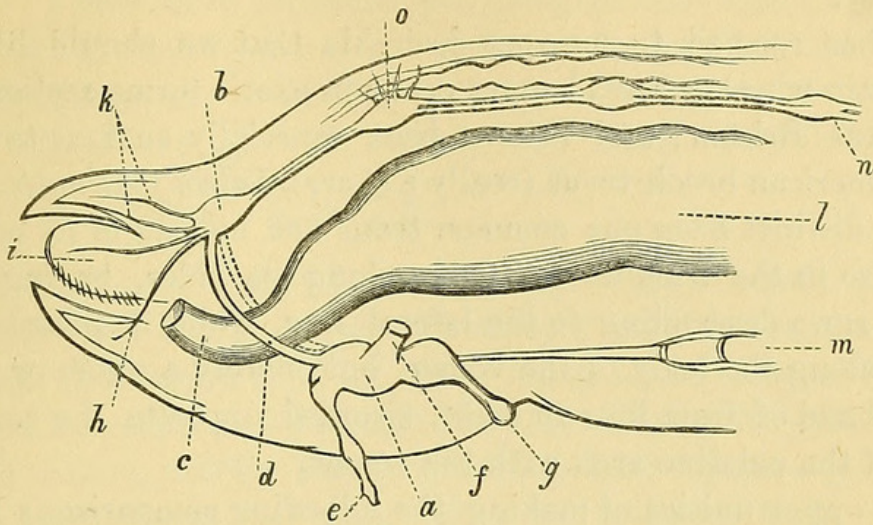


aspect, the myelon the "neural" aspect of his body, as in the animals below him whether vertebrate or invertebrate.



Profile diagram of head and brain of insect, with fore part of the neural and hæmal tracts or centres, in the position thereby indicated.

The letters of reference are:—*a*. Hæmæsoophageal centre or "ganglion" = fore brain. *b*. Neuræsoophageal centre or "ganglion" = hind brain. *c*. Oesophagus traversing the crura cerebri, or connecting-cords, *d*, to the neurostome in its course. *e*. Nerve (olfactory?) to antenna. *f*. Optic nerve. *g*. Ocellar nerve. *h*. Mandibular nerve. *i*. Lingual nerve. *k*. Maxillary and labial palpal nerves. *l*. Stomach, or alimentary axis. *m*. Heart, or hæmal axis. *n*. Ganglionic cords, or neural axis = myelon. *o*. Foremost thoracic centre or "ganglion."

### On Variations in Form and Hybridism in *Salmo fontinalis*.

By Mr. FRANCIS DAY, F.L.S.

[Read November 2, 1882.]

THERE are few investigations more interesting in ichthyology than ascertaining the amount of variation which a given species of fish is capable of undergoing while adapting itself to new conditions of life; and there does not appear to be any form more susceptible of change, when introduced into new regions, than members of the genus *Salmo*. As opportunities occur of observing any modifications, I think it highly desirable that such should be recorded; for even if unimportant when taken alone, they may prove a link in some future inquiry.

During the past twenty years many additions to our knowledge of the natural history of members of this genus have resulted



from carefully watching and noting the progeny of these fishes when introduced into the Antipodes by means of ova sent from this country.

It has seemed to me very desirable that we should likewise ascertain whether any changes occur in exotic forms acclimatized in Great Britain; and I have been especially anxious to watch the American brook-trout (really a charr), *Salmo fontinalis*. This fish is distinct from our common trout not merely in its colours, but also in the number of scales along its sides, having many more rows descending to the lateral line, while it possesses no teeth along the body of the vomer, but merely a patch or transverse band of from four to eight, situated opposite the conjunction of the palatine arch with the vomer.

For opportunities of making the following comparisons I have to thank Sir Pryse Pryse, of Goggerdan, Cardiganshire, Sir J. Gibson-Maitland, Bart., F.L.S., of Craigend near Stirling, and Mr. J. Carrington, F.L.S., of the Westminster Aquarium. For the American specimens I am indebted to Professor A. Agassiz.

I propose dividing the substance of my present paper under the following heads, each of which will require a short notice:—

(1) The appearance of *Salmo fontinalis* as existing in its native country; (2) As living in this country in a wild condition in streams; (3) As kept in ponds into or through which there is a plentiful supply of running water; (4) As retained in aquaria where the water-supply is small; (5) Hybrid examples.

(1) The appearance of the American brook-trout has been so often described that recapitulation here appears to be unnecessary. I have found 57 vertebræ, and the anal rays from 2-3/7-8. The number of scales varies very considerably in the enumerations given by different authors, due to the two modes of counting in force. In one only the pierced row of scales along the lateral line is taken; and these vary from 115 to 140. But some ichthyologists assert that 200 or more rows exist along the lateral line; this is due to their counting the number of rows of scales passing down from the back and falling upon the lateral line. In a very well preserved male example in spirit in the British Museum from Lake Superior,  $12\frac{1}{2}$  inches in length, the head is  $4\frac{3}{4}$  in the total length, while the subopercle is nearly square, and the cæcal appendages are said to number 34.

(2) What are the appearances of this fish living in this country in a wild state in streams? It is difficult to answer this ques-



tion, because, owing to its roving disposition, the *Salmo fontinalis* is generally only for some period of its existence retained in ponds. I have been furnished with several fine examples from  $9\frac{1}{2}$  up to  $11\frac{1}{2}$  inches, and some smaller ones, by Sir Pryse Pryse from Cardiganshire; and they give the following results:—

B. x.-xi. D. 13 ( $\frac{4}{9}$ ). P. 12-13. V. 8-9. A. 10-11 ( $\frac{2-3}{7-8}$ ).  
 C. 19. L. l.  $\frac{200-210}{125-140}$ . L. tr.  $\frac{48-50}{58-62}$ .

Length of head, males  $4\frac{1}{2}$ , females  $4\frac{3}{4}$  to  $4\frac{4}{5}$ , of caudal fin 5 to  $7\frac{1}{2}$  in the total length. *Eye*—diameter 5 to  $5\frac{1}{2}$  in the length of the head,  $1\frac{1}{2}$  diameter from the end of the snout and from its fellow. The maxilla reaches to beneath the hind edge of the eye. Subopercle differs, mostly nearly quadrangular; opercle generally much narrower in its upper than in its lower half. *Teeth* normal. *Fins*—all the smaller examples (that is, those most distantly removed from the United-States parent stock) have 2 to 3 undivided and 8 divided rays to the anal fin. My American specimen has 3 undivided and 7 to 8 divided rays in the same fin. At Howietoun all I have examined have 8 divided anal rays. If this is invariable, it demonstrates that the fish in this country develops the maximum number of its anal fin-rays as found in its native habitat. Cæcal appendages 25 in one examined. *Scales*—42 to 48 rows of scales from the lateral line to the base of the ventral fin; 21 to 26 rows in an oblique line from the posterior end of the base of the adipose dorsal fin downwards and forwards to the lateral line. *Colours*—the smaller ones with light sinuous lines, not seen in the large examples; covered with light round or oval yellow spots, which occasionally coalesce.

(3) What are the characters of this fish kept in this country in ponds wherein there is a plentiful supply of water? Personally I have only visited one such locality, the magnificent breeding-ponds at Howietoun, from which Sir J. Gibson-Maitland, Bart., has been so good as to furnish me with specimens. These fish, taken in July 1882, varied in length from  $7\frac{1}{2}$  to  $8\frac{1}{2}$  inches; and in every one the ova or milt was well advanced.

B. x.-xi. D. 13 ( $\frac{4}{9}$ ). P. 12. V. 8-9. A. 11 ( $\frac{3}{8}$ ). C. 19.  
 L. l.  $\frac{185-206}{122-125}$ . L. tr.  $\frac{36-47}{51-63}$ . Cæc. pyl. 34.

Length of head, males  $4\frac{3}{4}$  to  $5\frac{1}{4}$ , females  $5\frac{2}{3}$ , of caudal fin  $6\frac{3}{4}$ , height of body  $4\frac{2}{3}$  to  $5\frac{1}{2}$  in the total length. *Eye*—diameter  $4\frac{1}{2}$  to 5 in the length of the head, 1 to  $1\frac{1}{4}$  diameter from the end of



the snout, and  $1\frac{2}{3}$  to  $1\frac{3}{4}$  apart. Maxilla reaches to beneath the hind edge of the eye. Posterior edge of preopercle regularly curved, and with a very short but distinct lower limb. As to the form of the opercle, it differs in the different examples: in one that on the right side of the head is not properly developed, leaving a portion of the gills exposed in a similar manner, though to a much less extent than observed in the trout and perch at Malham Tarn in Yorkshire, due, I am informed, to the occurrence of gill-fever in the early age of its existence. The subopercle also differs very considerably in the different specimens. *Teeth*—in none is there a median row of teeth along the body of the vomer, while the transverse band completing the palatine arch of teeth consists of from 3 to 5. *Fins*—the dorsal commences slightly nearer the snout than to the base of the caudal fin; the latter forked. *Scales*—40 to 49 rows of scales from the lateral line to the base of the ventral fin; 21 to 23 rows in an oblique line from the posterior end of the base of the adipose dorsal fin downwards and forwards to the lateral line. *Colours*—the light sinuous bands of the river-form are very slightly developed in these lacustrine fish, which are covered with oval or round yellowish spots, one or two of which occasionally run into one another, while red spots exist on, above, and below the lateral line.

The eggs from which these fish were reared were received direct from the Cold-Spring trout-ponds, New Hampshire, U. S.

The external appearance of these charr is different in colour from small ones received from Welsh rivers, but more similar to the larger examples. Whether such is accidental or will be persistent so long as the same influences are at work, only time can decide.

(4) The appearance of these fish as detained in aquaria where the water-supply is insufficient. By this I do not mean insufficient for life and health, but for continuation of the species. The example I possess was given me by Mr. J. Carrington; it is 9 inches in length, in good condition, and, when received, had brilliant colours. It was reared by the late Mr. Frank Buckland in his tanks at the Horticultural Gardens at South Kensington from eggs received direct from Lake Huron. He presented some young to the authorities of the Westminster Aquarium soon after it was opened; and the fish on the table is the last which survived, having died in October 1879 from jumping out of its tank.

B. x.-xi. D. 13 ( $\frac{4}{9}$ ). P. 11. V. 8. A. 10 ( $\frac{3}{7}$ ). L. 1. 130.  
L. tr. 49/64.



Length of head  $4\frac{1}{4}$ , height of body  $5\frac{1}{3}$  in the total length. *Eye*—diameter 6 in the length of the head,  $1\frac{2}{3}$  diameter from the end of the snout, and 2 diameters apart. Subopercle twice as long as deep. *Teeth* normal. *Scales*—43 rows between the lateral line and the base of the ventral fin; 24 rows from the hind edge of the base of the adipose dorsal downwards and forwards to the lateral line.

Before passing on to the next specimen from Cardiganshire, I would allude, for comparison, to some examples of brook-trout received from the same locality and from the same donor.

B. xii. D. 12-15 ( $\frac{3-4}{9-11}$ ). P. 13-15. V. 9. A. 10-12 ( $\frac{3}{7-9}$ ).  
C. 19. L. 1.  $\frac{128-135}{113-115}$ .  
 $\frac{118-125}{113-115}$

*Scales*—13 rows from the posterior edge of the base of the adipose dorsal fin downwards and forwards to the lateral line; 26 rows from the lateral line to the base of the ventral fin.

(5) *Hybrids*.—Some excellent anglers have informed me that *Salmo fontinalis* has interbred in the Wandle, and also in Cardiganshire waters, with the common brook-trout. I have also been told that the same occurrence has taken place elsewhere. Hunter, we know, was of opinion that hybrids were not productive except in cases where the generative organs were in a state of perfection, a state which might be considered unnatural in hybrids. These views have been considerably modified of late years; and the opinion of Pallas seems regarded as reasonable, that domestication tends to eliminate hybridism. Be this as it may, we know from the experiments of Rasch and others that hybridism between the charr and the trout, and the salmon and the trout, may be brought about, and it has been stated that occasionally their offspring are prolific\*.

I have had examples sent to me which certainly appeared (judging solely by external form and colour) that such an admixture had resulted. A minute examination, however, failed to confirm first impressions, the small size of the scales of the American trout and its peculiar dentition showing that no reliance could be placed on

\* Mr. Davidson informs me of a hybrid having existed in the East between a Muscovy and a Common Duck. One female laid many eggs of a deep sea-green colour; but every trial to hatch such proved abortive. Consequently I think it may not be unreasonable to argue that the existence of ova or milt in fish may not be absolute proof of sterility or prolificness. Here the fish-culturist's opportunities for observation will doubtless prove invaluable.



the external form and colour. At last, in June this year I received from Sir Pryse Pryse an undoubted hybrid ; its total length was 9 inches. The fish is now on the table.

B. x. D. 14 ( $\frac{4}{10}$ ). P. 14. V. (right) 9, (left) 8. A. 11 ( $\frac{3}{8}$ ).  
C. 19. L. l.  $\frac{170}{119}$ . L. tr. 27 / 39.

Length of head 5, of caudal fin  $5\frac{1}{3}$ , height of body 5 in the total length. *Eye*—diameter one fifth of the length of the head,  $1\frac{1}{4}$  diameter from the end of the snout and  $1\frac{3}{4}$  apart. Posterior edge of the preopercle somewhat angular at its centre, and again where it commences to form its lower limb, which is distinct. Width of opercle equal to two thirds of its height. Height of subopercle at its base  $2\frac{1}{4}$  in that of the opercle, and having a rounded posterior edge. *Teeth*—2 at the anterior portion of the body of the vomer where it joins the palatine arch ; 6 more along the body of the bone, the anterior 4 in alternate rows, the last 2 single and the most posterior one the largest. *Fins*—dorsal commences midway between the end of the snout and the base of the caudal, which latter fin is forked. *Scales*—119 rows along the lateral line ; 29 from the lateral line to the base of the ventral fin ; 19 rows in an oblique line from the posterior end of the base of the adipose dorsal downwards and forwards to the lateral line. Fish sterile : this of course may be temporary ; but examples of a similar and even smaller size from Howietoun had the ova and milt well developed. *Colours*—those of fluviatile *Salmo fontinalis*, being grey rivulated with broad serpentine bands of yellowish white, or forming rings enclosing grey blotches which have a light centre. A few red spots along the lateral line, but none apparent above or below it. Dorsal, caudal, and ventral fins coloured similarly to *S. fontinalis* ; but the black band to the anal at the base of the white outer edge not so distinct.

Here, as shown by the scaling and dentition, was an undoubted hybrid between the American charr and the common brook-trout ; but it was sterile. It would be exceedingly interesting were a close scrutiny to be kept on any of these fish captured in a wild state, in order to ascertain when hybrids are present, and also to be clear as to whether such are sterile or the reverse. Until more examples have been obtained, I do not propose offering any opinion upon the foregoing interesting specimens, but merely to record facts. Sir J. Gibson-Maitland possesses numerous year-



ling hybrids, the progeny of a male *Salmo salar* and a female Lochleven trout. The interesting and practical question arises, Will these, as a rule, be sterile or prolific? If sterile, will they possess the migratory instinct of the salmon or the non-migratory habits of the brook-trout. Should the latter occur, rivers, such as the Thames, might be stocked with fish suitable for sport and food above the polluted portion. Then, again, would arise the inquiry whether they would remain in condition all the year round; for if so, such stock might afford constant sport to the angler, while the captures would be clean fish.

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Notes on some little-known Collembola, and on the British Species of the Genus *Tomocerus*. By GEORGE BROOK, F.L.S.

[Read December 7, 1882.]

(PLATE I.)

THE four species which form the subject of the present notes have all been described by Tullberg. Dr. Reuter has come across a single specimen of *Tomocerus vulgaris* in Shetland, and also a single specimen, which he queries *Achorutes manubrialis*, from Finland. With these two exceptions I am not aware that any of them have been since observed. Tullberg's specimens were from Sweden, so that notes of their occurrence in England and in Jersey may prove of value. When quoting Tullberg I have made use of his latest descriptions, as these are in some cases altered a little from the originals.

*ACHORUTES MANUBRIALIS*, Tullb. (Pl. I. figs. 1-5.)

In October 1880, while on a dredging-trip with Dr. Murie, we landed one day on Warden Point, Thanet, and began searching the sun-dried blocks of clay on the beach. Amongst the crevices of one large block I found swarms of an *Achorutes*, which appeared at first sight to be *A. purpurescens*, Lubbock; but a closer inspection made this doubtful, and we collected a good many for reference. Twelve months passed over without the specimens being examined; but when at last they were brought out, they proved to be *A. manubrialis*, Tullb., and an addition to our fauna.

Tullberg's description is as follows:—"Unguiculus inferior adest. Dentes furculæ, manubrio breviores, vix duplo longiores quam mucrones, qui graciles sunt. Spinæ anales perparvæ.



Day, Francis. 1883. "On Variations in Form and Hybridism in *Salmo fontinalis*." *The Journal of the Linnean Society of London. Zoology* 17(97), 13–19.  
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