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Fish otoliths from the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Central Poland)

ABSTRACT: The assemblage of the fish otoliths from the Middle Miocene (Badenian) Korytnica Clays exposed on the southern slopes of the Holy Cross Mts, Central Poland, comprises 43 species belonging to 33 genera. Five species are new, viz.: *Hyporhamphus baluki* sp. n., *Physiculus fitchi* sp. n., *Trachurus? formosus* sp. n., *Parequula crenata* sp. n., and *Thalassophryne korytnicensis* sp. n. Of this assemblage, 31 species have as yet been unknown from the Korytnica basin, and 28 species from Poland. An ecological analysis of fish families and genera that lived in the Korytnica basin is also presented, and its bearing upon the recognition of environmental conditions is discussed.

INTRODUCTION

The Middle Miocene (Badenian) Korytnica Clays exposed within the Korytnica basin on the southern slopes of the Holy Cross Mountains, Central Poland (*cf.* Bałuk & Radwański 1977, 1979) contain a rich assemblage of fish otoliths, some of which have previously been recognized, either in Korytnica or in neighboring localities Chomentów and Karsy (*see* Text-fig. 1), both by the former students (Friedberg 1924, Chaine & Duvergier 1928) and by the present author herself (Śmigielska 1966). This study is mostly based on the material obtained by Doc. Dr. W. Bałuk when sifting the clay samples for collecting diverse small-sized invertebrates. The whole assemblage of the diversified fossils from the Korytnica Clays makes this locality one of the most famous exposures of the Middle Miocene deposits in Europe. The very favorable environmental and burial conditions within the Korytnica basin resulted in preservation of components of very rich and diverse organic communities, some of them containing quite unique animal remains (*cf.* Bałuk & Radwański 1977, 1979). The investigated assemblage of fish otoliths also falls into such characteristics, and the assemblage itself is the richest one of all hitherto known from the Miocene deposits of Poland (*see* Table 1).

The manuscript of the present paper has been completed in 1977; the taxonomy of some species and/or other data remain therefore actual up to that date.

The collection of the otoliths described in the present paper is housed at the Institute of Geology and Mineral Deposits of the University of Mining and Metallurgy, Cracow, except for the otoliths of the genus *Sciaena* housed at the Institute of Geology of the University of Warsaw and kept under the catalogue numbers *BkK-P7/1—2*.

Acknowledgements. The author expresses her best thanks to Docent W. Bałuk and Professor A. Radwański, both from the Institute of Geology of the University of Warsaw, for donation of the whole investigated otolith material. Most sincere thanks are also due to Dr. J. E. Fitch, Long Beach, California, who kindly offered for comparison Recent otoliths from his outstanding collection. Thanks are also due to Docent F. Szymakowska for making all the drawings.

PRESERVATION AND FREQUENCY OF THE OTOLITHS

In general, the investigated otoliths (Text-figs 2—37 and Pls 1—8) are very well preserved; the species are commonly represented by numerous specimens.

The otolith assemblage is predominated by *Dentex latior* (437 specimens) and *Gobius vicinalis* (373 specimens). Less frequently occur: *Cepola rubescens* (142 specimens), *Urophycis tenuis* (85 specimens), *Merluccius merluccius* (49 specimens), *Parequula crenata* (46 specimens), *Hyporhamphus baluki* (23 specimens), *Physiculus fitchi* (23 specimens), and *Citharus lusitanicus* (22 specimens). A dozen or so specimens were found of the species: *Myripristis banatica*, *Saurida germanica*, *Smaris elegans*, *Clupea pulchra*, *Trigla rhombica*, and *Congermuraena balearica*. The other recognized otolith species are rather rare, sometimes represented by a single sagitta, e.g.: *Antigonia alta*, *Coelorhynchus coelorhynchus*, *Sciaena* cf. *aquila*, *Trachurus*? *formosus*, and *Trachinus verus*.

ECOLOGICAL REMARKS

The generic composition of the investigated fish assemblage appears indicative of a heterogeneous biotope, as some genera recorded in the Korytnica basin are confined to different ecological conditions. Dominant otolith species represent fishes either living usually in the littoral zone (e.g. *Dentex*, *Gobius*, and *Citharus*) or reaching the neritic zone (e.g. *Cepola*, *Trigla*). The genus *Urophycis*, also common in the investigated material, lives exclusively in the neritic zone, whereas *Pterothrissus* inhabits pelagic or even bathypelagic waters. Representatives of the families Ophidiidae and Congridae are usually found in bathypelagic and/or bathyal waters but some congrids are also met (*cf.* Jonet 1973, pp. 252, 274) in the littoral (*Conger conger* L.) to littoral-neritic zones (*Congermuraena*). All genera of the family Moridae, the investigated *Physiculus* including, are exclusively deep-water fishes ranging from 200 down to 450 m (*cf.* Fitch & Brownell 1968, p. 2565).

In the Korytnica assemblage, there occur also (eventhough rarely) fishes migrating at the time of reproduction into brackish (*Merluccius*) or even fresh waters (*Sciaena*). On the other hand, the Atherinidae live exclusively in lagoons and estuaries.

The investigated assemblage comprises some predatory species feeding commonly upon shoals of little fishes (*e.g.* the Clupeidae) they follow. Those known from the

present-day Mediterranean Sea (*cf.* Jonet 1973, pp. 252—254) are among the predatory fishes (e.g. *Congermuraena*, *Sphyraena*, *Sciaena*). Moreover, there lived numerous sharks and rays in the Korytnica basin, the remains of which are carefully examined by Schultz (1977, 1979).

The investigated otolith material includes also remains of highly specialized forms, such as e.g. *Carapus* living in holothurian cloaca (*cf.* Bałuk & Radwański 1977, p. 111); *Trachinus* burying in sand to wait for prey; *Citharus* showing a considerable deformation in symmetry due to its living on the bottom. This specialization accounts probably for the variability in sagittal shape.

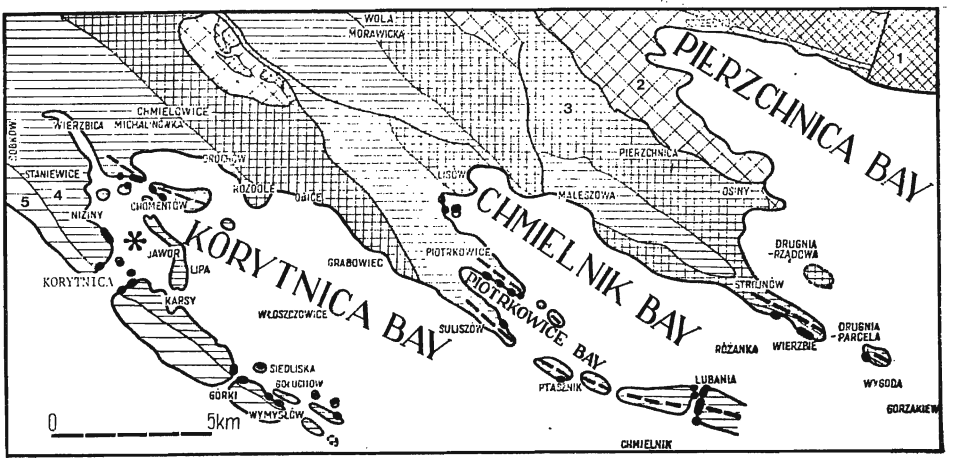

Fig. 1. Middle Miocene (Badenian) shoreline and extent of the bays on the southern slopes of the Holy Cross Mountains, to show the location of the Korytnica basin (*asterisked*) and investigated and/or referenced exposures (Chomentów, Karsy); preserved localities of littoral structures bounding the basin are marked with black spots along the shoreline (*taken from*: Bałuk & Radwański 1977, Text-fig. 1C)

Within the inland areas distinguished are the occurrence zones of: *1* Cambrian (including locally Ordovician and Silurian), *2* Devonian, *3* Triassic, *4* Jurassic, *5* Cretaceous; marked with heavy dashes are the ridges in morphology that separate particular bays

The fishes recorded in the Korytnica basin are mostly subtropical to tropical forms, and such very climatic conditions are indeed indicated by the whole organic assemblage of the Korytnica Clays (*cf.* Bałuk & Radwański 1977, 1979). The occurrence of deep-water forms within the predominantly littoral-neritic fish assemblage may be explained by unusually favorable life conditions (warm and calm water, abundant food) permitting easy survival of the juveniles. On the other hand, this points to a connection between the Korytnica basin and deeper marine waters, from where bathypelagic and bathyal fishes immigrated.

Table 1

List of the species investigated from the Korytnica basin

Species	Friedberg (1924)	Chaine & Duvergier (1928)		Śmigielska (1966)		Śmigielska (1979)	previously unknown from	
	Chomentów	Chomentów	Korytnica	Korytnica	Karsy	Korytnica	Korytnica	Poland
Pterothrissus minor (Koken)						+	+	+
Clupea pulchra Śmigielska					+	+		
Clupea weileri Śmigielska					+	+		
Clupea sp.						+	+	+
Saurida germanica (Weiler)						+	+	+
Diaphus debilis (Koken)					+			
Conger conger L.					+	+		
Congermuraena balearica (De la Roche)					+	+		
Uroconger pulcher (Bassoli)						+	+	+
Congridarum? *semiapertus* (Brzobohaty)						+	+	+
Hyporhamphus baluki sp. n.						+	+	+
Physiculus fitchi sp. n.						+	+	+
Urophycis tenuis (Koken)			+	+		+		
Gadus planatus (Bassoli & Schubert)			+					
Merluccius merluccius (L.)						+	+	
Coelorhynchus coelorchynchus (Risso)						+	+	+
Hoplostethus praemediterraneus Schub.				+				
Myripristis banatica Weiler						+	+	+
Myripristis sp.						+	+	+
Antigonia alta (Weiler)						+	+	+
Sphyraena hansfuchsi Schubert						+	+	+
Atherinidarum? sp.						+	+	+
Serranus noetlingi Koken					+	+		
Sillago hassovicus (Koken)						+	+	+
Trachurus? *formosus* sp. n.						+	+	+
Sciaena pecchioli Lawley						+	+	+
Sciaena cf. *aquila* Lacépède						+	+	+
Dentex gregarius (Koken)					+	+		
Dentex latior Schubert	+	+		+	+	+		
Smaris elegans (Procházka)						+	+	+
Parequula crenata sp. n.						+	+	+
Spondyliosoma tietzei (Schubert)		+						
Cepola rubescens L.					+	+		
Crenilabrus simplicissimus Schubert					+			
Trachinus verus Koken						+	+	+
Uranoscopus? aff. *scaber* L.						+	+	+
Hoplobrotula acutangula (Koken)						+	+	+
Hoplobrotula? *ornatissima* (Robba)						+	+	+
Carapus nuntius (Koken)						+	+	
Gobius intimus Procházka		+						
Gobius ex gr. *multipinnatus* H. v. Meyer				+	+	+		
Gobius telleri Schubert		+		+	+	+		
Gobius vicinalis Koken	+	+		+	+	+		
Scorpaena sp. an nova Śmigielska					+			
Trigla asperoides Schubert						+	+	+
Trigla rhombica Schubert						+	+	
Trigla? *schuberti* Posthumus						+	+	?
Citharus lusitanicus (Jonet)						+	+	+
Solea aff. *taureri* Weinfurter					+			
Thalassophryne korytnicensis sp.n.						+	+	+
genus (inc. sedis) *aquitanicus* Priem		+						
genus et sp. indet.						+	+	+

SYSTEMATIC DESCRIPTION

Order **Clupeiformes**
Family **Pterothrissidae**
Genus *PTEROTHRISSUS* Hilgendorf, 1877
Pterothrissus minor (Koken, 1884)
(Text-fig. 2 and Pl. 1, Figs 1—3)

1884. *Otolithus* (incertae sedis) *minor*; E. Koken, p. 558 (non Pl. XI, Fig. 14).
1891. *Otolithus* (incertae sedis) *minor* Koken; E. Koken, p. 135, Text-figs 23—24.
1914. *Otolithus* (*Dentex*?) aff. *subnobilis* Schubert; F. Priem, p. 263, Fig. 42.
1973. *Pterothrissus minor* (Koken); S. Jonet, p. 134, Text-fig. 11, Item 2 and Pl. II, Figs 3—5.
1974. *Pterothrissus minor* (Koken); W. Schwarzhans, pp. 93—94, Text-fig. 1.
Material: 18 well preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 1	Text-fig. 2
Ot.M.150	6.5	4.0	0.9	Fig. 1	Item 1
Ot.M.151	5.9	3.6	0.9	Fig. 2	Item 2
Ot.M.152	4.6	2.7	0.5	—	Item 3
Ot.M.153	2.8	1.6	0.4	—	Item 4
Ot.M.154	2.45	1.40	0.40	—	Item 5
Ot.M.155	2.35	1.45	0.35	Fig. 3	Item 6
Ot.M.156	2.60	1.50	0.35	—	Item 7

Remarks. — The investigated otoliths resemble closely those referred to in the synonymy. They differ from the species *P. umbonatus* (Koken) in their less regular outline. The two species may actually represent a single phyletic lineage beginning with the latter species recorded in the Eocene.

Occurrence. — Oligocene of Germany (Koken 1884, 1891; Schwarzhans 1974); Miocene of France (Priem 1914) and Portugal (Jonet 1973).

Family **Clupeidae** Bonaparte, 1831
Genus *CLUPEA* Linnaeus, 1758
Clupea pulchra Śmigielska, 1966
(Text-fig. 3 and Pl. 1, Fig. 4)

1966. *Clupea pulchra* n. sp.; T. Śmigielska, pp. 226—227, Pl. XII, Figs 1—2.
Material: 13 specimens, 5 of them well preserved, the others damaged.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 1	Text-fig. 3
Ot.M.157	2.7	1.4	0.40	—	Item 1
Ot.M.158	2.5	1.3	0.35	—	Item 2
Ot.M.161	2.5	1.3	0.25	Fig. 4	—
Ot.M.159	2.4	1.2	0.30	—	Item 3
Ot.M.160	2.3	1.1	0.35	—	Item 4

Remarks. — The investigated specimens are entirely consistent with the holotype described from the Middle Miocene Korytnica basin, Poland (Śmigielska 1966).

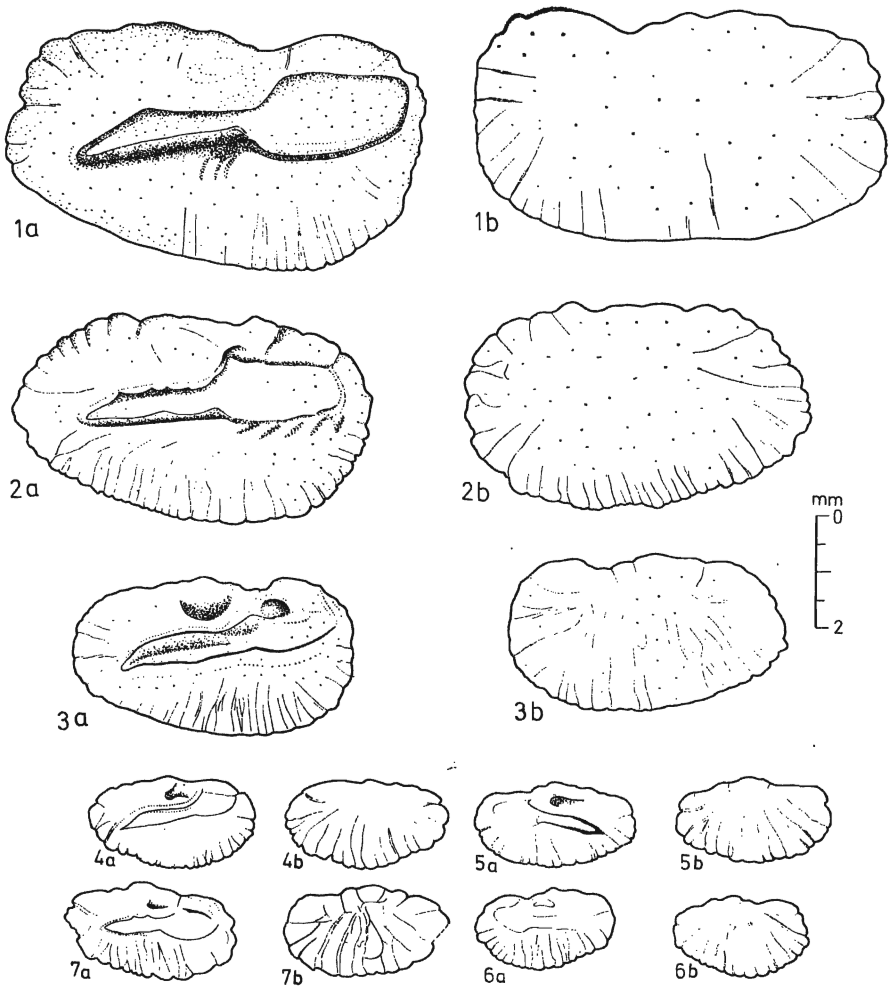

Fig. 2. *Pterothrissus minor* (Koken)

1 – 3 adult specimens, left sagitta; **4 – 7** juvenile specimens (*4* and *7* left sagitta, *5—6* right sagitta); *a* inner face, *b* outer face

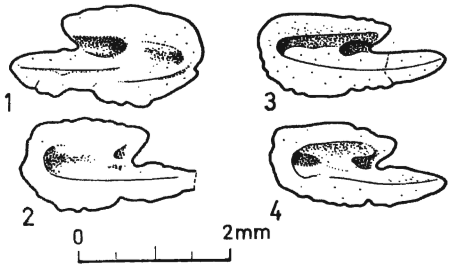

Fig. 3
Clupea pulchra Śmigielska

1 inner face of right sagitta, **2 – 4** inner face of left sagitta

Clupea weileri Śmigielska, 1966
(Text-fig. 4 and Pl. 1, Fig. 6)

1966. *Clupea weileri* n. sp.; T. Śmigielska, pp. 227—228, Pl. XII, Figs 3—4.
Material: 2 specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 1	Text-fig. 4
Ot.M.162	3.2	1.7	0.5	—	Item 1
Ot.M.163	3.2	1.6	0.5	Fig. 6	Item 2

Supplementary description. — Rostrum is obtuse and antirostrum is small-sized. There is no excisura. Ventral rim is a little denticulated.

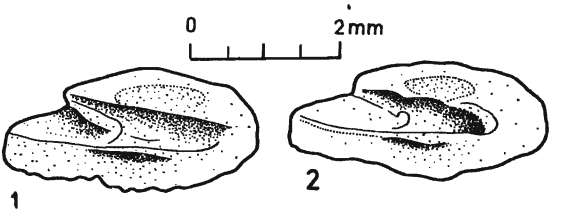

Fig. 4. *Clupea weileri* Śmigielska
1—2 inner face of right sagitta; *2* presents the neotype

Remarks. — The investigated specimens resemble the type material described from the Middle Miocene Korytnica basin, Poland (Śmigielska 1966). The holotype and paratype of the species are juvenile forms and hence, the adult otolith presented in Text-fig. 4, Item 2 and Pl. 1, Fig. 6 is here designated for a neotype.

Clupea sp.
(Text-fig. 5 and Pl. 1, Fig. 5)

Material: a single well preserved specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.164	3.5	1.7	0.5

Description. — Rostrum is wedge-like, subacute. Dorsal rim is undulate, while ventral one shows an incision at the beginning of rostrum. Both ostium and cauda display a triangular incision.

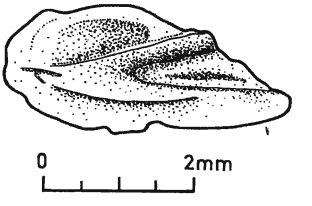

Fig. 5
Clupea sp.; inner face of left sagitta

Order **Aulopiformes**
Family **Synodontidae**
Genus *SAURIDA* Cuvier & Valenciennes, 1849
Saurida germanica (Weiler *in* Weinfurter, 1952)
(Text-fig. 6 and Pl. 1, Figs 7—9)

1952*a*. *?Cottus germanicus* Weiler; E. Weinfurter, p. 164, Pl. 2, Fig. 8.
?1952*b*. *Sphyraena* cf. *hansfuchsi* Schubert; E. Weinfurter, p. 462, Pl. 2, Fig. 5.
Material: 17 specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 1	Figured in: Text-fig. 6
Ot.M.170	*c.* 6.2	2.1	0.50	—	Item 6
Ot.M.171	*c.* 5.8	2.2	0.90	Fig. 9	Item 7
Ot.M.169	*c.* 5.2	2.3	0.50	—	Item 5
Ot.M.166	3.8	1.2	0.35	Fig. 8	Item 2
Ot.M.168	*c.* 3.6	1.6	0.50	—	Item 4
Ot.M.165	3.0	1.2	0.35	Fig. 7	Item 1
Ot.M.167	*c.* 2.8	1.5	0.40	—	Item 3

Description. — Slender, elongate sagitta with a prominent, pointed rostrum. There is no antirostrum or excisura. Dorsal rim is crenulate, while ventral rim is smooth and slightly arched, and posterior one is most commonly rounded. In lateral view, dorsal rim is thick and rounded, while ventral one is acute.

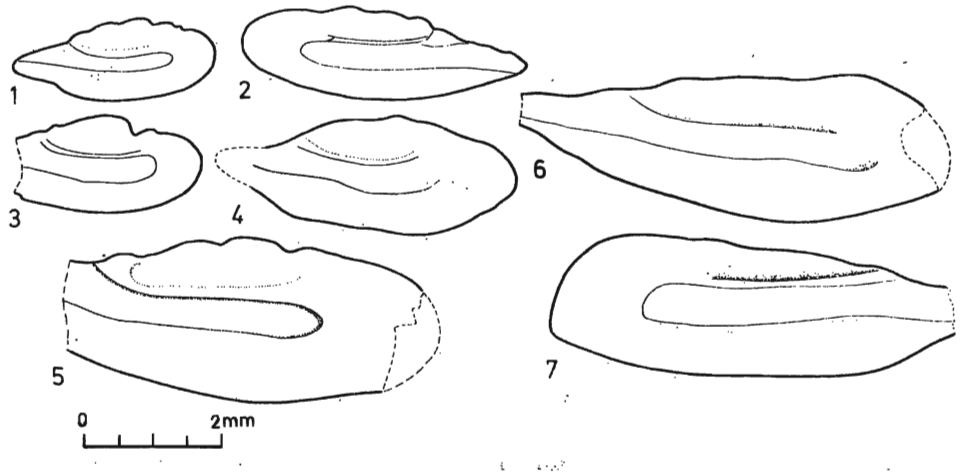

Fig. 6. *Saurida germanica* (Weiler)
1—4 juvenile specimens, 5—7 adult specimens (*1* and *3—6* inner face of right sagitta, *2* and *7* inner face of left sagitta)

Outer face is a little convex, with grooves starting at notches situated at dorsal rim.

Inner face is flat to somewhat convex, with a horizontal, median to supramedian, fairly deep sulcus. Ostium is a little shorter and shallower than cauda. It opens at the beginnig of dorsal rim, while its lower margin lies close to the point of rostrum. Caudal end is rounded and fairly distant from posterior rim. Well developed crista superior is weakly arched and disappears at the end of cauda. Crista inferior is almost straight.

Remarks. — The investigated otoliths resemble closely a specimen described by Weinfurter (1952*a*) from the Middle Miocene of Austria. Their generic assignment is based upon a similarity in sagittal outline and sulcus shape to the Recent otoliths *Saurida undosquamis* (Richardson). However, the latter species appears more closely related in morphology to its Recent congeners, e.g. *S. tumbil* (Bloch, 1795) or *S. recta* (Frost, 1933) as described and illustrated by Nolf (1974, p. 57, Pl. VII, Figs 4 and 6—13), than to the material under study.

Occurrence. — Middle Miocene of Austria (Weinfurter 1952*a*,*b*).

Order **Anguilliformes**
Family **Congridae** Kaup, 1856
Genus *CONGERMURAENA* Kaup, 1856
Congermuraena balearica (De la Roche)
(Text-fig. 7 and Pl. 2, Figs 1—2)

1888. *Otolithus (Platessa) flesus* L.; E. Koken, p. 292, Pl. XVIII, Figs 1—2.
1926. *Congromuraena balearica* Delar.; G. A. Frost, p. 102, Pl. IV, Fig. 15.
1938. *Congermuraena balearica* Delar.; J. Chaine, p. 242, Pl. XVIII.
1966. *Congermuraena balearica* Delar.; T. Śmigielska, p. 237, Pl. XIV, Fig. 3.
1973. *Paraconger sector* (Koken, 1888); S. Jonet, p. 147, Text-fig. 11, Item 14 and Pl. II, Fig. 24.
Material: 13 specimens, most of them well preserved.
Dimensions (in *mm*):

Coll. No	L	H	T	Figured in: Pl. 2	Figured in: Text-fig. 7
Ot.M.172	5.8	5.2	1.2	Fig. 1	Item 1
Ot.M.173	4.8	4.1	0.9	Fig. 2	Item 2
Ot.M.174	2.2	2.2	0.6	—	Item 3

Remarks. — The investigated specimens are no doubt conspecific with the Recent ones referred to in the synonymy. This is also the case of the form recorded by Jonet (1973) in the Miocene of Portugal and attributed originally to *Paraconger sector* (Koken); the latter species shows actually a different sagittal outline and sulcus shape from those displayed by the Portuguese specimens.

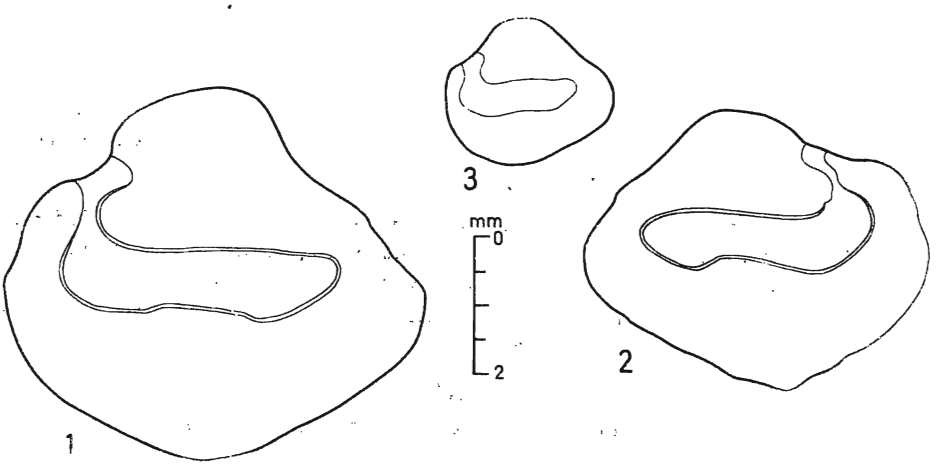

Fig. 7. *Congermuraena balearica* (De la Roche)
1 – 2 adult specimens, 3 juvenile specimen (*1* and *3* inner face of right sagitta, *2* inner face of left sagitta)

The genus *Paraconger* Kanazawa, 1961, shows an anteriorily opened sulcus (*cf.* Stinton 1968, p. 157, Fig. 11; Nolf 1974, p. 54, Pl. VI), whereas the sulcus is invariably closed and at a considerable distance from both posterior and anterior rims in *Congermuraena*. Therefore, there is little doubt that the considered species is to be indeed assigned to the latter genus.

Occurrence. — Oligocene of Germany (Koken 1888); Miocene of Poland (Śmigielska 1966) and Portugal (Jonet 1973); Recent Mediterranean Sea (Frost 1926, Chaine 1938).

Genus *UROCONGER* Kaup, 1856
Uroconger pulcher (Bassoli, 1906)
(Text-fig. 8 and Pl. 2, Fig. 3)

1906. *Otolithus (Ophidium) pulcher* Bass.; G. G. Bassoli, p. 44, Pl. 1, Figs 46—47.
1970. *Uroconger* sp.; E. Robba, p. 117, Pl. 10, Fig. 1.
?1973. *Congermuraena weileri* nov. sp.; S. Jonet, p. 145, Text-fig. 11, Items 11—12 and Pl. II, Figs 19—21.
Material: a single well preserved specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.175	6.5	4.2	1.2

Remarks. — The otolith under study resembles very closely those described from the Miocene of Italy by Bassoli (1906) and Robba (1970). The latter author has given an excellent illustration of the sagitta and claimed his specimen to differ from the holotype in its sulcus shape. However, the original illustration and description given by Bassoli (1906) are so poor that the present author is of the opinion that the two considered otoliths may well be conspecific.

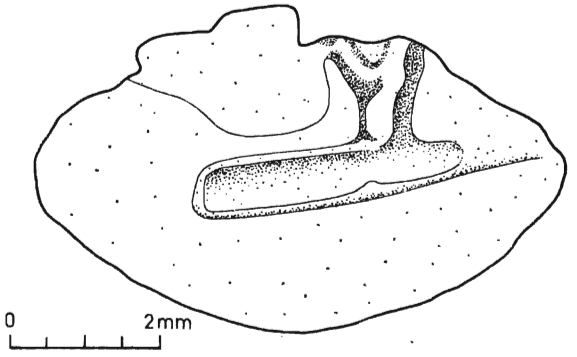

Fig. 8
Uroconger pulcher (Bassoli); inner face of left sagitta

The species *Congermuraena weileri* erected by Jonet (1973) for some Miocene otoliths from Portugal differs from the considered species merely in a little more pointed anteriorily and posteriorily outline of sagitta, which may well fall within the range of intraspecific variability.

Occurrence. — Miocene of Italy (Bassoli 1906, Robba 1970) and possibly Portugal (Jonet 1973).

Genus *CONGRIDARUM*
Congridarum? semiapertus (Brzobohatý, 1967)
(Pl. 2, Fig. 4)

1967*a*. *Congermuraena semiaperta* n. sp.; R. Brzobohaty, p. 131, Pl. 3, Figs 2 and 4—6.

Material: a single well preserved specimen.
Dimensions (in *mm*);

Coll. No.	L	H	T
Ot.M.294	5.0	3.6	1.1

Description. — Wide, oval sagitta with an indistinct, rounded rostrum but without any antirostrum or excisura (anterior rim shows merely a slight bend). Dorsal rim is arcuate, while ventral one is rounded.

Outer face is weakly convex with the largest rise of the surface displaced posteriorily. Inner face is also convex, with a smooth ventral field. Sulcus is undivided, almost horizontal, a little submedian, filled up with a single colliculus almost constant in width (it is a little narrower anteriorily). Deep area occurs above distinct crista superior. Ventral furrow lies very closely to ventral rim.

Remarks. — The investigated specimen resembles very closely in its sagittal outline and sulcus characteristics the type material of *Congermuraena semiaperta* Brzobohatý. It shows also an affinity with *Otolithus (Congridarum) occidentalis* Weiler (1959, p. 156, Text-fig. 12) but the latter species displays a distinct antero-ventral corner at its ventral rim. Another related form is *Bathycongrus pantanellii* (Bassoli & Schubert) as illustrated by Bassoli (1906, p. 43, Pl. 1, Fig. 41, non Fig. 42).

The proper systematic position of the considered species is uncertain, as there is no ostial channel typical of the entire family Congridae (*cf.* Frizzell & Lamber 1962, p. 91). This is why Schwarzhans (1976, p. 470) assigned tentatively the species to *Pseudophichthys* Roule, 1915. The present author is, however, of the opinion that the species shows actually much congrid affinities.

Occurrence. — Oligocene of Moravia (Brzobohatý 1967*a*).

Order **Beloniformes**
Family **Exocoetidae**
Genus *HYPORHAMPHUS* Gill, 1859
Hyporhamphus baluki sp. n.
(Text-fig. 9 and Pl. 2, Figs 5—7)

Holotype: specimen presented in Text-fig. 9, Item 1 and Pl. 2, Fig. 5 (Coll. No. *Ot.M.176*).
Type locality: Korytnica basin, Poland.
Type horizon: Badenian (Middle Miocene).
Derivation of the name: in honor of Dr. W. Baluk, student of the Korytnica fossils and the collector of the present material.
Diagnosis: Scalene triangular sagitta with crenulate rims, concave outer face, and convex inner face; sulcus bipartite, with ostium almost closed at anterior rim and enlarged in mid-length, and fairly wide cauda rising dorsally at the beginning but curved ventrally at its posterior end; sulcus filled up with colliculi.
Material: 23 specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 2	Text-fig. 9
Ot.M.176	4.2	2.8	0.6	Fig. 5	Item 1
Ot.M.177	4.1	2.7	0.4	—	Item 2
Ot.M.178	3.5	2.5	0.4	—	Item 3
Ot.M.179	4.7	3.1	0.5	Fig. 6	Item 5
Ot.M.180	3.9	2.5	0.3	Fig. 7	Item 4
Ot.M.181	3.8	2.6	0.4	—	Item 6
Recent congener	3.3	2.1	0.4	—	Item 7

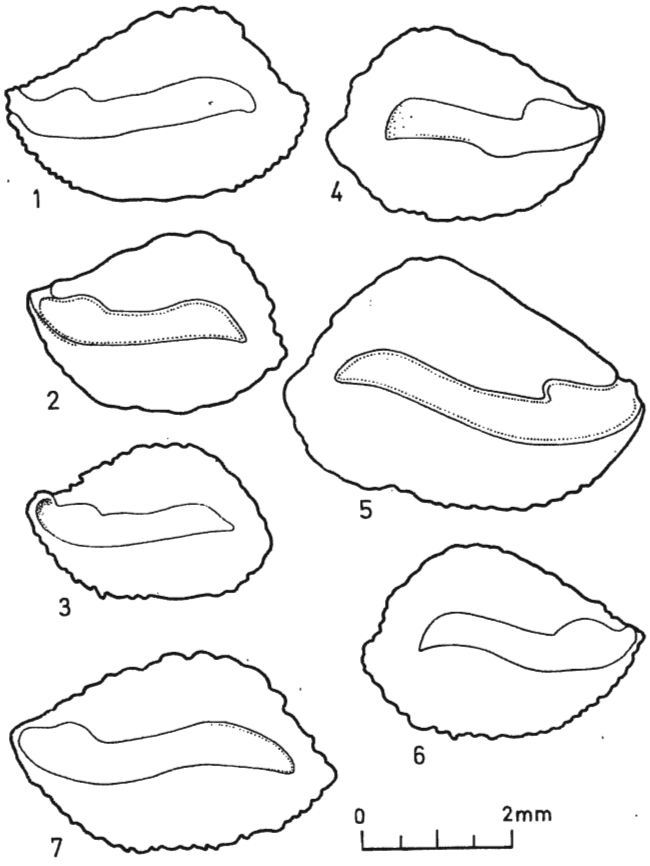

Fig. 9. *Hyporhamphus* spp.

1–6 *Hyporhamphus baluki* sp. n. (*1*—*3* inner face of right sagitta, *4*—*6* inner face of left sagitta; *1* presents the holotype)
7 *Hyporhamphus unifasciatus* (Ranzani), Recent otolith; inner face of right sagitta

Description. — Sagitta is scalene triangular in outline, with a more or less arched ventral rim. Dorsal rim rises obliquely backwards from rostrum but it recurves forming a subacute postero--dorsal corner. There is no antirostrum or excisura. Dorsal, ventral, and posterior rims are distinctly crenulate in juveniles but they smoothen with otolith size.

Outer face is concave, sometimes with radial furrows in proximity of the rim. Inner face is convex. Sulcus consists of a narrow, closed (*2*—*4* in Text-fig. 9) or almost closed (*1* and *5*—*6* in Text--fig. 9) ostium widening posteriorily, and a twice as long, fairly wide cauda rising dorsally at the beginning but curved ventrally at its posterior end. Ostium comes very close to anterior rim. Sulcus is filled entirely up with colliculi.

Remarks. — The material under study resembles the Recent species *H. unifasciatus* (Ranzani) illustrated here (*7* in Text-fig. 9) for comparative purposes, which permits a generic assignment of the investigated otoliths.

From the species *Chirodorus miocaenicus* erected by Weinfurter (1952*b*, p. 462, Pl. I, Fig. 7) for some Miocene otoliths from Austria, the investigated specimens differ in their arcuate ventral rim instead of a distinctly pentagonal sagittal outline.

Order **Gadiformes**
Family **Moridae**
Genus *PHYSICULUS* Kaup, 1858
Physiculus fitchi sp. n.
(Text-fig. 10 and Pl. 3, Figs 1—2)

Holotype: specimen presented in Text-fig. 10, Item 1 and Pl. 3, Fig. 2 (Coll. No. *Ot.M. 182*).
Paratype: specimen presented in Text-fig. 10, Item 2 and Pl. 3, Fig. 1 (Coll. No. *Ot.M.184*).
Type locality: Korytnica basin, Poland.
Type horizon: Badenian (Middle Miocene).
Derivation of the name: in honor of Dr. J. E. Fitch, eminent student of Recent and fossil fish otoliths.

Diagnosis: Thick, elongate sagitta with subacute anterior end and pointed posterior one; well developed, rounded antero-dorsal corner and indistinct postero-dorsal one; sulcus bipartite, with oval, shallow ostium and deep, long cauda filled up with a blade-like colliculus; outer face knobbed.

Material: 23 specimens, most of them well preserved.
Dimensions (in *mm*):

Coll. No.	l.	H	T	Figured in: Pl. 3	Text-fig. 10
Ot.M.182	6.0	1.6	1.7	Fig. 2	Item 1
Ot.M.183	4.9	1.4	1.3	—	—
Ot.M.184	c. 4.0	1.2	1.1	Fig. 1	Item 2

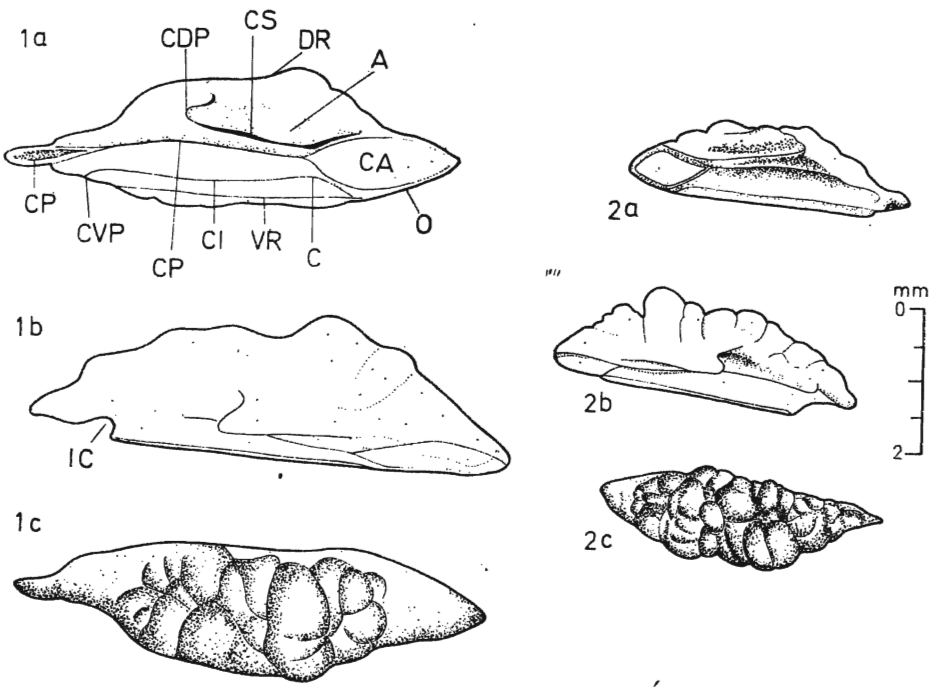

Fig. 10. *Physiculus fitchi* sp. n.
1 holotype, adult specimen, left sagitta; **2** paratype, juvenile specimen, right sagitta; *a* inner face, *b* lateral view, *c* outer face

CDP caudo-dorsal point, *CS* crista superior, *DR* dorsal rim, *A* area, *CA* colliculus anterior, *O* ostium, *CP* colliculus posterior, *CI* crista inferior, *VR* ventral rim, *C* collum, *IC* caudal incision (*after* Karrer 1971)

Description. — Sagitta is rather gracile although thick in lateral view. Its anterior end is subacute, whereas posterior one is distinctly pointed as a rule but abrupt in a few cases. Dorsal rim rises above the ostium, forming a well developed, rounded antero-dorsal corner above the collum in adult specimens. Less distinct postero-dorsal corner may be separated from the former one by a little concavity. In juveniles, dorsal rim is markedly notched. Posterior rim is steeply inclined, while ventral rim is more or less straight.

Outer face is distinctly knobbed in juvenile specimens but the tubercles become less prominent in adults. In lateral view, the largest swelling of antero-dorsal corner inclines dorsally.

Inner face is flat. Sulcus consists of an oval, somewhat narrowing posteriorily, weakly depressed ostium filled in some specimens up with colliculus anterior (*1a* in Text-fig. 10), and a deep cauda more than twice as long as the ostium, filled up with a blade-like colliculus posterior. Crista superior ranges between mid-length of ostium and caudo-dorsal point, forming an obtuse angle above the anterior part of colliculus posterior. Area is fairly deep. Ventral field is discernible but very narrow. There is also a distinct postcaudal incision.

Remarks. — Much attention has been recently paid to the modern morid otoliths, resulting in recognition of 4 distinct taxa of lower than familial rank, referred to as the *Mora*, *Physiculus*, *Pseudophycis*, and *Actuariolum* groups (Schmidt 1968, Karrer 1971, Fitch & Barker 1972, and others). The investigated otoliths from the Korytnica basin are then to be attributed to the *Physiculus* group, as indicated by their close resemblance to the Recent specimens representative of this group (Dr. J. E. Fitch, *personal communication*). In fact, they show much affinity with the species *Ph. rastrelliger* Gilbert and *Ph. nematopus* Gilbert as illustrated by Fitch & Barker (1972, p. 574, Fig. 1*D* and *C*, respectively), or *Ph. capensis* Gilchr, as illustrated by Karrer (1971, p. 166, Text-fig. 6); the latter species appears actually most closely related to the considered newly erected species, as the only difference is in some details of dorsal-rim outline.

Gaemers (1973, p. 68, Pl. 2, Fig. 5) reported a new fossil morid species from the lowermost Middle Miocene of Germany, named *Tripterophycis multituberosus*. The type material consists of a single juvenile specimen resembling the otoliths from Korytnica but differing in its triangular ostium and very weakly pronounced antero-dorsal corner.

The genus *Physiculus* Kaup, 1858, has insofar not been known from the fossil record, as the two species assigned originally to this genus (*Ph. bicaudatus* Frost and *Ph. terakohensis* Frost) were recently re-interpreted and attributed by Karrer (1971) and Fitch & Barker (1972) to the *Actuariolum* group.

Family **Merlucciidae**

Genus *MERLUCCIUS* Rafinesque, 1810

Merluccius merluccius (Linnaeus, 1758)

(Text-fig. 11 and Pl. 2, Fig. 8)

1884. *Otolithus (Merluccius) esculentus*; E. Koken, p. 529, Pl. IX, Fig. 1.
1973. *Merluccius vulgaris* Fleming; T. Śmigielska, p. 7, Pl. I, Fig. 2 [*cum syn*].
1973*b*. *Merluccius vulgaris* Fleming, 1828; P.A.M. Gaemers & W. Schwarzhans, p. 217, Pl. VI, Fig. 5.
1977. *Merluccius merluccius* (Linnaeus, C., 1758); D. Nolf, p. 21, Pl. III, Figs 1—3.
Material: 49 specimens, 25 of them well preserved.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in:
Ot.M.185	*c.* 16.0	7.0	1.2	—
Ot.M.186	11.0	4.4	0.9	Text-fig. 11 and Pl. 2, Fig. 8
Ot.M.187	10.6	4.1	0.9	—
Ot.M.188	5.9	2.3	0.6	—
Ot.M.189	5.1	2.1	0.6	—
Ot.M.190	3.3	1.8	0.3	—

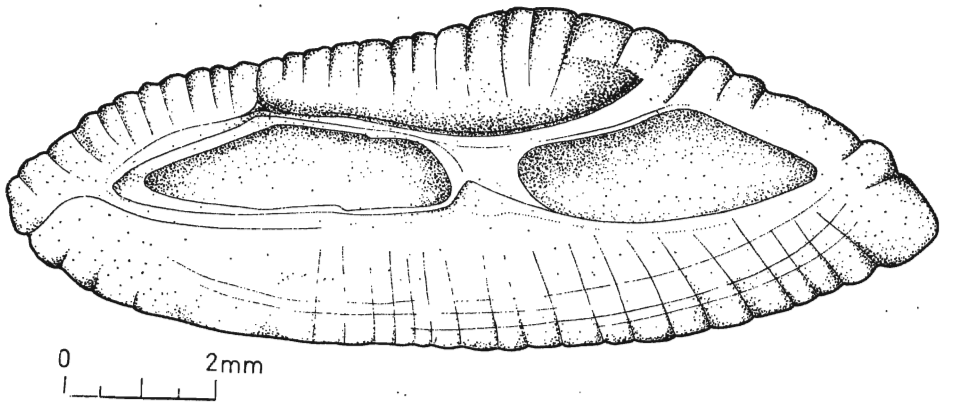

Fig. 11. *Merluccius merluccius* (Linnaeus); adult specimen, inner face of left sagitta

Remarks. — The investigated material from Korytnica comprises both juvenile and adult specimens showing all the morphological characteristics of the species.

Occurrence. — Upper Oligocene (?) to Miocene of Germany (Koken 1884, Weiler 1958, Heinrich 1969); Miocene of Italy (Bassoli 1906), Austria (Schubert 1906), and Poland (Śmigielska 1973); Miocene to Pleistocene of Belgium (Gaemers 1971, Nolf 1977); Pleistocene of the Netherlands (Gaemers & Schwarzhans 1973).

Family **Gadidae** Rafinesque, 1810
Genus *UROPHYCIS* Gill, 1863
Urophycis tenuis (Koken, 1891)
(Pl. 3, Figs 3—5)

1891. *Ot. (Gadus) tenuis* Koken; E. Koken, p. 92, Pl. IV, Figs 3 and 3*a*.
1966. *Phycis tenuis* (Koken); T. Śmigielska, p. 238, Pl. XIV, Figs 4—6 [*cum syn*].
1973. *Urophycis tenuis* (Koken, 1891); S. Jonet, p. 154, Text-fig. 11, Item 27 and Pl. II, Fig. 33.

Material: 85 specimens, most of them well preserved.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in Pl. 3:
Ot.M.191	9.6	4.0	2.6	—
Ot.M.192	9.4	3.7	2.7	—
Ot.M.193	8.3	2.9	1.9	Fig. 5
Ot.M.194	*c.* 7.6	3.3	2.2	Fig. 3
Ot.M.195	6.0	2.2	1.7	—
Ot.M.196	5.8	2.1	1.5	Fig. 4
Ot.M.197	4.2	1.5	1.0	—

Remarks. — As noted already by Chaine & Duvergier (1928), Weiler (1950), and the present author (Śmigielska 1966), two morphotypes can be distinguished within the species under consideration, different mostly in conspicuousness of their ornamentation.

Occurrence. — Miocene of southern France (Koken 1891), Austria (Schubert 1906), Rumania (Weiler 1950), Poland (Śmigielska 1966), and Portugal (Jonet 1973); Miocene to Pliocene of Italy (Bassoli 1906).

Family **Macruridae** Bonaparte, 1838
Genus *COELORHYNCHUS* Giorna, 1805
Coelorhynchus coelorhynchus (Risso, 1810)
(Text-fig. 12 and Pl. 3, Fig. 6)

1905. *Otolithus (Macrurus) Toulai* n. m.; R. J. Schubert, p. 620, Pl. XVI, Text-figs 34—37.
1962. *Coelorhynchus toulai* (Schubert); W. Weiler, p. 282, Pl. 1, Figs 14—16.
1967*b*. *Coelorhynchus toulai* (Schubert); R. Brzobohatý, p. 239, Fig. 2*D*.
1970. *Glyptorhynchus toulai* (Schubert); E. Robba, p. 123, Pl. 11, Fig. 6.
1977. *Coelorhynchus coelorhynchus* (Risso, A., 1810); D. Nolf, p. 37, Pl. XI, Figs 1—8.

Material: a single specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.198	7.3	5.0	1.3

Description. — Right sagitta widening anteriorily, with indistinct rostral part, elongate posteriorily. Antero-dorsal corner is well developed, while antero-ventral one is rounded in outline. Dorsal rim and a portion of anterior rim are denticulated. Ventral rim is a little arcuate.

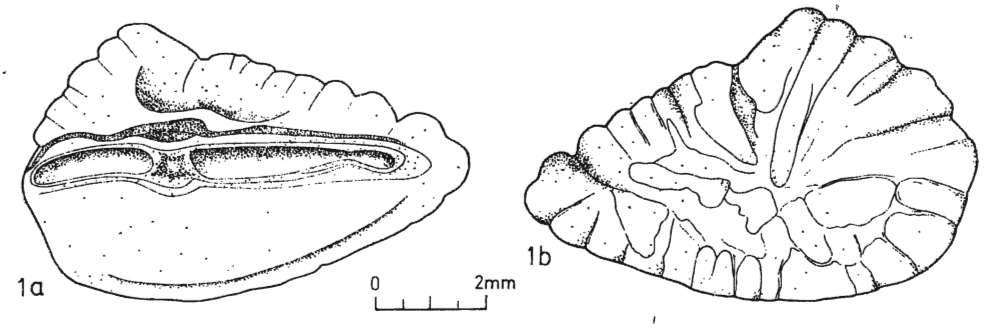

Fig. 12. *Coelorhynchus coelorhynchus* (Risso); right sagitta; *a* inner face, *b* outer face

Outer face shows considerable radial ribbing and a distinct umbo. Inner face is a little convex. Bipartite sulcus almost reaches both the anterior and posterior rims. Ostium is shorter and a little deeper than cauda; the latter shows straight dorsal margin and slightly incised ventral one (*1a* in Text-fig. 12). Collum and crista inferior are indistinct, whereas crista superior is quite conspicuous. Area is fairly shallow but well developed. There is also ventral furrow.

Remarks. — The investigated otolith resembles in outline and ornamentation as well as in sulcus development the specimens referred to in the synonymy. Its elongation falls within the range given by Schubert (1905) for medium-sized individuals. The specimen illustrated by Brzobohatý (1967*b*) shows a little less prominent antero-dorsal corner than found in the otolith under consideration.

Middle Oligocene specimen assigned by Brzobohatý (1967*a*, p. 135, Pl. 4, Fig. 5) to this species appears less elongate and with a much higher antero-dorsal corner.

Occurrence. — Oligocene to Miocene of Moravia (Brzobohatý 1967*b*); Miocene of Austria (Schubert 1905), Germany (Weiler 1962), Italy (Robba 1970), and Belgium (Nolf 1977).

Order **Beryciformes**
Family **Myripristidae** Nelson, 1955
Genus *MYRIPRISTIS* Cuvier, 1829
Myripristis banatica Weiler, 1950
(Text-fig. 13 and Pl. 4, Figs 1—2)

1950. *Myripristis banatica* n. sp.; W. Weiler (partim), p. 217, Pl. 1, Fig. 6 (non Fig. 5).
1961. *Weileria banatica* (Weiler); D. L. Frizzell & C. K. Lamber, p. 3.
Material: 18 poorly preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 4	Text-fig. 13
Ot.M.199	*c.* 9.7	7.6	2.4	—	—
Ot.M.201	*c.* 4.3	3.1	1.3	Fig. 1	Item 2
Ot.M.200	*c.* 4.0	2.8	1.1	Fig. 2	Item 1
Ot.M.202	2.7	1.7	0.6	—	—

Remarks. — The investigated otoliths fit well with the specimen recognized by Weiler (1950, Pl. 1, Fig. 6) for holotype of the species, whereas the present author is of the opinion that the paratype designated by Weiler (1950, Pl. 1, Fig. 5) represents actually a different species.

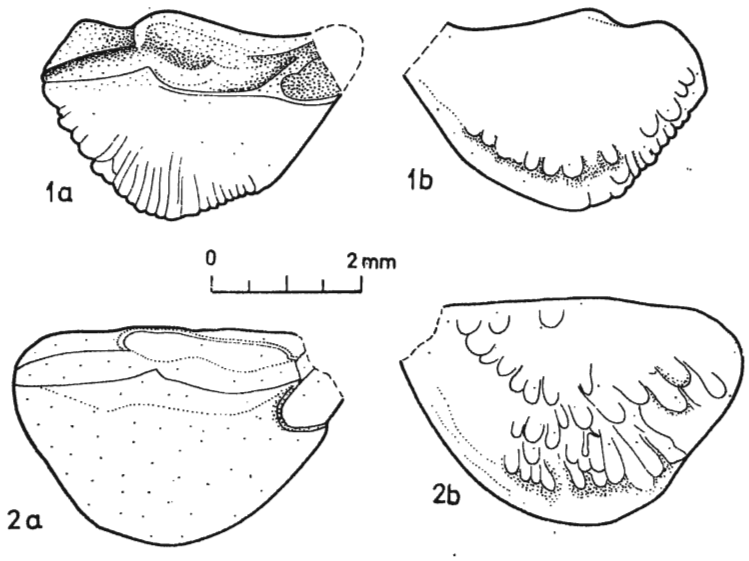

Fig. 13. *Myripristis banatica* Weiler; left sagitta
1 juvenile specimen, **2** adult specimen; *a* inner face, *b* outer face

It was noted by Stinton (1968, p. 155) that there had been no sufficient justification for erection of the genera *Weileria* and *Stintonia* by Frizzell & Lamber (1961) which should therefore be considered as junior synonyms of the genus *Myripristis* Cuvier, 1829.

Occurrence. — Miocene of Rumania (Weiler 1950).

Myripristis sp.
(Text-fig. 14 and Pl. 4, Figs 3—4)

Material: 3 damaged specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 4	Text-fig. 14
Ot.M.205	*c.* 4.9	3.7	1.2	Fig. 4	Item 3
Ot.M.204	*c.* 4.2	3.2	0.8	—	Item 2
Ot.M.203	*c.* 2.5	1.7	0.5	Fig. 3	Item 1

Description. — High sagitta with slender ventral part incised both anteriorily and posteriorily. There is no antero-ventral corner. Caudal part is markedly elongate, a little raised dorsally, and cut obliquely at its posterior end.

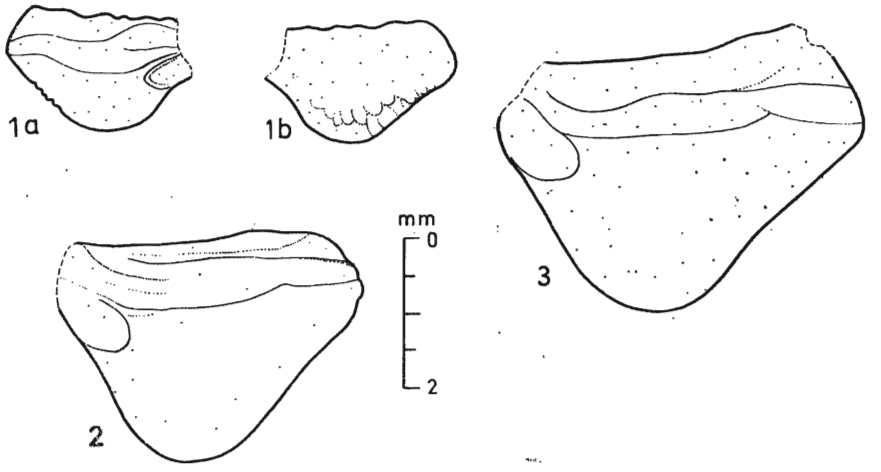

Fig. 14. *Myripristis* sp.

1 juvenile specimen, 2–3 adult specimens

Outer face is convex and shows indistinct swellings and depressions in adults, whereas fine ribbing at ventral rim and scarce tubercles at dorsal rim appear in the only juvenile specimen. There are no tubercles in umbonal part of sagitta.

Inner face is weakly convex and displays sulcus typical of the genus.

Remarks. — The investigated otoliths differ from *M. banatica* Weiler in their ventrally inclined collum and especially in slenderness of their ventral part. The latter feature makes them similar to the specimen described by Weiler (1950, Pl. 1, Fig. 5) from the Miocene of Rumania as well as to the Recent form *M. jacobus* (Cuvier) as illustrated by Nolf (1974, Pl. XX, Fig. 3).

Order **Zeiformes**
Family **Antigoniidae**
Genus *ANTIGONIA* Lowe, 1843
Antigonia alta (Weiler, 1950)
(Text-fig. 15 and Pl. 4, Fig. 6)

1950. *Otolithus (Monocentridarum) altus* n. sp.; W. Weiler (partim), p. 218, Pl. 2, Fig. 7 (non Fig. 8).
1973. *Antigonia alta* (Weiler, 1950); S. Jonet, p. 156, Text-fig. 11, Item 29 and Pl. II, Fig. 32.
1975. *Antigonia postangusta* n. sp.; P. Holec, p. 262, Pl. 1, Fig. 3.

Material: a single specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.206	1.75	2.2	0.35

Remarks. — The investigated left sagitta appears entirely consistent with the original description and illustrations given by Weiler (1950). The present author is of the opinion that there is no sufficient morphological difference between the type material and Middle Miocene specimens from Slovakia to justify erection of the species *A. postangusta* Holec for the latter material.

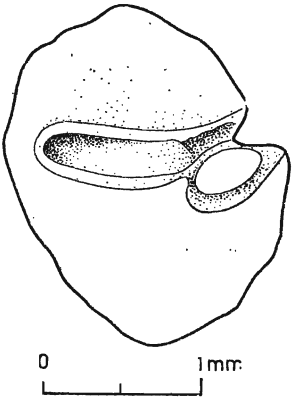

Fig. 15
Antigonia alta (Weiler); inner face of left sagitta

Occurrence. — Miocene of Rumania (Weiler 1950), Portugal (Jonet 1973), and Slovakia (Holec 1975).

Order **Atheriniformes**
Family **Atherinidae** Risso, 1836
Genus *ATHERINIDARUM*
Atherinidarum? sp.
(Text-fig. 16 and Pl. 4. Fig. 5)

Material: 2 specimens with their rostral part damaged.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.207	*c.* 3.2	3.0	0.7

Description. — Rounded right sagitta with dorsal rim crenulate antero-dorsally, inclined downwards in the mid-length, and undulate posteriorily. Ventral rim is rounded, a little crenulate posteriorily and even less so anteriorily.

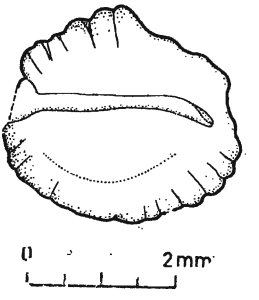

Fig. 16
Atherinidarum? sp.; inner face of right sagitta

Outer face is strongly concave and shows radial furrows. Inner face is markedly convex and bears supramedian, bipartite sulcus consisting of a very short but wide ostium and a long and narrow cauda rising posteriorily. There is smooth, elevate ventral field and distinct ventral furrow. Small marginal furrows occur in antero-ventral part, while they become very prominent at postero-ventral and antero-dorsal rims.

Remarks. — The investigated otoliths resemble closely representatives of the family Atherinidae as described by Fitch (1964, p. 18). They are probably conspecific with a specimen from the Miocene of Moravia misinterpreted by Brzobohatý (1967*b*, p. 241, Pl. 20, Fig. 3) as *Dentex* cf. *gregarius* (Koken).

Order **Perciformes**
Family **Sphyraenidae** Bonaparte, 1831
Genus *SPHYRAENA* Röse, 1793
Sphyraena hansfuchsi Schubert, 1906
(Text-fig. 17 and Pl. 4, Fig. 7)

1906. *Sphyraena Hansfuchsi* n. sp.; R. J. Schubert, p. 650, Pl. XVIII, Figs. 40—42.
1963. *Sphyraena hansfuchsi* Schubert; J. Lafond-Grellety, p. 152, Pl. II, Fig. 8.
1973. *Sphyraena hansfuchsi* Schubert, 1906; S. Jonet, p. 157, Text-fig. 11, Item 30 and Pl. II, Figs 35—36.

Material: 9 damaged specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in:
Ot.M.209	*c.* 8.4	3.0	0.4	—
Ot.M.208	6.4	2.5	0.4	Text-fig. 17 and Pl. 4, Fig. 7

Remarks. — The investigated otoliths appear consistent with those referred to in the synonymy. The apparent abruptness of their rostrum reflects actually their incompleteness.

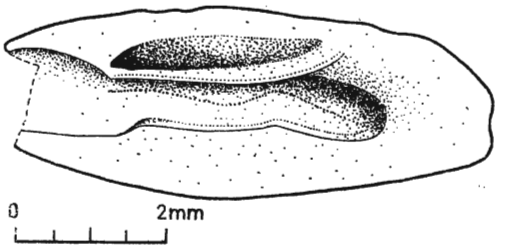

Fig. 17
Sphyraena hansfuchsi Schubert; inner face of right sagitta

Occurrence. — Miocene of Austria (Schubert 1906), France (Lafond-Grellety 1963), and Portugal (Jonet 1973).

Family **Serranidae** Richardson, 1848
Genus *SERRANUS* Cuvier, 1817
Serranus noetlingi Koken, 1891
(Text-fig. 18 and Pl. 5, Figs 1—2)

1891. *Ot. (Serranus) Noetlingi* Koken; E. Koken, p. 124, Pl. VIII, Figs 1 and 1*a*.
1923. *Otolithus (Serranus) Noetlingi* Koken; O. Posthumus, p. 109, Text-figs 5—6.
1966. *Serranus noetlingi* Koken; T. Śmigielska, p. 252, Pl. XVII, Fig. 2 [*cum syn*].
1973. *Serranus noetlingi* Koken, 1891; S. Jonet, p. 164, Text-fig. 12, Items 4—5 and Pl. II, Figs 43—45.

Material: 8 specimens, 5 of them well preserved.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 5	Figured in: Text-fig. 18
Ot.M.211	4.2	2.3	0.5	Fig. 2	Item 2
Ot.M.210	3.7	1.9	0.5	Fig. 1	Item 1
Ot.M.212	3.6	1.9	0.5	—	—

Remarks. — The investigated otoliths agree well with the original diagnosis and illustrations. There is an intraspecific variability in outline of dorsal rim, as it is undulate as a rule but serrate in a few cases (*2* in Text-fig. 18).

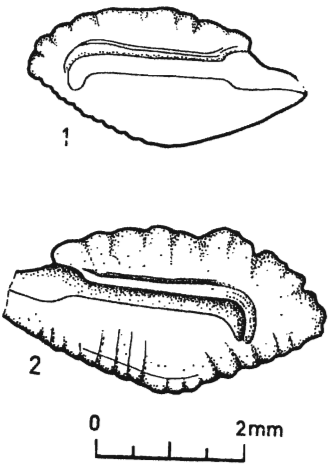

Fig. 18
Serranus noetlingi Koken
1 inner face of left sagitta, 2 inner face of right sagitta with damaged rostrum

Occurrence. — Upper Oligocene of Germany (Koken 1891, Weiler 1958); Miocene of southern France (Priem 1914), the Netherlands (Posthumus 1923), Austria (Weinfurter 1952*b*), Poland (Śmigielska 1966), and Portugal (Jonet 1973).

Family **Sillaginidae**
Genus *SILLAGO* Cuvier, 1817
Sillago hassovicus (Koken, 1891)
(Text-fig. 19 and Pl. 4, Fig. 8)

1891. *Otolithus* (incertae sedis) *hassovicus* Koken; E. Koken, p. 138, Pl. X, Fig. 15.
1952*b*. *Ot.* inc. sedis *hassovicus* Koken; E. Weinfurter, p. 487, Pl. 1, Fig. 3.
1965. *Otolithus* (inc. sed.) *hassovicus* Koken; A. Zilch, p. 474, Pl. 37, Fig. 24.

Material: 2 poorly preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 4	Figured in: Text-fig.19
Ot.M.214	4.4	2.6	0.5	—	Item 2
Ot.M.213	*c.* 4.1	2.5	0.6	Fig. 8	Item 1

Description. — Elliptical left sagitta with a little protruded ends. Dorsal rim is raised and arcuate anteriorily, slightly undulate in the mid-length. Ventral rim is smooth and rounded anteriorily, obliquely inclined posteriorily. There is no rostrum, antirostrum, or excisura.

Outer face is concave. Inner face is convex and smooth, with supramedian, horizontal, bipartite sulcus ranging from anterior rim to posterior one, and filled up with colliculi. Short ostium opens

at anterior rim; a little narrower cauda extends close to posterior rim. Dorsal margin of cauda is slightly arcuate, whereas ventral margin is straight in its anterior part but inclined postero-ventrally to form an angle and an indistinct enlargement at the posterior extremity of cauda. There is no area or ventral furrow.

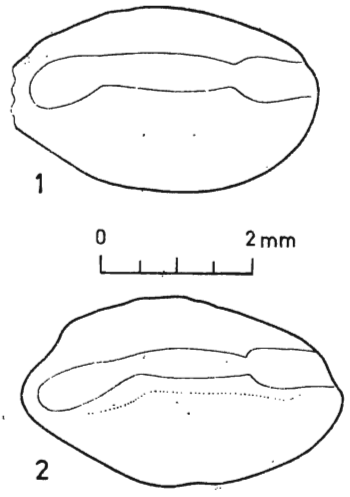

Fig. 19
Sillago hassovicus (Koken)
1–2 inner face of left sagitta

Remarks. — The investigated specimens resemble very closely those described by Koken (1891) and Weinfurter (1952*b*). A comparison with the Recent material has permitted the generic assignment of the considered otoliths, since their sulcus corresponds exactly to that shown by the species *Sillago ciliata* Cuvier or *S. maculata* Quoy & Gaimard.

The specimens under study are much more elongate than their congeners described under the name of *S. pliocaenica* Stinton (1958, p. 89, Pl. 13, Fig. 4) from the Oligocene to Pliocene of Australia.

Occurrence. — Oligocene of Germany (Koken 1891); Miocene of Austria (Weinfurter 1952*b*).

Family **Carangidae** Rafinesque, 1815
Genus *TRACHURUS* Rafinesque, 1810
Trachurus? formosus sp. n.
(Text-fig. 20 and Pl. 5, Fig. 3)

Holotype: specimen presented in Text-fig. 20 and Pl. 5, Fig. 3 (Coll. No. *Ot.M.215*).
Type locality: Korytnica basin, Poland.
Type horizon: Badenian (Middle Miocene).
Derivation of the name: Latin *formosus* — beautiful.
Diagnosis: Elongate sagitta with very long and pointed rostrum and dentiform antirostrum; dorsal and posterior rims denticulate; ventral rim crenulate posteriorily but almost smooth anteriorily; bipartite sulcus with elongate ostium and inclined ventrally cauda.

Material: a single well preserved specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.215	6.8	3.1	1.0

Description. — Elongate sagitta with both anterior and posterior end pointed, very long rostrum, dentiform antirostrum, and small excisura. Horizontal dorsal rim shows rounded denticles

variable in size at the margin. Posterior rim forms three large and distinct, subacute denticles. Gently arcuate ventral rim is minutely denticulate, especially in its posterior portion, with two small knees in the mid-length and anteriorily. There is well developed caudal incision.

Slightly concave outer face is covered with concentric growth-lines and distinct furrows starting at dorsal rim.

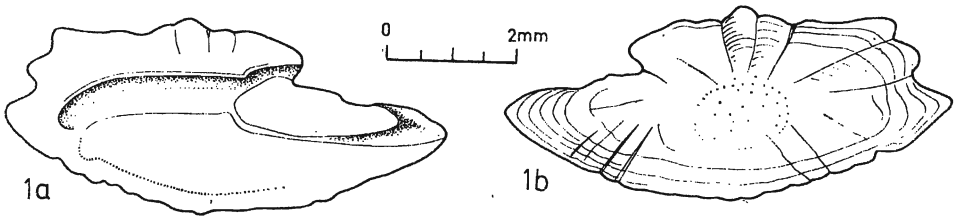

Fig. 20. *Trachurus? formosus* sp. n.; left sagitta; *a* inner face, *b* outer face

Bipartite sulcus consists of a fairly narrow, long ostium filled up with colliculus anterior, and a deep cauda with gradually inclined lower margin. Inner face bears also distinct crista superior and ventral furrow along with narrow, shallow area.

Remarks. — To the best of the present author's knowledge, any related fossil otolith has insofar not been recorded. The only form resembling somewhat the investigated one is *Trachurus symmetricus* (Ayres) from the Plio-Pleistocene of California but its cauda runs horizontally except for a slight posterior bend downwards.

Family **Sciaenidae** Cuvier, 1829
Genus *SCIAENA* Linnaeus, 1758
Sciaena pecchioli Lawley, 1876
(Text-fig. 21 and Pl. 7, Fig. 2)

1906. *Otolithus (Sciaena) Pecchioli* Lawley; R. J. Schubert, p. 637 [*cum syn*].
1950. *Sciaena pecchioli* Lawley, 1876; W. Weiler, p. 224, Pl. 3, Fig. 13.
1973. *Sciaena* sp.; S. Jonet, p. 179, Text-fig. 12, Item 18 and Pl. III, Fig. 70.

Material: 2 specimens, one of them well preserved.
Dimensions (in *mm*):

Coll. No.	L	H	T
BkK-P7/1	7.0	5.3	2.3 (max)

Description. — Oval, posteriorily widened sagitta with rounded postero-dorsal corner, a little oblique anterior rim, and vertical posterior one.

Outer face is flat to convex, with depressed central area showing a distinct, eccentrically located swelling in form of a large group of joined, variform tubercles. Three pillar-shaped tubercles appear at the dorsal rim.

Inner face is markedly convex, with typically sciaenid, bipartite sulcus consisting of a very wide ostium and much narrowed cauda; the latter runs a little upwards but very soon declines vertically downwards.

Remarks. — The investigated specimens resemble very closely in their sagittal outline, sulcus shape, and outer-face morphology otoliths described from the Miocene of Czechoslovakia by Schubert (1902, p. 308, Pl. X, Figs 20—21) under the name of *Ot. (Sciaenidarum) corii*, in particular

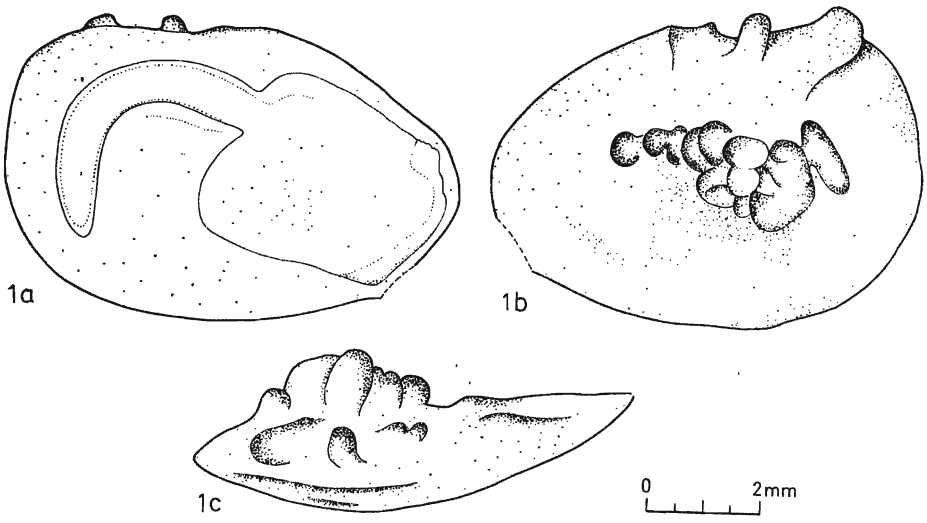

Fig. 21. *Sciaena pecchioli* Lawley; left sagitta; *a* inner face, *b* outer face, *c* lateral view

those representative of the subspecies *abrupta* (p. 308, Pl. X, Fig. 21). However, both Schubert (1906) and Weiler (1950) considered the latter species as a junior synonym of *S. pecchioli*. The present author disagrees with the opinion of Weiler (1968) that the species *pecchioli* is actually a junior synonym of *S. aquila* Lacépède.

The specimens attributed by Jonet (1973) to *Sciaena* sp. do not show any significant difference in sagittal outline or sulcus or outer-face morphology from the others referred to in the synonymy or from those collected in the Korytnica basin.

Occurrence. — Miocene of Czechoslovakia (Schubert 1902), Austria (Schubert 1906), Rumania (Weiler 1950), and Portugal (Jonet 1973).

Sciaena cf. *aquila* Lacépède
(Pl. 7, Fig. 1)

Material: a single poorly preserved specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
BkK-P7/2	12.5	7.6	4.5 (max)

Description. — Very large, elongate sagitta narrowing anteriorily. Outer face is concave, with a single thick and smooth, eccentrically located knob. Inner face is convex, with bipartite sulcus consisting of a wide ostium occupying all the anterior part of the sagitta, and a little depressed cauda, narrow and bent downwards at its end. Ostium and cauda lie very close to each other.

Remarks. — The investigated otolith appears very similar to the Recent *S. aquila* Lacépède as described and illustrated by Chaine (1938, p. 72, Pl. IX), as well as to Miocene specimens from Portugal (Jonet 1973, p. 176, Pl. III, Fig. 65), but the poor preservation state does not permit its unequivocal identification.

Family **Sparidae** Bonaparte, 1831
Genus *DENTEX* Cuvier, 1815
Dentex latior Schubert, 1906
(Pl. 6, Figs 1—2)

1906. *Otolithus (Dentex) latior* Schubert; R. J. Schubert, p. 627, Pl. XVIII, Figs 7—8.
1973. *Dentex latior* Schubert; T. Śmigielska, p. 16, Pl. II, Figs 7—8 [*cum syn*].
1973. *Dentex latior* Schubert, 1906; S. Jonet (partim), p. 195, Pl. III, Figs 82—83 (non Figs 84—85).
1973. *Spondyliosoma cantharus*? Linné, 1758; S. Jonet (partim), p. 201, Pl. IV, Figs 98—99 (non Fig. 100).

Material: 437 well preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in Pl. 6:
Ot.M.217	7.5	4.8	1.5	Fig. 1
Ot.M.218	7.3	4.8	1.5	—
Ot.M.219	6.5	4.2	1.3	—
Ot.M.220	5.4	3.8	1.0	Fig. 2
Ot.M.221	5.4	3.5	1.0	—
Ot.M.222	4.7	3.3	0.9	—
Ot.M.223	4.1	2.8	0.8	—

Remarks. — These forms predominate in the material under examination. They are entirely consistent with the otoliths referred to in the synonymy.

Nolf (1977, p. 118) pointed to the great resemblance in sagittal morphology between the Recent species *Acropoma japonica* Günther and the fossil form *D. nobilis* Koken. In fact, the investigated species may also be transferred to the genus *Acropoma*.

Occurrence. — Miocene of Austria (Schubert 1906), France (Priem 1914), Poland (Chaine & Duvergier 1928; Śmigielska 1966, 1973), Rumania (Weiler 1950), Italy (Robba 1970), and Portugal (Jonet 1973).

Dentex gregarius (Koken, 1891)
(Text-fig. 22 and Pl. 6, Figs 3—4)

1891. *Otholitus (Sparidarum) gregarius* Koken; E. Koken (partim), p. 128, Text-figs 18—19 (non Text-fig. 20).
1906. *Otholithus (Pagellus?) gregarius* Koken; R. J. Schubert (partim), p. 630, Pl. XVIII, Figs 23, 25—27, ?28, and 29 (non Fig. 24).
1950. *Pagellus gregarius* (Koken); W. Weiler, p. 223, Pl. 3, Fig. 18 and Pl. 4, Figs 20 and ?21.
1958. *Dentex gregarius* (Koken); W. Weiler (partim), p. 339, Pl. 2, Fig. 19 (non Fig. 20).
1966. *Pagellus gregarius* (Koken); T. Śmigielska, p. 255, Pl. XVII, Fig. 6.
1971. *Dentex gregarius* (Koken) 1891; P.A.M. Gaemers, p. 246, Pl. II, Fig. 8, Pl. III, Figs 3, 15 and Pl. VII, Fig. 2.
1973. *Dentex gregarius simplex* nov. subsp.; S. Jonet, p. 192, Pl. III, Figs 78, 85, and 87.
1977. *Dentex (Polysteganus) gregarius* (Koken, E., 1891); D. Nolf, p. 54, Pl. XV, Figs 18—20.

Material: 10 specimens, 3 of them (juveniles) well preserved.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 6	Figured in: Text-fig. 22
Ot.M.224	7.2	6.0	1.3	Fig. 3	Item 1
Ot.M.225	7.0	5.4	1.4	Fig. 4	Item 2
Ot.M.226	3.1	2.6	0.7	—	—

Remarks. — The investigated large-sized specimens resemble very closely those recorded by Gaemers (1971) in the Miocene of Belgium. In turn, the juvenile specimens agree well with the original illustrations of Koken (1891) as well as with the forms described by Gaemers (1971) and Jonet (1973).

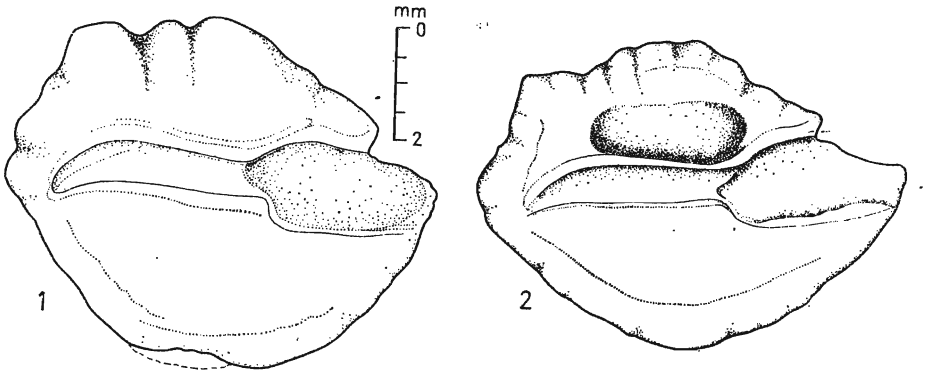

Fig. 22. *Dentex gregarius* (Koken)
1–2 inner face of left sagitta (*2* presents a specimen consistent with the holotype)

Actually, diverse forms were assigned to *D. gregarius* because the illustrations given by Koken (1891) show two largely different specimens. However, Zilch (1965, p. 473, Pl. 37, Fig. 10) recognized the specimen cited above for a lectotype.

Occurrence. — Eocene (Koken 1891) and Oligocene of Germany (Weiler 1958, 1968); Miocene of Germany (Weiler 1968), Austria (Schubert 1906), Rumania (Weiler 1950), Poland (Śmigielska 1966), Belgium (Gaemers 1971, Nolf 1977), and Portugal (Jonet 1973).

Family **Maenidae** Gill, 1885
Genus *SMARIS* Cuvier, 1815
Smaris elegans (Procházka, 1893)
(Text-fig. 23 and Pl. 5, Figs 6—7)

1893. *Otolithus (Spadidarum) elegans* nov. sp.; V. J. Procházka, p. 62, Pl. II, Fig. 10.
1906. *Otolithus (Smaris?) elegans* Proch.; R. J. Schubert, p. 632, Pl. XVIII, Figs 38—39 (non Fig. 36).
Material: 15 well preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 5	Figured in: Text-fig. 23
Ot.M.227	4.2	3.0	0.9	Fig. 7	Item 1
Ot.M.228	3.2	2.6	0.7	Fig. 6	Item 2
Ot.M.229	3.0	2.5	0.7	—	Item 3

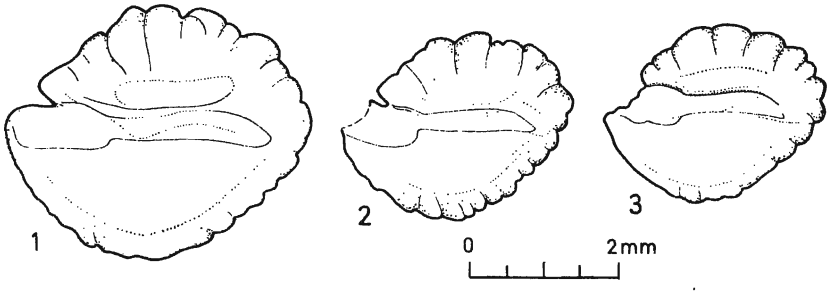

Fig. 23. *Smaris elegans* (Procházka); inner face of right sagitta
1 adult specimen, 2–3 juvenile specimens

Remarks. — The investigated specimens correspond exactly to those referred to in the synonymy.

Occurrence. — Miocene of Czechoslovakia (Procházka 1893) and Austria (Schubert 1906).

Family **Gerreidae**

Genus *PAREQUULA* Steindachner, 1879

Parequula crenata sp. n.

(Text-fig. 24 and Pl. 5, Figs 4—5)

Holotype: specimen presented in Text-fig. 24, Item 5 and Pl. 5, Fig. 4 (Coll. No. *Ot.M.235*).
Type locality: Korytnica basin, Poland.
Type horizon: Badenian (Middle Miocene).
Derivation of the name: Latin *crenatus* — crenate, after crenate rim margins.

Diagnosis: Sagitta pentagonal in outline, with distinctly crenate dorsal rim and less distinctly crenate other rims; postero-ventral part obliquely truncated; rostrum, antirostrum, and excisura present; sulcus bipartite, with oval ostium and straight cauda with parallel margins.

Material: 46 well preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 5	Text-fig. 24
Ot.M.236	5.0	4.4	1.2	—	Item 6
Ot.M.230	5.0	4.1	1.1	—	Item 1
Ot.M.234	4.7	4.0	1.0	—	Item 2
Ot.M.232	*c.* 4.5	3.9	1.0	—	Item 3
Ot.M.233	*c.* 4.5	4.0	0.9	—	Item 4
Ot.M.235	4.1	3.7	0.9	Fig. 4	Item 5
Ot.M.237	5.4	4.5	1.4	Fig. 5	Item 7
Ot.M.238	*c.* 5.0	4.5	1.0	—	Item 8
Ot.M.239	4.5	3.8	1.0	—	Item 9
Ot.M.231	*c.* 4.3	3.7	0.9	—	Item 10

Description. — Sagitta pentagonal in outline, with prominent rostrum, small antirostrum, and distinct excisura. Rims are more or less crenate. Dorsal rims shows usually three rounded denticles, almost equal in size (*1—6* in Text-fig. 24); in a few specimens, it is irregularly denticulated and with a deep incision anteriorily to postero-dorsal corner (*7—10* in Text-fig. 24). Ventral rim is considerably arcuate, obliquely truncated posteriorily.

Outer face is convex in its rostral and umbonal parts, with well developed furrows starting at excisura and notches of dorsal rim.

Inner face is convex, with bipartite sulcus consisting of a wide, oval ostium and a fairly deep, narrow cauda with parallel margins. Cauda is most commonly straight but sometimes inclines downwards at its posterior end. There is distinct crista superior accompanied by ventral furrow and area.

Remarks. — The investigated otoliths resemble in their sagittal outline, sulcus shape, and other morphological characteristics the Recent form *P. melboarnensis* (Castelanau) as judged after the material collected and identified by Dr. J. E. Fitch (*personal communication*).

To some extent, they resemble also a specimen assigned with reservations by Schubert (1906, p. 632, Pl. XVIII, Fig. 36) to *Otolithus (Smaris?) elegans* Proch.; actually, however, the latter specimen should almost certainly be excluded of the species *elegans*, as it appears different in both sagittal outline and sulcus shape from the type material.

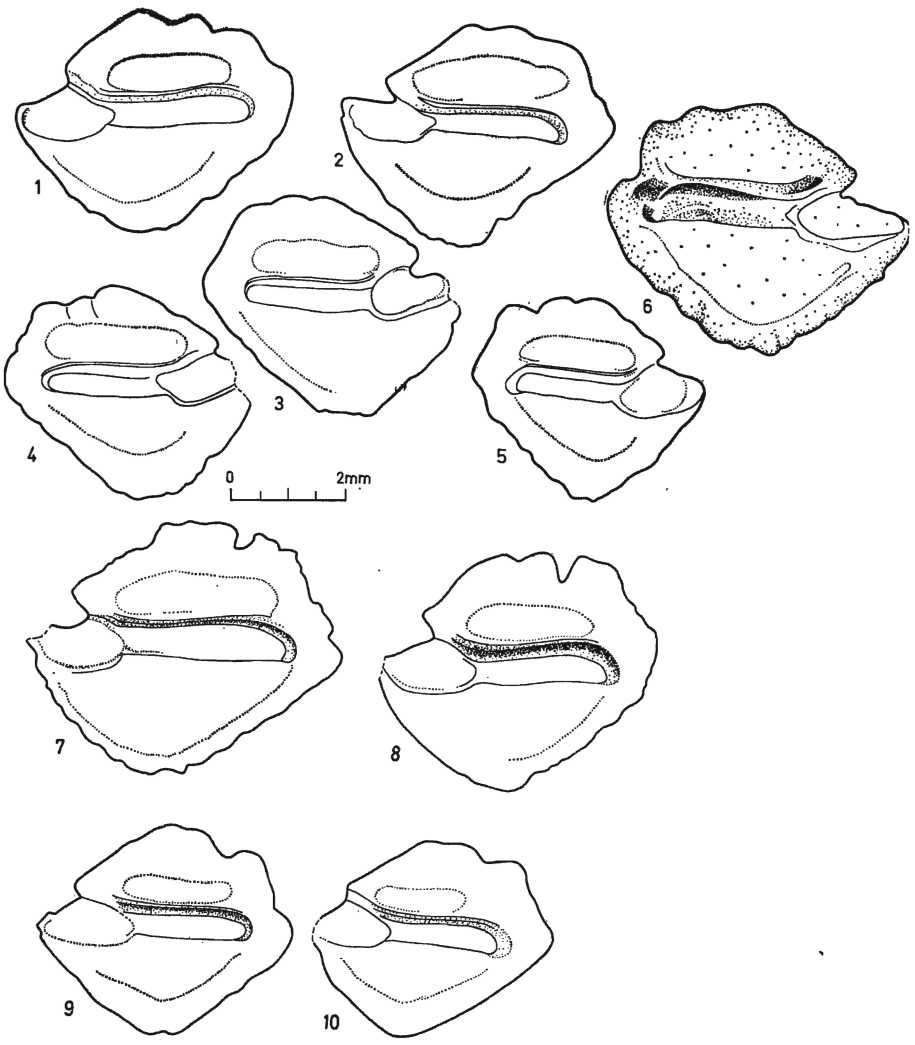

Fig. 24. *Parequula crenata* sp. n.; inner face

1—6 morphotype with three rounded denticles in dorsal rim, 7—10 morphotype with deep incision anteriorily to postero-dorsal corner (*1—2* and *7—10* right sagitta, *3—6* left sagitta; *5* presents the holotype)

Family **Cepolidae**

Genus *CEPOLA* Linnaeus, 1766

Cepola rubescens Linnaeus, 1766

(Text-fig. 25 and Pl. 6, Figs 5—7)

1906. *Otolithus (Cepola) praerubescens* Bassoli et Schubert sp. nov.; R. J. Schubert, p. 642, Pl. XIX, Figs 1—5.
1966. *Cepola praerubescens* Bassoli et Schubert; T. Śmigielska, p. 256, Pl. XVIII, Fig. 2 [*cum syn*].
1969. *Cepola praerubescens* Bassoli e Schubert; G. Anfossi & S. Mosna, p. 43, Pl. IX, Fig. 1.
1973. *Cepola praerubescens* Bassoli & Schubert, 1906; S. Jonet, p. 203, Text-fig. 12, Item 28 and Pl. IV, Figs 105—107.
1977. *Cepola rubescens* Linnaeus, C., 1764; D. Nolf, p. 56, Pl. XVI, Figs. 10—11.

Material: 142 specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 6	Text-fig. 25
Ot.M.240	5.1	3.0	1.0	—	Item 1*a*
Ot.M.241	6.1	3.8	1.1	Fig. 5	Item 1*b*
Ot.M.242	5.8	3.1	0.9	—	Item 2*a*
Ot.M.243	5.8	3.7	1.1	—	Item 2*b*
Ot.M.244	4.3	2.4	0.8	—	Item 3*a*
Ot.M.245	5.8	3.0	1.2	—	Item 3*b*
Ot.M.246	6.2	3.4	1.2	—	Item 4*b*
Ot.M.247	5.8	3.1	1.2	Fig. 6	Item 4*a*
Ot.M.248	4.2	2.4	0.7	—	Item 5*a*
Ot.M.249	5.7	3.0	1.0	Fig. 7	Item 5*b*

Intraspecific variability. — The investigated material from the Korytnica basin shows a wide intraspecific variability in sagittal outline (Text-fig. 25). The following morphotypes can be recognized: (*i*) wide, oval, posteriorily subacute sagitta with prominent, acute rostrum, small antirostrum, wide and shallow excisura and dentiform postero-dorsal corner; (*ii*) sagitta similar in outline to the former but much lower than it; (*iii*) sagitta with obliquelly truncated posterior part; (*iv*) sagitta with distinctly incised posterior rim; and (*v*) sagitta regularly oval in outline, without any secondary modification.

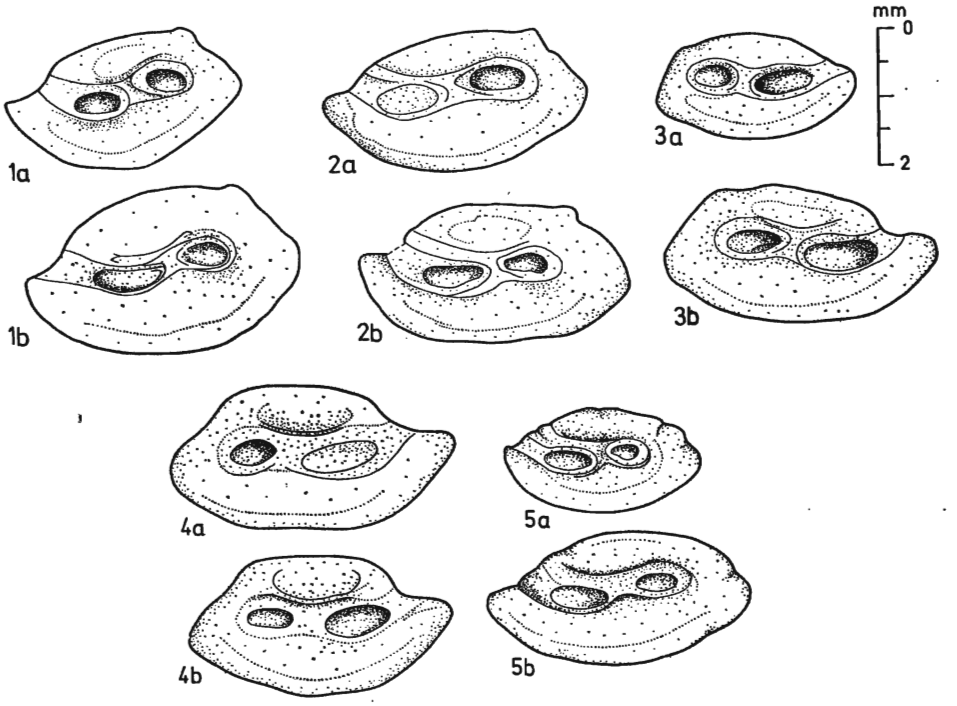

Fig. 25. *Cepola rubescens* Linnaeus; inner face

1 morphotype with dentiform postero-dorsal corner, right sagitta, 2 low morphotype with dentiform postero-dorsal corner right sagitta, 3 morphotype with obliquely truncated posterior part, left sagitta, 4 morphotype with incised posterior rim, left sagitta, 5 morphotype regularly oval in outline, right sagitta; *a* juvenile specimen, *b* adult specimen

Remarks. — The only otolith of this species reported previously from the Korytnica basin (Śmigielska 1966) is a juvenile consistent with the fifth morphotype. The fourth morphotype resembles in outline the species *C. voeslauensis* Schubert (1906, p. 643, Pl. XIX, Figs 6—7).

As pointed out by Weiler (1968, p. 66) and Nolf (1977), there is no reason to distinguish between the fossil species *C. praerubescens* and the Recent *C. rubescens*. Therefore, the former is to be considered as a junior synonym of the latter.

Occurrence. — Miocene of Austria (Schubert 1906), France (Priem 1914), Rumania (Weiler 1950), Portugal (Jonet 1973), and Belgium (Nolf 1977); Miocene to Pliocene of Italy (Bassoli 1906, Anfossi & Mosna 1969).

Family **Trachinidae** Günther, 1860
Genus *TRACHINUS* Linnaeus, 1758
Trachinus verus Koken, 1891
(Text-fig. 26 and Pl. 6, Fig. 8)

1891. *Otolithus (Trachini) verus* Koken; E. Koken, p. 113, Pl. X, Figs 13—14.
1958. *Trachinus verus* Koken; W. Weiler, p. 342, Pl. 3, Fig. 1.
1971. *Trachinus verus* Koken; P. A. M. Gaemers, p. 247, Pl. III, Fig. 7 and Pl. IX, Fig. 3.
1972. *Trachinus verus* Koken; P. A. M. Gaemers, p. 79, Pl. III, Figs 1—2.
1977. *Trachinus verus* Koken, E., 1891; D. Nolf, p. 58, Pl. XVI, Fig. 18.
Material: a single specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.250	4.2	2.0	0.6

Remarks. — The otolith under study appears consistent with the holotype, except for its posterior end less distinctly truncated than in the latter.

Occurrence. — Oligocene to Miocene of Germany (Koken 1891, Weiler 1958) and Belgium (Gaemers 1971, 1972; Nolf 1977).

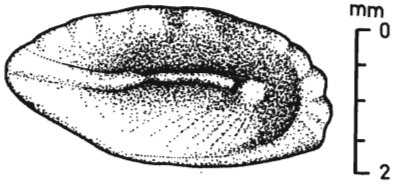

Fig. 26
Trachinus verus Koken; inner face of right sagitta

Family **Uranoscopidae**
Genus *URANOSCOPUS* Linnaeus, 1758
Uranoscopus? aff. *scaber* Linnaeus, 1758
(Text-fig. 27 and Pl. 6, Fig. 10)

Material: a single well preserved specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.251	7.4	3.7	1.2

Description. — Elliptical right sagitta with wide but short, subacute rostrum and small, dentiform antirostrum. Dorsal rim is crenate, while ventral rim undulates a little.

Outer face is concave, with ventrally located depressions and swellings, and fairly deep furrows running downwards from notches at dorsal rim.

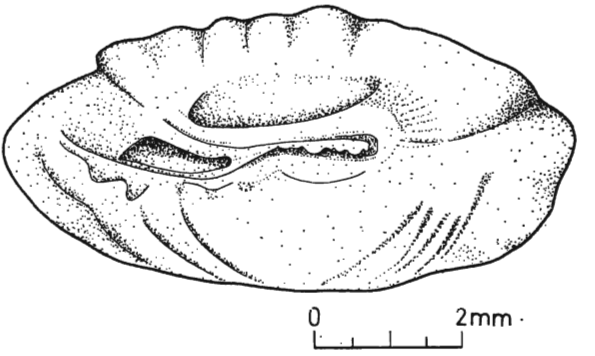

Fig. 27
Uranoscopus? aff. *scaber* Linnaeus; inner face of right sagitta

Inner face is convex, with narrow, bipartite sulcus consisting of cauda filled up with colliculus posterior, and a little longer, wider, and deeper ostium. Upper margin of sulcus is arcuate, whereas lower margin runs parallel to ventral rim but curves upwards between ostium and cauda which results in a dorsal displacement of the latter. Cauda disappears far away from posterior rim. Inner face shows also distinct crista superior, crista inferior, shallow area, and ventral field; the latter is markedly corrugated by diagonal ribs.

Remarks. — The investigated specimen resembles considerably the Recent form *U. scaber* as described and illustrated by Bauzá-Rullán (1962, pp. 10—11, Pl. III, Fig. 30). Unfortunately, no more illustrations of this species appear sufficiently good to permit unequivocal comparison with the specimen under study.

Family **Ophidiidae**
Genus *HOPLOBROTULA* Gill, 1863
Hoplobrotula acutangula (Koken, 1884)
(Text-fig. 28 and Pl. 8, Fig. 1)

1884. *Otolithus (Gadidarum) acutangulus*; E. Koken, p. 546, Pl. XI, Fig. 13 (non Fig. 11).
1891. *Otolithus (Ophidiidarum) difformis* var. *acutangula* Koken; E. Koken, p. 101, Pl. V, Fig. 9.
1906. *Otholithus (Ophidiidarum) difformis* Kok. var. *acutangula* Kok.; G. G. Bassoli, p. 45, Pl. I, Figs 31—33.
1950. *Otolithus (Ophidiidarum) joachimicus* Koken; W. Weiler, p. 248, Pl. 6, Fig. 37.
1958. *Ot. (Ophidiidarum) joachimicus* Koken; W. Weiler, p. 345, Pl. 3, Fig. 7.
1962. *Otolithus (Ophidiidarum) acutangulus* (Koken); W. Weiler, p. 286, Text-fig. 2, Items 2 and 4.
1970. *Bauzaia acutangula* (Koken); E. Robba, p. 144, Pl. 15, Fig. 7.
1977. *Hoplobrotula joachimica* (Koken, E., 1891); D. Nolf, p. 34, Pl. IX, Figs 12—13.

Material: 2 specimens, one of them well preserved, the other incomplete.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 8	Text-fig. 28
Ot.M.252	6.1	3.0	1.0	Fig. 1	Item 1
Ot.M.253	—	4.2	1.1	—	Item 2

Remarks. — The investigated well preserved specimen resembles very closely that one illustrated mistakenly by Koken (1884) in Pl. XI, Fig. 11 instead of Fig. 13 but corresponding exactly to the original description of the species *acutangulus* (cf. Koken 1884, p. 546). In turn, the incomplete specimen collected in the Korytnica basin appears entirely consistent with an Oligocene otolith from Germany assigned by Koken (1891) and Weiler (1962) to the considered species.

Robba (1970) discussed in some detail systematic position of the species *acutangulus* and attributed it to the genus *Bauzaia* Frizzell & Dante, 1965, the type species of which is *Otolithus (Gadi-*

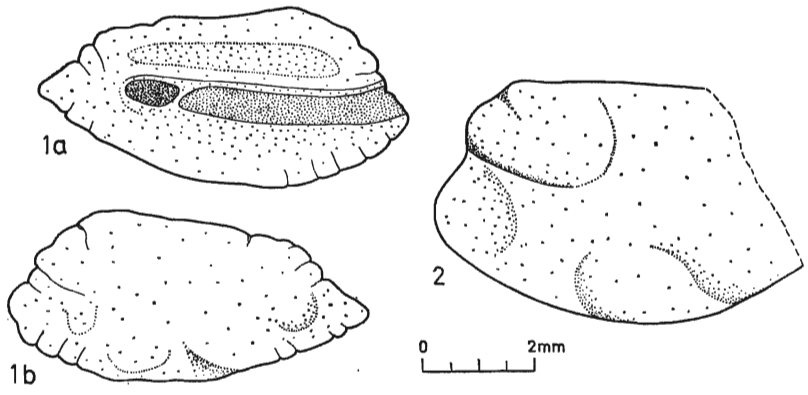

Fig. 28. *Hoplobrotula acutangula* (Koken)

1 left sagitta (*a* inner face, *b* outer face); 2 outer face of incomplete left sagitta

darum) mucronatus Koken (1888, p. 290, Pl. XVII, Figs 10—11) resembling indeed the former species in sulcus shape but with a strongly, perhaps abnormally, developed antero-dorsal corner. The present author agrees, however, with Nolf (1977) that the species under study should be assigned to the genus *Hoplobrotula* Gill, 1863, the type species of which, *Brotula armata* Teminck & Schlegel, shows actually extremely similar sagittal outline and sulcus shape (*cf.* Schwarzhans 1972, pp. 109 and 113, Text-fig. 13; Nolf 1974, p. 68, Pl. XII).

Occurrence. — Lower Oligocene to Miocene of Germany (Koken 1884, 1891; Weiler 1962); Oligocene of Belgium (Nolf 1977); Miocene of Italy (Bassoli 1906, Robba 1970) and Rumania (Weiler 1950).

Hoplobrotula? ornatissima (Robba, 1970)
(Text-fig. 29 and Pl. 8, Fig. 2)

1970. *Bauzala ornatissima* sp. n.; E. Robba, p. 148, Pl. 16, Figs 3—5.

Material: 2 poorly preserved specimens.

Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 8	Figured in: Text-fig. 29
Ot.M.254	*c.* 6.5	4.5	1.9	Fig. 2	Item 1
Ot.M.255	5.5	3.6	2.0	—	Item 2

Remarks. — The investigated specimens are entirely consistent with the type material as described and illustrated by Robba (1970).

Occurrence. — Miocene of Italy (Robba 1970).

Family **Carapidae** Gill, 1864
Genus *CARAPUS* Rafinesque, 1810
Carapus nuntius (Koken, 1891)
(Text-fig. 30 and Pl. 6, Fig. 9)

1891. *Otolithus (Fierasfer) nuntius* Koken; E. Koken, p. 99, Pl. VI, Figs 2 and 2*a*.

1971. *Carapus nuntius* (Koken); W. Weiler, pp. 24—25.

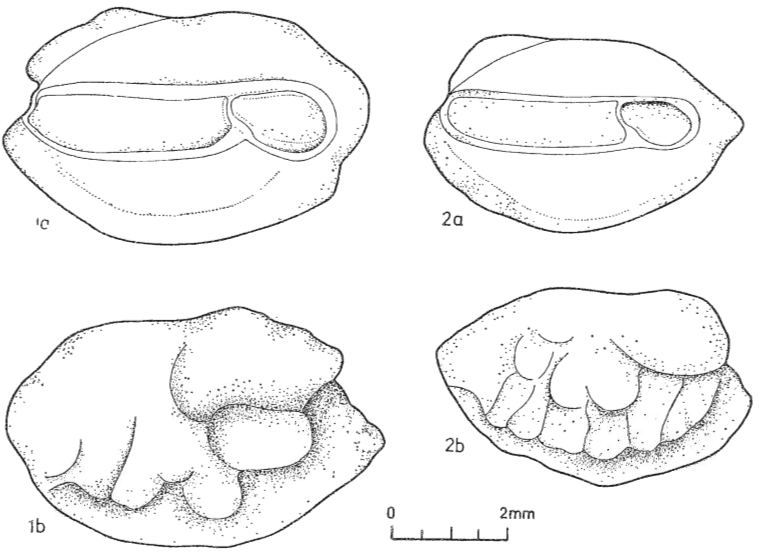

Fig. 29. *Hoplobrotula*? *ornatissima* (Robba)

1–2 right sagitta (*a* inner face, *b* outer face)

1973. *Fierasfer nuntius* Koken, 1891; S. Jonet, p. 207, Text-fig. 12, Item 42 and Pl. IV, Fig. 109.
1973. *Carapus nuntius* (Koken); T. Śmigielska, p. 21, Pl. III, Fig. 7 [*cum syn*].

Material: 9 specimens, most of them well preserved.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 6	Text-fig. 30
Ot.M.256	4.5	2.6	1.05	—	Item 1
Ot.M.257	4.2	2.3	1.0	Fig. 9	Item 2
Ot.M.258	3.4	2.0	0.8	—	Item 3
Ot.M.259	2.8	1.65	0.5	—	Item 4

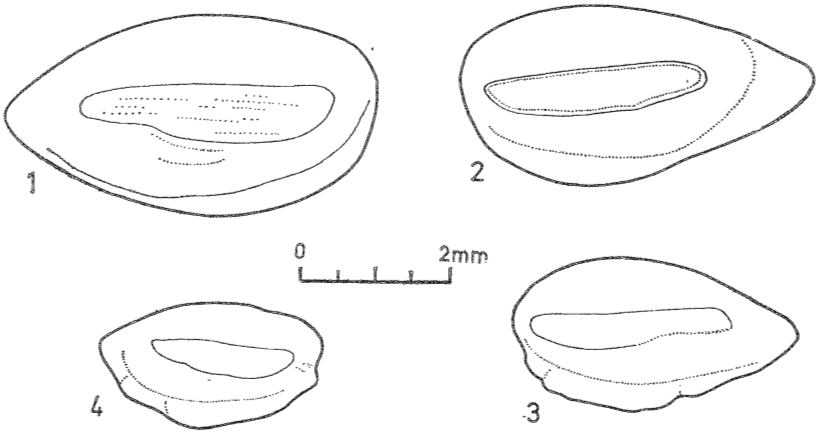

Fig. 30. *Carapus nuntius* (Koken); inner face

1–3 adult specimens, **4** juvenile specimen (*1* and *4* left sagitta, *2—3* right sagitta)

Remarks. — The investigated specimens resemble more closely in outline the holotype than does the sagitta described previously by the present author (Śmigielska 1973) from the Middle Miocene of Niskowa, southern Poland. In fact, they are more elongate posteriorily than the latter specimen. With respect to the other morphological characteristics, they are entirely consistent with the type material.

Occurrence. — Oligocene of Germany (Koken 1891, Weiler 1958); Upper Oligocene to Miocene of the Netherlands (Posthumus 1923); Miocene of Austria (Schubert 1906; Weinfurter 1952*a*, *b*). Poland (Śmigielska 1973), and Portugal (Jonet 1973).

Family **Triglidae** Risso, 1826
Genus *TRIGLA* Linnaeus, 1758
Trigla asperoides Schubert, 1906
(Text-fig. 31 and Pl. 8, Fig. 5)

1906. *Otolithus (Trigla) asperoides* sp. nov.; R. J. Schubert, p. 641, Pl. XX, Figs 3—5.
1971. *Trigla asperoides* Schubert; P. A. M. Gaemers, p. 248, Pl. III, Fig. 11 and Pl. VIII, Fig. 4.
?1973. *Trigla asperoides* Schubert, 1906; P. Holec, p. 411, Pl. VI, Figs 9—10.
1974. *Trigla asperoides* Schubert, 1906; W. Schwarzhans, p. 117, Text-fig. 53.

Material: 2 specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in:
Ot.M.260	3.9	2.8	1.0	Text-fig. 31 and Pl. 8, Fig. 5
Ot.M.261	2.0	1.6	0.5	—

Description. — Right sagitta almost triangular in outline, with rounded dorsal rim and arcuate ventral one, provided with small, obtuse rostrum and indistinct antirostrum.

Outer face is concave dorsally but shows a swelling and irregular, tuberculate ornamentation in its ventral part. Sparse, radial furrows run downwards from indistinct notches at dorsal rim.

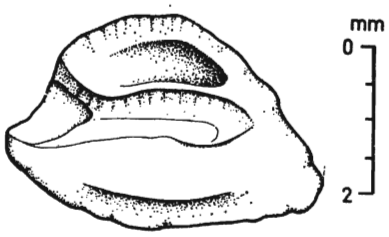

Fig. 31
Trigla asperoides Schubert; inner face of right sagitta

Inner face is strongly convex, especially in its ventral field. Very deep, bipartite sulcus consists of a wide ostium and a little narrower cauda displaced dorsally and with fine, radial grooves at its dorsal slope. Inner face shows also very thick crista superior, remarkable crista inferior, large and deep area, and distinct ventral furrow.

Remarks. — The investigated specimens resemble those referred to in the synonymy.

Occurrence. — Upper Oligocene of northern Germany (Schwarzhans 1974); Miocene of Austria (Schubert 1906), Belgium (Gaemers 1971), and Slovakia (Holec 1973).

Trigla rhombica Schubert, 1906
(Text-fig. 32 and Pl. 8, Fig. 4)

1906. *Otolithus (Trigla) rhombicus* Schubert; R. J. Schubert, p. 641, Pl. XX, Figs 6—7.
1969. *Trigla rhombica* Schubert; W. D. Heinrich, p. 43, Pl. X, Fig. 4.
1971. *Trigla rhombica* Schubert, 1906; P. A. M. Gaemers, p. 248, Pl. III, Fig. 11 and Pl. VIII, Fig. 4.
1973. *Trigla rhombica* Schubert; T. Śmigielska, p. 27, Pl. V, Figs 5—6, ?7 and 8.

Material: 13 well preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 8	Text-fig. 32
Ot.M.268	4.3	3.1	0.6	—	Item 7
Ot.M.266	4.0	3.3	0.6	—	Item 5
Ot.M.267	4.0	3.0	0.6	—	Item 6
Ot.M.262	3.4	3.1	0.6	Fig. 4	Item 1
Ot.M.263	3.4	3.0	0.6	—	Item 2
Ot.M.265	3.2	2.8	0.5	—	Item 3
Ot.M.264	3.2	3.0	0.6	—	Item 4

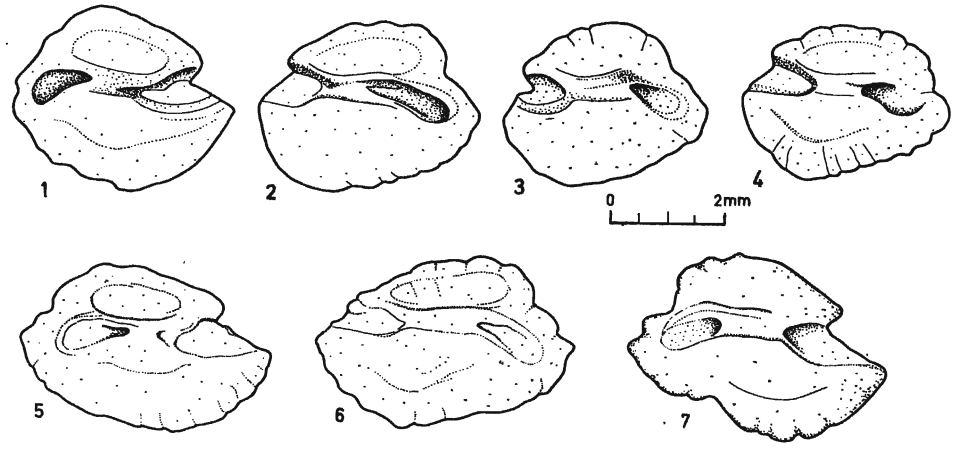

Fig. 32. *Trigla rhombica* Schubert; inner face

1—4 morphotype consistent with holotype, 5—7 elongate morphotype (*1*, *5* and *7* left sagitta; *2—4* and *6* right sagitta

Remarks. — Most investigated specimens (*1—4* in Text-fig. 32) appear consistent with those referred to in the synonymy. However, there are also some more elongate sagittas (*5—7* in Text-fig. 32), one of which shows a distinct incision in both its posterior and postero-ventral rim (*7* in Text-fig. 32). This morphological variability is here interpreted as an intraspecific one.

Occurrence. — Miocene of Austria (Schubert 1906), Germany (Heinrich 1969), Belgium (Gaemers 1971), and Poland (Śmigielska 1973).

Trigla? schuberti Posthumus, 1923
(Text-fig. 33 and Pl. 8, Fig. 3)

1923. *Otolithus (Trigla) Schuberti* n. sp.; O. Posthumus, p. 115, Text-figs 18—19.
1958. *Trigla schuberti* Posthumus; W. Weiler, p. 348, Pl. 3, Figs 11—13.

1977. *"genus ?Triglidarum" schuberti* (Posthumus, O., 1923); D. Nolf, p. 45, Pl. XIII, Fig. 11.

Material: 8 well preserved specimens.
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in: Pl. 8	Text-fig. 33
Ot.M.269	*c.* 3.0	2.8	0.6	—	Item 1
Ot.M.270	2.4	2.1	0.5	Fig. 3	Item 2
Ot.M.271	2.2	2,0	0.5	—	Item 3
Ot.M.272	2.0	1.9	0.5	—	Item 4

Remarks. — The investigated otoliths resemble closely those referred to in the synonymy. They show also some affinity with *T. arambourgi?* Weiler, 1928, as described and illustrated by Schwarzhans & Weiler (1971, pp. 531—532, Text-figs 1—2) but the latter form lacks any rostrum, antirostrum, or excisura.

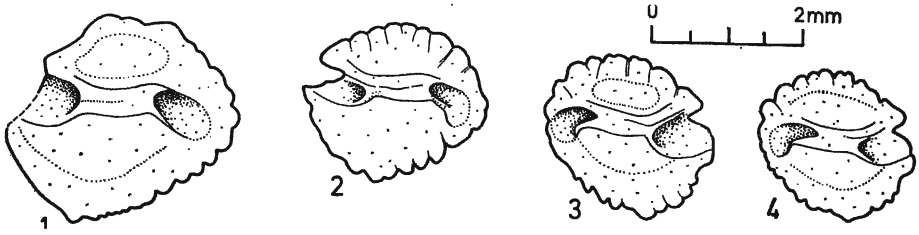

Fig. 33. *Trigla? schuberti* Posthumus; inner face
1—2 right sagitta, 3—4 left sagitta

Proper systematic position of the species *schuberti* remains thus far uncertain (*cf.* Nolf 1977, p. 44).

Occurrence. — Upper Oligocene to Miocene of the Netherlands (Posthumus 1923); Miocene of northern Germany (Weiler 1958) and Belgium (Nolf 1977).

Order **Pleuronectiformes**
Family **Citharidae**
Genus *CITHARUS* Röse, 1793
Citharus lusitanicus (Jonet, 1973)
(Text-figs 34—35 and Pl. 8, Figs 6—8)

1973. *Eucitharus lusitanicus* nov. sp.; S. Jonet, pp. 225—228, Text-fig. 12, Items 33—34 and Pl. IV, Figs 131—133.

Material: 22 well preserved specimens.
Dimensions (in *mm*):

	Coll. No.	L	H	T	Figured in: Pl. 8	Text-fig. 35
left sagitta:	Ot.M.273	5.2	2.9	0.7	Fig. 6	Item 1
	Ot.M.274	4.7	2.6	0.8	—	Item 2
	Ot.M.275	4.4	2.5	0.7	—	Item 3
	Ot.M.276	4.0	2.6	0.5	—	Item 4
	Ot.M.277	3.4	2.2	0.5	—	Item 5
	Ot.M.278	3.1	2.1	0.4	—	Item 6

	Coll. No.	L	H	T	Figured in: Pl. 8	Figured in: Text-fig. 34
right sagitta:	Ot.M.280	4.1	2.3	0.9	—	Item 1
	Ot.M.284	3.5	2.2	0.6	Fig. 8	Item 6
	Ot.M. 285	3.2	2.3	0.6	—	Item 7
	Ot.M.279	4.3	2.6	0.6	Fig. 7	Item 8
	Ot.M.281	*c.* 3.7	2.5	0.6	—	Item 5
	Ot.M.282	3.6	2.2	0.4	—	Item 4
	Ot.M.283	3.5	2.5	0.5	—	Item 2
	Ot.M.286	3.3	2.2	0.5	—	Item 3
	Ot.M.287	2.8	1.8	0.4	—	Item 9

Description and intraspecific variability. — Otoliths highly variable in sagittal outline, with more or less prominent, usually pointed rostrum, small antirostrum, and excisura; the latter may be fairly incised (*1* in Text-fig. 35; Pl. 8, Fig. 6). Well pronounced, rounded antero-dorsal corner occurs in most specimens (*1—2*, *4—7*, and *9* in Text-fig. 34), accompanied by postero-dorsal corner, most commonly lower than antero-dorsal one. The uppermost point of dorsal rim may be reached in the mid-length (*1* and *3* in Text-fig. 35; Pl. 8. Fig. 6) or a little posteriorily (*8* in Text-fig. 34; Pl. 8, Fig. 8). Posterior rim is bluntly pointed as a rule, but protrudes more or less considerably in some specimens (*1*, *2*, *6*, and *8* in Text-fig. 34; Pl. 8, Fig. 7). Ventral rim shows most commonly obtuse antero- and postero-ventral corners.

Outer face is a little convex, with irregular surface.

Inner face is also slightly convex, with bipartite sulcus consisting of ostium and a little longer and narrower cauda somewhat inclined posteriorily. Both crista superior and crista inferior are very distinct; the latter appears a little widened in its median portion.

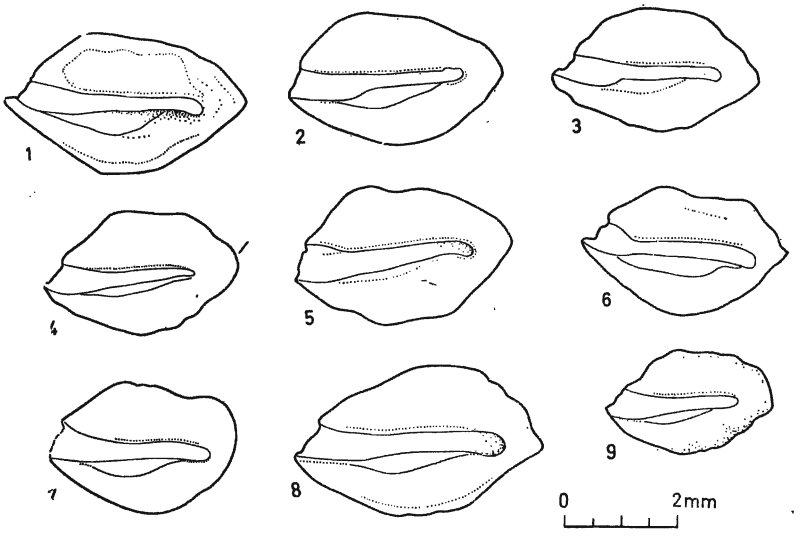

Fig. 34. *Cithatus lusitanicus* (Jonet); inner face of right sagitta

A single juvenile left sagitta shows very fine striae in its ventral field (*6* in Text-fig. 35).

Remarks. — The investigated specimens appear entirely consistent with the type material. As pointed out by Jordan (1963, p. 52) and Nolf (1977, p. 60), the generic name *Eucitharus* Gill, 1888, is actually a junior synonym of *Citharus* Röse, 1793.

Occurrence. — Miocene of Portugal (Jonet 1973).

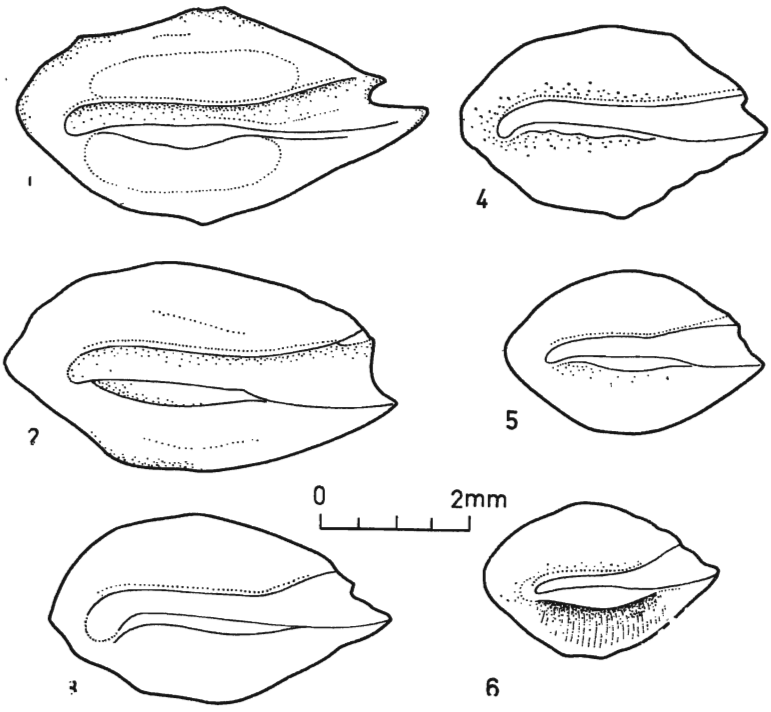

Fig. 35. *Citharus lusitanicus* (Jonet); inner face of left sagitta

Order **Batrachoidiformes**
Family **Batrachoididae** Swainson, 1839
Genus *THALASSOPHRYNE* Günther, 1861
Thalassophryne korytnicensis sp. n.
(Text-fig. 36 and Pl. 8, Fig. 10)

Holotype: specimen presented in Text-fig. 36 and Pl. 8, Fig. 10 (Coll. No. *Ot.M.289*).
Type locality: Korytnica basin, Poland.
Type horizon: Badenian (Middle Miocene).
Derivation of the name: after the type locality, Korytnica.
Diagnosis: Scalene triangular sagitta elongate posteriorily, without excisura; concave outer face with swelling running from umbo backwards; convex inner face with bipartite sulcus covered with thin colliculi; distinct swelling below well developed collum; striated area and fairly deep ventral furrow, the latter with nodes and ridges.

Material: 6 well preserved specimens (the largest one a little damaged).
Dimensions (in *mm*):

Coll. No.	L	H	T	Figured in:
Ot.M.288	*c.* 5.0	2.8	1.0	—
Ot.M.289	4.8	2.6	0.8	Text-fig. 36 and Pl. 8, Fig. 10
Ot.M.290	4.1	2.0	0.7	—
Ot.M.291	3.6	1.8	0.6	—
Ot.M.292	3.6	1.8	0.6	—

Description. — Scalene triangular in outline sagitta protruding anteriorily, elongate and pointed posteriorily. It is fairly thick, especially in its median part, distinctly bent in lateral view. Dorsal

rim is relatively thin, markedly raised and slightly notched, whereas ventral rim is thick, rounded, a little undulate.

Outer face is concave, with distinct swelling extending from umbo up to the posterior end, provided with irregular nodes and oblong tubercles. Indistinct concentric growth-lines and well marked radial furrows occur at the surface, the most prominent furrow being situated in place of absent excisura.

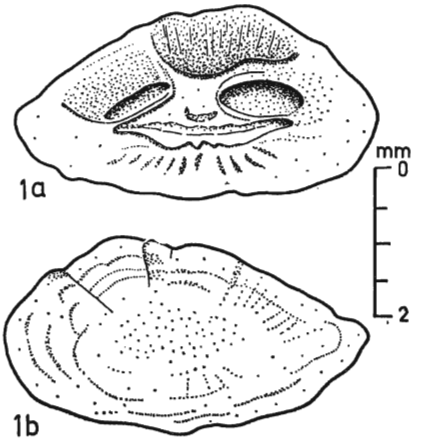

Fig. 36
Thylassophryne korytnicensis sp. n.; left sagitta; *a* inner face, *b* outer face

Inner face is convex, with bipartite, median to somewhat supramedian sulcus consisting of a wide, oval ostium and a slightly elongate cauda, almost equal in size. Both ostium and cauda are strongly depressed and filled up with thin colliculi. They are separated by an elevated collum below which a conspicuous swelling occurs along with deep ventral furrow ornamented by small nodes and ridges (*1a* in Text-fig. 38; Pl. 8. Fig. 10*a*). Inner face displays also distinct crista superior, well developed crista inferior, and fairly shallow, remarkably striated area.

Remarks. — The investigated otoliths resemble strikingly the Recent and Lower Miocene species representative of *Thalassophryne* Günther, 1861, as described by Nolf (1976, p. 721, Pl. IV, Figs 7—10). They appear also comparable to the species *Batrachus didactylus* Bloch as described and illustrated by Chaine (1937, p. 88, Pl. XI) but they differ from the latter in their scalene triangular instead of trapezoidal outline.

gen. et sp. indet.
(Text-fig. 37 and Pl. 8, Fig. 9)

Material: a single well preserved specimen.
Dimensions (in *mm*):

Coll. No.	L	H	T
Ot.M.293	4.1	2.3	0.7

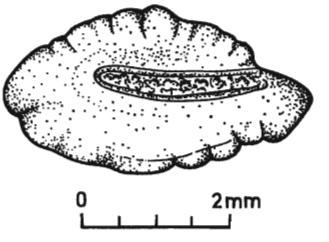

Fig. 37
gen. et sp. indet.; inner face of left sagitta

Description. — Oval left sagitta with prominent rostrum, small, dentiform antirostrum, crenulate dorsal rim, and anteriorily crenulate ventral rim.

Outer face is convex (except for a centro-dorsal concavity), with deep, radial furrows beginning at rim notches.

Inner face is convex, with continuous, very narrow, a little raised posteriorily sulcus filled entirely up with colliculus. Sulcus disappears at a distance from posterior rim.

Remarks. — As far as the morphology of sagitta and sulcus is concerned, the specimen resembles otoliths of the genus *Ammodytes* Linnaeus, 1758.

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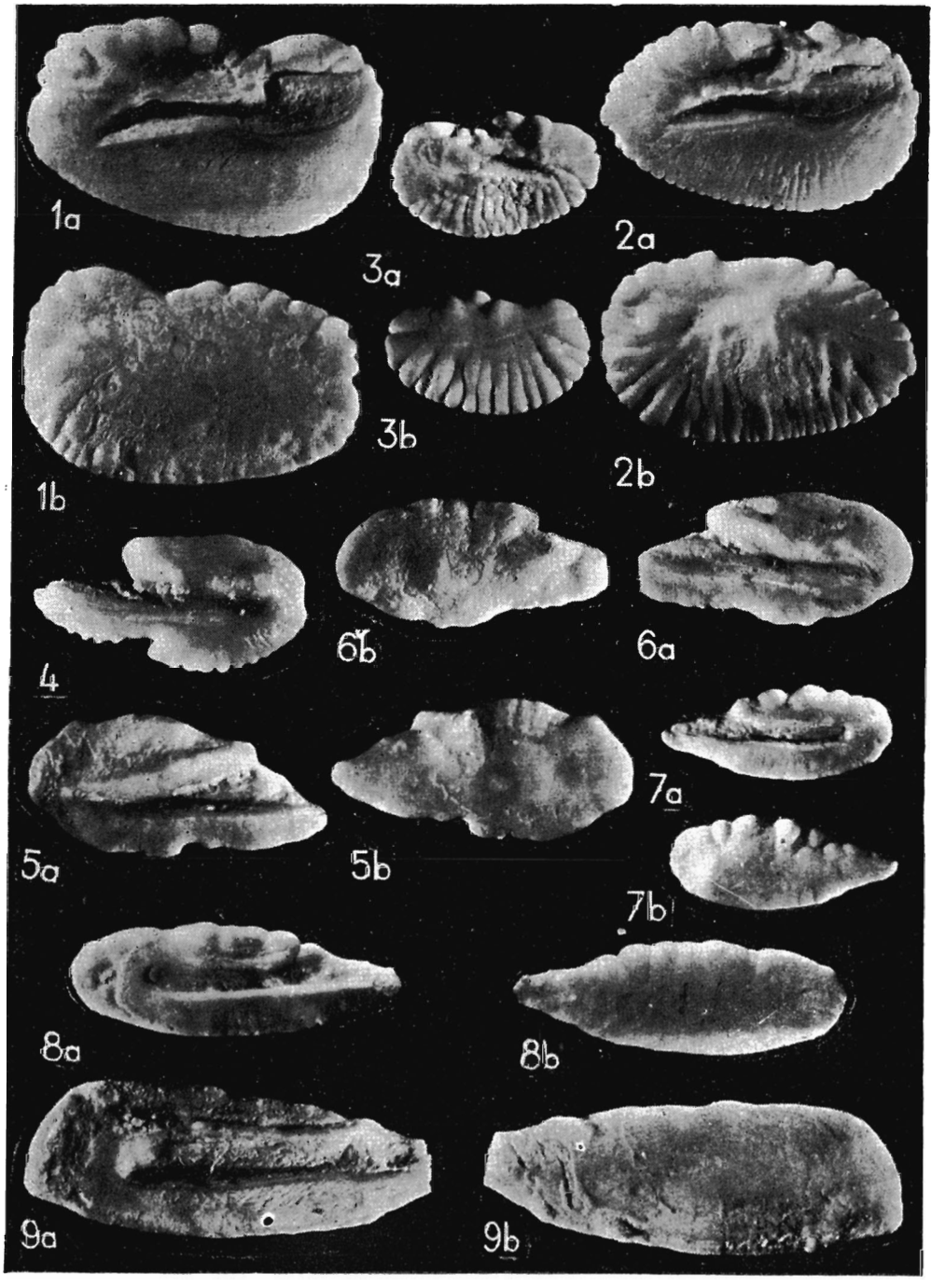
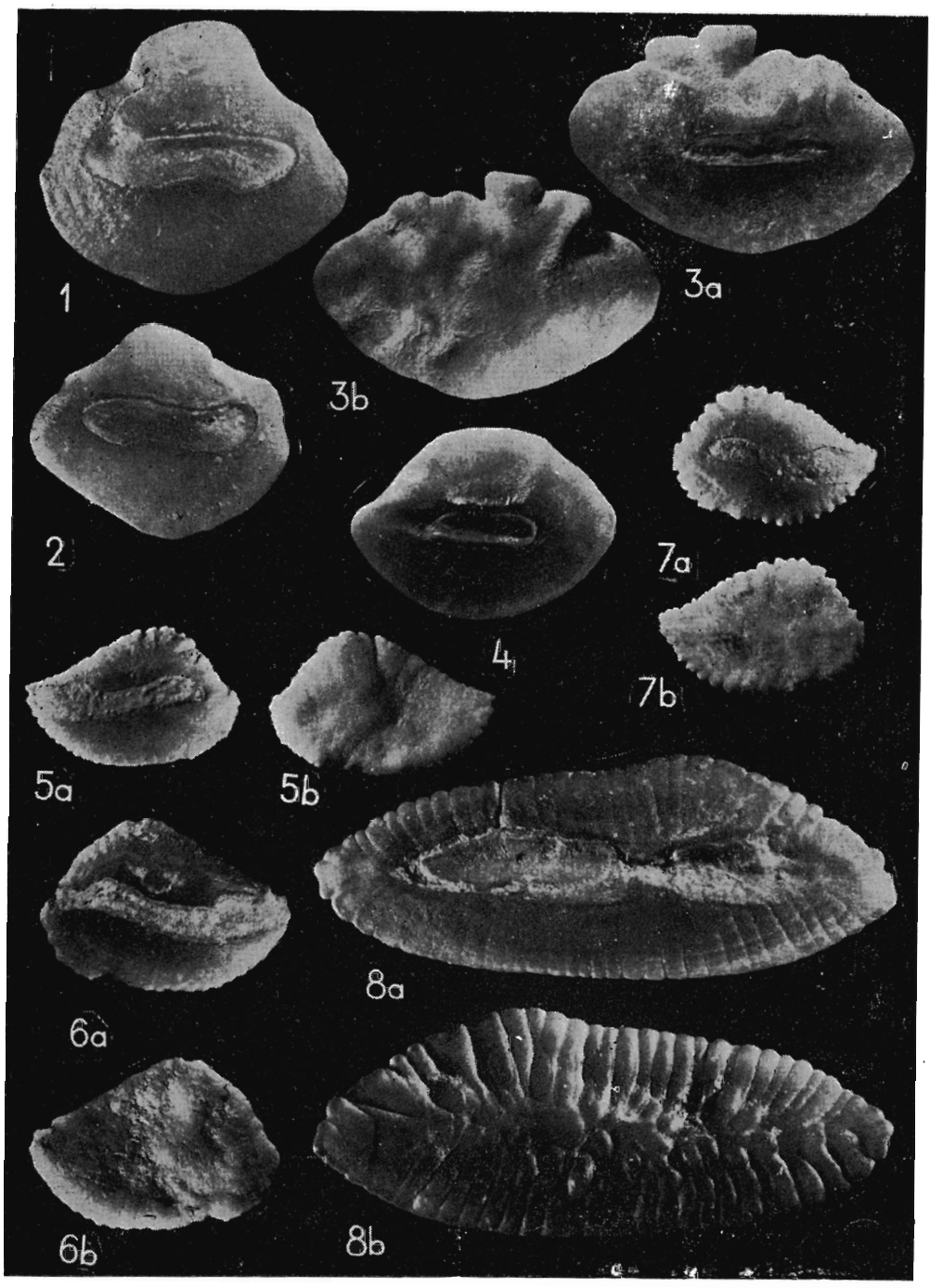
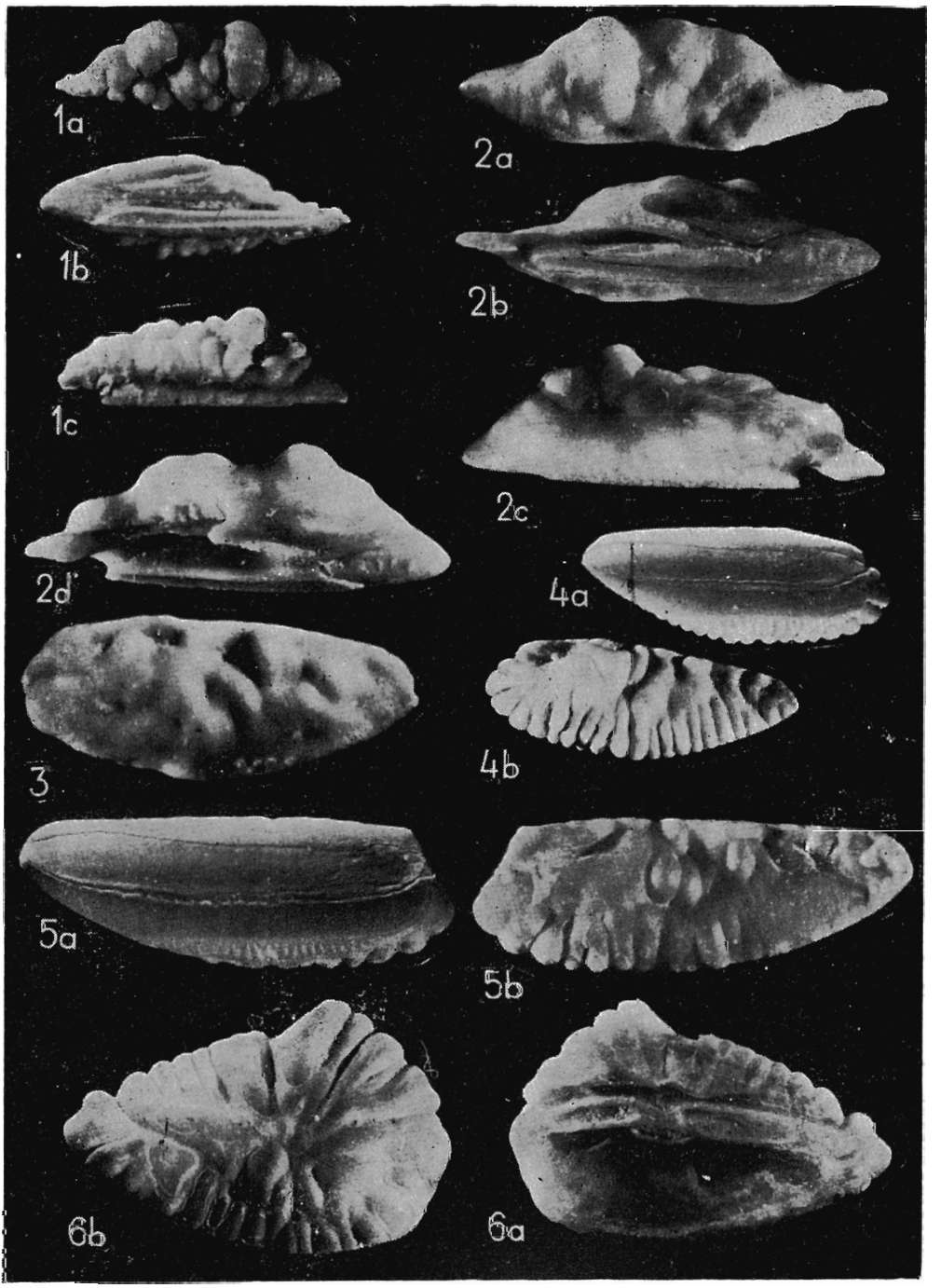


1–3 — *Pterothrissus minor* (Koken); 1 (*Ot.M.150*) and 2 (*Ot.M.151*) left sagitta of adult specimen, ×7.5; 3 (*Ot.M.155*) right sagitta of juvenile specimen, ×12.5; *a* inner face, *b* outer face
4 — *Clupea pulchra* Śmigielska; right sagitta (*Ot.M.161*); inner face, ×15
5 — *Clupea* sp.; left sagitta (*Ot.M.164*); *a* inner face, *b* outer face; ×12
6 — *Clupea weileri* Śmigielska; right sagitta (*Ot.M.163*); *a* inner face, *b* outer face; ×12
7–9 — *Saurida germanica* (Weiler); 7 (*Ot.M.165*) and 8 (*Ot.M.166*) right sagitta, ×12.5; 9 (*Ot.M.171*) left sagitta, ×10; *a* inner face, *b* outer face



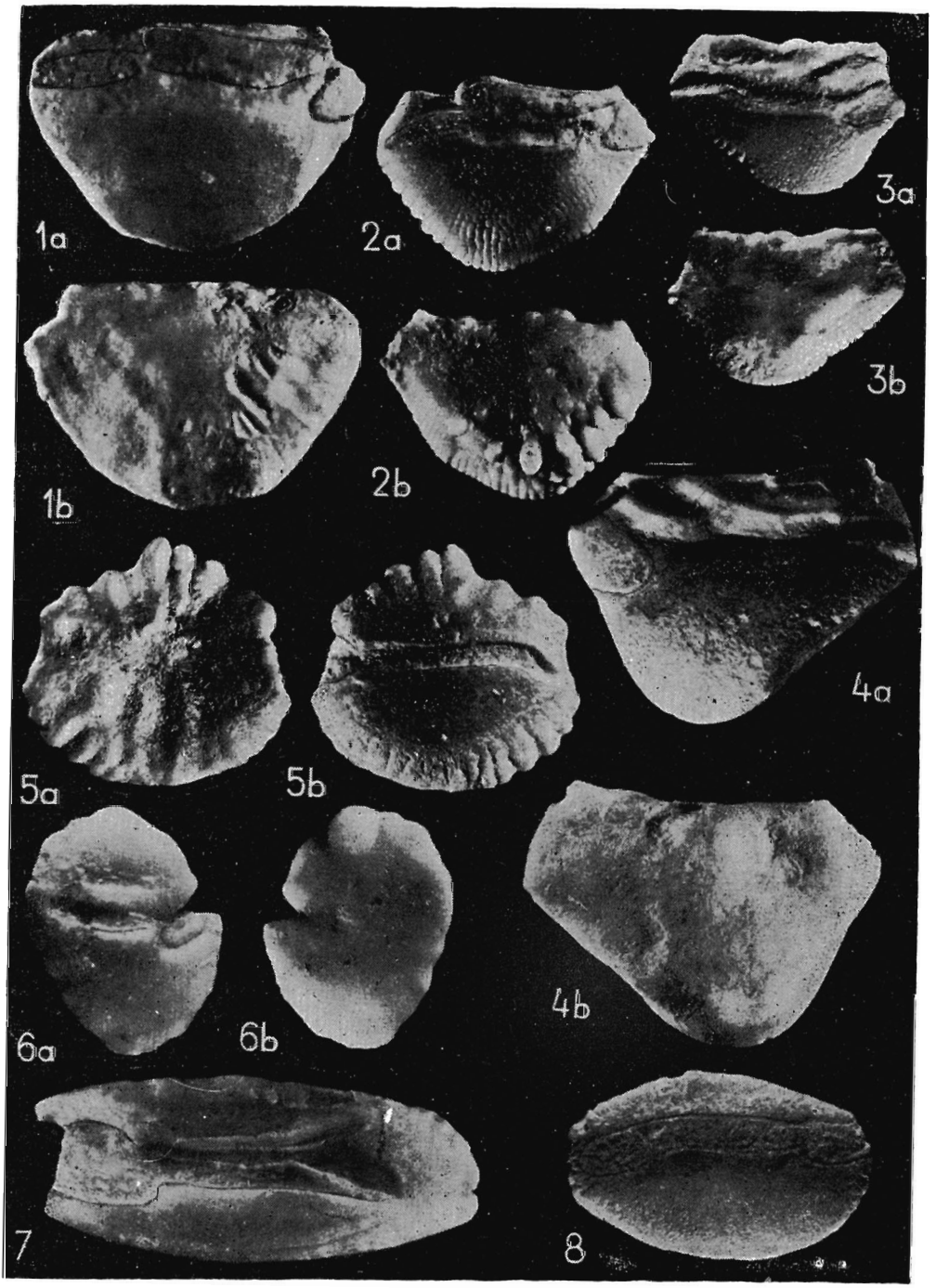
1–2 — *Congermuraena balearica* (De la Roche); 1 (*Ot.M.172*) right sagitta, 2 (*Ot.M.173*) left sagitta; inner face, ×7.5
3 — *Uroconger pulcher* (Bassoli); left sagitta (*Ot.M.175*); *a* inner face, *b* outer face; ×7.5
4 — *Congridarum? semiapertus* (Brzohohaty); right sagitta (*Ot.M.294*); inner face, ×7.5
5–7 — *Hyporhamphus baluki* sp. n.; 5 (*Ot.M.176*) holotype, right sagitta, inner face; 6 (*Ot.M.1*[illegible] and 7 (*Ot.M.180*) left sagitta (*a* inner face, *b* outer face); ×7.5
8 — *Merluccius merluccius* (Linnaeus); left sagitta (*Ot.M.186*); *a* inner face, *b* outer face; ×7.5



1—2 — *Physiculus fitchi* sp. n.; 1 (*Ot.M.184*) right sagitta of juvenile specimen; 2 (*Ot.M.182*) holotype, left sagitta of adult specimen; *a* outer face, *b* inner face, *c*—*d* lateral view; ×10

3—5 — *Urophycis tenuis* (Koken); 3 (*Ot.M.194*) left sagitta of poorly ornamented specimen; 4 (*Ot.M.193*) and 5 (*Ot.M.196*) left sagitta of well ornamented specimens; *a* inner face, *b* outer face; ×7.5

6 — *Coelorhynchus coelorhynchus* (Risso); right sagitta (*Ot.M.198*); *a* inner face, *b* outer face; ×7.5



1–2 — *Myripristis banatica* Weiler; 1 (*Ot.M.201*) and 2 (*Ot.M.200*) left sagitta; *a* inner face, *b* outer face; ×10

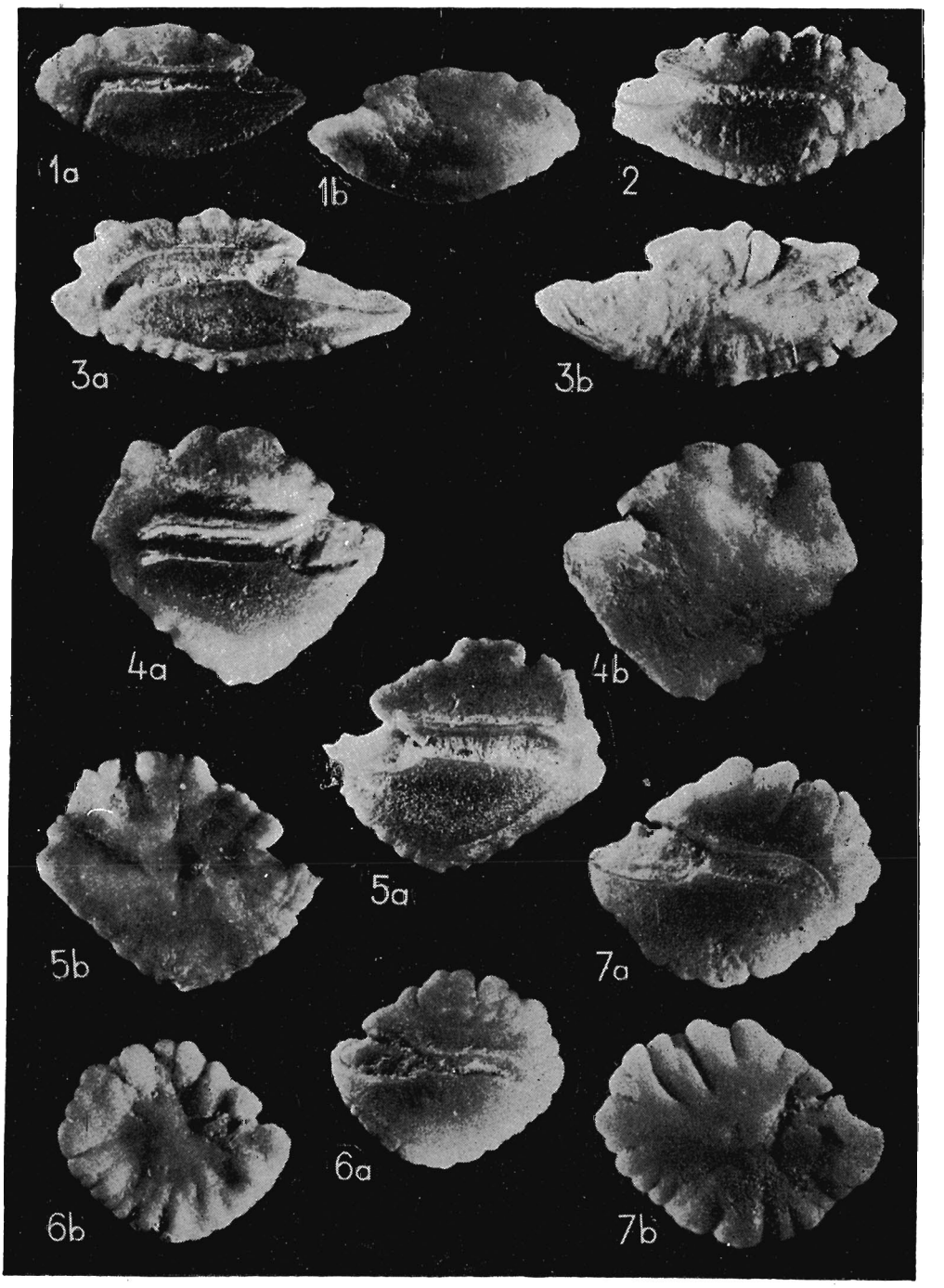
3–4 — *Myripristis* sp.; 3 (*Ot.M.203*) left sagitta of juvenile specimen, ×12.5; 4 (*Ot.M.205*) right sagitta of adult specimen, ×10; *a* inner face, *b* outer face

5 — *Atherinidarum*? sp.; right sagitta (*Ot.M.207*); inner face, ×12

6 — *Antigonia alta* (Weiler); left sagitta (*Ot.M.206*); *a* inner face, *b* outer face; ×15

7 — *Sphyraena hansfuchsi* Schubert; right sagitta (*Ot.M.208*); inner face, ×10

8 — *Sillago hassovicus* (Koken); left sagitta (*Ot.M.213*); inner face, ×10.5

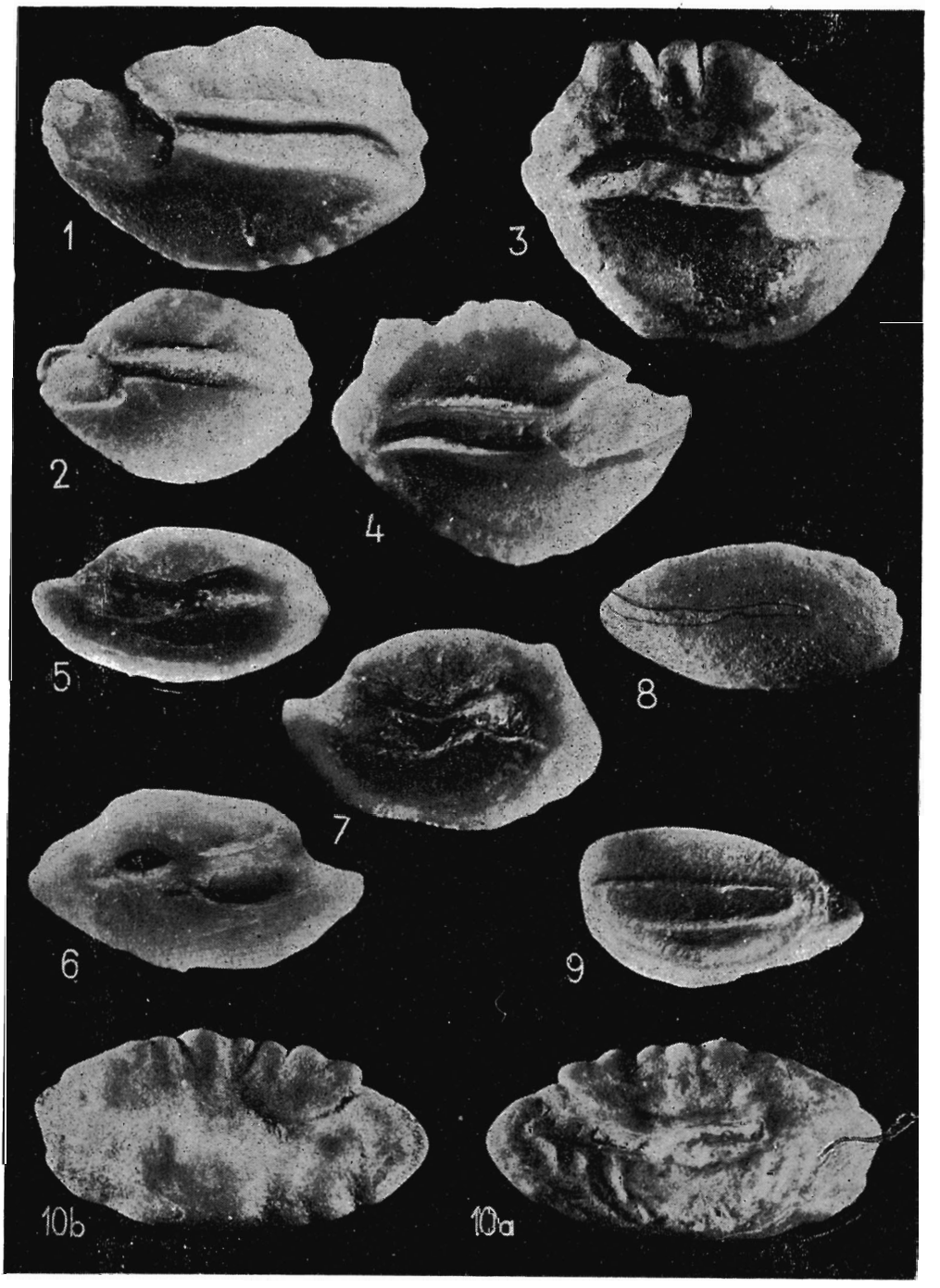


1–2 — *Serranus noetlingi* Koken; 1 (*Ot.M.210*) left sagitta (*a* inner face, *b* outer face); 2 (*Ot.M.211*) right sagitta, inner face; ×10

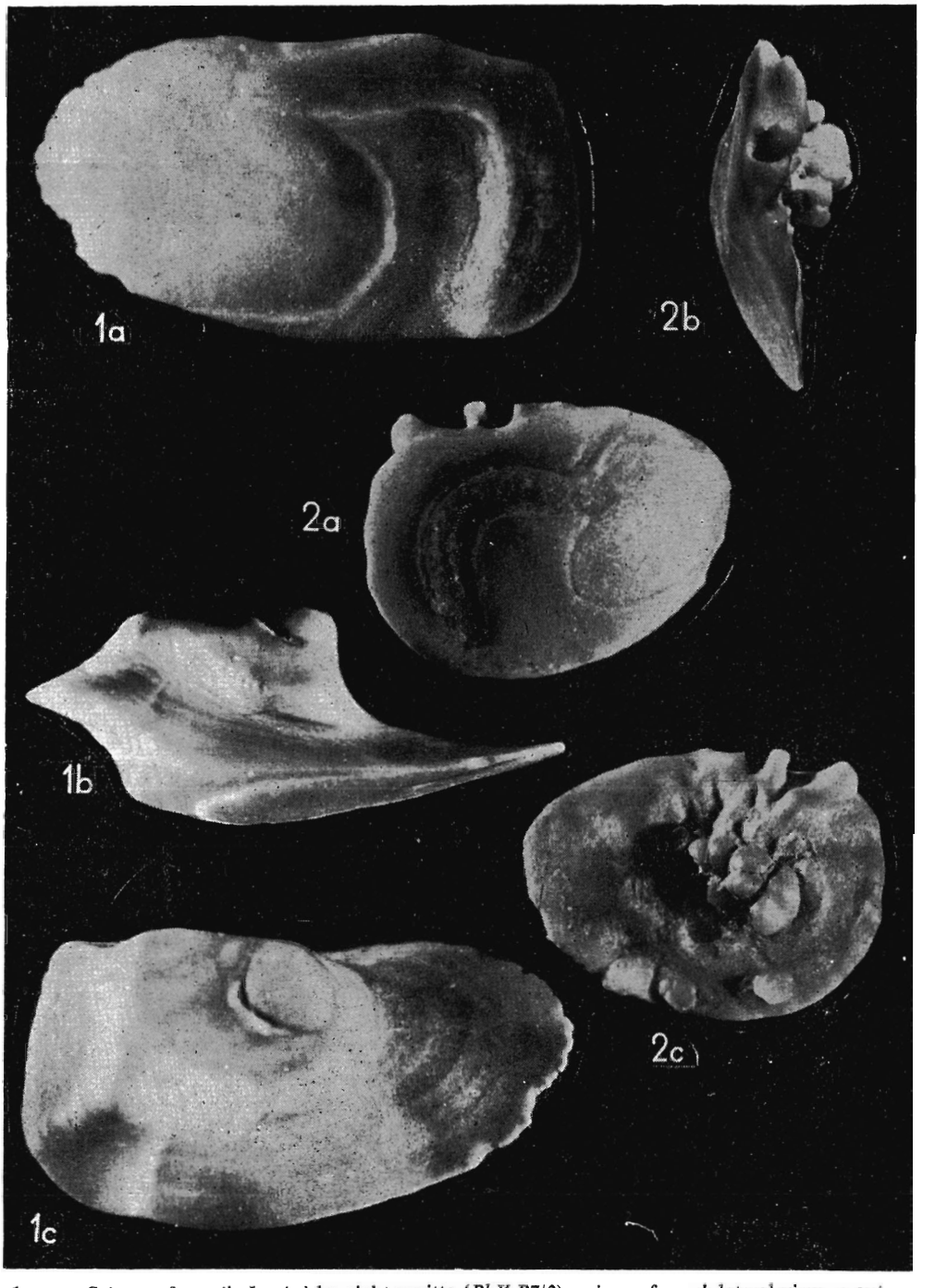
3 — *Trachurus*? *formosus* sp. n.; holotype (*Ot.M.215*), left sagitta; *a* inner face, *b* outer face; ×7.5

4–5 — *Parequula crenata* sp. n.; 4 (*Ot.M.235*) holotype, left sagitta; 5 (*Ot.M.237*) right sagitta; *a* inner face, *b* outer face; ×10

6–7 — *Smaris elegans* (Procházka); 6 (*Ot.M.227*) and 7 (*Ot.M.228*) right sagitta; *a* inner face, *b* outer face; ×10

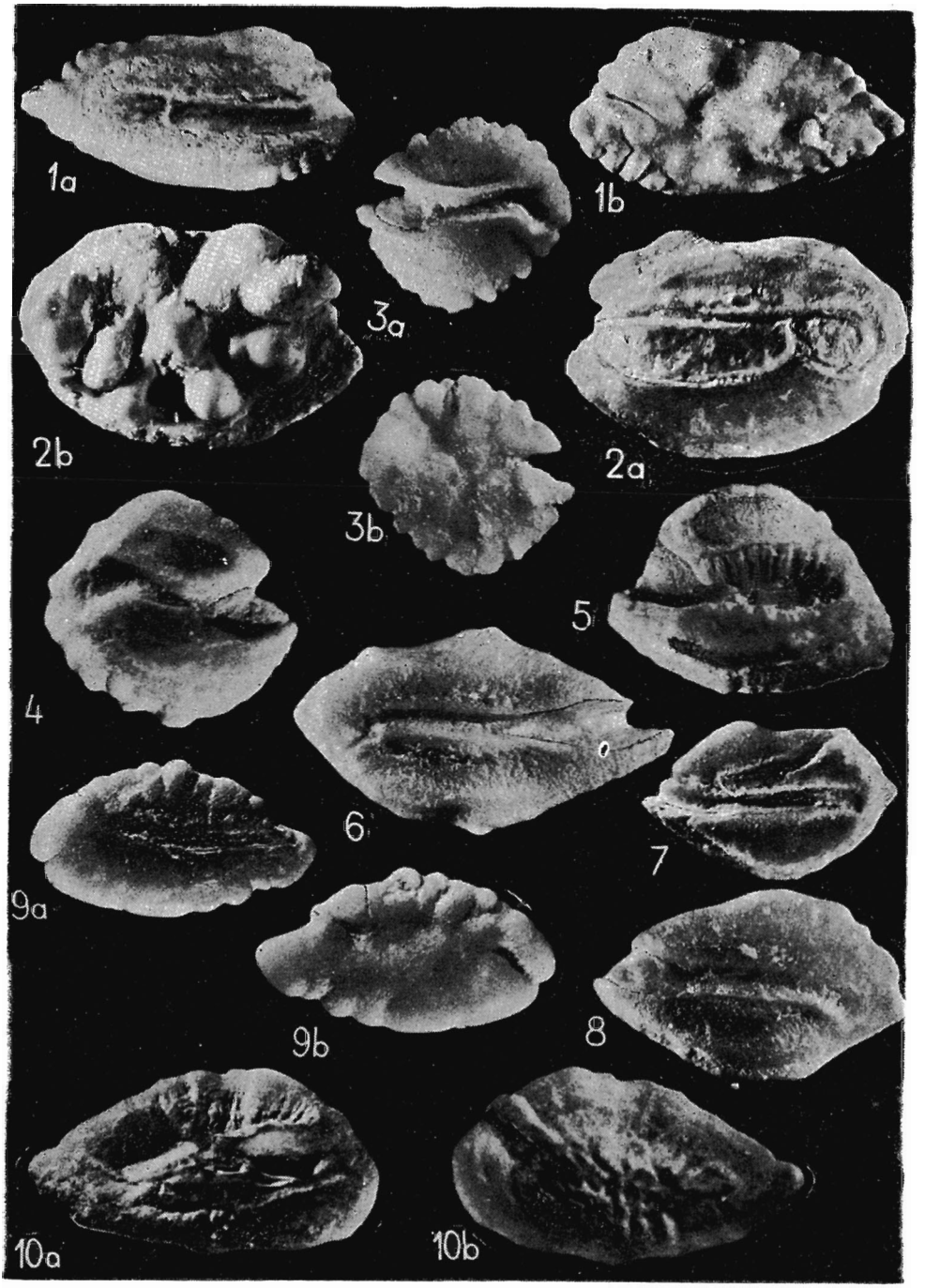


1–2 — *Dentex latior* Schubert; 1 (*Ot.M.217*) and 2 (*Ot.M.220*) right sagitta; inner face, ×7.5
3–4 — *Dentex gregarius* (Koken); 3 (*Ot.M.224*) and 4 (*Ot.M.225*) left sagitta; inner face, ×7.5
5–7 — *Cepola rubescens* Linnaeus; 5 (*Ot.M.241*) and 7 (*Ot.M.249*) right sagitta; 6 (*Ot.M.247*) left sagitta; inner face, ×7.5
8 — *Trachinus verus* Koken; right sagitta (*Ot.M.250*); inner face, ×10
9 — *Carapus nuntius* (Koken); right sagitta (*Ot.M.257*); *a* inner face, *b* outer face, ×10
10 — *Uranoscopus*? aff. *scaber* Linnaeus; right sagitta (*Ot.M.251*); *a* inner face, *b* outer face; ×7.5



1 — *Sciaena* cf. *aquila* Lacépède; right sagitta (*BkK-P7/2*); *a* inner face, *b* lateral view, *c* outer face; ×6.5

2 — *Sciaena pecchioli* Lawley; left sagitta (*BkK-P7/1*); *a* inner face, *b* lateral view *c*, outer face; ×7.5



1 — *Hoplobrotula acutangula* (Koken); left sagitta (*Ot.M.252*); *a* inner face, *b* outer face; ×7.5
2 — *Hoplobrotula*? *ornatissima* (Robba); right sagitta (*Ot.M.254*); *a* inner face, *b* outer face; ×7.5
3 — *Trigla*? *schuberti* Posthumus; right sagitta (*Ot.M.270*); *a* inner face, *b* outer face; ×12.5
4 — *Trigla rhombica* Schubert; right sagitta (*Ot.M.262*); inner face, ×10
5 — *Trigla asperoides* Schubert; righ sagitta (*Ot.M.260*); inner face, ×10
6–8 — *Citharus lusitanicus* (Jonet); 6 (*Ot.M.273*) left sagitta; 7 (*Ot.M.279*) and 8 (*Ot.M.284*) right sagitta; inner face, ×10
9 — gen. et sp. indet.; left sagitta (*Ot.M.293*); *a* inner face, *b* outer face; ×10
10 — *Thalassophryne korytnicensis* sp. n.; holotype (*Ot.M.289*), left sagitta; *a* inner face, *b* outer face; ×10

T. ŚMIGIELSKA

OTOLITY RYB Z IŁÓW KORYTNICKICH

(Streszczenie)

W badanym zespole otolitów ryb z iłów korytnickich (*patrz* fig. 1—37 oraz pl. 1—8) stwierdzono występowanie 43 gatunków, spośród których 28 gatunków zostało opisanych po raz pierwszy z miocenu Polski (*patrz* tab. 1). Pięć gatunków uznano za nowe: *Hyporhamphus baluki* sp. n., *Physiculus fitchi* sp. n., *Trachurus? formosus* sp. n., *Parequula crenata* sp. n., oraz *Thalassophryne korytnicensis* sp. n.

Przeprowadzona analiza ekologiczna wskazuje, iż obok otolitów ryb typowych dla strefy litoralnej jak *Cepola*, *Gobius*, a także form z rodziny Sparidae, występują otolity należące do ryb batypelagicznych (*Pterothrissus*) oraz batybentonicznych (*Physiculus*, *Coelorhynchus*), których obecność w zespole o przewadze ilościowej rodzajów litoralnych może wskazywać na dobre połączenie basenu Korytnicy z morzem o głębokości przekraczającej 200 m. Stwierdzono także występowanie otolitów ryb bardzo żarłocznych, jak np. *Congermuraena* oraz *Sphyraena* (por. Schultz 1977, 1979). Pojawienie się w basenie Korytnicy ryb batypelagicznych i batybentonicznych tłumaczyć można ich okresowymi migracjami, związanymi z rozrodem lub poszukiwaniem pożywienia. Częste występowanie osobników młodocianych u przedstawicieli ryb głębokowodnych wskazuje, iż w płytkich, ciepłych i spokojnych wodach basenu Korytnicy (*por.* Bałuk & Radwański 1977, 1979) osobniki młode znajdowały nadzwyczaj dogodne warunki swego rozwoju.