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Results of the research cruises of the F. R. V. „Walther Herwig” to South America XLIX.

The otoliths of *Diretmus* JOHNSON, 1863
(Osteichthyes, Beryciformes, Diretmidae)

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(With 3 figures)

Abstract

Otoliths of the fish-family Diretmidae are described and illustrated and intra-specific variations of otoliths are discussed. The family Diretmidae includes two valid species, *Diretmus argenteus* JOHNSON, 1863 and *Diretmus pauciradiatus* WOODS, 1973. Previously found morphological discontinuities within *D. pauciradiatus* as defined by POST (1976) have been confirmed by the study of the otoliths, suggesting that two taxa are included in this species-group. Considering the degree of differences between the three taxa in question we suggest, that *D. argenteus* and the *D. pauciradiatus*-group should probably be considered separate genera.

Introduction

Otoliths, mainly the sagitta, have been used as a taxonomic character by palaeontologists for a long time. This practice has been rather neglected by ichthyologists dealing with recent fishes. In the last few years, however, the description of otoliths as an additional character is no more unusual (NAFFAKTITIS & PAXTON 1968, WEILER 1968, GAEMERS 1971, KARRER 1971, FITCH & BARKER 1972, KOTTHAUS 1972, STINTON 1967). Lack of experience in referring morphological distinctions of otoliths to other characters well known for their taxonomic value, insufficient knowledge of the degree of ontogenetic and individual variation of otoliths, and the dislike to injure valuable material, especially types, by removing otoliths, all may have contributed to this neglect.

The two species of the family Diretmidae, *Diretmus argenteus* JOHNSON, 1863 and *Diretmus pauciradiatus* WOODS, 1973 offer a good example of how such a comparative study of otoliths can be used for a taxonomic account of recent fishes. Extensive morphological and cytological studies have already been carried out to clear up the systematic relationship between the two *Diretmus* species. On the other hand the degree of relationship is not finally resolved. A comparative study of the otoliths of the two species could therefore be useful for further interpretations as well as to correlate differences in otoliths and other morphological characters.

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Taxonomy and distribution

The family Diretmidae was thought to be monotypic for a very long time. When very large specimens of a second species were caught and described for the first time, they were not recognized as new, but regarded as the adults of *D. argenteus* (BARNARD & BONDE 1944, MAUL 1949, ABE 1953). The description of *D. pauciradiatus* WOODS, 1973, and a following revision of the family (Post 1976) showed these large specimens to be adults of the *D. pauciradiatus*-group. It should be borne in mind that the taxonomic status of *D. pauciradiatus* is not finally resolved. Some discrepancies in meristic correlations (Post 1976), colour patterns and body shape (PARIN, personal note) cause us to suspect that *D. pauciradiatus* may possibly include two different species or subspecies. The latter species-group can easily be distinguished from *D. argenteus* by the position of the anus, the scale pattern of the ventral midline and the number of bony ridges on the operculum, as well as by some morphometric and meristic features and the different lengths of the adults (Post 1976). The *D. pauciradiatus*-group is distributed in the tropical areas of all oceans. Occasionally some adults or sub-adults are swept into subtropical waters. *D. argenteus* is distributed worldwide from tropical to temperate waters but mainly eurytropic. Both species reproduce in tropical waters.

Methods and material

The method employed in the present study to compare the otoliths of the *Diretmus* species, will be described in another paper (HECHT 1976 in press).

Abbreviations used: SL = standard length, OL = otolith length, OB = otolith breadth, OD = otolith depth.

Eighteen otoliths of *D. argenteus*, from various stages of ontogenetic development, and a total of 8 otoliths of the *D. pauciradiatus*-group were available. The sagittae were removed from the right hand sacculus of animals which had been preserved in isopropanol after being fixed for a short period in neutral formalin. The two different taxa which are included in *D. pauciradiatus* will be marked as form A and form B respectively.

18 *Diretmus argenteus*.

„Walther Herwig“: stat. 423—III/71 (SL 65.4 mm; 64.0 mm) 35° 29' S, 10° 32' E; stat. 279/73 (79.7) 47° 26' N, 46° 00' W; 696/73 (68.9) 55° 39' N, 25° 47' W to 55° 35' N, 25° 30' W; stat. 705/73 (79.7) 50° 08' N, 19° 46' W to 50° 08' N, 19° 46' W; stat. 11/74 (59.3; 72.7) 14° 11' N, 18° 28' W; stat. 25—III/74 (55.5; 55.0; 41.5; 31.7) 11° 01' N, 26° 07' W; stat. 32—II/74 (37.2; 27.2) 09° 30.5' N, 29° 35' W; stat. 32—III/74 (94.8) 09° 29' N, 29° 38' W; stat. 106—I/76 (72.8) 39° 39' S, 39° 56' W; stat. 109—II/76 (110.0) 35° 01.3' S, 40° 04.2' W. „Meteor“: stat. 118/70 (55.5) 29° 30' N, 23° 39' W; stat. 184/70 (18.2) 32° 19' N, 18° 34' W.

5 *Diretmus pauciradiatus* (form A)

„Walther Herwig“: stat. 471—III/71 (70.3) 02° 27' S, 19° 00' W; stat. 478/71 (60.0; 32.9) 01° 04' N, 18° 22' W; stat. 61—III/74 (75.3; 46.4) 02° 26.5' N, 34° 50' W.

3 *Diretmus pauciradiatus* (form B)

„Walther Herwig“: stat. 443/71 (59.2; 63.8) 21° 35' S, 02° 00' W; stat. 502/71 (83.0) 20° 27' N, 21° 58' W.

The „Walther Herwig“-material is stored in the ISH-collection, the „Meteor“-material is stored in the ZMH-collection in: Zoologisches Institut und Zoologisches Museum der Universität Hamburg.

Results

Only the inner (medial) face of the otolith is described. The outer (lateral) faces possess no features of diagnostic value.

Diretmus argenteus JOHNSON, 1863. (Figure 1 a and b)

Material: 18 specimens. — Standard lengths (mm): 18.2, 27.2, 31.7, 37.2, 41.5, 55.0, 55.5, 55.5, 59.3, 62.7, 64.0, 65.4, 68.9, 72.8, 79.7, 79.7, 94.8, 110.0. — Otolith lengths (mm): 1.15, 1.7, 1.8, 2.2, 2.6, 3.0, 3.0, 3.4, 3.6, 3.55, 3.2, 3.5, 3.2, 3.7, 4.1, 4.7, 4.65, 5.0. — OL : OB : OD : 1:1.59±0.13:0.29±0.02. — OL : SL : 1:18±2.

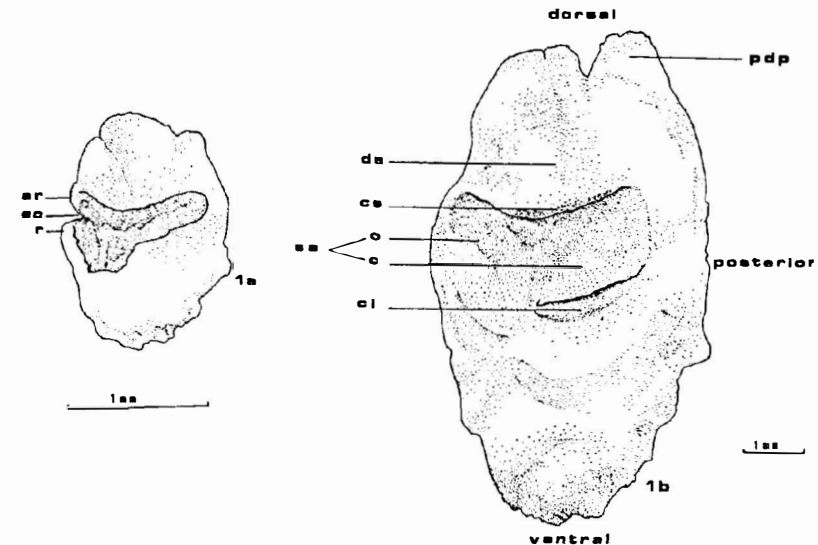


Fig. 1: Medial face of right sagittae of *Diretmus argenteus* (a) 18.2 mm („Meteor“ stat. 184/70) and (b) 110 mm („Walther Herwig“ stat. 109—II/76).

ar = antirostrum, r = rostrum, eo = excisura ostii, da = dorsal area, cs = crista superior, ci = crista inferior, pdp = postdorsal projection, sa = sulcus acusticus composed of o = ostium and c = cauda.

Description: Otolith dorso-ventrally oval to elliptical. Anterior and posterior margins generally smooth. Postero-ventral margin denticulate. Dorsal margin generally smooth with characteristic postero-dorsal projection. Medial and lateral faces slightly convex. Sulcus acusticus distinct, situated midway between dorsal and ventral ends and slightly bent toward post-dorsal corner. Sulcus length ca. 75% of otolith length, clearly divided into ostium and cauda. Ostium dorso-ventrally oval. Cauda closed posteriorly in juveniles (Fig. 1 a) and in adults (Fig. 1 b). Rostrum, antirostrum and excisura ostii absent in adults, but present as broad high ridge, crista inferior extremely sharp but not as thick as broad, posterior portion ridge-like. Both cristae highly developed, crista superior present as broad high ridge, crista inferior extremely sharp but not as thick as crista superior. Ventral groove situated immediately ventral to crista inferior. Ventral area absent. Dorsal area present, well developed.

Diretmus pauciradiatus WOODS, 1973 form A and B (Figs. 2 and 3)

Material: form A; 5 specimens. form B; 3 specimens. — Standard lengths (mm): form A; 32.9, 46.4, 60.0, 70.3, 75.3. — form B; 59.2, 63.8, 83.0. — Otolith lengths (mm): form A; 2.2, 3.05, 3.5, 4.5. — form B; 4.15, 4.25, 5.1. —

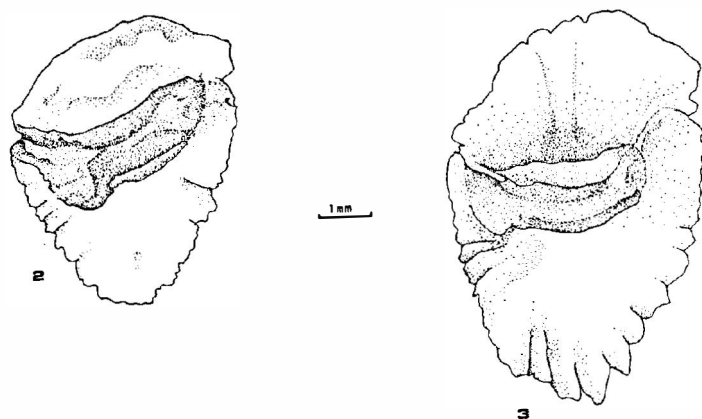


Fig. 2: Medial face of right sagitta of *Diretmus pauciradiatus* form A, 75.3 mm SL (WH 61—III/74).

Fig. 3: Medial face of right sagitta of *Diretmus pauciradiatus* form B, 63.8 mm SL (WH 443/71).

OL : OB : OD: form A; 1:1.36±0.10:0.27±0.05. — form B; 1:1.49±0.06:0.28±0.02. — OL : SL: form A; 1:17.38±2.2. — form B; 1:15.2±1.02.

Descriptions - form A (Fig. 2): Otolith more compact than that of *D. argenteus*, its shape distinctly triangular (Fig. 2). Dorsal margin smooth, remainder slightly crenulate. Postero-dorsal projection absent. Medial surface slightly convex, lateral surface slightly convex to flat. Sulcus acusticus clearly defined, directed postero-dorsally and clearly divided into ostium and cauda. Ventral margin of ostium distinctly bulbous, dorsal margin only slightly curved. Anterior portion of colliculum broad, with dorsal section raised and ridge-like, posterior section similar to *D. argenteus*, ridge-like. Cauda closed posteriorly. Rostrum, antirostrum and excisura ostii present in all specimens, extremely small and all of approximately equal size. Crista superior and inferior present over entire sulcus, extremely well developed. Ventral area absent. Dorsal area present above cauda, relatively shallow in comparison to form B. Otoliths of *D. pauciradiatus* — form A have a low organic content and are, therefore, extremely crumbly. The extreme fragility and crumbly nature of form A otoliths should, therefore, be regarded as a further characteristic feature.

Form B (Fig. 3): Otoliths of form B are distinctly different from *D. argenteus* as well as from form A otoliths. Oval-triangular in shape. Entire perimeter usually coarsely crenulate. Postero-dorsal projection absent. Medial surface slightly convex, lateral surface flat to slightly concave. Sulcus acusticus clearly defined, directed postero-dorsally but not as acutely as in the other two *Diretmus* taxa. Sulcus clearly divided into ostium and cauda. Ostium relatively smaller than in the other two taxa, its ventral margin not as distinctly bulbous as in form A. Anterior portion of colliculum similar to *D. pauciradiatus* form A, posterior portion not ridge-like, but uniformly flat. Cauda closed posteriorly. Rostrum, antirostrum and excisura ostii present but small and of equal size. Crista superior and inferior well developed and present over entire sulcus. Ventral area absent. Dorsal area large and relatively deep.

Discussion

The differences between *Diretmus argenteus* and the *Diretmus pauciradiatus*-group in morphological, anatomical and cytological features (Post 1973 and 1976) is amplified by differences in their otolith morphology. Five characteristics were found to differ significantly: 1. The sculpture of the margins; 2. The relationship OL:OB:OD; 3. The relationship OL:SL; 4. The geometric shape; 5. The presence of a rostrum, anti-rostrum and excisura ostii.

The remaining features were found to correspond.

Otoliths are usually considered to be species-specific (Weiler 1968 and Stinton 1975) but little is known about their intraspecific variation. The intraspecific variation of *Diretmus argenteus* otoliths is extremely insignificant within all ontogenetic stages above a standard length of 30 mm. The otoliths of specimens less than 30 mm differ from those larger than this length in that they have a rostrum, antirostrum and excisura ostii. The latter feature corresponds to the otoliths of the *Diretmus pauciradiatus*-group which retain those structures in all available ontogenetic stages. Furthermore the otoliths of *D. argenteus* are all dorso-ventrally oval (see Figs. 1 a und 1 b). On the other hand the otoliths of *D. pauciradiatus* (form A) are distinctly triangular in shape (see Fig. 2) whereas the otoliths of form B have a more oval-triangular shape (see Fig. 3).

The otoliths of the three taxa are, therefore, easily recognized by their shape alone and those of *D. argenteus* are furthermore characterized by the postero-dorsal projection present in all ontogenetic stages. Considering the differences between the two actually recognized *Diretmus* species, which have become evident from the morphological and cytological studies and further more the discrepancy of meristic characters within *Diretmus pauciradiatus* as mentioned in the chapter „taxonomy and distribution“ it seems necessary to reconsider the taxonomical status of the species, bearing in mind the results of the otolith study. Although these results cannot solve this problem they might at least offer a further clue as to their correct taxonomic status. If the differences, as well in otolith as in other morphological features, were not brought about by environmental effects, two different taxa would be included in *Diretmus pauciradiatus* (as referred to by Post 1976), which are much closer related to each other than each of them to *Diretmus argenteus*. Taking into account that a different degree of relationship should be indicated by different taxonomic levels, we feel justified to suggest that *Diretmus argenteus* and *Diretmus pauciradiatus* (with its two forms) should be considered separate genera, although we do not propose formal action of this time.

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