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GADICULUS ARGENTEUS AND GADICULUS THORI

BY

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IN the year 1850 GUICHENOT described a small Gadoid, of which he possessed 3 specimens from Algiers: He placed them in the neighbourhood of the genus *Gadus* ("morue" and "merlan"), but formed for them a special genus, *Gadiculus*, characterised by the unusual size of the eyes and by the lack of vomerine teeth. On Pl. 6, fig. 2 he gave a figure, which is not specially good but yet permits us to recognise the species. Otherwise GUICHENOT's description is far from complete, perhaps due to the fact that the 3 specimens, he had at his disposal, were badly preserved ("trois individus altérés", is remarked by GUICHENOT himself).

Gadiculus has later been rediscovered by a number of naturalists, first by GÜNTHER (1874), who describes a specimen of 5½ in. in length taken on 18/6 1869 in 183 fathoms west of the British Isles (55°10' N., 10°59' W.) by the Porcupine Expedition. GÜNTHER saw already, and all later authors after him, that the genus *Gadiculus* could not be maintained on the basis of the absence of vomerine teeth, since these may be absent or present by individual variation.

Our acquaintance with *Gadiculus* and its distribution has been greatly extended by various later publications, especially by the work of BELLOTTI (1879), VAILLANT (1888), HOLT (1892), HOLT and CALDERWOOD (1895) and COLLETT (1901). As COLLETT (1901) gives a very careful summary of the literature on *Gadiculus*, it is superfluous to enter into all details here. For these, reference may be made to COLLETT and I shall confine myself to some few remarks.

Whilst all authors, as mentioned, are agreed, that the genus *Gadiculus* cannot be maintained on the basis given it by GUICHENOT, namely, lack of vomerine teeth, there is still lack of agreement as to its systematic position. Various authors, for example, refer it directly to the *Gadus* genus (COLLETT 1901), others owing to the absence of a barbel to *Merlangus* (after VAILLANT 1888), others again maintain the name either as genus or as subgenus (HOLT). It seems to me (1905, p. 64), that there is very good reason for separating it from the true *Gadus* species merely from the characters, which have

already been emphasized by HOLT and COLLETT as characteristic of the species, namely, the large, readily deciduous scales and the highly remarkable mucous cavities on the upper side of the head, which are already present in the young, though still covered by the skin. We may add to these the distribution of the primary pigment in the larval and postlarval stages, which I have found to be divergent from the types of pigmentation occurring in the *Gadus* species and which approaches more to that known in the genus *Merluccius*.

Within the Mediterranean, the waters from which the species was first known, it has been found at various places, hitherto however only in the western basin (west of Italy), namely, at Algiers, Messina, Palermo, Naples, Genoa and Nizza. Outside the Mediterranean it has been recorded from the coast of Sudan, Morocco, Gibraltar Bay (HOLT and BYRNE 1909), Bay of Biscay, west of the British Isles, the northern North Sea and coast of Norway from the Skagerak up to Trondhjems Fjord (63°30' N. L.).



Fig. 1. *Gadiculus Thori*.



Fig. 2. *Gadiculus argenteus*.

COLLETT (1901) also states regarding its distribution (p. 9), that "*G. argenteus* belongs to the most widely distributed of all the Gadoids", and that "its region of distribution extends from the African coasts a little north of the equator — — — up to 63°30' N. L. (Trondhjems Fjord)". It deserves to be mentioned, that the species is not found in the western part of the Atlantic.

The depth, at which *Gadiculus* occurs, is distinctly greater than for the true *Gadus* species, the species, according to COLLETT (1901, p. 10), seldom being found at less depth than ca. 180 meters, whilst it has been taken in quantities at depths of 400—600 meters.

Lastly, it may be remarked, that I have described (1905), (1906), (1909) the postlarval, pelagic stages from the waters west of the Faeroes and the British Isles, when I was carrying out investigations during the years 1903—1908 with the Danish research-steamers "Thor" on the stretch from Iceland to the Bay of Biscay. On these cruises far more specimens of the species were obtained than had hitherto been known, at stages from 5 mm. and upwards, and it proved, that the pelagic stages of this species occur deeper down in the water than the corresponding developmental stages of the *Gadus* species.

On the basis of the material collected by the "Thor" Expeditions in the North Atlantic I had described, in the papers just cited, the pelagic, postlarval stages of all the 11 species of *Gadus* occurring in the region and showed, among other things, that they could be readily distinguished especially by means of the distribution of the primary pigment. I was surprised, therefore, on my first expedition to the Mediterranean in 1908—1909, to find in many hauls in the western basin and round Gibraltar the postlarval stages of a *Gadus* species (3 dorsals, 2 anals), which differed greatly from all the known species. Of these it seemed only possible to refer them to the Mediterranean form of *Gadus minutus* ("capelan"), which LILLJEBORG (1891) considered different from the northern form, and which was the only species, whose postlarval stages I had not seen. Yet the pigmentation was so totally different from that of the northern *Gadus minutus*, that I could scarcely believe, that the specimens belonged to a form nearly related to *Gadus minutus*. Further, the next station yielded specimens which were so far advanced in development, that it could be said with certainty, from the position of the fins and number of rays etc., that they did not belong to "le capelan". And on the second expedition to the Mediterranean in 1910 the pelagic stages of the same Gadoid were also found in such considerable quantities, that I was able to conclude, that the species must be common in the Mediterranean. What distinguished the species at the first glance was the presence of posterolateral, transverse pigment bars, which resembled not a little those I had found in *Merluccius* (1907). From this and from the absence of a mediolateral streak it could be concluded, that the specimens belonged neither to the first nor to the second of the 3 principal groups, into which I had subdivided the *Gadus* species according to the primary pigment (1906, pp. 17—19). On the other hand, they could be placed in the group (containing *Gadiculus*), which is characterized by: "Mediolateral streak wanting. A posterolateral transverse bar present", with the modification, that not one only but 3 transverse bars occurred here.

Reasoning in this way I came to the conclusion, that this must be a *Gadiculus* species and that the *Gadiculus* genus must therefore contain several species. Further investigation showed the correctness of these conclusions and a new proof was thus added to that already obtained of the systematic importance of the primary pigment's distribution in the Gadoids.

All postlarval stages are present in my material, from a length of ca. 4 to ca. 30 mm. At this place, however, I shall not enter upon a description of the postlarval development with figures, but restrict myself to a brief account of the differences between our species and the northern *Gadiculus*. Figs. 1 and 2 represent the two species, the northern and the southern, at almost the same stage of development. Whilst the first has a length of 10 mm., the second is only 7 mm. long. This shows us already, that our species is a smaller form than the northern. We see, further, that it is stouter and shorter in form

than the northern. Both these features can be recognised in all the stages, from the youngest to the oldest. The most striking difference between the two species, however, is the postanal pigmentation. Whilst the northern only has one "transverse bar" (between D^3 and A^2), the southern has 3: one at the end of the tail, one between D^2 and A^1 and a third intermediate, corresponding to that found in the northern species. We find quite the same features in all stages of development, even in the smallest examined, 4—5 mm. long, that is, 3 postanal bars in the southern and only 1 in the northern species. As is usual in the *Gadus* species, the characteristic distribution of the primary pigment is effaced in the oldest, postlarval stages, new pigment gradually covering most of the lateral aspects. Yet even in the oldest postlarval stages the northern species is far less pigmented than the southern.

The proof, that our postlarval stages belong to the Mediterranean *Gadiculus argenteus* Guichenot, lies in the complete agreement between them and older specimens in the characters which are already permanently developed in the young, postlarval stages, especially the number of vertebrae.

In 3 adult specimens of *Gadiculus argenteus* from Naples the following number of vertebrae was found: 13 + 27, 13 + 27 and 13 + 26, and in 3 postlarval specimens taken by the "Thor" in the Western Mediterranean: 13 + 27, 13 + 27 and 13 + 26. The number of fin-rays also showed agreement.

That the 3 specimens from Naples really belonged to GUICHENOT'S *Gadiculus argenteus*, I was able to prove from a direct comparison with one of GUICHENOT'S type specimens, which Prof. LOUIS ROULE, Muséum d'Histoire Naturelle in Paris, kindly placed at my disposal. I found complete agreement. The specimen possessed 27 caudal vertebrae i. e. the number of most frequent occurrence in specimens belonging to the southern species.

It was thus evident, that the pelagic stages taken by the "Thor" Expeditions in the Mediterranean and near Gibraltar belonged to GUICHENOT'S species. At the same time it was clear, that the postlarval *Gadiculus* from the Atlantic previously described by me (1906) could not belong to GUICHENOT'S species, as I then believed without knowing specimens from the Mediterranean. Such a complete and typical difference in the primary pigment, as that found between specimens from the Mediterranean and the Atlantic, must necessarily indicate a difference in species, to judge from the conditions known in all the other allied, European species of the genus *Gadus* and in other northern Gadoids.

My material of the bottom-stages of *Gadiculus* from the Mediterranean is still sparse and only contains specimens considerably smaller than the *Gadiculus* bottom-stages I have from the waters west of the British Isles and the Skagerak. On the other hand, I possess well over 3000 postlarval specimens from the cruises of the "Thor" in 1905—

1910. For this reason I have restricted the comparison to those characters, which are comparable in both the older and younger stages, especially the number of vertebrae, and this all the more, because such a character is more precise and exact than the measurement of the outer characteristics.

In 6 specimens of *Gadiculus* (adult) from Irish waters, taken by Mr. E. W. L. HOLT and kindly lent me by the Dublin Museum, the following number of vertebrae was found:

13 + 29, 13 + 29, 13 + 29, 13 + 29, 13 + 29, 13 + 30.

In a specimen from the Skagerak, kindly given me by Dr. A. C. JOHANSEN, the number was 13 + 29, and in 5 postlarval stages (15—20 mm. long) taken by the "Thor" in 1905 west of Scotland:

13 + 29, 13 + 29, 13 + 29, 13 + 29, 13 + 29.

A comparison of the number of vertebrae in the northern and southern *Gadiculus* (20 chance specimens of each) gave the following result:

northern species (<i>G. Thori</i>) (west of Scotland)		southern species (<i>G. argenteus</i>) (Mediterranean)	
No. of vert.	No. of spec.	No. of vert.	No. of spec.
43	3	41	3
42	16	40	14
41	1	39	3

We see, therefore, that there is on an average over 2 vertebrae more in the northern than in the southern species, a very considerable difference on such a low number of vertebrae as is here in question. The number of fin-rays in D³ and A² was also on an average several rays higher in the northern than in the southern species, but in this species the rays are difficult to count with absolute accuracy, for which reason I shall not give the detailed numbers at present.

The conclusion from the above is, that such great differences exist between specimens of *Gadiculus* from the Mediterranean and the Atlantic west of the British Isles (and the Skagerak), that they must be regarded as belonging to 2 different species, distinguishable by exact and reliable characters.

The species living in the Mediterranean, which was described first by GUICHENOT under the name *Gadiculus argenteus*, must retain that name. For the North Atlantic species I propose the name *Gadiculus Thori* nov. nom. in memory of the Danish research-vessel "Thor", on the cruises of which the postlarval developmental history of both species has been cleared up.

It should be stated, that this is not the first time, that a postlarval stage of *Gadiculus argenteus* Guichenot, non auctorum, has been mentioned and figured. In his meritorious work on the young stages of the Mediterranean fishes L. FAGE (1910, pp. 29—31) gives a description and figure of a *Gadus* postlarva, taken by the Oceanographical Institute of Monaco, which with some doubt he refers to the Mediterranean *Gadus minutus*¹⁾. The reasons, which induced him to do so, were the same as those which led me in the beginning to believe, that the postlarval stages in question belonged to "le capelan". From FAGE's description and figure, however, it is quite evident, that his postlarva belonged to *Gadiculus argenteus* Guichenot. Enumeration of the vertebrae would have shown at once here, that there could be no question of "le capelan", and I am also glad to be able to report, that Dr. FAGE has later independently arrived at the conjecture, that his postlarva belongs to *Gadiculus argenteus*; this is seen in a copy of his paper, which he has sent me, where, under the figures on p. 30, he has written "*Gadiculus argenteus*?"

As already mentioned, COLLETT (1901) lays stress on the unusually great distribution for a Gadoid, right from the coasts of Sudan to the Trondhjems Fjord.

As we have now proved, that "*Gadiculus argenteus* auctorum" is not a systematic unit, but consists of 2 different species, the next question is, to endeavour to fix their relative distribution. For this purpose the postlarval, pelagic material of the "Thor" Expeditions is obviously better qualified than the comparatively few available data regarding the bottom-stages.

To judge from the "Thor" material, *Gadic. argenteus* Guichenot within the region investigated seems to be commonest in the Alboran Sea between the Spanish south coast and North Africa, thus in the neighbourhood of the Straits of Gibraltar. On the other hand, *Gadic. Thori* has undoubtedly a centre of distribution in the Atlantic off the northern part of the British Isles. It will be seen from my earlier work (1909, Chart I), that very considerable numbers occur in these waters, for example, 532, 334, 314 specimens in hauls of half an hour's duration. And I can remember noting with surprise, when working along the west coast of Europe both in 1905 and 1906, that *Gadiculus* distinctly decreased in numbers from north to south, so that already S. W. of Ireland only comparatively few specimens were taken per haul. This would be very remarkable, if the species, as generally believed, is of more southern origin. As we now know, that we approach here the southern boundary for the northern *Gadiculus Thori*, this condition is very easily understood.

¹⁾ I may remark here, that in the spring of 1913 some collections, I had arranged to be made in the Mediterranean, yielded postlarval specimens of "le capelan". These prove to be nearly related to *Gadus minutus* and *Esmarki* from northern waters and are totally different from *Gadiculus argenteus*. In his excellent paper of 1911 FAGE has proved that the northern and the Mediterranean "*Gadus minutus*" are different species and that the last-named should bear the name *Gadus capelanus*.

In addition to the pelagic *Gadiculus* material collected by myself, I have also been able to investigate the following point of interest in connection with the distribution of the 2 species.

In 3 specimens (adult) from Cadiz Bay (HOLT and BYRNE 1909), kindly sent me by Mr. E. W. L. HOLT, Dublin, the following number of vertebrae was found: 13 + 27, 13 + 27, 13 + 28, which proves, that they belonged to the Mediterranean *Gadiculus argenteus* Guich.

I have also received from the Museum of Paris a few of the specimens mentioned by VAILLANT (1888). One specimen from the Atlantic coast of Morocco had 13 + 27 vertebrae and another from the Bay of Biscay (Golfe de Gascogne) 13 + 27. Thus, both specimens proved to belong to *Gadic. argenteus* Guich. I have unfortunately not had the opportunity of examining any of the specimens taken on the coast of Sudan.

From the foregoing the regions of distribution of the two species seem to meet off the west coast of France, where, however, the "Thor" has only taken specimens of *Gadic. Thori*, whereas specimens of the southern species have also been taken by the French expeditions¹). North of this region *Gadic. argenteus* Guich. has not been found²), whilst on the other hand *Gadic. Thori* has not been taken further south.

Just as the two species proved to be well separated in their structure, we thus see, that they also are well characterised by their regions of distribution.

The counting of the vertebrae in the postlarval stages has been carried out by myself, in the adult specimens by Stud. mag. VILH. EGE.

Prof. E. EHRENBAUM, Hamburg, has kindly aided me to obtain literature which was not obtainable here.

¹) In this connection I subjected my specimens taken in 1905 and 06 in the southern part of *Gadic. Thori's* region of occurrence to a new examination, but found nothing to indicate any confusion with *Gadic. argenteus*. In 7 specimens from St. 70, ⁸/₆ 1906 at 47°20' N. 12°23' W., the vertebrae numbered 13 + 29, 13 + 29, 13 + 29, 13 + 29, 13 + 28, 13 + 28, 13 + 29, and in 6 others from St. 61, ³¹/₆ 06 at 51°04' N, 11°39' W. 4 had 13 + 29, 1 had 13 + 30 and 1 had 13 + 28.

²) I have not been able to examine specimens from the north-eastern part of the *Gadiculus* region, i. e. from the Norwegian coast and fjords, but DAMAS (1909, 209), who has examined pelagic stages from there, states, that they agree well in pigment with my description of post-larvae from west of the British Isles, i. e. of *Gadic. Thori*. From the Skagerak I have myself examined specimens of *Gadic. Thori*.

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