

4. **On the occurrence of *Cottus quadricornis* in Lake Mälaren and its variation according to the natural conditions.**

By

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Already 1836 it became known to Swedish ichthyologists that, the otherwise marine fish *Cottus quadricornis* occurred in Lake Vettern, as staff-sergeant HALL¹ that year sent specimens of this fish to the Zoological State-museum in Stockholm. The great scientific importance of this find was not, however, fully acknowledged and realised till the late SVEN LOVÉN 1861 (62)² in his ingenious mind had framed and later published his theory about an early connection between certain swedish lakes resp. the Baltic and the Arctic Sea resp. White Sea via Ladoga, Onega etc. Later it became known that the Fourhorned Cottus was not only an inhabitant of Lake Vettern, but occurred as a relict species in Lake Venern³ and in Lake Fryken⁴ (in the province of Värmland) as well. When Professor LILLJEBORG wrote his work on »Sveriges och Norges Fiskar» he had heard fishermen say that this fish occasionally was caught in Lake Mälaren in the neighbourhood of Engstö, but still oftener in the neighbourhood of Strengnäs. He had not, however, as it seems, seen any specimens himself. In the great work »Scandinavian Fishes» by F. A. SMITT nothing is mentioned about this occurrence and the late Dr. RUD. LUNDBERG must have doubted the existence of the Fourhorned Cottus in Lake Mälaren as he does not with a word touch on this subject in his paper about the distribution of the swedish fresh water fishes.

Some years ago when I was occupied with certain investigations concerning the fisheries in Lake Mälaren at the estates Ådö and Säbyholm I was told by a fisherman C. F. THORÉN, that he, now and then, got specimens of the Fourhorned Cottus in his gill-nets when these were

¹ See about this F. A. SMITT: Scandinavian Fishes, Stockholm 1892.

² Öfvers. K. Vet. Akad. Handl. 1861 (printed 1862).

³ Conf. MALM: Göteborgs och Bohusläns Fauna, p. 390. 1877.

⁴ Fully confirmed by C CEDERSTRÖM in Sv. Fiskeritidskr., 1899, but first mentioned by Hj. WIDEGREN, Landtbr. Akad. Tidskr. 1863, his statement, however, only depending on a hearsay.

laid in deep water for gwyniad. I requested THORÉN to send me some specimens the next time he should get any and he promised to do so. But time went on and as I did not get the specimens wanted, I naturally believed that THORÉN had forgotten the whole question. I was therefore the more pleased when I some days ago received from him four specimens, and then again, a few days later, still seven specimens. These specimens had all of them been caught in Northern Björkfjärd between Svallgarn and Ärtskär in a depth estimated by THORÉN to be 22 fathoms. The occurrence of the Fourhorned Cottus in Lake Mälaren is thus now fully proved. I have later also received information in a letter from Mr. V. WAHLBERG, Second Assistant of Fisheries, that he had seen three specimens of this species caught in approximately the same locality $\frac{1}{8}$ 1901, and five other large specimens he had witnessed being caught in gill-nets together with 29 gwyniads (weighing from 1—3 kg. a piece) at Borholm. The latter nets had been laid in a depth between 40 and 50 m. near Obygdö in the bay of Mariefred.

The greatest interest is, not however, connected only with the simple statement, that this species of fish lives in Lake Mälaren, but lies in the general appearance, size and structure of the specimens obtained from this lake compared with the same of the specimens from the Baltic on one hand and with those of the true relict variety for instance from Lake Vettern on the other. The specimens from Lake Mälaren are in several respects quite intermediate.

The truly relict and degenerated variety of this fish which is found in the lakes Vettern and Venern has been named *var. relicta* by LILLJEBORG. FRIES and EKSTRÖM, S. LOVÉN¹, LILLJEBORG², F. A. SMITT³ a. o. have described this variety and pointed out its differences from the typical form of the Baltic. Among the main differences may be mentioned its small size, as a rule a good deal less than 21 cm. and never more, while the baltic specimens often measure more than 25 cm. The relict variety is also more slender and its four »horns» are much smaller than those of the baltic⁴ form. In the former they are only small tuberosities, in the latter large spongy looking outgrowths of varying size. The eyes of the relict variety are comparatively larger measuring more than 22,5 (usually 23—24) per cent of the length of the head, while the same percentage of the baltic specimens, as a rule, is less than 17, only in quite small specimens (7—8 cm.) amounting to 21. The relict variety thus exhibits in this respect a juvenile characteristic in an excessive degree. The interorbital breadth of the latter is, on the contrary, comparatively small, never exceeding 88 percent of the smallest height of the caudal peduncle and usually being only about 76 $\frac{0}{10}$ of that measurement. The same percen-

¹ Öfvers. K. Vet. Akad. Förh. 1862. Stockholm 1863.

² I. c. ³ I. c.

⁴ The fourhorned Cottus of the Baltic is, of course, also relict but for shortness sake is in the following only the more degenerated *var. relicta* termed relict.

tage in baltic specimens is, as a rule, at least 100 and often considerably more. To these and some other distinguishing characteristics of less importance A. G. NATHORST in his interesting account¹ about the fauna of the clay-deposits at Skattmansö in Upland has added some more from the shape and structure of the preopercle. This bone is deeply grooved



Fig. 1. An average specimen of the Fourhorned Cottus, true relict type from Lake Vetttern. About half nat. size. — Fig. 2. An average specimen of the Fourhorned Cottus from Lake Mälaren. About half nat. size.

along its outer surface so that a canal is formed which typically is bridged over by bony matter in five places through which a series of different pits opening towards the outer side is formed. According to the author quoted these bony bridges are considerably broader and consequently the

¹ Om en fossilförande leraflagring vid Skattmansö i Upland. Geol. Fören. Förh. Bd. 15, Hft. 7. Stockholm 1893.

openings of the pits narrower in the baltic than in the relict forms. Although this characteristic, as I have stated myself, is subjected to some variation it holds good in most instances.

If we now consider the dimensions and proportions of the specimens of *Cottus quadricornis* from Lake Mälaren the following result is obtained. All of them show a strikingly large size, the smallest female measuring 230 and the largest 281 mm. in length, the smallest male 244 and the largest 266 mm. They have thus attained a size which may be considered fully equal to that of baltic specimens and very much larger than that of the typical relict form of Lake Vettern. In accordance with the great total length of the specimens from Lake Mälaren other juvenile characteristics exhibited by the specimens from Lake Vettern are wholly lost by the former. The length of the eyes is only from 15,0 to 17,2 per cent of the length of the head in the specimens from Lake Mälaren. They agree thus in this respect with marine specimens from the Baltic and the Arctic Sea in which according to SMITT'S measurement (l. c. p. 177) the same percentage varies from 12,1 to 17,2. In a similar way the interorbital breadth of the specimens from Lake Mälaren is large (Fig. 2) so that it as a rule amounts to 100—127 per cent of the least height of the caudal peduncle and only in one female is less than that namely 94,1 %.

This is consequently a »marine» characteristic, so to say, as the corresponding percentage for adult marine specimens according to SMITT (l. c.) is from 100 to 145. The relation of the interorbital breadth in the different varieties may also be expressed thus: in the specimens from Lake Vettern (Fig. 1) the interorbital breadth is narrower than the length of the vertical diameter of the eye, in the specimens from Lake Mälaren (Fig. 2) the former measurement is much the larger.

The horns of the typical relict variety from Lake Vettern are very small and rudimentary and, as LILLJEBORG has pointed out, the anterior pair is never larger, but usually a good deal smaller than the posterior, contrary to what is the case in marine specimens. In the specimens from Lake Mälaren the horns are a good deal better developed than in the specimens from Lake Vettern and those of the anterior pair is often just as large or larger than the posterior ones. In this respect the specimens from Lake Mälaren could be termed intermediate although, perhaps nearer the lacustrine than the marine form. (The horns of the figured specimen are perhaps somewhat smaller than the average.)

The preopercle of the Fourhorned Cottus from Lake Mälaren (Fig. 3 *e* and *f*) has, disregarding the difference in size, a certain resemblance to the same bone of the typical relict form from Lake Vettern (Fig. 3 *g* and *h*). This manifests itself therein that the bony bridges across the groove of the bone are less well developed than in baltic specimens (Fig. 3 *a—d*). Especially, this is the case on the vertical (resp. upper) ramus of the said bone on which the bridge is missing and only represented by a small rudiment on each side of the groove. The vertical

ramus looks also as well in the specimens from Lake Vettern as in those from Lake Mälaren, broader than in marine specimens, and the groove is, in the former case, more open in the lateral direction so that it appears

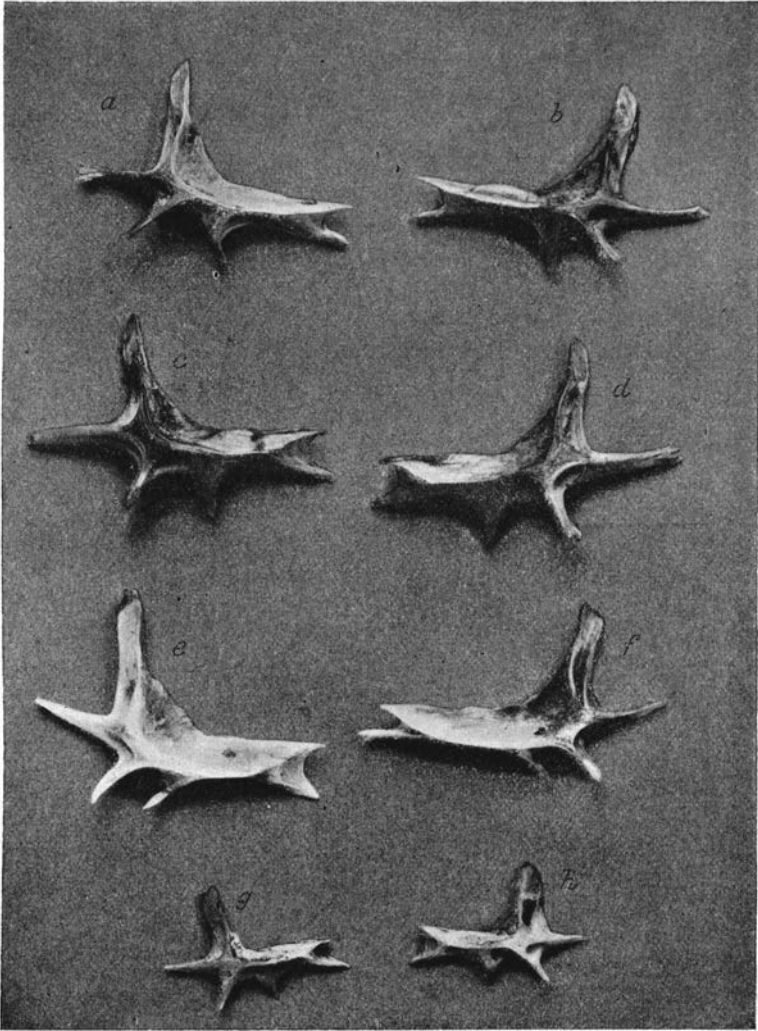


Fig. 3. Preopercular bones of *Cottus quadricornis*. *a—d* of the baltic variety, *e* and *f* of the variety from Lake Mälaren, and *g* and *h* of the true relict type from Lake Vettern. Four thirds nat. size.

more broadly spoonshaped when viewed from the side (comp. the figures *e—h*). The horizontal (resp. lower) ramus again has in the baltic specimens (*a—d*) and those from Lake Vettern (*g, h*) the groove more decidedly open in an oblique lateral direction so that the pits can be seen

in a lateral (resp. anterior) view. In this respect the specimens from Lake Mälaren (*e, f*) differ from both the others in having the groove open directly downwards so that it is quite hidden from the outer side, but can be seen a little from the median side.

From this description becomes evident that the Fourhorned Cottus of Lake Mälaren is in several respects intermediate between the baltic and the typical lacustrine variety and although inhabiting a lake it approaches in its dimensions more the marine form at the same time as it has developed some small peculiarities of its own. It is evident that the great size of the Mälär variety must be due to some favourable circumstances in the physical and biological conditions under which this fish lives. If we then try to find out which these are it might at once be ascertained that food is plentiful. The ventricles of the specimens I have opened were literally stuffed with amphipods (*Pallasiella quadrispinosa*) and in some were also found some fish-remains probably of smelt (*Osmerus*).

Concerning the physical conditions of Lake Mälaren there have as yet no thoroughgoing investigations been made. But it is nevertheless a well known fact that Lake Mälaren now and then when it is high flood (»uppsjö») receives salt water from the Baltic.

This salt water does not, however, reach the innermost parts of the lake but is shut of from the same by shallow places in certain sounds. The localities mentioned above in which the Fourhorned Cottus has been found belong to the interior or central part of the lake which only by means of rather shallow sounds (for instance Bockholm-sound 5 $\frac{1}{2}$ m. and the somewhat deeper sound south of the Svartsjö-island) is connected with the eastern or outer basin. In the year 1877(6) the late Professor F. L. EKMAN published some results of hydrographical investigations¹ made by him the previous years in Lake Mälaren. Unfortunately he has not, however, taken any samples of water from the Northern Björkfjärd, but the nearest sampling station to the same is situated in the Prestfjärd which seems to stand in quite open connection with the former. The author quoted thus found in the Prestfjärd southern part 0,0279 gr. »marine salt pr liter» and in the northern part of the same 0,0246 gr. »marine salt pr. liter». According to the table the salinity appears to have been the same from surface to bottom. But in the southern Björkfjärd the salinity was greater; for instance at one of the sampling stations:

	surface	0,087	»marine salt pr. liter»			
	8 fathoms	0,0848	»	»	»	»
	16	»	0,142	»	»	»
	20	»	0,318	»	»	»
	22	»	0,555	»	»	»
	24	»	1,165	»	»	»
	26	»	1,275	»	»	»

¹ Om hydrografiska förhållanden inom Mälardalens vattenområden. Bih. K. Vet. Akad. Handl. 1877. Bd. 4.

This indicates that at least in the Southern Björkfjärd the water in the depth is in a considerable degree mixed with water of marine origin.

In March 1895 H. WITT and G. LUNDELL¹ analysed the water in the Kalmar-bay which opens into the Northern Björkfjärd. They found then at the surface 0,028 gr. Cl. pr. liter and in a depth of 43 meter 0,043 gr. Cl. pr. liter. In the main basin of the Northern Björkfjärd it is probable that the salinity is a little greater although no distinct proofs are available². All taken together it might, however, be assumed that the water inhabited by the Fourhorned Cottus in Lake Mälaren contains some more marine salts than a common freshwater lake does and this is, of course, even if the percentage is very low, a favourable condition for a fish of marine origin. I think therefore that this together with the abundance of food may serve as an explanation for the strong development of the Fourhorned Cottus in Lake Mälaren when compared with the same species of fish from Lake Vettern³.

¹ Några hydrografiska iakttagelser i Mälaren och Saltsjön. Bih. K. Vet. Akad. Handl. Bd. 21.

² In the outer or eastern part of Lake Mälaren outside the Bockholm-sound the same authors found a much greater salinity viz. surface to 10 m. — 0,06 ‰; 12 m. — 1,19 ‰; 20 m. — 1,87 ‰; 24 m. — 2,00 ‰; 25 m. — 2,71 ‰; 30 m. — 2,81 ‰; 32 m — 2,82 ‰.

³ An analogous account about the variation of *Mysis relicta* in the southern part of the Bay of Bothnia has been given by the present author in Zool. Anzeiger, Bd. XXVI. N:o 704. Leipzig 1903.

