which, having obtained

access from the sea, has had its retreat to the ocean cut off, and has consequently now taken on a freshwater existence. Its numerous cæcal appendages seem to show its affinities are more related to marine than freshwater forms; while its grey colour and black spots are also what are seen in salt-water residents. It may be that the theory I heard in Scotland is correct, and that the anadromous *Salmo albus** was the ancestor of this, a now freshwater non-migratory trout.

Before concluding this paper I must remark upon what anadromous species of Salmonidæ I allude to when using the term *Salmo albus*. It is the fish known as the *White Salmon*, Pennant (1776), *Salmo albus*, Artedi, *S. phinok*, Turton (1807), *S. brachypoma*, Günther (1866); but by the majority of recent authors placed as a synonym to *S. trutta*.

Pennant, in his 'British Zoology' (ed. 1776), iii. p. 302, described a *white salmon* from the Esk in Cumberland, where he observed that it was obtained from July until September, that it never exceeded a foot in length, and that "this is the fish called by the Scots *Phinoc*." Bonnaterre, 'Encyclopédique Ichthyologie' (1788), p. 161, referred to Pennant's fish as *Salmo albus*; in Schneider's edition of Bloch (1801), p. 409, and in Lacépède's 'Histoire Naturelle des Poissons,' v. p. 219, this term was continued; so likewise in Fleming, 'British Animals' (1828), p. 180, where he also called it the "Whitling, Hirling. Common in the sea and rivers of Scotland and the north of England," and that it spawned in August and September. Jardine described it in the 'Edinburgh New Philosophical Journal,' xviii. p. 40; and likewise gives an excellent figure of it (No. III.) in his Plates of Salmonidæ, appending the name *Salmo albus*, Fleming, but which he considered a synonym of *S. trutta*, of which likewise he gives a recognizable illustration.

It was about this time that *S. albus* began to be suppressed under the belief that it was the young or a variety of the salmon- or sea-trout. Jenyns placed it as *Salmo trutta* in his 'Manual of British Vertebrate Animals' (1835), p. 424, observing that neither he nor Yarrell could see any appreciable difference between them. Parnell, 'Wernerian Memoirs,' vii. (1838), p. 295, White, in his 'List of the Specimens of British Animals in the Collection of the British Museum' (1851), p. 75,

* I leave to a future date the consideration of whether *S. albus* is or is not a synonym of *S. trutta*, and also further remarks on *S. levenensis*.

and Thompson, 'Natural History of Ireland' (1856), iv. p. 151, adopted the same view; while it is worthy of note that examples of the species here referred to are still in the National museum received from the collections of Yarrell and Parnell.

Lastly, Dr. Günther, in the 'Catalogue of Fishes in the British Museum' (1866), vi. p. 23, with a more extended collection, reverted to the opinion of Pennant, and remarked how the species differed from *S. trutta*, five out of seven of his types being from Yarrell's and Parnell's collections. But, probably due to some oversight, he placed all the synonyms of *S. albus* under the head of *S. trutta*, even when the authors had referred to both. It thus came to pass that this northern species, or *S. albus*, has since 1866 been known as *S. brachypoma*, Günther, which is the more remarkable, as, prior to the publication of the volume referred to, the author was able to record in the Addenda, p. 357, that he had received examples from the Beaulieu, "and that they are named there 'Phinok.'"

Finally, I may observe that now we possess absolute proof of what previously has been supposed by most practical anglers and ichthyologists—a change of habitat may eventuate in a structural change in trout so marked, that either the New-Zealand forms, all descended from our brook-trout, must be allowed specific rank, or the six various species of non-migratory freshwater forms admitted into the British-Museum Catalogue must be relegated to *Salmo fario*. We find the number of vertebræ in all six may undoubtedly exist in one form; while the cæcal appendages may be augmented in number to an extent unknown in this country. That the size of the great lake-trout may be attained by the brook-trout indulging in luxurious food and resident in a suitable habitat is also evident; while the largest races may become dwarfed by insufficient or inappropriate food and unsuitable localities.

This question of whether our non-migratory freshwater trout (excluding the Loch-Leven) are local races or distinct species is not merely a curious one or of passing interest, but has, I believe, a practical bearing upon pisciculture. If all these races are distinct species and they were interbred, hybrids would result; and hybrids have a tendency towards sterility: but we are told they are as prolific as the parent stock. This last fact goes towards corroborating my contention, which is, that we are not dealing with species and obtaining hybrids, but we are crossing

varieties or local races, and mongrels are the result. Consequently sterility need not be anticipated; but, on the contrary, improvement is more likely to ensue (should there be no deficiency in food) than when the stock is bred in and in.

It also tends to show that where small, but not malformed, breeds of trout exist, riparian proprietors had far better investigate the condition of the food-supply and nature of the waters in their streams than rely upon the introduction of larger races. They may be assured that the Gillaroo, when it cannot obtain shellfish, will in time lose its thickened stomach; and descendants of the various malformed varieties which I have alluded to will revert to common brook-trout—that, in short, sooner or later new stock will become indistinguishable from the original local breed in colour, form, and size.

On a Marine Caddis-fly (*Philanisus*, Walker, = *Anomalostoma*, Brauer) from New Zealand. By R. M^cLACHLAN, F.R.S., F.L.S., Hon. Memb. N.-Z. Institute.

[Read June 15, 1882.]

IN April of this year I received a letter from Prof. F. W. Hutton of Canterbury College, Christchurch, New Zealand, in which was the startling announcement that the larva of a Caddis-fly lives habitually in rock-pools, *between high and low water-marks*, in Lyttleton Harbour in that colony, and forms its case of coral-line seaweed. He had often attempted to rear the perfect insect, but only once succeeded, and then when he was away from home; so that only the dead remains were obtainable*. Prof. Hutton gave me the welcome intelligence that these remains, with larva and case, were on their way to this country in charge of a friend who was coming home. This gentleman (Mr. C. C. Bowen, Governor of the Canterbury Province) recently arrived, and the materials are now in my hands.

We are so accustomed to associate Caddis-worms with fresh water, that the arrival of these materials was awaited by me with not unnatural impatience. We are already acquainted with a terrestrial species (*Enoicyla*); but no truly marine form had

* A short notice to this effect was published by me in the 'Entomologist's Monthly Magazine,' vol. xviii. p. 278 (May 1882).



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