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FISH OTOLITHS FROM THE LOWER TORTONIAN DEPOSITS AT NISKOWA NEAR NOWY SĄCZ

(Pl. I—V and 5 Text-figs.)

Otolity ryb z dolnotortońskich osadów w Niskowej (koło Nowego Sącza)

(Tabl. I—V i 5 fig.)

Abstract: The author has described otoliths (Pisces) from the Lower Tortonian deposits occurring near Nowy Sącz in the Carpathians. In general, 25 species have been distinguished and among them two new ones have been recognized; 19 species from Poland have been described for the first time[2]. The paleoecological analysis showed that the majority of otoliths from Niskowa is characteristic of the fishes which live in the littoral zone (*Serranus, Centropristis, Carapus, Gobius, Trigla, Solea, Arnoglossus*), and of those which appear at river mouths and in lagoons (*Sparus, Pagrus*). There is complete absence of representatives of the Myctophidae or Macrouridae families living in bathypelagic or bathybenthonic zones of open seas, which have been recognized in Poland from the Lower and Upper Tortonian deposits of the Upper Silesia and the Lower Tortonian of the Kraków region. The marine pelagic forms are represented by the genera: *Merluccius, Gadus, Dentex*. Otoliths of fishes found at Niskowa indicate a warm climate. Only 2 genera: *Gadus* and *Gobius* are eurythermic.

INTRODUCTION

The investigation of the marine Tortonian deposits at Niskowa near Nowy Sącz was started in the last century. The first scientific investigator and explorer of geology as well as of fauna in that region was V. Uhlig (1888). On the grounds of analogies with deposits of the Vienna vicinity the author assigned them to the Tortonian (vide: W. Bałuk, 1970).

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[1] Kraków, ul. Smoleńsk 50 m. 48.

[2] In table 1 they are indicated with asterisks.

Numerous molluscs were found in the fauna assemblage of the Niskowa deposits. They were described by V. Uhlig (1888), W. Friedberg (1907, 1914, 1911—1928, 1934—1936), K. Skoczylasówna (1930), and W. Bałuk (1965, 1970). Apart from molluscs (pelecypods, gastropods), comparatively frequent foraminifers were found at Niskowa (V. Uhlig, 1888, S. Alexandrowicz 1960) vide: W. Bałuk 1970, as well as representatives of other systematic groups such as corals, polychaetes, bryozoans (J. Małecki — vide: W. Bałuk 1970), brachiopods, ostracods, crabs, chitons (W. Bałuk 1965), scaphopods, echinozoans, asterozoans, teeth and otoliths of fishes (T. Śmigielska — vide: W. Bałuk 1970). The latter have been the subject of the detailed studies presented here.

Remains of plants belonging to *Chlorophyceae* were also found at Niskowa. They are mentioned by W. Bałuk (1970) and J. Małecki (1970); the latter described them systematically.

The paleontological material from Niskowa was collected by Dr W. Bałuk to whom the author expresses her thanks for submitting the otoliths for examination. Thanks are due to Dr habil. S. Alexandrowicz for his remarks concerning the age of the Niskowa deposits.

The preliminary designation of otoliths, in form of a list of species together with general ecological conclusions was included in W. Bałuk's work (1970). The list of otoliths presented originally has been slightly altered recently.

In the present work W. Bałuk's profile (1966, 1970) has been used as well as numerical symbols of layers introduced by him.

The taxonomical part was based on classification of fishes of L. S. Berg (1958), D. S. Jordan (1963), and P. G. Daniltshenko (1964). Also W. Weiler's (1968) publication on the fossil and recent otoliths was used here.

VIEWS UPON THE AGE OF THE MIOCENE DEPOSITS AT NISKOWA

The Miocene deposits cropping out at Niskowa were described as different horizons of the Tortonian.

The profile described by K. Skoczylasówna (1930) included "bluish clays with lignite intercalation" and higher placed thick-bedded sands and then thin-bedded ones. The fauna determined by the quoted author made her express her opinion of the Upper Tortonian age of the deposits and their possible partial connection with the Sarmatian.

In her further work this author assumes that the Miocene profile at Niskowa may also comprise the Lower Tortonian (K. Skoczylas-Ciszewska, 1960).

A detailed profile of the described deposits about 25 m in thickness was given by W. Bałuk (1966, 1970). This author distinguished 20

layers, classifying them into 4 litho-stratigraphic sets, denoted by symbols I—IV. They are, going upwards: Set I (layer 1) — "argillaceous deposits with brown coal intercalations", with fragments of shells of the molluscs *Loripes dentatus niveus* E i c h w., *Potamides* sp., *Hydrobia* sp. and foraminifers from the genera: *Quinqueloculina* and *Borelis*. Set II (layers 2—6) — "sandy-argillaceous deposits with brackish and marine fauna". In the lower part of clays there are numerous fossils, especially foraminifers and gastropods *Potamides* sp. div., *Neritina picta* F é r r u s a c. Set III (layers 7—9) — "sandy silty deposits without fauna". Set IV (layers 10—20) — "sandy silty deposits with rich marine fauna". Layers 11, 12, 15, 20 possess the greatest amount of fossils. In the upper part of the profile (layer 19), a bentonite intercalation was found.

Geological-paleontological investigations of the Miocene deposits allowed a comparison between the Niskowa profile and other Miocene localities both in Poland and in adjacent areas. S. A l e x a n d r o w i c z, W. K r a c h (1963) expressed an opinion that the argillaceous deposits with brown coal intercalations from Niskowa (set I acc. to W. B a ł u k), considering the presence of brackish fauna, bear a resemblance to clays with brown coal from Przeciszów near Oświęcim. These clays were classified by these authors as Lower Tortonian and, in particular, as Lower Opolian on the basis of the fauna analysis. Further on, these authors compare this deposit with the Sublithothamnian horizon (Lower Opolian) of the southern margin of the Holy Cross Mountains region. They also pointed to the occurrence of parallel brackish deposits in Moravia and to their relation with the marine Tortonian formations in Austria, Hungary and Roumania.

The Miocene formations with brown coal have been also found in Podolia and Volhynia. Formerly, they were considered Helvetian — Tortonian by some Polish authors; latter on, Helvetian, by Russian scientists and recently they have been assigned to the Lower Tortonian (W. K r a c h, 1962).

A presumable paleogeographical connection of the Miocene marine deposits from Niskowa (sets II—IV acc. to W. B a ł u k) with other Miocene localities in the Flysh Carpathians was indicated by S. A l e x a n d r o w i c z (1962). This author compared the marine clays and sands from Niskowa with marine deposits of Iwkowa and Żegocina which contained a very abundant assemblage of the Lower Tortonian foraminifers (so called "Lancendorf fauna"), and with clays from Benczyn, Brzozowa, Mazańcowice, from which similar microfauna was quoted (E. Ł u c z k o w s k a 1957, S. A l e x a n d r o w i c z 1959). S. A l e x a n d r o w i c z classified the latter as Lower Tortonian (=Badenian), Upper Opolian.

W. B a ł u k (1970) made a detailed revision of the hitherto existing views upon the problem of age of Niskowa Miocene deposits. He assumed that deposits in the lower part of the Niskowa profile (layers 1—6) are

representing the Lower Opolian, on the grounds of analysis of results of investigations carried out by various authors on the stratigraphic position of clays with brown coal, containing brackish fauna and described as the Lower Opolian deposits. According to the quoted author, also higher layers (10—20), sandy silty, with rich marine fauna can be classified as Lower Opolian.

In W. Bałuk's estimation, the thesis accepting the Lower Opolian age of the described deposits can be supported, among others, by the statement that the fauna of these layers is of the Lower Opolian type, and it occurs in situ. This is bored on the state of fossil preservation and frequent life position of molluscs.

In his paleogeographical remarks W. Bałuk suggested that the sea might have extended with its wide bay from the Nida trough towards south-east, filling the depression at the foot of the Carpathians.

So far, the stratigraphic position of the Niskowa deposits has not been determined in detail. However, their Lower Tortonian age is generally accepted. There is only a divergence of opinions: whether the Niskowa deposits belong to the Lower or to Upper Opolian.

SYSTEMATIC DESCRIPTION OF SPECIES

Class: Osteichthyes
Subclass: Actinopterygii
Superorder: Teleostei
Order: Gadida
Suborder: Gadoidei Cuvier, 1829
Family: Gadidae Rafinesque, 1810
Genus: *Gadus* Linné, 1758

Gadus elegans Koken
Pl. I, fig. 1a-b

1884 *Otolithus* (*Gadidarum*) *elegans* Koken; E. Koken, pars: p. 542, pl. XI, fig. 2, 4 (non fig. 3)
? 1891 *Otolithus* (*Gadus*) *elegans* Koken; E. Koken pars: p. 93, pl. IV, fig. 1, 1a.
1906 *Gadus elegans* Koken juv.? R. J. Schubert, pars: p. 660—62, pl. XX, fig. 16, 17, 18, (non pl. V, fig. 13—18).
Material: 5 specimens (layers 2, 12, 13, 18).
Dimensions: Length 4,5 mm Ot. M. II/1 — layer 13
Width 1,8 mm
Thickness 0,6 mm

Description: An elongated otolith, narrowed and subacute in its posterior part. A small excisura in the anterior rim. In its extension a deep furrow is formed, visible on the outer and inner faces of sagitta. The dorsal and ventral rims are slightly notched, especially in the middle part. From the rims disperse not very numerous, radial furrows and rounded folds, visible on the outher face and slightly less noticeable on the inner one.

Inner face flat. Sulcus divided by the central narrowing and depression into a smaller ostium and a large cauda in which collicula are present.

The outer face slightly convex in the anterior part, and a little concave in the posterior one. In all specimens the whole sagitta is relatively flat and not so richly ornamented as in *Gadus elegans sculptus* Koken (T. Śmigielska, 1966, p. 241—2, pl. XV, fig. 3a-b) [1].

Remarks: In his description of *Gadus elegans,* Koken (1884) had included various forms, a part of which were later recognized as different species or subspecies. The author emphasized a remarkable variability in shape, thickness and ornamentation. Besides the typical thick specimens, relatively richly ornamented, from the Middle Oligocene of Germany (pl. XI, fig. 2, 4),there occur flatter ones, also richly or poorly ornamented. Presumably, the Upper Oligocene form (Koken 1891, pl. IV, fig. 1, 1a) can be included here; it is quoted in the synonymy with reservations, if we consider the lack of a distinct division of sulcus into ostium and cauda. The form from the Miocene of Austria, presented by R. J. Schubert 1906, pl. XX, fig. 16—18, bears an extremely close resemblance to our specimens.

Family: Gadidae
Genus: *Merluccius* Rafinesque, 1810

Merluccius vulgaris Fleming

Pl. I, fig. 2a-b

1891 *Otolithus* (*Merluccius*) *miocenicus* Koken; E. Koken, p. 85, textfig. 3.
1906 *Otolithus* (*Merlucius*) *preesculentus* Bassoli et Schubert; G. G. Bassoli, p. 39, pl. I, fig. 7, 9, 10.
1906 *Otolithus* (*Merlucius*) *praeesculentus* Bassoli et Schubert; R. J. Schubert, p. 657, pl. XIX, fig. 29a-b.
1958 *Merluccius vulgaris* Fleming; W. Weiler, p. 333, pl. 1, fig. 22.
1969a *Merluccius vulgaris* Fleming; P. A. M. Gaemers, p. 10, pl. I, fig. 11 (vol. VI, nr. 1—2).
1969b *Merluccius vulgaris* Fleming; P. A. M. Gaemers, p. 74, pl. IV, fig. 7a-b (vol. VI, nr. 4).
1969 *Merluccius vulgaris* Fleming; W.-D. Heinrich, p. 28—29, pl. XI, fig. 1a, 1b.

Material: damaged specimen.
Dimensions: Length ? mm; Width 5,0 mm; Thickness 1, 2 mm; Ot. M. II/2

In the material we have only the middle part of a large otolith which, however, allows us to classify it as the species of *Merluccius vulgaris* Fleming, 1828. The posterior part of the sagitta is absent and damage is visible in the anterodorsal rim.

Description: Outer face shows slight but distinct ornamentation,

[1] Acc. W. Weiler 1968 — *Gadus elegans* mut. *sculpta* Koken 1891.

composed of rounded folds, dispersing radially from the rims towards the raised central part.

On the inner face a characteristic sulcus with a nearly completely preserved ostium and a small part of cauda is visible; especially in cauda collicula are visible. There is also marked crista superior, a slightly concave area and a distinct ventral line. Delicate, radial furrows occur in the dorsal and ventral parts.

Remarks: Our specimen does not show any differences in relation to forms quoted in the synonymy. According to Weiler (1935, p. 42), the genus *Merluccius* had appeared earlier in Eastern Europe than in its central and western parts. In the East it had spread in the Lower and Middle Oligocene, while in Central Western Europe it occurred in the Upper Oligocene-Miocene.

W. Weiler (1968), W. D. Heinrich (1969) include the species known from the Miocene: *Merluccius miocenicus* Koken and *M. praeesculentus* Bassoli et Schubert, into the species *Merluccius vulgaris* Fleming.

Occurrence: ? Upper Oligocene, Middle and Upper Miocene of North — Western Germany, Middle Miocene of Italy, Miocene (Tortonian) of Austria, Miocene and Pleistocene of Belgium. So far, it has not been known from Poland.

Order: Mugilida
Suberder: Mugiloidei
Family: Mugilidae Cuvier, 1829
Genus: *Mugil* Linné. 1758

Mugil applanatus (Rzehak)
Pl. I, figs. 3, 4a-b, 5

1893 *Otolithus* (Percidarum) *applanatus* Rzehak; vide in R. J. Schubert (1906), p. 629, pl. XIX, fig. 46.

1966 *Mugil applanatus* (Rzehak); W .Weiler, p. 121—22, fig. 2—5 (cum synonimis).

1969 *Mugil applanatus* (Rzehak); R. Brzobohatý, p. 14—15, pl. 6, fig. 13.

Material: 3 specimens.

Dimensions:	Length	2,7 mm	3,7 mm	5,7 mm /abrupt rostrum/
	Width	1,7 mm	2,1 mm	2,7 mm
	Thickness	0,3 mm	0,4 mm	0,7 - 0,8 mm
	L:W = 1,5		L:W = 1,76	
	Ot.M.II/4 - Pl.I, fig. 4a-b		Ot.M.II/3- Pl.I,fig.3	Ot.M.II/5 - Pl.I, fig. 5

Description: 3 otoliths were found in the material. They belong to the genus *Mugil,* which is apparent because of the characteristically shaped sulcus. It runs supramedially, in a more or less distinct way. Ostium, as it can be well seen in the specimen (fig. 3), is short and only slightly wider than the caudal part of sulcus. Long and narrow cauda

gradually rises upwards towards the dorsal rim. In its posterior part it curves downwards and virtually approaches the rim.

The two smaller otoliths are well preserved. They have an oval outline. The specimen shown in fig. 3 is slightly damaged in the posterior part, which gives an impression of sagitta being obliquely cut. Rostrum equals here antirostrum. In the other specimen (fig. 4a-b) rostrum is protruding forwards and it is subacute. Antirostrum in a form of a denticle. Excisura is very small in both described specimens. The ventral rim of the specimens is markedly notched; the dorsal rim is more or less undulated. The inner face is convex, the outer one is concave. As far as their shape, dimensions and length-width relation are concerned, these specimen correspond to the description of the Miocene species *Mugil similis* Schubert.

The specimen (fig. 5) with an abrupt anterior part of sagitta varies in proportions from the two described otoliths. It is much slimmer and larger than the remaining ones; it is probably connected with its more advanced stage of development. Rims of the specimen are nearly smooth. Above crista superior there is a marked, large area, narrowing in the posterior part. This specimen bears an extremely close resemblance to the species *Mugil applanatus* (Rzehak). It can be compared with ?*Mugil dissimilor* Schubert, thanks to its resemblance in shape and dimensions; the difference can be observed only in a more curved cauda in our specimen, resembling the final part of the letter "S". Our specimen, also resembles the recent species *Mugil saliens* Risso and *M. auratus* Risso (J. Chaine, 1938, pl. XIV and XVI).

Remarks: W. Weiler (1966) describes several otoliths from the Helvetian of Moravia (Ivančice), which he classifies among the species *Mugil applanatus* (Rzehak). He includes Schubert's species: *M. similis* and *M. dissimilor* into the species *Mugil applanatus* synonymy. Illustrations of Weiler's specimens are virtually identical to the Rzehak's species; they also bear a certain resemblance to ?*Mugil dissimilor* Schubert. On the other hand, typical forms *M. similis* Schubert are not present among them, and that makes the problem a little complicated. However, investigating forms of variability of otoliths in the recent species *Mugil auratus* Risso or *M. saliens* Risso (J. Chaine, 1938), in the presented population there can be observed specimens similar to the typical *M. similis* (e.g. the smallest specimen among *M. auratus)*, and more elongated forms resembling in proportions *M. applanatus*. It can be thus assumed that the range of variability is so large that the 3 described otoliths from the Lower Tortonian of Niskowa can be included within one species.

Occurrence: Lower Helvetian of Moravia, Tortonian of Austria. Apart from Paratethys, R, Brzobohatý mentions occurrence of this species in the Neogene of Majorca.

Order: Percida
Suborder: Percoidei
Family: Serranidae Richardson, 1846
Genus: *Serranus* Cuvier, 1817

Serranus an sp. *nova*?
Pl. I, fig. 6a-b; Text-fig. 1

Material: 1 specimen.
Dimensions: Length 4,0 mm Ot. M. II/6
Width 1,85 mm
Thickness 0,3 mm

Description: A slim, thin otolith with a quite narrow rostrum protruding forwards. A subacute sagitta in the posterior part. No excisura. The dorsal rim rises slightly backwards. It is smooth in the anterior part; farther on, in the middle-posterior part two wide, rounded notches are visible. A smooth, widely arched ventral rim.

A convex inner face. Median sulcus. A slightly widened ostium, narrower than cauda and somewhat deeper. The narrow cauda deepens slightly in the posterior part and curves downwards. It ends near the ventral rim. The outer face of sagitta is concave.

Remarks: As far as the type of shaping is concerned, sagitta in our specimen corresponds to specimen of the recent species *Serranus cabrilla* L., and *S. scriba* L. (J. Chaine, 1935; pp. 103, 109; pl. VIII). A certain similarity in the shape of sagitta and sulcus can be also observed in the specimen *Serranus* sp. from the Lower and Middle Oligocene of Moravia (R. Brzobohatý, 1967, p. 139, pl. 3, fig. 9-ab). Unfortunately, the rostrum of the specimen is abrupt; also its dorsal and ventral rims in the posterior part of sagitta are more notched than the ones in our specimen.

It is not unlikely that the specimen from Niskowa represents a new species. But as we posses only one slightly polished specimen, we do not give it a new species name.

Family: Serranidae
Genus: *Centropristes* Cuvier, 1829 [1]

Centropristis integer Schubert
Pl. I, figs. 7a-b, 8

1906 *Otolithus* (*Centropristis*) *integer* Schubert; R. J. Schubert, p. 626, pl. XVIII, fig. 6.
1823 *Otolithus* (*Centropristis*) *integer* Schubert; O. Posthumus, p. 108, fig. 1, 2.
1965 *Centropristis integer* Schubert; R. Brzobohatý, p. 121, pl. 2, fig. 16a-b; 1967 — p. 241, pl. 2 D, fig. 8a-b.

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[1] Later on, Cuvier and other authors following him use permanently the name *Centropristis* (Jordan, 1963; Weiler, 1968).

Material: 2 specimens.

Dimensions:	Length	2,15 mm	∓ 1,70 mm
	Width	1,50 mm	1,40 mm
	Thickness	0,30 mm	0,30 mm
		Ot.M.II/7 - Pl. I, fig. 7a-b	Ot.M.II/8 - Pl. I, fig. 8

Description: Otolith of an oblong outline. A wide, acute rostrum. A small antirostrum; a visible excisura. Of two specimens one is preserved in full shape and it is wider; the other has an abrupt rostrum and is a little narrower and slimmer. A slightly raised and noched dorsal rim; the ventral rim is more convex, especially in the specimen in fig. 7a-b.

A slightly convex inner face. A wide ostium, somewhat shorter than cauda, which curves slightly downwards in its posterior part. A very distinct crista superior; deep area. A visible ventral furrow. Marked radial furrows, running from notches in the ventral rim. They can be seen also on the outer face.

Remarks: When compared with the Schubert holotype, our well preserved specimen (fig. 7a-b) is slightly wider. As far as the outline is concerned, the other specimen, damaged in its rostral part, resembles it better. In both our specimens cauda is also slightly more curved downwards than it can be observed in the specimens mentioned in the synonymy.

In her successive works, G. Rado observes the occurrence of this species in the Tortonian and Sarmatian of Roumania (1965, p. 60, pl. II, fig. 8a-b; 1968, pl. I, fig. 4a-b; 1969, p. 195, pl. I, fig. 1a-b). However, the author does not give its description, and the included drawings show forms with a fairly differently shaped sagitta and cauda. The latter is straight in some specimens and slightly curved upwards or downwards in others (1968).

Occurrence: Miocene (Tortonian of Austria and Roumania?), Middle Miocene of Holland, Carpathian-Tortonian s.l. of Moravia. It is also found in Upper Oligocene and Upper Miocene of Germany by Weiler (vide: Brzobohatý, 1967).

Family: Percidae Bonaparte, 1831
Genus: *Perca* Linné, 1758

Perca aff. *praefluviatilis* Weiler

Pl. II, fig. 2a-b

1963 *Perca* aff. *praefluviatilis* Weiler; W. Weiler, pp. 37—8, fig. 151—154.

Material: 1 specimen.

Dimensions: Length 3,5 mm — Ot. M. II/10
Width 1,9 mm
Thickness 0,4 mm

L : W = 1,84

Description: Otolith not quite regularly elliptical. Rostrum produced forwards, but, unfortunately, its terminal part is abrupt. A small excisura. A small denticle is visible just below it. Antirostrum not very distinct. The dorsal rim is slightly but widely arched in its anterior part; farther on the rim line slopes down and is notched. An obliquely cut sagitta is visible from the posterodorsal dome. The ventral rim is nearly smooth and not very well arched.

A slightly convex inner face. The ostium forms an angle of about 45°, shorter but more concave than cauda. The cauda is filled with colliculum; it is slightly curves downwards in its posterior part. The lower margin of cauda runs a little obliquely from collum; the upper one goes straight in the anterior part and curves only in the posterior. A very distinct crista superior, thickened in the anterior part. A very distinct area.

A slightly concave outer face, with radial furrows and folds.

Remarks: The described otolith displays features of the sagitta morphology, characteristic of the genus *Perca*. It can be compared with the otolith of the recent species *Perca fluviatilis* L. (vide: Koken 1884, pl. IX, fig. 11). Among fossil forms, the otoliths *Perca praefluviatilis* Weiler, which were found in the Lower Miocene (Aquitanian) formations of North Germany, are very similar to it. In the holotype presented by Weiler (fig. 151) which is nearly identical to our specimen, we observed that the excisura is more incised and the rims more markedly and deeper notched. As far as the remaining details of morphology and general proportions are concerned, no differences have been observed.

Occurrence: Lower Miocene (Aquitanian) of North Germany.

Otol. [*Percidarum*] *oblongus* Brzobohatý

Pl. II, fig. 1a-b

1967 *Ot.* (*Percidarum*) *oblongus* Brzobohatý; R. Brzobohatý, p. 143, pl. 9, fig. 12a, b, 13—15.

Material: 1 specimen

Dimensions: Length 1,85 mm Ot. M. II/9
Width 1,05 mm
Thickness 0,30 mm

Description: A small, oblong otolith. Rostrum produced forwards; its end is acute and somewhat raised upwards. A small, sharply incised excisura; a denticle is marked below it. A small, distinct antirostrum. The posterior rim of sagitta is nearly sharp but there can be noticed a slight damage between the part produced backwards and the posterodorsal dome (the supposed outline has been marked with a dashed line on the photograph).

Dorsal rim fairly sharply denticulated. Ventral rim irregularly denticulated.

Inner face convex. Sulcus in the middle of sagitta. Ostium nearly as long as cauda, but much deeper. Cauda runs horizontally; in the posterior part its upper margin curves slightly downwards. Distinct crista superior; a small but fairly deep area.

The outer face is slightly concave in the umbonal part; several shallower or deeper furrows are visible on its surface. The most distinct ones are the furrows running from excisura towards the middle of sagitta and also those in the posterior part, running from the posterodorsal dome.

Remarks: As far as morphology is concerned, the otolith described above corresponds to the species *Ot. (Percidarum) oblongus* Brzobohatý. Proportions of the specimens are identical here; the ratio $\frac{\text{length of sagitta}}{\text{width of sagitta}} = 1{,}8$ in our specimen (in Brzobohaty's specimens 1,75—1,80), and the ratio $\frac{\text{length of sagitta}}{\text{thickness of sagitta}} = 0{,}6$, both in our specimen and in the holotype. The outline of sagitta also corresponds to the holotype, as well as the shape of sulcus.

Certain features of resemblance to our otolith can be also found in the specimen *Ot. (Percidarum) opinatus* Procházka, presented by Schubert (1906, p. 628, pl. XVIII, fig. 30, 31) from the Miocene of Austria. However, our specimen differs from the holotype of this species described by Procházka (1893, p. 62, pl. 3, fig. 10a, b) from the Miocene of Moravia. Sagitta of our specimen is not rounded in its posterior part as it is in Procházka's specimen; the specimens also differ in proportions.

Occurrence: Lower-Middle Oligocene of Moravia.

Family: Pomadasyidae
Genus: *Orthopristis* Girard, 1859

? *Orthopristis vöslauensis* (Schubert)
Pl. II, fig. 3a-b

1906 *Otolithus (Sparidarum?) vöslauensis* Schubert; R. J. Schubert, p. 634, pl. XVIII, fig. 34, 35.

Material: 1 specimen

Dimensions:		/Niskowa/	/Vöslau/
	Length	2,2 mm	2,4 mm
	Width	1,5 mm	1,8 mm
	Thickness	0,4 mm	0,5 mm

Ot.M.II/11

Description: Otolith of a widely elliptic outline. Rostrum nearly rounded; small, rounded antirostrum. A shallow depression marked in the anterior part of the dorsal rim; beyond it, the rim forms a widely arched line. Farther on, the rim slopes gently backwards. A smooth ventral rim.

Sulcus placed supramedially. Not very wide, spatular ostium, shorter than the caudal part of sulcus. A narrowed collum. The cauda runs horizontally in the anterior part; farther on it curves downwards, but it is at a certain distance from the ventral rim. A distinct crista superior. Above it, the area is visible; it is more depressed in the anterior part. Indistinct ventral furrow.

A convex inner face. The outer face is only slightly concave in the umbonal part. Numerous irregular depressions and bosses can be seen here (pl. II, fig. 3a-b). The whole sagitta is fairly thick, with a rounded dorsal rim and not sharp ventral one.

Our specimen corresponds entirely to the otolith described by R. J. Schubert (1906) from the Tortonian of Vöslau, as *Ot. (Sparidarum?) vöslauensis*. However, its classification among the family Sparidae seems incorrect, as sulcus is shaped in the way typical of the family Pomadasyidae, which have occured in warm seas from Eocene to Recent. Having compared Schubert's specimen from Vöslau and ours from Niskowa with a number of forms met in this family, a great resemblance to otoliths of the genus *Orthopristis* can be found. In the recent specimens *Orthopristis bennetti* Lowe[1] (J. Chaine, 1937, p. 5, pl. I), the resemblance is visible in the shape of sulcus acusticus and in the outline of sagitta, with the only difference that in most presented forms cauda is still more curved and nearly reaches the ventral rim. In specimens of the genus *Pristipoma* (J. Chaine, 1937, pl. II, III), the cauda approaches, still in a greater degree, the ventral rim. Therefore, we have rather classified our specimen among the genus *Orthopristis* with reservation.

Family: Sparidae Bonaparte, 1831
Genus: *Sparus* Linné, 1758

Sparus doderleini (Bassoli et Schubert)
Pl. II, figs. 5a-b, 6

1906 *Otolithus* (*Chrysophris*) *Doderleini* Bassoli et Schubert; G. G. Bassoli, p. 52, pl. II, fig. 34.
1906 *Otolithus* (*Chrysophris*) *Doderleini* Bassoli et Schubert; R. J. Schubert, p. 631, pl. XVIII, fig. 46—48.
1914 *Otolithus* (*Serranus*) *noetlingi* Koken; F. Priem, pars: p. 259, fig. 32, 33, ? 36, (non fig. 34, 35, 36—40).
1950 *Chrysophris doderleini* Bassoli et Schubert; W. Weiler p. 227, pl. 3, fig. 19a-b.
1966 *Chrysophris doderleini* Bassoli et Schubert; T. Śmigielska, p. 255, pl. XVII, fig. 7a-b.
1970 *Sparus doderleini* (Bassoli et Schubert); E. Robba, p. 142, pl. 15, fig. 4a-b.

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[1] Pristipoma prebennetti Bauza-Rullan, 1964 (v. Weiler, 1968 Fossilium Catalogus).

Material: 2 specimens.

Dimensions:	Length	3,1 mm	4,6 mm
	Width	2,2 mm	3,3 mm
	Thickness	0,4 mm	0,5 mm
		Ot.M.II/14 - Pl.II, Fig.6	Ot.M.II/13 - Pl.II, fig. 5a-b

Description: A widely oval outline. Notched rims, especially the dorsal one, in the middle of which there is the highest protrusion. A distinct posterodorsal dome. Wide, prominent rostrum; a small antirostrum in form of a rounded denticle. A wide ostium. Cauda slopes down in form of a gentle arch; it curves downwards in its posterior part. Distinct crista superior and area.

A convex inner face; the outer one is concave, with radial furrows and folds.

Our both sagittas correspond to the description of the species.

Remarks: Recently, some specimens classified by F. Priem (1914) as *Serranus noetlingi* Koken have been included in the synonymy of the species described above, since the shape of sulcus, as well as the outline of sagitta, are characteristic of the otoliths which had been described by different authors as *Chrysophris doderleini*. W. Weiler (1968) and E. Robba (1970) classify specimens of this species among the genus *Sparus*, since the genus *Chrysophris* Cuvier, 1829 was included in the synonymy of the genus *Sparus* L., 1758.

Occurrence: Burdigalian of France, Middle Miocene of Italy, Austria; Miocene (Tortonian) of Roumania, Poland, Czechoslovakia; R. Brzobohatý (1963) mentions the occurrence of this species in the Tortonian of the Slovakian and Moravian part of the Vienna Basin.

Otol. [*Sparidarum*] sp.
Pl. II, fig. 4a-b

Material: 3 damaged specimens.

Dimensions: Length ? (the anterior part of sagitta is absent)
Width 4,6 mm
Thickness 0,8 mm

Ot. M. II/12

In layer 12, three damaged specimens have been found together with otoliths described in the present work as *Sparus doderleini* (Bassoli et Schubert). They differ in the shape of sagitta and sulcus. The otoliths classified by us as the species *Sparus doderleini* have a nearly oval outline, yet with a prominent posterodorsal dome. The dorsal rim, as well as the ventral one in juvenile specimens, have few wide, rounded notches. The three remaining specimens, which cannot be joined to the ones described before, have a more angular outline. Their posterodorsal

dome is very strongly marked; the posterior part of sagitta is truncate. Rims are ended with numerous, prominent, sharp denticles.

In *Sparus doderleini* the sulcus slopes down in an arched line in the caudal part, starting from collum. In the form described at present, it runs horizontally in the anterior part, and only in the posterior one it curves downwards. That can be easily seen, especially when the upper margin of cauda is observed.

Distinct crista superior and area.

Comparison: In the form mentioned recently (pl. II, fig. 4a-b), the shape of sagitta and sulcus corresponds to the specimen illustrated by Schubert (1906, pl. XVIII, fig. 48). Also the otolith presented by Weiler (1950, pl. 3, fig. 19a-b) as *Chrysophris doderleini,* corresponds to this shaping. The latter author also probably pointed out the difference between the three forms quoted by Schubert, for while comparing his specimens with them, he quoted Schubert's specimen (fig. 48) with reservations.

As our specimens have been damaged, we only give our remarks with reference to differences, which rather make us separate the otoliths described here from the typical *Sparus doderleini* (Bassoli et Schubert).

Occurrence: Miocene of Austria, Middle Miocene of Roumania.

Genus: *Dentex* Cuvier, 1815

Dentex latior Schubert

Pl. II, figs. 7a-b, 8a-b

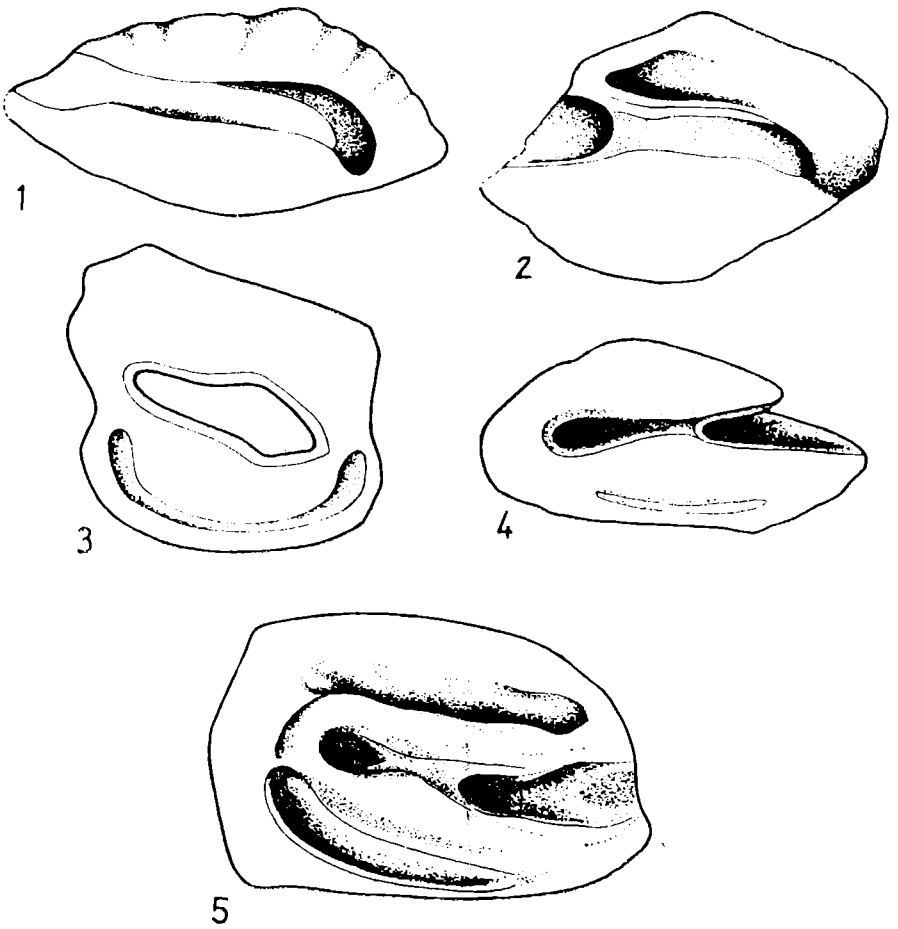
1906 *Otolithus* (*Dentex*) *latior* Schubert; R. J. Schubert, p. 627, pl. XVIII, fig. 7—9.
1914 *Otolithus* (*Percidarum*) aff. *moguntinus* Koken; F. Priem, pars: pp. 257—8, fig. ? 24, 25—27.
1928 *Otolithus* (*Dentex*) *latior* Schubert; J. Chaine et J. Duvergier, p. 202, pl. VI, fig. 7—9.
1950 *Dentex latior* Schubert; W. Weiler, p. 226, pl. 3. fig. 15—17.
?1952a *Dentex* aff. *latior* Schubert; E. Weinfurter, p. 160, pl. 1, fig. 11.
?1963 *Dentex latior* Schubert; J. Lafond-Grellety, p. 144, pl. I, fig. 7.
1966 *Dentex latior* Schubert; T. Śmigielska, p. 254, pl. 17, fig. 4, 5.
1970 *Denex lation* Schubert; T. Robba, pl. 141, pl. 15, fig. 3a, 3b.

Material: 16 specimens (Layers: 11, 12, 18).

Dimensions:

	Length	Width	Thickness	L : W	Layer	Pl.fig.	Nr of spec.
1.	± 4,7 mm	3,1 mm	0,5-0,6 mm	-	18	II, 8	Ot.M.II/16
2.	5,1 mm	3,4 mm	0,8 mm	1,2	18	II, 7	Ot.M.II/15
3.	3,0 mm	2,0 mm	0,5 mm	1,5	18	-	-
4.	± 5,7 mm	3,5 mm	1,1 mm	-	18	-	-

Description: Otoliths of a wide-oval but not quite regular outline. A district, slightly produced rostrum, usually rounded, often abrupt at



Text-fig. 1 — *Serranus* an sp. *nova*, inner face of right sagitta, x15 (p. 10);
Text-fig. 2 — *Pagrus distinctus* (K o k e n), inner face of right sagitta, x 30 (p. 17—18);
Text-fig. 3 — *Gobius* aff. *vicinalis* K o k e n, inner face of left sagitta, x 16 (p. 23);
Text-fig. 4 — *Otol.* [*Cottidarum*] *modestus* n. sp., inner face of left sagitta, x 36 (p. 26—27);
Text-fig. 5 — *Arnoglossus inconspectus* n. sp., inner face of left sagitta, x 33 (p. 28—29).

terminal part. A markedly arched, and usually fine denticulated ventral rim. An undulating dorsal rim, slightly raised in the middle. A prominent posterodorsal dome, behind which a slight truncation of the posterior rim is noticeable.

Sagitta arched in profile. A concave outer face, frequently with numerous, irregular swellings and depressions which sometimes form folds and furrows running in the dorsal-ventral direction. The greatest thickening of sagitta is always marked in the umbonal part. The maximum thickness of sagitta was measured in this place.

A convex inner face. Sulcus placed somewhat supramedially. A very wide, spatular ostium, deeper than cauda. The lower margin of the ostium often forms an angle, while turning into cauda. The angle may be right, or sometimes, even acute. It may be indistinct in some specimens, especially in the more polished ones.

Cauda is narrow in its anterior part; it slightly widens in the middle--posterior portion, and slightly curves downwards in the posterior one. A very distinct crista superior, in form of a small, rounded fold or sharp edge, though it is not very prominent while running from the ostial part of sulcus, and it ends in the place where the cauda is bent. A quite distinct area.

Remarks: In general our specimens fully correspond to the otoliths presented by different authors (vide synonyms). We have included E. Weinfurter's specimen (1952a) with an abrupt rostrum in the synonymy, with reservation. It differs from our specimens in having much narrower cauda. The cauda is only slightly bent in the posterior part, while in our specimens it is wider and curves visibly in the posterior portion. The description of the species *Dentex latior* Schubert, which is not illustrated by this author in his succesive work (1952b), correspond to the shaping of our forms.

A large otolith from J. Lafond-Grellety's adult specimen has, behind the posterodorsal dome, a deep incision which has not been observed in other specimens of this species.

Occurrence: Upper Oligocene of Germany; Burdigalian, Helvetian of SW France; Miocene (Tortonian) of Austria, Southern Poland (the southern margin of the Holy Cross Mountains); Middle Miocene of Roumania; Tortonian of SW Italy.

Genus: *Pagrus* Cuvier, 1817

Pagrus distinctus (Koken)
Pl. III, fig. 4; Text-fig. 2.

1891 *Otolithus* (*Serranus*) *distinctus* Koken; E. Koken, p. 125, pl. X, fig. 2.
1965 *Pagrus distinctus* (Koken); A. Zilch, p. 477, pl. 37, fig. 11.

Material: 2 specimens.

Dimensions:			
	Length	2,0 mm	1,9 mm
	Width	1,40 mm	1,2 mm
	Thickness	0,35 mm	0,2 mm
		Ot.M.II/20 - Pl.III, fig.4	Ot.M.II/20 a - Text-fig.

Description: 2 small otoliths have been found in the material. They are narrower both in the posterior and anterior part, which can be observed in the smaller specimen only. In the specimen presented on the photograph (Pl. III, fig 4), the posterior part of rostrum is abrupt. A notched dorsal rim, slightly raised in the middle. Antirostrum and excisura are nearly indistinct. The ventral rim is obliquely truncated in the posterior part.

A convex inner face. Median sulcus. A wide, open ostium, somewhat deeper than cauda. The cauda is bent in the posterior part. Distinct crista superior. A distinct, concave area.

The outer face is nearly flat, slightly concave in the middle.

Remarks: As far as morphology is concerned, our specimens correspond to the species described by Koken from the Middle Oligocene of Germany. A. Zilch (1965) presents a photograph of Koken's holotype and states the range of occurrence of this species from the Middle Oligocene through the Upper Oligocene of Germany to the Middle Miocene of Holland, according to W. Weiler's work (1942), which, unfortunately, we do not possess. P. A. M. Gaemers (1971) presents the form *Pagrus* aff. *distinctus* (Koken) from the highest part of the Middle Miocene of Belgium, which he compares with the specimen described by Koken. It differs from the latter in having a distinct excisura.

Pagrus sp.

Pl. III, figs. 1a-b, 2

Material: 2 damaged specimens.

Dimensions:

	Length	Width	Thickness	L : W	Layer	Pl.fig.	Nr of spec.
1.	2,4 mm	1,7 mm	0,3 mm	1,4	12	III,1a-b	Ot.M.II/17
2.	± 1,9 mm	1,8 mm	0,4 mm	-	12	III, 2	Ot.M.II/18

Of the two specimens, one is preserved nearly in full shape (fig. 1a-b); only the terminal part of ostium is abrupt. Antirostrum shows a trace of slight damage. In the other specimen the whole anterior part of sagitta is abrupt, while the caudal part is well preserved (fig. 2).

Sagitta of a widely oval outline. Prominent rostrum; antirostrum forms a small denticle. Rims are distinctly notched. The middle part of the dorsal rim is slightly raised. A distinct posterodorsal dome. A subacute

posterior part of sagitta, produced backwards. The ventral rim is markedly arched. In the posterior part, on the level of the posterior portion of cauda, there is a distinct notch in the rim line.

A slightly convex inner face. Sulcus placed supramedially. A wide ostium. The narrowed cauda curves downwards in the posterior part. It is slightly bent in shape of the letter "S". Crista superior forms a distinct thickening. Above it, a narrow area is marked. The ventral furrow is visible in the specimen in fig. 2. Radial furrows run from notches in the rim.

A nearly flat outer face with radial furrows.

Comparison: As far as the shape is concerned, our specimens resemble the otoliths classified by R. Brzobohatý (1967, p. 139, pl. 7, fig. 2a, b, 7) as *Pagrus* sp.; however, forms from the Lower and Middle Oligocene of Moravia are narrower, they have a less arched ventral rim and a lower dorsal one. This author compares his specimens with *Pagrus distinctus* (Koken), 1891 (p. 125, pl. X, fig. 2; Zilch 1965, p. 477, pl. 37, fig. 11). Our specimens can also be compared with this species with reservations, however, as they resemble the holotype of this species in the outline, yet they differ in the position of sulcus. The sulcus of our specimens is placed distinctly supramedially, while in Koken's specimen it runs medially.

Genus: *Diplodus* Rafinesque, 1810

?Diplodus sp.
Pl. III, fig. 3a-b

Material: 2 specimens.

Dimensions:

	Length	Width	Thickness	L:W	Layer	Pl.fig.	Nr of spec.
1.	3,9 mm	2,5 mm	0,5 mm	1,5	12	III,3	Ot.M.II/19
2.	2,6 mm	1,6 mm	0,3 mm	1,5	12	-	-

Description: Otolith of a pentagonal outline; its angles are rounded. Rostrum protruding forwards, damaged in the anterior part. Antirostrum in form of a small denticle. The dorsal rim runs almost horizontally.

A distinct posterodorsal dome. Behind it, the sagitta is obliquely truncated. A fairly arched ventral rim, notched in the posterior part.

A convex inner face. Sulcus placed somewhat supramedially. Open ostium, a little deeper than cauda. The cauda curves downwards in the posterior part. Its lower margin runs a little obliquely from a somewhat narrower collum. Distinct crista superior and area.

A concave outer face, yet with numerous swellings on the surface. The biggest one is above umbo. Radial furrows and regularly placed oblong swellings run from the rim in the lower part of sagitta.

Comparison: As far as the outline and the shape of sulcus are concerned, our specimen slightly resembles the fossil form *Otol. [Sparidarum] plebejus* (Koken) 1891, p. 126, pl. X, fig. 1; Zilch 1965, pl. 37, fig. 12, described from the Middle Oligocene of Germany.

It can be also compared with the specimen *Pagellus bogaraveo* (Brünn.) and *Pagellus breviceps* (Cuvier et Valenc.), which are considered by J. Chaine (1937, pl. XIII, pp. 138—9) as belonging to the some species, together with *Pagellus centrodontus* (Delar.).

However, as far as the morphology of sagitta is concerned, we find more similarities in typical representatives of the genus *Diplodus*, especially in *Diplodus annularis* L. and *D. vulgaris* Geof. St. Hil., described by J. Chaine (1937, pp. 139—158, pl. XIV). Until a richer material with otoliths resembling in shape the specimens described above is found, we can classify it among the genus Diplodus, with reservations.

This genus has been known in West Europe from the Eocene to the Miocene.

Genus: *Boops* Cuvier, 1815

? *Boops insignis* (Procházka)
Pl. III, fig. 5

1893 *Otolithus* (*Serranus*) *insignis* Procházka; V. J. Procházka, p. 61 (83), pl. II, fig. 9a, 9b.
1906 *Otolithus* (*Box* ?) insignis Procházka; R. J. Schubert, p. 633, pl. XVIII, fig. 19, ? (20—22).

Material: 2 specimens.
Dimensions: Length 4,15 mm (layer 18, pl. III, fig. 5)
Width 2,50 mm Ot. M. II/21
Thickness 0,40 mm

Description: A slightly polished sagitta, relatively thin and markedly curved. Sharp rims. An elliptic outline; a subacute rostrum; the posterior part is narrowed and blunt. A slightly arched and somewhat undulating dorsal rim. A prominent posterodorsal dome; behind it there is an obliquely cut sagitta. No antirostrum and excisura.

A convex inner face. Large ostium, markedly widened in the anterior part and only a little shorter than cauda. The cauda curves visibly downwards in the posterior part and nearly reaches the ventral rim. Slightly marked crista superior and area.

A concave outer face. Concentric lines of growth can be easily seen. Remarks: Our specimen, which has been shown in the photograph, corresponds to Procházka's species, as far as its morphology is concerned. It is only somewhat larger and thinner than the latter. Schubert classifies forms which very often occur in the Miocene of

Vöslau as the genus *Box* on the grounds of their resemblance to the recent species *Box boops*. L. Since *Box* Curvier et Valenc., 1830, is a somewhat later synonym of *Boops* Cuvier, 1815, the name of genus of the described species has been changed (vide: D. S. Jordan, 1963, p. 94; W. Weiler, 1968, p. 60).

The average dimensions of Schubert's specimens are somewhat greater then those of our specimen, and they are: length: 5,0 mm, width: 3,0 mm, thickness: 0,8 mm. Among the four specimens presented by Schubert, the specimen in fig. 19 is virtually identical to ours in shape.
Occurrence: Miocene of Czechoslovakia (Moravia, Bohemia), Austria.

Otol. [incertae sedis]
Pl. III, fig. 6

Material: 1 damaged specimen.

Dimensions:	Length	4,7 mm	Ot. M. II/22
	Width	3,1 mm	
	Thickness	0,6 mm	

In the sample from Niskowa one specimen, slightly damaged in the posterior part and with an abrupt rostrum, has been found. The outline of sagitta resembles otoliths of the genus Diplodus (vide: J. Chaine, 1937, pl. XIV, XV). At present, the genus of this otolith cannot be precisely defined. Still, as far as the shape of sulcus is concerned, it bears an extremely close resemblance to otoliths of the representatives of the family Embiotocidae, known from the Eocene.

Our specimen has been compared with otoliths of the genus *Embiotoca* Agassiz, 1853, as well as with other representatives of the family Embiotocidae, e. g. *Rhacochilus* Agassiz, 1854, *Amphistichus* Agassiz, 1854 (vide: F. E. Fitch, 1967, fig. 20; 1970, fig. 5); in all the mentioned forms, a great similarity in the outline of sagitta and, especially, in the shape of sulcus has been found. For comparison we also used original Recent and Pleistocene materials from the Californian coast, which we got by courtesy of J. E. Fitch (USA).

Suborder: Ophidioidei
Family: Fierasferidae Gill, 1864
Genus: *Carapus* Rafinesque, 1810

Carapus nuntius (Koken)
Pl. III, fig. 7

1891 *Otolithus (Fierasfer) nuntius* Koken; E. Koken, p. 99, pl. VI, fig. 2, 2a.
1906 *Otolithus (Fierasfer) nuntius* Koken; R. J. Schubert, p. 666, pl. XIX, fig. 43, 44.
1923 *Otolithus (Fierasfer) nuntius* Koken; O. Posthumus, p. 123, fig. 46, 47.
1952b *Fierasfer nuntius* Koken; E. Weinfurter, p. 157, pl. 1, fig. 10a, 10b.
1958 *Fierasfer nuntius* Koken; W. Weiler, p. 346, pl. 3, fig. 5, 6.

Material: 1 specimen.
Dimensions: Length 2,5 mm Ot. M. II/23
Width 1,4 mm
Thickness 0,6 mm

Description: Otolith of an irregularly oval outline, slightly narrowed in the posterior part, but subacute.

A flat inner face. A straight, closed sulcus acusticus, slightly narrowed in the posterior part. It is entirely filled with colliculum. A long ostium and a very short cauda are not very distinctly separated.

The outer face is markedly convex in the ventral part; it gradually becomes flatter towards the dorsal rim which forms a sharp margin. Slight irregularities are marked on the surface; there occur indistinct furrows.

Remarks: The described otolith corresponds, in principle, to the species *Carapus nuntius* (Koken). It is only somewhat more rounded at both ends and has not so distinct furrows in the ventral part of the outer face. W. Weiler (1971, pp. 24—25) observes that a number of known fossil species, regarded as the genus *Fierasfer*, should be classified among the genus *Carapus* Rafinesque, 1810 (the latter being an earlier synonym of the genus *Fierasfer* Cuvier, 1817), the species *Fierasfer nuntius* Koken, among others.

Occurrence: This species was described as a very rare one from the Middle Oligocene of North Germany (Koken, 1891); from the Upper Oligocene of the Lower Rhine Bay (Weiler, 1958); from the Upper Oligocene — Middle Miocene of Holland; from the Miocene of Austria. It has not been known from Poland, so far.

Suborder: Gobioidei
Family: Gobiidae Bonaparte, 1831
Genus: *Gobius* Linné, 1758

Gobius vicinalis Koken
Pl. III, figs. 8—14; pl. IV, figs. 1, 2a-b

1891 *Otolithus* (*Gobius*) *vicinalis* Koken; E. Koken, p. 133, text-fig. 21.
1906 *Otolithus* (*Gobius*) *vicinalis* Koken; R. J. Schubert, p. 644, pl. XX, fig. 32—34.
1965 *Gobius francofurtanus* Koken; G. Rado, p. 62, pl. III, fig. 14a-b.
1965 *Gobius vicinalis* Koken; G. Rado, p. 63, pl. IV, fig. 18a-b, 20a-b.
1966 *Gobius vicinalis* Koken; T. Śmigielska, p. 260, pl. XVIII, fig. 8, 9, 10, 11 (cum synonimis).
1966 *Gobius vicinalis* Koken; W. Weiler, p. 132, fig. ? 40, 41.
1969 *Gobius vicinalis* Koken; R. Brzobohatý, p. 23, pl. 3, fig. 2—4, ? 1.
1969 *Gobius francofurtanus* Koken; G. Rado, pl. I, fig. 12a-b.
1969 *Gobius vicinalis* Koken; G. Rado, pl. I, fig. 16a-b.
1969 *Gobius laevis* Koken; G. Rado, pl. I, fig. 19a-b, 20a-b, 21a-b.
1970 *Gobius vicinalis* Koken; E. Robba, p. 150, pl. 16, fig. 7a-b.

Material: 228 specimens.

Dimensions:

	Length	Width	Thickness	L:W	Layer	Pl.fig.	Nr of spec.
1.	1,7 mm	1,7 mm	0,35 mm	1,0	18	III,10	Ot.M.II/26
2.	1,7 "	1,8 "	0,30 "	0,9	12	III,12	Ot.M.II/28
3.	1,8 "	2,0 "	0,50 "	0,9	13	III,13	Ot.M.II/29
4.	1,9 "	2,0 "	0,40 "	0,9	12	III,14	Ot.M.II/30
5.	2,0 "	2,1 "	0,50 "	0,9	12	III,11	Ot.M.II/27
6.	2,1 "	2,1 "	0,50 "	1,0	12	III, 9	Ot.M.II/25
7.	2,1 "	2,2 "	0,50 "	0,9	12	III, 8	Ot.M.II/24
8.	2,2 "	2,3 "	0,55 "	0,9	18	IV, 1	Ot.M.II/31
9.	2,7 "	2,6 "	0,65 "	1,04	18	IV, 2	Ot.M.II/32

Description: Otoliths of this species are the most frequent forms in the Lower Tortonian of Niskowa. They are somewhat varied in shape. Those which are virtually identical to Koken's holotype, have an outline resembling a square with rounded domes (pl. III, fig 9), on condition that there is usually a prominent notch in the dorsal, posterior and anterior rims. The greatest variability can be observed in the shape of the dorsal rim, which may be smooth (pl. III, fig. 8), slightly undulating with a single notch (pl. III, fig. 9, 10, 11), or markedly undulating with very distinct 2—3 rounded notches or denticles, especially visible in the posterodorsal dome. In all the specimens the dome is well shaped, raised upwards and produced somewhat backwards. The posteroventral dome is usually truncated, and the anteroventral one — slightly produced forwards.

In the forms (pl. IV, fig. 1, 2a-b) nearly all domes are angular, and the upper part of sagitta is particularly widened. It is strongly marked in the four specimens (e. g. text-fig: 3) by a very prominent posterodorsal dome, resembling *Gobius guerini* Chaine et Duvergier (1923—24, p. 31, pl. I, fig. 29—31), described from the Pliocene of Spain (vide: Smigielska, 1966, p. 261, pl. XVIII, fig. 11; Rado 1968, pl. III, fig. 6a—b). It seems that as far as the outline is concerned, these forms resemble better the species *Gobius vicinalis* than does *G. multipinnatus*, as it consider R. Brzobohatý (1969, p. 25).

The dimensions given above are representative of small and medium specimens, which are in majority in the examined material. There also occur larger or much smaller specimens among the juvenile forms.

Occurrence: Miocene of Germany, Hungary; Helvetian of Moravia; Tortonian of Italy, Austria, Poland and Roumania; Pliocene of Roumania, ? Spain.

Gobius praetiosus Procházka

Pl. IV, figs. 6, 7, ? (3, 4, 5)

1893 *Otolithus* (*Gobius*) *praetiosus* Procházka; V. J. Procházka, pp. 63 (85), pl. III, fig. 2a-b.

1906 *Otolithus (Gobius) pretiosus* Procházka; R. J. Schubert, p. 645, pl. XX, fig. 29—31.
1950 *Gobius pretiosus* Procházka; W. Weiler, p. 231, pl. 4, fig. 25a-b, 27; non pl. 8, fig. 62.
1952a *Gobius pretiosus* Procházka; E. Weinfurter, p. 162, pl. 2, fig. 4a-b.
1965 *Gobius multipinnatus* (H. v. Meyer); R. Brzobohatý, p. 122, pl. 2, fig. 1a-b.
1966 *Gobius multipinnatus* (H. v. Meyer); T. Śmigielska, p. 262, fig. 12a-b, 14, 16 (non fig. ? 13, 15).
1966 *Gobius pretiosus* Procházka; W. Weiler, p. 129, fig. 34—36.
1969 *Gobius praetiosus* Procházka; R. Brzobohatý, p. 29, pl. 3, fig. 11, 12, ? 7.
1969 *Gobius praetiosus* Procházka; W. D. Heinrich, p. 41, fig. 2a-b, 6a-b.

Material: 128 specimens.

Dimensions:

	Length	Width	Thickness	L:W	Layer	Pl.fig.	Nr of spec.
1.	1,2 mm	0,9 mm	0,2 mm	1,3	2	IV, 3	Ot.M.II/33
2.	1,1 "	0,8 "	0,2 "	1,4	2	IV, 4	Ot.M.II/34
3.	2,8 "	1,4 "	0,4 "	1,3	2	IV, 5	Ot.M.II/35
4.	3,9 "	2,8 "	0,6 "	1,4	12	IV, 6	Ot.M.II/36
5.	3,9 "	2,9 "	0,6 "	1,4	12	IV, 7	Ot.M.II/37

The outline and dimensions of the otoliths which have been classified in the present work among the species *Gobius praetiosus* are fairly varied. Among the species of the genus *Gobius*, known from the Miocene, 2 species bear especially numerous features of resemblance. They are: *Gobius multipinnatus* (H. v. Meyer), 1852 and *Gobius praetiosus* Procházka, 1893. It is thus difficult to separate them from each other, as it may be seen in the synonymy given above.

On the grounds of the otoliths found in situ in the Upper Helvetian of Unterkirchberg, W. Weiler (1955) revised the genus *Cottus*? *multipinnatus* H. v. Meyer, stating their affiliation to the genus *Gobius*. This author joins *G. multipinnatus* and *G. praetiosus* together in one species, giving it the name *Gobius multipinnatus* on the grounds of priority.

After the examination of otoliths from Ivančice (Moravia) in 1966, Weiler again separated the two species, on finding that the otoliths of *G. multipinnatus* are relatively higher than those of *G. praetiosus*. In *G. multipinnatus* the ratio $\frac{\text{length}}{\text{width}} = 1{,}4$ (Weiler 1955).

Having considered this characteristic, it seems that among the otoliths described before (Śmigielska, 1966), the specimens in pl. XVIII, fig. 12, 13, 14, 15 may be classified among *G.* cf. *multipinnatus*. However, on the basis of the outline, the specimens in fig. ?13, 15 can be compared with G. multipinnatus.

Among the otoliths from Niskowa, the specimens in pl. IV, fig. 3, 4, 5, coming from the same sample, may be classified as *Gobius* cf. *multipinnatus*.

G. Rado (v. 1968, pl. III, fig. 5, 7, 8) illustrates otoliths occurring in the Sarmatian of Roumania, which are virtually identical to the mentioned above from Niskova, as far as their outline is concerned. This author classifies the presented otoliths among *G. multipinnatus*.

Our remaining forms correspond better to the otoliths of the species *G. praetiosus*. Yet, since the criteria which have been refered to often do not allow an explicit classification of a given specimen among one of the species mentioned above, we leave it an open question for the present.

Occurrence: Helvetian of Moravia; Tortonian of Austria, Bohemia, Poland; Upper Miocene of NW Germany; Middle and Upper Miocene and Pliocene of Roumania; Pliocene of Hungary.

Gobius cf. *francofurtanus* Koken

Pl. IV, figs. 8a-b, 9a-b

1891 *Otolithus* (*Gobius*) *francofurtanus* Koken; E. Koken, p. 132, pl. VI, fig. 7, 7a.
1963 *Gobius francofurtanus* Koken; W. Weiler, pp. 40—44, text-fig. 169—187.
1968 *Gobius francofurtanus* Koken; G. Rado, pl. III, fig. 3a-b, (non. 4a-b).
1969 *Gobius francofurtanus* Koken; R. Brzobohatý, p. 25, fig. 1—7.

Material: 2 specimens.

Dimensions:

	Length	Width	Thickness	L:W	Layer	Pl.fig.	Nr of spec.
1.	3,4 mm	2,6 mm	0,6 mm	1,3	12	IV,8a-b	Ot.M.II/38
2.	4,1 mm	2,9 mm	0,9 mm	1,4	12	IV,9a-b	Ot.M.II/39

Description: Our specimens have the dorsal rim very distinctly and characteristically denticulated. A smooth ventral rim. The posterodorsal dome is well shaped and markedly produced; the anterodorsal one is rounded. The posterior part of sagitta is rounded and not produced.

On the inner face, the ventral furrow and area are strongly marked. The outer face is convex, with a slight depression in the umbonal part and distinct furrows running from notches in the rim line.

Comparison: Our specimens are larger than the ones described by Weiler (1963) and Brzobohaty (1969). Weiler's longest specimen is 1,94 mm long and 1,56 mm wide; the ratio $\frac{\text{length}}{\text{width}} = 0{,}9—1{,}3$, while Brzobohatý's one is 2,7 mm in max. length and 2,3 mm in max. width; the ratio $\frac{\text{length}}{\text{width}} = 1{,}1—1{,}3$.

In Koken's holotype the posterodorsal dome forms the greatest projection in the dorsal rim. In our specimens the highest one is the middle part of the dorsal rim; they have not a produced posteroventral part of sagitta as in Koken's specimen, either.

Our otoliths bear an extremely close resemblance to certain specimens of *Gobius francofurtanus*, described by Weiler (vide: text-fig. 171,

172, 175, 176) and Brzobohatý (pl. 4, fig. 6, 7). The latter are still somewhat shorter but also higher then our specimens. Also one of G. Rado's specimens (1968, pl. III, fig. 3a—b) correspond to ours, as far as the outline is concerned.

Occurrence: Lower Miocene (Aquitanian) of Germany — frequent; Upper Miocene of Germany — rare; Lower Miocene of South Moravia; Sarmatian of Roumania.

Gobius telleri Schubert

Pl. V, figs. 1—3

1906 *Otolithus (Gobius) Telleri* Schubert; R. J. Schubert, p. 648, pl. XX, fig. 27, 28.
1952a *Gobius telleri* Schubert; E. Weinfurter, p. 162, pl. 2, fig. 5a, b.
1965 *Gobius telleri* Schubert; G. Rado, p. 62, pl. III, fig. 13a-b.
1966 *Gobius telleri* Schubert; T. Śmigielska, p. 263, pl. XIX, fig. 1a, 1b.

Material: 12 specimens.

Dimensions:

Length	Width	Thickness	Nr of spec.	Pl.fig.
2,2 mm	1,9 mm	0,5 mm	Ot.M.II/40	V, 1
1,7 mm	1,5 mm	0,3 mm	Ot.M.II/41	V, 2
2,2 mm	1,0 mm	0,5 mm	Ot.M.II/42	V, 3

Our specimens quite agree with Schubert's specimens and they, undoubtedly, represent the same species. It is indicated by a characteristic, trapezoidal outline, as well as by the shape of sulcus with a particularly widened ostial part. Some otoliths display slight deformation, probably caused by fluctuations in the sea salinity in the littoral zone, connected with the inflow of fresh waters.

The specimen in pl. V, fig. 3 displays marks of polishing.

Occurrence: Miocene (Tortonian) of Austria; Miocene of Hungary, Czechoslovakia, Roumania, Poland. Schubert also describes this species from the Pliocene of Italy.

Suborder: Cottoidei
Family: Cottidae Richardson, 1836

Otol. [Cottidarum] modestus n. sp.

Pl. V, fig. 4a-b; text-fig. 4.

Holotypus: left sagitta; pl. V, fig. 4a-b; Ot. M. II/43
Locus typicus: Niskowa near Nowy Sącz
Stratum typicum: Lower Tortonian
Derivatio nominis: modestus (lat.) = modest
Diagnosis: The left sagitta resembles a triangle with rounded angles in the outline. The dorsal rim is raised, the posterior one is rounded. Rostrum produced forwards, subacute. A small antirostrum; a distinct excisura.
Material: 1 specimen.

Dimensions: Length 1,55 mm Ot. M. II/43
Width 0,80 mm
Thickness 0,30 mm

Description: A convex inner face. Sulcus distinctly divided into ostium and cauda by protrusion in the place collum. An open ostium; its lower and upper edges form a fairly acute angle. Cauda in form of a deep groove with steep margins; it is somewhat wider and slopes downwards in the posterior part. The posterior portion of cauda is far away from the rim. A visible ventral line. The ventral area is slightly raised. A shallow area above sulcus.

A convex outer face with not quite smooth surface. On the rostrum there are slight, radial furrows.

Remarks: The described, well preserved otolith bears the closest resemblance to otoliths of the family Cottidae, when we consider the characteristics of morphology (vide: J. E. Fitch, 1967; 1968, fig. 2, the Pleistocene of California). It can be also compared with specimens of the recent species *Cottus bubalis* Euphr. (J. Chaine et J. Duvergier, 1934, p. 159, pl. V; it differs from the latter in a more rounded rostrum, as well as in a less elongated and more rounded posterior part of sagitta.

Among fossil otoliths, described in the quoted works, there has not been found a form which might correspond to our specimen, as far as morphology is concerned. *Otol* [*Cottidarum*] *sulcatoides* Schubert 1906, p. 642, pl. XVIII, fig. 37, described from the Tortonian of Vöslau, differs widely in the shape of sagitta. Also *Otol. [Cottidarum] degrangei* Priem, 1914, p. 245, fig. 1, from the Oligocene of SW France, has an entirely different outline.

Family: Triglidae Risso, 1826
Subfamily: Triglinae
Genus: *Trigla* Linné, 1758

Trigla rhombica Schubert

Pl. V, figs. 5a-b, 6, 7a-b, 8

1906 *Otolithus (Trigla) rhombicus* Schubert; R. J. Schubert, p. 641, pl. XX, fig. 6, 7.
1914 *Otolithus (Trigla) rhombicus* Schubert; F. Priem p. 272, fig. 65.
1952c *Trigla rhombica* Schubert; E. Weinfurter, p. 477.
1969 *Trigla rhombica* Schubert; W. D. Heinrich, p. 43, pl. X, fig. 4ab.
1969 *Trigla rhombica* Schubert; P.A.M. Gaemers, p. 15, pl. 3, fig. 9ab.

Material: 10 specimens.

Dimensions:

	Length	Width	Thickness	L:W	Layer	Pl.fig.	Nr.of spec.
1.	±3,0 mm	2,5 mm	0,3 mm	1,2	18	V, 8	Ot.M.II/47
2.	2,3 mm	1,9 mm	0,3 mm	1,2	18	V, 5	Ot.M.II/44
3.	2,2 mm	2,2 mm	0,3 mm	1,0	12	V, 6	Ot.M.II/45
4.	2,0 mm	1,9 mm	0,3 mm	1,0	12	V, 7	Ot.M.II/46

Description: We have ten otoliths in the material: four are preserved in full shape, the others have damaged anterior parts. All the

otoliths resemble a rhomb, as far as their shape is concerned. The dorsal rim is markedly arched, generally in the posterior part, while the ventral one — in the anterior part. At the later stages of growth of otoliths, the rims are slightly notched; at the earlier ones the notches are more distinct, smaller and more numerous. From the notches in the rim there disperse radial furrows (pl. V, fig. 7a—b), especially prominent on the outer face of sagitta. Rostrum more produced forwards than antirostrum. A distinct excisura, deeply incised.

A convex inner face. Sulcus placed supramedially. A wide ostium, only somewhat shorter than cauda. Behind ostium, a narrower and raised collum is marked. In the posterior part, the cauda curves slightly upwards, becomes wider and deeper. A very distinct, arched crista superior; above it a depressed area is marked in most specimens.

In all the otoliths the ventral area is convex. The outer face of sagitta is concave, with prominent, usually radial furrows and folds.

Remarks: Our specimens bear a resemblance to the description of the species *Trigla rhombica*, quoted by Schubert from the Tortonian of Austria on condition, however, that the author presented a specimen damaged in the anterior part as a holotype; in consequence, no excisura can be seen in it, and this detail is missed in the description.

The species *Trigla schuberti* Posthumus, described from the Upper Oligocene and Miocene of Holland (1923), and then by Weiler (1958, pl. 348, pl. III, fig. 11—13), from the Middle Miocene of the Lower Rhine Bay, resembles our specimens in morphology. Still, it has a very acute rostrum and antirostrum.

Among our specimens in the material from the same sample, we have forms which correspond to the species *Trigla rhombica* Schub: they are usually larger. There are also smaller specimens, richly ornamented, resembling the species *Trigla schuberti* Posth. However, it does not seem possible to separate our specimens into two different species. We presume that the observed differences show only various stages of growth of the same species.

Occurrence: Burdigalian of France; Miocene (Tortonian) of Austria; Miocene of Belgium; Upper Miocene of NW Germany. It has not been known from Poland, so far.

Order: Pleuronectida
Family: Bothidae
Genus: *Arnoglossus* Bleeker, 1862

Arnoglossus inconspectus n. sp.
Pl. V, fig. 10; Text-fig. 5

Holotypus: left sagitta; pl. V, fig. 10; Text-fig. 5 Ot. M. II/49
Locus typicus: Niskowa near Nowy Sącz
Stratum typicum: Lower Tortonian
Derivatio nominis: inconspectus (lat.) = unnoticed

Diagnosis: The outline of sagitta irregularly tetragonal, rounded in the place of the anterodorsal and anteroventral domes. Very prominent posterodorsal and posteroventral domes. A straight ventral rim. A deep sulcus, which runs obliquely and rises from ostium to cauda. It is surrounded with a thick, rounded thickening. A deep area. The ventral area below crista inferior markedly depressed.

Material: 1 specimen

Dimensions: Length 1,9 mm Ot. M. II/49
Width 1,3 mm
Thickness 0,5 mm

Description: Otolith of an irregularly tetragonal outline. In the anterior part there is a slightly marked excisura. A small, subacute rostrum; a rounded antirostral part. In the posterior part, the posterodorsal and posteroventral domes can be easily seen. An arched posterior rim; the ventral one is straight. The sulcus runs obliquely. Ostium larger then cauda, open in the anterior part; it becomes narrower and deeper in the posterior one. A distinct collum; a small cauda, markedly depressed and rounded in the posterior part. Its end is visibly far away from the posterior rim. Crista superior and crista inferior form a massive thickening, which surrounds sulcus.

A very prominent area, markedly depressed. Below crista inferior a similar, strongly marked depression can be seen. A slightly convex outer face, nearly smooth, with a slight thickening in umbo.

Remarks: The described otolith belongs, undoubtedly, to the family Bothidae and shows characteristics of the genus *Arnoglossus*.

J. Chaine (1936, pl. III) illustrates the recent species: *Arnoglossus grohmanni* Bonaparte, *A. laterna* (Walbaum) and *A. conspersus* Günter, though he joins the latter to the previous one. With visible variability of shape, the remaining basic features of the morphology of sagitta in recent and fossil fishes of this species are the same. Our specimens differs from the species mentioned above mainly in smaller dimensions.

Among few fossil species of this genus, which have been known so far, there should be mentioned *Arnoglossus holleri,* described by Weinfurter in 1952 from the Tortonian of Austria, which differs from our form in an exactly horizontally placed sulcus, and *Arnoglossus miocenicus*, described by Weiler in 1962 from the Miocene of Twistringen (North Germany). The latter differs from our specimen in the outline and nearly horizontally placed sulcus, which is visibly oblique in the specimen from Niskowa.

Family: Soleidae Bonaparte, 1833
Genus: *Solea* Quensel, 1806

Solea subglabra Schubert
Pl. V, fig. 9a-b

1906 *Otolithus (Solea) subglaber* Schubert; R. J. Schubert. p. 672, pl. XX, fig. 19—26.

1952b *Solea subglaber* Schubert; E. Weinfurter, p. 166, pl. 2, fig. 11a-b.

Material: 1 specimen.

Dimensions: Length 3,0 mm; L : W = 1,5 Ot. M. II/48
Width 2,0 mm
Thickness 0,5 mm

Description: A widely elliptic otolith, with a very slightly marked posterodorsal dome; it is rounded in the posterior part. A short, subacute rostrum. Antirostrum in form of a small denticle. The rims of sagitta nearly sharp.

Sulcus placed in the middle of inner face, which is relatively convex. Ostium longer than cauda, open on the anterior rim. A prominent collum. Sulcus is filled with collicula; only in the middle there is a small groove, running along the sulcus through its length. Crista inferior and crista superior are very strongly marked; they form a rounded protrusion which surrounds the sulcus. From the outside, the whole sulcus is surrounded with a depression.

A slightly convex outer face, with concentric depressions.

Remarks: Our otolith bears a close resemblance to the description of the species *Solea subglaber*, quoted by Schubert from the Miocene of Austria. This author mentions variability in the outline of these otoliths, which he also presents on the included photographs. Our otolith is rather elliptic in shape and especially resembles Schubert's specimen in fig. 26, rarer in his material; it can be also compared with the specimens in fig. 19, 20, 23, 25. In the remining ones, there is a prominent antedorsal dome, which is absent in the specimens from Niskowa. There can be also observed a certain similarity in dimensions and in the length-width relation (the ratio $\frac{\text{length}}{\text{width}} = 1{,}5$), both in our specimen and in the specimens from Vöslau.

However, in Schubert's specimens (except the otolith in fig. 19) there cannot be observed such a marked depression round sulcus as in our specimen.

Frizzel and Dante, 1965 (pp. 715—716), introduce the new genus *Eosolea*, which differs from *Solea* in sulcus being not divided into ostium and cauda, and in its opening on the anterior rim of sagitta. The authors include, among others, the species *Solea subglaber* Schubert, into the new genus *Eosolea*.

In Schubert's specimens there is a division into ostium and cauda, though not a very distinct one; the division is strongly marked in our otolith. Therefore, we regard Schubert's specimens as well as ours, as belonging to the genus *Solea* and not *Eosolea*.

REMARKS ON THE OCCURRENCE AND PALEOECOLOGY OF OTOLITHS FROM NISKOWA

The fauna of fossil fishes in the Lower Tortonian of Niskowa is represented by otoliths and few teeth. Among otoliths, 15 genera and 7 forms of an uncertain taxonomical position have been classified. In general, 25 species have been distinguished; among them 2 species have been considered as new ones.

Table 1

	Name of otolith	general number of spec.	Number of layer						
			2	11	12	13	15	18	20
1.	Gadus elegans Koken	5	1		2	1		1	
x 2.	Merluccius vulgaris Fleming	1			1				
x 3.	Mugil applanatus /Rzehák/	3		1	1				
x 4.	Serranus an sp. nova	1			1				
x 5.	Centropristis integer Schubert	2			2				
x 6.	Perca aff.praefluviatilis Weiler	1			1				
x 7.	Otol. [Percidarum] oblongus Brzoboh.	2	2						
x 8.	? Orthopristis vöslauensis /Schub./	1			1				
9.	Sparus doderleini /Bass. et Schub./	2			1			1	
x 10.	Otol. [Sparidarum] sp.	3			3				
11.	Dentex latior Schubert	16		2	2			12	
x 12.	Pagrus distinctus /Koken/	2			2				
x 13.	Pagrus sp.	2			2				
x 14.	? Diplodus sp.	2			2				
x 15.	Otol. [incertae sedis]	1					1		
x 16.	? Boops insignis /Procházka/	2			1			1	
x 17.	Carapus nuntius /Koken/	1			1				
18.	Gobius vicinalis Koken	228	3		192	12	8	9	4
19.	Gobius praetiosus Procházka	128		1	104		16	5	2
20.	Gobius telleri Schubert	12			10		2		
x 21.	Gobius cf.francofurtanus Koken	2			2				
x 22.	Otol. [Cottidarum] modestus n.sp.	1					1		
x 23.	Trigla rhombica Schubert	10			8	1		1	
x 24.	Arnoglossus inconspectus n.sp.	1			1				
x 25.	Solea subglabra Schubert	1							1
	Total otoliths	430							

x Species described from Poland for the first time

The examined otoliths are irregularly placed in the profile of the deposits of Niskowa. They have been found in the layers: 2, 11, 12, 13, 15, 18, 20. The richest assemblage containing 21 forms, occurs in layer 12, then in the layers 18 (7 species), 15 (5 species), 13 (4 species). The

remaining layers, in which otoliths have been found, are: 2, 11, 20. Each of them contains 3 species (table 1).

The genus *Gobius* is the most frequent one. It is represented by 4 species: *Gobius vicinalis* Koken (228 specimens), *G. praetiosus* Procházka (128 specimens), *G. telleri* Schubert (12 specimens), *G.* cf. *francofurtanus* Koken (2 specimens). There is striking abundance of the species *G. vicinalis* and *G. praetiosus* in layer 12.

Among the genus *Pagrus,* 2 species have been distinguished in this layer. Other genera occur as single species.

Dentex latior Schubert (16 specimens) and *Trigla rhombica* Schubert (10 specimens) should be considered relatively frequent.

There occur, in small numbers, *Gadus elegans* Koken (5 specimens), *Mugil applanatus* (Rzehak) — (3 specimens), *Centropristis integer* Schubert (2 specimens), *Otol.* [*Percidarum*] *oblongus* Brzobohatý and *Otol.* [*Sparidarum*] sp. (3 specimens in each), *Sparus doderleini* (Bassoli et Schubert), *Pagrus distinctus* (Koken), *Pagrus* sp., ? *Diplodous* sp., ? *Boops insignis* (Procházka) — 2 specimens in each. The remaining forms are quite rare; they occur only as single otoliths.

Table 2

Genus	Depth zones			nekton	benthos	Climatic zones			
	littoral	pelagic	bathypelagic			tropical	subtropical	temperate	cold
Gadus	+	+		+			+	+	+
Merluccius	+			+					
Mugil	+					+	+	+	
Serranus	+			+		+	+	+	
Centropristis	+					+	+	+	
Sparus	+					+	+	+	
Dentex	+	+		+		+	+	+	
Pagrus	+			+		+	+		
Carapus	+					+	+	+	
Gobius	+			+	?	+	+	+	+
Trigla	+			+	?		+	+	
Solea	+				+	+	+	+	

The character of the whole assemblage indicates a rather shallow sea. The majority of genera of fishes, which have been found here, indicate a littoral, shallow-sea environment. Some of them occur abundantly (*Gobius*), or numerously (*Trigla*); others, e.g. *Carapus, Arnoglossus, Solea,* as single specimens. Also representatives of the genera: *Sparus, Pagrus,* ? *Diplodus*, met in river-mouth and lagoons (W. Weiler 1966, p. 139), may indicate littoral environment.

Representatives of the families Myctophidae or Macrouridae, which live in bathypelagic or bathybenthonic zones of open seas, are completely absent here. These families have been already known from the Lower and Upper Tortonian of Poland in the Upper Silesia and the Cracow regions (T. Śmigielska, 1966).

The marine pelagic forms are represented here by the genera: *Gadus, Merluccius, Dentex*; their presence, especially of the genus *Merluccius,* may indicate the connection with an open sea. *Merluccius* lives in deeper waters than Gadus. The recent species *Merluccius merluccius* (L.) is found in the Mediterranean Sea and in the Atlantic Ocean at a depth of 200—300 metres (G. Nikolski 1970, pp. 349—350).

Certain species occurring at Niskowa represent euryhaline forms, e.g. *Gobius*; they are frequent in brackish waters but, at the same time, they are also met in waters of normal salinity or in fresh waters; therefore they are less useful for paleoecology. Also representatives of the family Mugilidae show certain tolerance for the degree of salinity. They live in seas of the tropical, warm and temperate zones, but can also live periodically in estuaries and even migrate into rivers. These migrations are connected with reproduction, which takes place in the sea, while feeding — usually in bays and rivers. They feed on plankton and plants (Suworow 1954, p. 782).

The presence of the species *Mugil applanatus* (Rzehak) and *Perca* aff. *praefluviatilis* Weiler in the assemblage may indicate the neighbourhood of river estuaries. Weiler (1963) considers the species *Perca praefluviatilis* to be a limnetic form.

Most otoliths represent the genera of fishes which live in the warm and temperate zones, e.g. *Mugil, Serranus, Centropristis, Dentex, Pagrus, Carapus, Trigla, Solea* (table 2). Only some of them show a wider thermic tolerance, e.g. the genera *Gadus, Gobius.*

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STRESZCZENIE

Osady tortonu morskiego w Niskowej interesowały badaczy od dawna. Przebieg tych badań o charakterze geologoiczno-paleontologiczno-stratygraficznym przedstawiono we wstępie. Podano również zarys poglądów na sprawę wieku tych osadów, które w okresie kilkudziesięciu lat ulegały stopniowej ewolucji.

W ostatnich latach W. Bałuk (1965—1970) na podstawie szczegółowej analizy materiałów paleontologicznych oraz obserwacji geologicznych prowadzonych w Niskowej przyjął, że osady te zaliczyć należy do dolnego tortonu, przy czym cały profil umieścił w dolnym opolu.

Opracowane obecnie otolity nie wykluczają możliwości przyjęcia takiego poglądu na wiek osadów w Niskowej, chociaż zaznaczyć należy, że otolity ryb nie należą do skamieniałości, które precyzyjnie wyznaczają wiek.

Stwierdzono jednak, że skład jakościowy otolitów różni się od wcześniej poznanych zespołów z osadów górnego i dolnego tortonu południowej Polski.

Otolity w Niskowej reprezentowane są przez 25 gatunków, z których 2 gatunki uznano jako nowe: *Otol.* [*Cottidarum*] *modestus* i *Arnoglossus inconspectus*. 19 gatunków należy do form opisanych po raz pierwszy z Polski.

Otolity pochodzą z profilu, w którym warstwy oznaczono cyfrowo. Rozmieszczenie ich w poszczególnych warstwach nie jest równomierne. Szczegółowo przedstawia to tabela 1.

Najliczniej występuje rodzaj *Gobius*, reprezentowany przez 4 gatunki *G. vicinalis, G. praetiosus, G. telleri, G.* cf. *francofurtanus*, z których dwa pierwsze pojawiają się masowo w pewnych warstwach. Dość licznie występuje *Dentex latior, Gobius telleri, Trigla rhombica*. Nieliczne są *Gadus elegans, Mugil applanatus*, przedstawiciele rodzin Percidae i Sparidae.

Do form rzadkich należą *Merluccius vulgaris, Serranus* an sp. *nova,* ? *Orthopristis vöslauensis, Carapus nuntius, Otol.* [*Cottidarum*] *modestus* n. sp., *Arnoglossus inconspectus* n. sp., *Solea subglabra.*

Wnioski paleoekologiczne, jakie można podać na podstawie analizy całego zespołu, są następujące:

1. Większość otolitów należy do ryb żyjących w wodach litoralnych. Niektóre występują tu niekiedy masowo (*Gobius*), licznie (*Trigla*), lub pojedynczo (*Serranus, Carapus, Arnoglossus, Solea*). Pojawiają się także inne jak *Sparus, Pagrus,* ? *Diplodus* spotykane u ujść rzek lub w lagunach.
2. Z form morskich pelagicznych stwierdzono tu jedynie rodzaje: *Gadus, Merluccius* (rzadki), *Dentex*, co świadczy o połączeniu z morzem otwartym. Potwierdzeniem tego może być również obecność rodzaju *Mugil*, żerującego zwykle w lagunach i przy ujściach rzek, lecz wędrującego do mórz w okresach rozrodu.
3. Rodzaj *Mugil* i *Perca* wskazywać mogą na sąsiedztwo ujść rzecznych, podobnie jak masowe występowanie rodzaju *Gobius,* częstego w wodach brakicznych. Przypuszczalnie wody przybrzeżne w Niskowej stanowiły środowisko częściowo wysłodzone.
4. Brak form głębokowodnych z rodzin Myctophidae i Macrouridae.
5. W badanym zespole większość otolitów reprezentuje ryby zamieszkujące strefy ciepłe i umiarkowane: *Mugil, Serranus, Centropristis, Sparus, Dentex, Pagrus, Carapus, Trigla, Solea.*
   Jedynie *Gadus* i *Gobius* należą do ryb eurytermicznych.
   Cały zespół ma charakter płytkowodny i ciepłolubny.

Zakład Paleontologii i Stratygrafii
Akademii Górniczo-Hutniczej w Krakowie

OBJAŚNIENIA TABLIC
EXPLANATION OF PLATES

Tablica — Plate I

Fig. 1. *Gadus elegans* Koken; left sagitta, 1a-inner face, 1b-outer face, Ot. M. II/1 — x 10

Fig. 2. *Merluccius vulgaris* Fleming; right sagitta, 2a-inner face, 2b-outer face, Ot. M II/2 — x 6

Fig. 3, 4, 5. *Mugil applanatus* (Rzehak); 3-left sagitta, inner face, Ot. M. II/3 — x 9; 4-right sagitta, 4a-outer face, 4b-inner face, Ot. M. II/4 — x 12; 5-right sagitta, inner face, Ot. M. II/5 — x 7

Fig. 6. *Serranus* an sp. *nova*?; right sagitta, 6a-inner face, 6b-outer face, Ot. M. II/6 — x 10

Fig. 7, 8. *Centropristis integer* Schubert; 7-left sagitta, 7a-inner face, 7b-outer face, Ot. M. II/7 — x 15; 8-right sagitta, inner face, Ot. M. II/8 — x 15

Tablica — Plate II

Fig. 1. *Otol.* [*Percidarum*] *oblongus* Brzobohatý; right sagitta, 1a-outer face, 1b-inner face, Ot. M. II/9 — x 16

Fig. 2. *Perca aff. praefluviatilis* Weiler; right sagitta, 2a-outer face, 2b-inner face, Ot. M. II/10 — x 11

Fig. 3. ? *Orthopristis vöslauensis* (Schubert); right sagitta, 3a-inner face, 3b-outer face, Ot. M. II/11 — x 14

Fi. 4. *Otol.* [*Sparidarum*] sp.; left sagitta, 4a-inner face, 4b-outer face, Ot. M. II/12- x 7

Fig. 5, 6. *Sparus doderleini* (Bassoli et Schubert); 5-right sagitta, 5a-outer face, 5b-inner face, Ot. M. II/13 — x 8; 6-right sagitta, inner face. Ot. M. II/14 — x 11

Fig. 7, 8. *Dentex latior* Schubert; 7-left sagitta, 7a-inner face, 7b-outer face, Ot. M. II/15 — x 7; 8-right sagitta, 8a-inner face, 8b-outer face, Ot. M. II/16 — x 7

Tablica — Plate III

Fig. 1, 2. *Pagrus* sp.; left sagitta, 1a-inner face, 1b-outer face, Ot. M. II/17 — x 13; 2-inner face, Ot. M. II/18 — x 12

Fig. 3. ? *Diplodus* sp.; right sagitta, 3a-outer face, 3-b-inner face, Ot. M. II/19 — x 9

Fig. 4. *Pagrus distinctus* (Koken); left sagitta, inner face, Ot. M. II/20 — x 14

Fig. 5. ? *Boops insignis* (Procházka); left sagitta, inner face, Ot. M. II/21 — x 10

Fig. 6. *Otol* [*incertae sedis*]; right sagitta, inner face, Ot. M. II/22 — x 8

Fig. 7. *Carapus nuntius* (Koken); left sagitta, inner face, Ot. M. II/23 — x 15

Fig. 8-14. *Gobius vicinalis* (Koken); 8, 9, 11, 12, 14 — left sagitta, inner face; 8-Ot. M. II/24 — x 10; 9-Ot. M. II/25 — x 10; 11-Ot. M. II/27 — x 11; 12-Ot. M. II/28 — x 13; 14-Ot. M. II/30 — x 13; 10, 13 — right sagitta, inner face; 10-Ot. M. II/26 — x 13, 13-Ot. M. II/29 — x 13

Tablica — Plate IV

Fig. 1, 2. *Gobius vicinalis* Koken; 1-right sagitta, inner face, Ot. M. II/31 — x 12; 2-left sagitta, 2a-outer face, 2b-inner face, Ot. M. II/32 — x 10

Fig. 3, 4, 5. *Gobius praetiosus* Procházka; 3-left sagitta, inner face, Ot. M. II/33 — x 21; 4-left sagitta, inner face, Ot. M. II/34 — x 19; 5-left sagitta, inner face, Ot. M. II/35 — x 9

Fig. 6, 7. *Gobius praetiosus* Procházka; 6-right sagitta, 6a-inner face, 6b-outer face, Ot. M. II/36 — x 9; 7-right sagitta, inner face, Ot. M. II/37 — x 10

Fig. 8, 9. *Gobius cf. francofurtanus* Koken; 8-right sagitta, 8a-inner face, 8b-outer face, Ot. M. II/38 — x 10; 9-right sagitta, 9a-inner face, 9b-outer face, Ot. M. II/39 — x 9

Tablica — Plate V

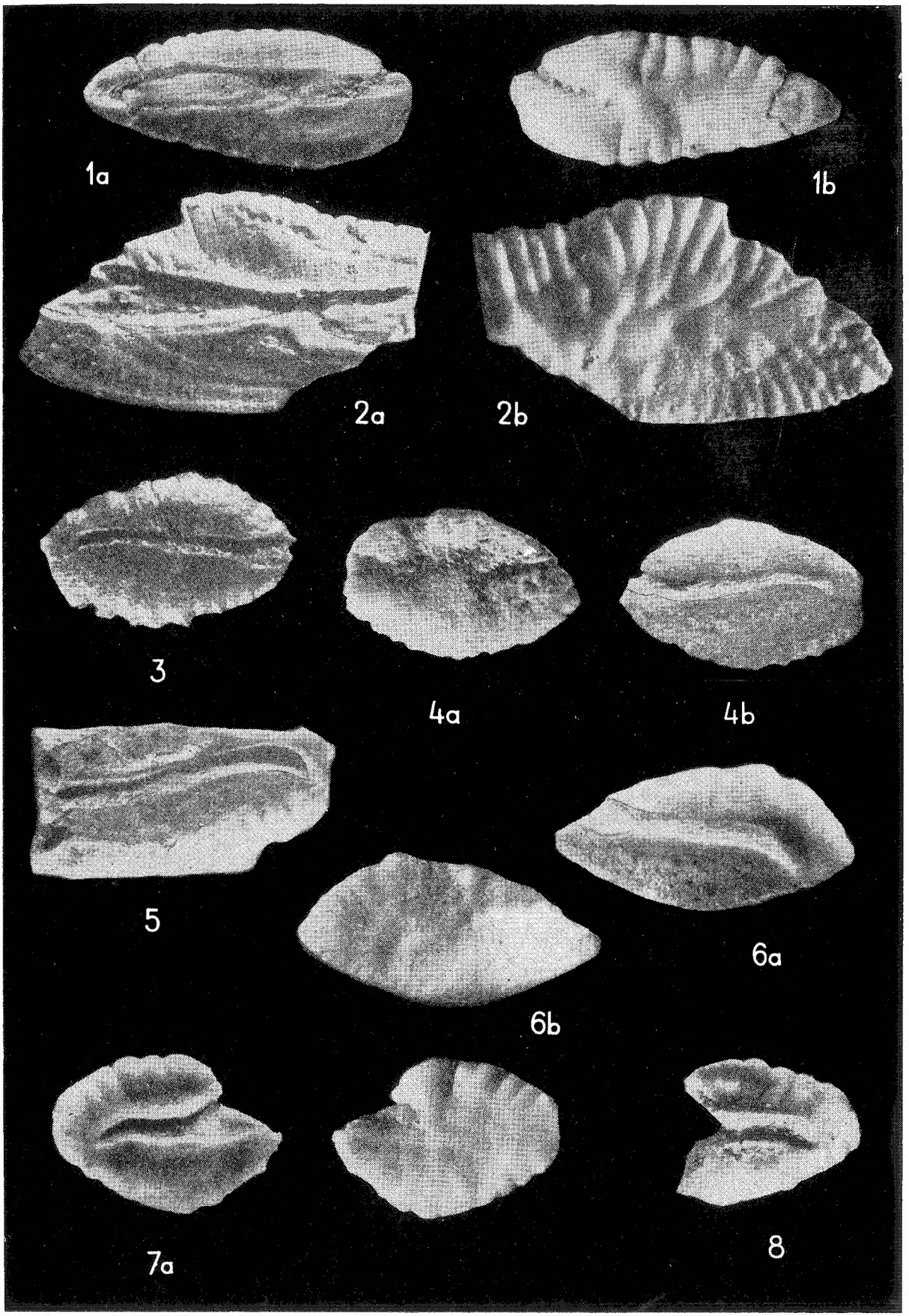
Fig. 1, 2, 3. *Gobius telleri* Schubert; 1-right sagitta, inner face, Ot. M. II/40 — x 12; 2-left sagitta, inner face, Ot. M. II/41 — x 14; 3-right sagitta, inner face, Ot. M. II/42 — x 13

Fig. 4. *Otol.* [*Cottidarum*] *modestus* n. sp.; left sagitta, 4a-inner face, 4b-outer face, holotype: Ot. M. II/43 — x 23

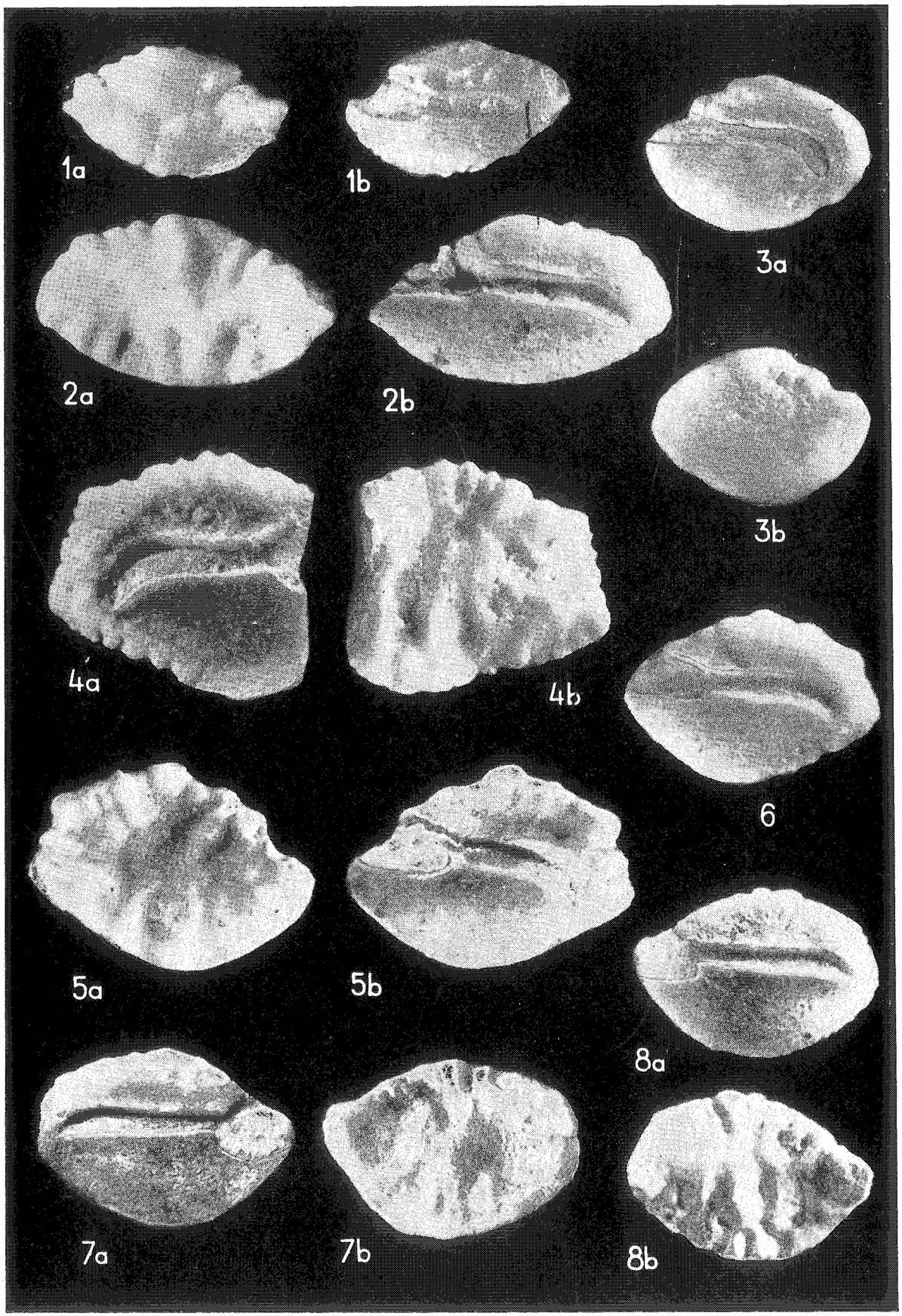
Fig. 5—8. *Trigla rhombica* Schubert, 5-left sagitta, 5a-inner face, 5b-outer face, Ot. M. II/44 — x 12; 6-left sagitta, inner face, Ot. M. II/45 — x 12; 7-right sagitta, 7a-outer face, 7b-inner face, Ot. M. II/46 — x 14; 8-right sagitta, inner face, Ot. M. II/47 — x 11

Fig. 9. *Solea subglabra* Schubert; right sagitta, 9a-outer face, 9b-inner face, Ot. M. II/48 — x 12

Fig. 10. *Arnoglossus inconspectus* n. sp.; left sagitta, inner face, holotype; Ot. M. II/49 — x 14



T. Śmigielska



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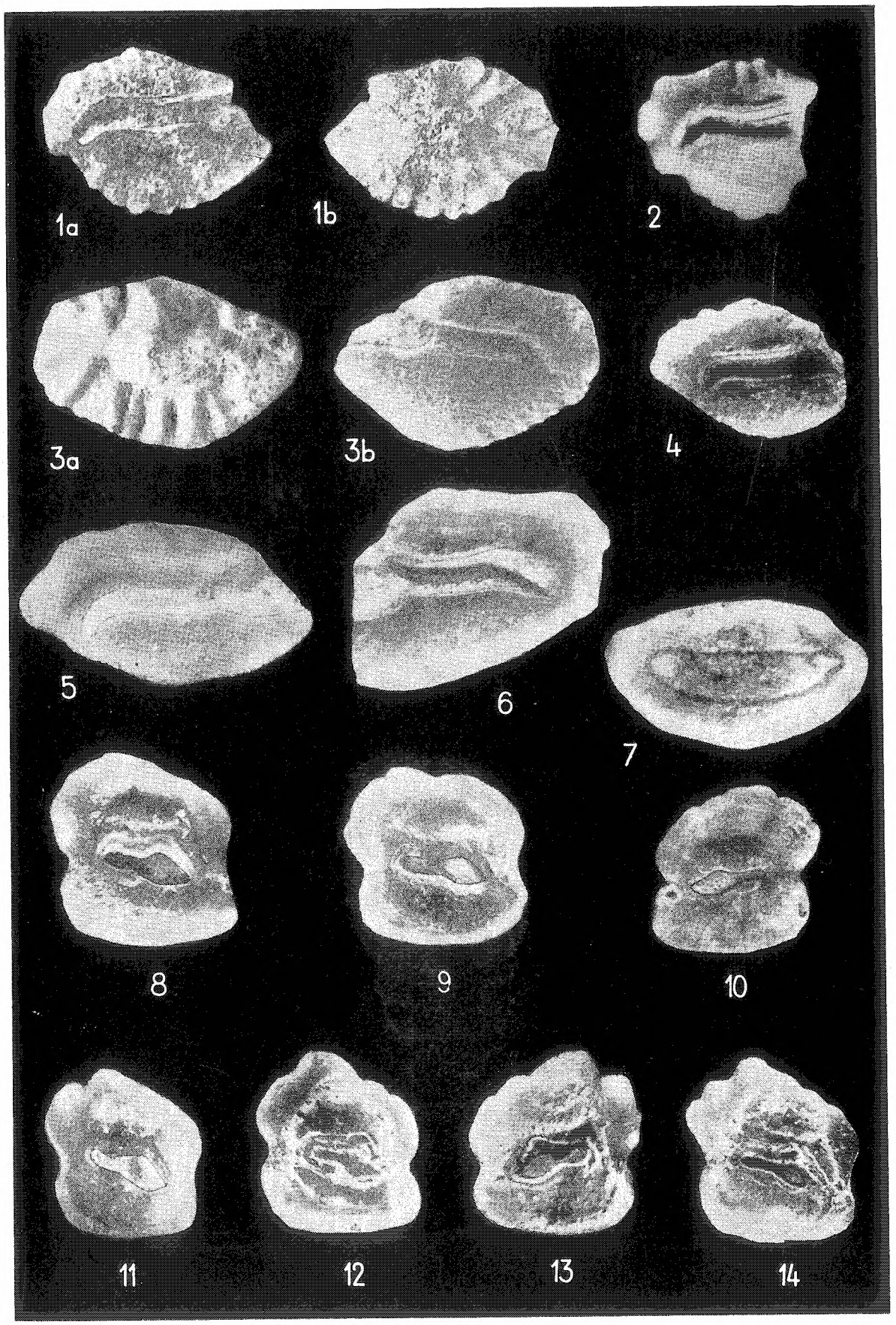

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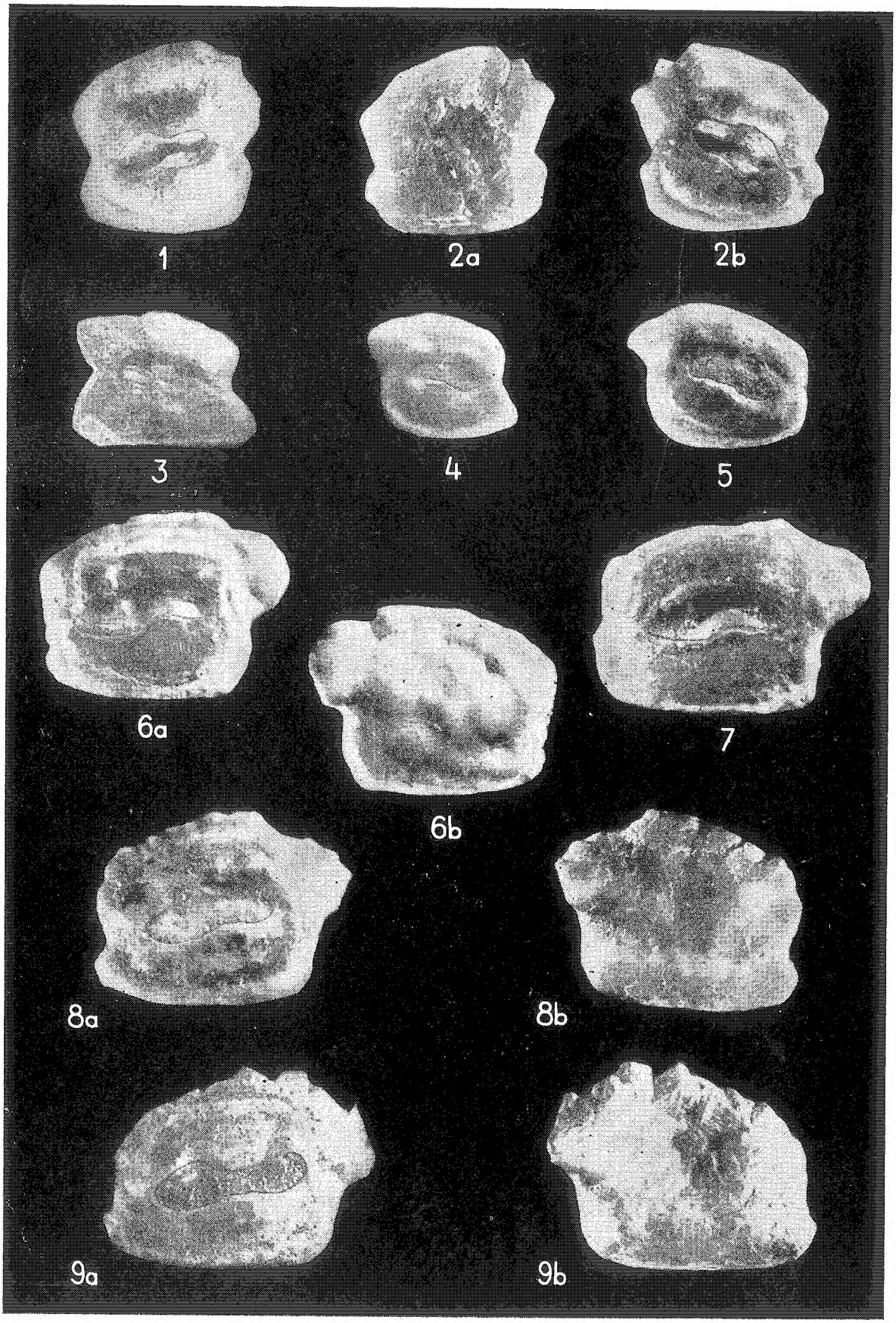

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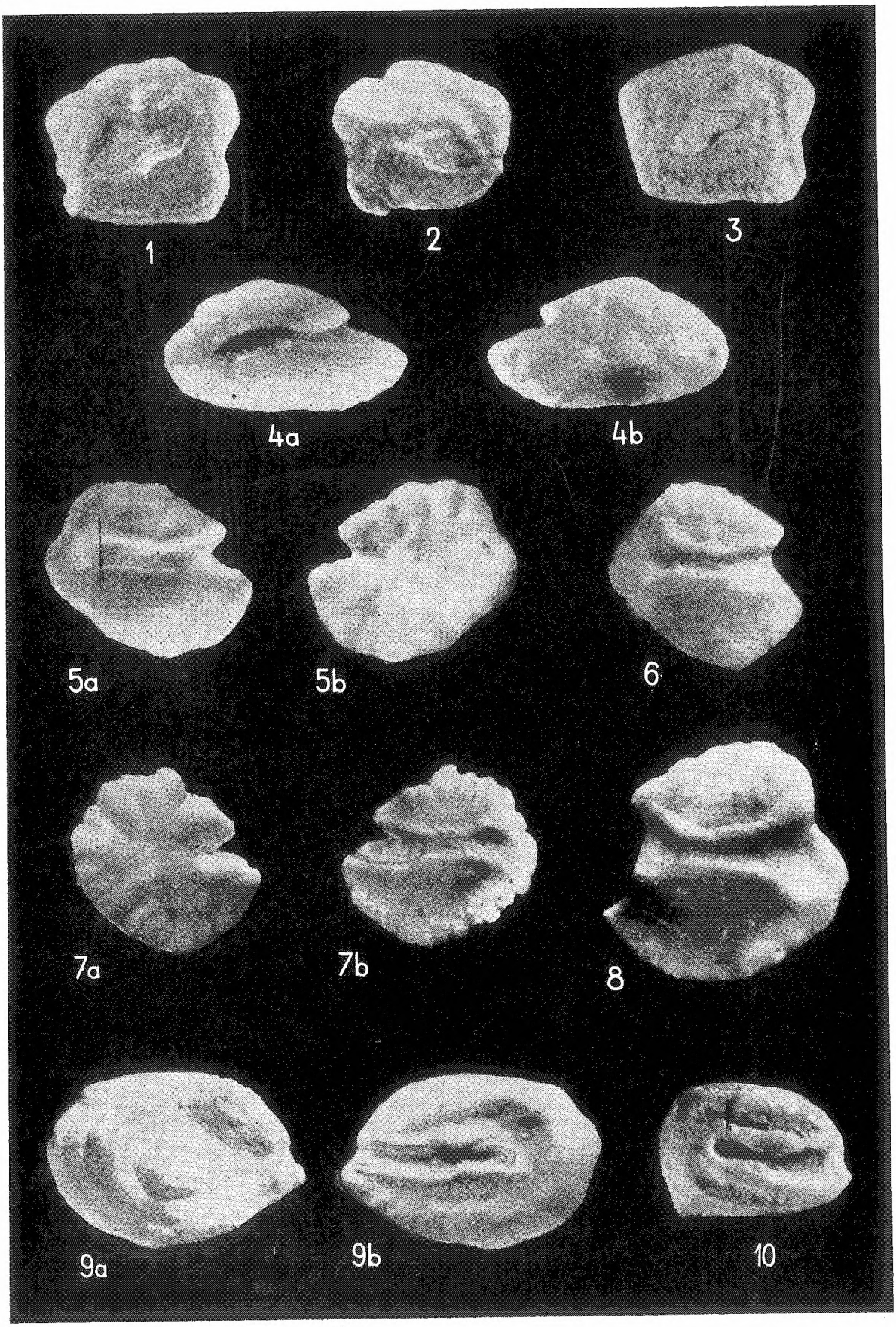

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