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FISH OTOLITHS FROM THE MIDDLE OLIGOCENE OF SIADŁO GÓRNE NEAR SZCZECIN, POLAND, AND THEIR STRATIGRAPHICAL IMPORTANCE

by

Pieter A. M. Gaemers
Leiden

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Otoliths of seven bony fish species were found in erratic limonitic sandstone at Siadło Górne. Gadidae dominate strongly in this fauna with five species, and all but five specimens belong to this family. The age of the sandstone is early Middle Oligocene, for the *Colliolus minutulus* Lineage-zone was recognized. From this and from literature data it is concluded that the sandstone does not belong to the Stettin Sand, but represents a lateral extension of the Neustadt-Magdeburg Sand. The facies of the Stettin Sand and the Neustadt-Magdeburg Sand are very similar.

Palaeoraniceps is the most common genus. A revision of this genus was possible and a new genus, *Igecepeia*, closely allied to it, is introduced.

Dr P.A.M. Gaemers, Zwenkgras 3, 2318 TH Leiden, The Netherlands.

Contents:

SAMENVATTING

Een kleine otolietenfauna, bestaande uit zeven soorten en afkomstig uit limonitische zandsteen, wordt hier beschreven. De vindplaats ligt aan de westzijde van een voormalige spoorweginsnijding bij Siadło Górne, een dorpje niet ver verwijderd van Stettin in NW-Polen. Het materiaal werd verzameld en uitgeprepareerd door de heer A.W. Janssen.

De zandsteen is van midden-oligocene ouderdom, werd samen met andere midden-oligocene en kwartaire afzettingen gestuwd door het landijs in het Pleistoceen, en ligt derhalve niet meer in situ.

De otolieten behoren tot de *Colliolus minutulus* Lineage-zone, waarmee de nauwkeurige ouderdom op het vroegste deel van het Midden-Oligoceen kan worden bepaald. Dit betekent, dat de zandsteen correleert met de Zanden van Berg en/of Nucula Klei in noordoost België en met het onderste deel van de Afzetting van Brinkheurne (septariënklei) in de Achterhoek.

Uit dit gegeven en uit gegevens in de literatuur blijkt, dat het zeer onwaarschijnlijk is dat de zandsteen gerekend kan worden tot het Stettiner Zand, dat in het jongere Midden-Oligoceen geplaatst wordt. Geconcludeerd wordt, dat het een laterale uitbreiding betreft van het Neustadt-Magdeburger Zand dat van Oost-Duitsland bekend is. Ten noorden van Stettin is deze afzetting altijd fossielloos en de fossielen van Siadło Górne zijn kennelijk tot voor kort aan de aandacht ontsnapt.

De kabeljauwachtigen domineren sterk met vijf soorten, en nog duidelijker met het aantal individuen. *Palaeoraniceps* komt het meest voor. Dankzij deze otolieten en materiaal van andere vindplaatsen kon dit fossiele geslacht gereviseerd worden. Een nieuw genus, *Igecepeia*, dat nauw verwant is aan *Palaeoraniceps*, wordt ingevoerd. De nieuwe naam is afgeleid van het International Geological Correlation Programme; deze publikatie is een bijdrage aan projekt 124 van dit I.G.C.P.

INTRODUCTION

During a collecting trip in Poland in September 1979 Mr A.W. Janssen visited a number of Tertiary localities together with Dr G. Jakubowski (Warsaw) in order to collect molluscs for the National Museum of Geology and Mineralogy at Leiden.

In the Middle Oligocene of Siadło Górne he collected a highly interesting molluscfauna. The locality is on the west side of a former railway cut at Siadło Górne, a village southwest of Szczecin, only a few kilometers from the border with the German Democratic Republic. The fossils come from a limonitic sandstone which was pushed by glaciers in the Pleistocene ice ages together with other Tertiary and Quaternary deposits (Kociszewska-Musiałowa & Kosmowska-Ceranowicz, 1969). The beds were strongly deformed and were displaced over some distance, probably from a northern direction. In a letter to Mr Janssen, written in April this year, Dr Jakubowski reports that Quaternary deposits are underlying the Oligocene strata, thus proving that the Tertiary beds are on a secondary place at Siadło Górne.

When preparing the molluscs from the sandstone Mr Janssen found a relatively large number of otoliths which are described in this paper. All material larger than 0.4 mm was picked out from the sediment sample. The otoliths are kept in the collection of the National Museum of Geology and Mineralogy at Leiden.

ACKNOWLEDGEMENTS

I am thankful to Mr A.W. Janssen (National Museum of Geology and Mineralogy, Leiden) for placing the material at my disposal. He also suggested the name *Igecepeia* for the new gadid genus. I am grateful to Mr D. Grüll (Gernsheim, Federal Republic of Germany) and Dr V.W.M. van Hinsbergh (Leiden) for their permission to study large numbers of otoliths of *Palaeoraniceps latisulcatus*, from the 'Unterer Meeressand' (sand-pit 'Zeilstück' at Weinheim, Mainz Basin, Federal Republic of Germany) and the Berg Sands (Borgloon, Belgium), respectively. I am also grateful to Dr W. D. Heinrich (Museum für Naturkunde an die Humboldt-Universität, Berlin, German Democratic Republic) for his kindness to send me Koken's type material of several gadid otoliths.

I wish to thank Messrs W.A.M. Devilé and J. Verhoeven (National Museum of Geology and Mineralogy, and Geological Institute, Leiden) for the well-prepared photographs.

Finally I wish to thank the Niels Stensen Foundation; this study was partly carried out during the stipend period granted to the author by this foundation.

STRATIGRAPHICAL CONCLUSIONS

From the area North of Szczecin otoliths were described by Richter (1928). His material originates from the Stettin Sand, in which otoliths seem to be extremely numerous. He mentions the following species in order of abundance: *Gadi tuberculosus*, Gadidarum *elegans*, *Merluccius esculentus* Risso, 1826, (inc. sed.) *umbonatus*, *Serranus noetlingi*, Gadidarum *faba* and Gadidarum *stettiniensis*.

Martini (1964, 1968) described otoliths of ten species from erratic stones (so-called 'Stettiner Gestein') from Sternberg and the left bank of the river Oder near Szczecin (= Stettin): *Raniceps tuberculosus*, *R. latisulcatus*, *R. planus* (Koken, 1884), *Gadus elegans*, *Palaeogadus emarginatus*, *P. stettinensis*, *Morrhua faba*, *Serranus noetlingi*, *Pterothrissus umbonatus* and *P. minor* (Koken, 1884).

Martini gives clear photographs in his publications which enables an updating of most of the taxonomy. The following faunal list can be composed from Richter (1928) and Martini (1964, 1968) for the Stettin Sand and the 'Stettiner Gestein':

Pterothrissus umbonatus (Koken, 1884)
Palaeoraniceps tuberculosus (Koken, 1884)
Palaeogadus compactus Gaemers & van Hinsbergh, 1978
Gaidropsarinarum *stettiniensis* (Richter, 1928)
Trisopterus elegans (Koken, 1884)
Palaeomorrhua faba (Koken, 1884)
Serranus noetlingi (Koken, 1891) ?

Richter and Martini did not illustrate the otoliths of *Palaeomorrhua faba* and *Serranus noetlingi* of the Stettin Sand. The type of the latter species originates from the Late Oligocene 'Sternberger Gestein'. It is very unlikely that it occurs in the Stettin Sand too. The type of *Palaeomorrhua faba* comes from the Middle Oligocene of Hermsdorf. It was also found in the Middle Oligocene Brinkheurne Member at Winterswijk (Gaemers & van Hinsbergh, 1978). It is a very typical otolith which can be identified easily.

Originally the limonitic sandstone of Siadło Górne was considered to be identical with the Stet-

tin Sand (Janssen, 1980, not published). The otolith fauna resembles that of the Stettin Sand, but some important differences occur. *Colliolus minutulus, Palaeoraniceps* aff. *latisulcatus* and Clupeidarum sp. are unknown from the Stettin Sand. For biostratigraphical purposes *Colliolus minutulus* is the most important species. It is the decisive species of the *Colliolus minutulus* Lineage-zone which represents the lowermost part of the Rupelian (Gaemers, 1978).

The same otolith biozone was demonstrated for the lower part of the Brinkheurne Member in the eastern part of the Netherlands and the Nucula Clay in the northeastern part of Belgium. Dr V.W.M. van Hinsbergh found one otolith in the Berg Sands of northeastern Belgium which I could identify as *C. minutulus*. Although the species proves to be rare in this deposit it allows to include the Berg Sands in the same biozone. The conclusion is that the limonitic sandstone of Siadło Górne correlates with the Berg Sands and/or the Nucula Clay in Belgium and also with the lower part of the Brinkheurne Member in the Netherlands. It is very likely that the *Colliolus minutulus* Lineage-zone also covers the lower part of the Boom Clay more to the West in Belgium, in the type area of the Boom Clay. *Colliolus minutulus* has not yet been found there, but on lithostratigraphical criteria it can be expected there.

After a preliminary study of the mollusc fauna Janssen (1980, unpublished report) concludes that many similarities exist between the fauna of Siadło Górne and those of the Berg Sands and Nucula Clay. Most similarities seem to exist with the Nucula Clay; he found several undescribed mollusc species in both deposits. The mollusc fauna of Siadło Górne will be described in a joint paper by Janssen and Jakubowski.

The shark and ray teeth of Siadło Górne show most resemblance with the lowermost part of the Brinkheurne Member and the lowermost part of the Boom Clay Formation (van den Bosch, 1981).

The general conclusion that can be drawn from otoliths, molluscs and shark teeth is of the same tenor: the limonitic sandstone of Siadło Górne correlates with the lowermost part of the Rupelian.

In NW-Poland the Rupelian Septaria Clay is situated below the Stettin Sand; the literature is very sure and clear about this succession (Richter, 1928; Sindowski, 1936; Hinsch, 1958). If the limonitic sandstone of Siadło Górne was identical with the Stettin Sand this would mean that the Septaria Clay of the Szczecin area was considerably older than the Boom Clay in Belgium. This is unlikely because the Middle Oligocene transgression was an important transgression in western Europe covering large areas at the same time.

More probable is that the limonitic sandstone of Siadło Górne does not belong to the Stettin Sand, but to the Neustadt-Magdeburg Sand (in the sense of Beyrich, 1856; see Hinsch, 1958, p. 32). This lithological unit belongs to the lowermost part of the Rupelian, and was described by Beyrich from the German Democratic Republic. This correlation is the more probable as Koken (1891) mentions *Palaeoraniceps tuberculosus* and *P. latisulcatus* from the Neustadt-Magdeburg Sand, while these species are the most common otoliths at Siadło Górne. Sindowski (1936, p. 199) mentions that the early Rupelian Magdeburg Sand of eastern Germany and the Stettin Sand of the Szczecin area have many species in common. This is confirmed by the otolith faunas of the Stettin Sand and the limonitic sandstone of Siadło Górne. *Palaeoraniceps tuberculosus* is by far the most abundant otolith in both faunas; moreover, three other species, viz. *Pterothrissus umbonatus, Palaeogadus compactus* and *Trisopterus elegans*, occur in both faunas.

Fossils were not known to occur in the early Middle Oligocene deposits around Szczecin according to Sindowski (1936). Anyhow, such deposits, although unfossiliferous, are known in that region. The literature on fossils seems always to concentrate on the region North of Szczecin and

therefore it is not unthinkable that the fossils of Siadło Górne escaped the attention of the palaeontologists up to 1979 when Janssen and Jakubowski made their trip.

Considering all available data my opinion about the limonitic sandstone of Siadło Górne is that it is a lateral fossiliferous extension of the Neustadt-Magdeburg Sand, whereas the early Rupelian deposits North of Szczecin represent an unfossiliferous counterpart of the same beds. Differential dissolution may have caused the disappearance of the fossils in the area North of Szczecin.

When this view is right it implies that the Rupelian transgression cycle in the Szczecin area is represented by the succession: Neustadt-Magdeburg Sand - blue Septaria Clay - violet Septaria Clay with phosphorites - Stettin Sand (see also Richter, 1927; Sindowski, 1936). In this sequence the Neustadt-Magdeburg Sand is the shallow marine transgressive beginning of the cycle and the Stettin Sand the shallow marine regressive end of the cycle, with the maximum of the transgression, the Septaria Clay, in between. According to Sindowski (1936) the blue Septaria Clay was formed in deeper water that the violet clay. The palaeo-environments of the Neustadt-Magdeburg Sand and the Stettin Sand must have been very similar. This can be deduced from the many mutual faunal elements. Such faunal similarities easily may cause confusion when identifying the lithological unit.

For final certainty about the stratigraphical development of the Rupelian deposits in the Szczecin area it will be necessary to study the faunas of the Septaria Clays and the Stettin Sand in detail. Especially the otoliths of the *Colliolus* lineage may be very helpful for this.

SYSTEMATICAL PART

Familia PTEROTHRISSIDAE Gill, 1892
Genus *Pterothrissus* Hilgendorf, 1877

Pterothrissus umbonatus (Koken, 1884)

1964 *Pterothrissus umbonatus* (Koken, 1884). - Martini, p. 57, 58, fig. 1 (1).
1964 *Pterothrissus minor* (Koken, 1884). - Martini, p. 58, fig. 3(1).
1968 *Pterothrissus umbonatus* (Koken, 1884). - Martini, p. 65, pl. 2, fig. 1.
1968 *Pterothrissus minor* (Koken, 1884). - Martini, p. 65.
For further synonymy see Gaemers & van Hinsbergh, 1978.

Material - 2 sagittas, coll. RGM 176 599.
Description - One sagitta is a medium-sized, juvenile otolith which is fairly well-preserved; all characteristics necessary for identification of the species are present. The other sagitta is a very small juvenile one, with a badly eroded outline; the shape of the sulcus and the general outline make an identification possible with difficulty.

Familia CLUPEIDAE Bonaparte, 1831

Clupeidarum sp.
Pl. 1, fig. 1

Material - 3 sagittas, coll. RGM 176 600, 176 601
Description - Only one of the specimens is well-preserved. All otoliths are small and probably not

full-grown. This hampers a precise identification, especially in a family as the Clupeidae with its many species and genera which have otoliths resembling each other strongly.

The most distinct characteristic is a large midventral knob along the ventral rim. The anterior part of the knob is more accentuated, the posterior part nearly shades off into the rest of the ventral rim.

Familia GADIDAE Rafinesque, 1810
Subfamilia RANICIPINAE
Genus *Palaeoraniceps* Gaemers, 1976

Palaeoraniceps tuberculosus (Koken, 1884)
Pl. 1, fig. 2a-c - 4a-c; Pl. 2, fig. 1a-d, 4a-d; Pl. 3, fig. 1a-d, 3a-d.

1884 *Otolithus (Gadi) tuberculosus* Koken, p. 540, pl. 11, fig 1 (partim; non Lattorf, Antwerpen).
1891 *Otolithus (Raniceps) tuberculosus* (Koken, 1884). - Koken, p. 88.
1928 *Otolithus (Gadi) tuberculosus* Koken, 1884. - Richter, p. 140, 142.
1942 ?*Raniceps tuberculosus* (Koken, 1884). - Weiler, p. 81, pl. 10, fig. 1, 2.
1964 *Raniceps tuberculosus* (Koken, 1884). - Martini, p. 58, fig. 1 (6), 3 (2).
1964 *Raniceps latisulcatus* (Koken, 1884). - Martini, p. 57, 58, fig. 1 (4).
1964 *Raniceps planus* (Koken, 1884). - Martini, p. 58, fig. 1 (5).
1968 *Raniceps tuberculosus* (Koken, 1884). - Martini, p. 65, pl. 1, fig. 2; pl. 2, fig. 6.
1968 *Raniceps latisulcatus* (Koken, 1884). - Martini, p. 65, pl. 1, fig. 3, pl. 2, fig. 4.
1968 *Raniceps planus* (Koken, 1884). - Martini, p. 65, pl. 2, fig. 5.
1976 *Palaeoraniceps tuberculosus* (Koken, 1884). - Gaemers (1976b), p. 517, pl. 4, fig. 5a-b.
non: 1977 *Raniceps tuberculosus* (Koken, 1884). - Nolf, p. 28, pl. 8, fig. 8.

Material - 56 sagittas of which 38 specimens are very small or small, 10 specimens are medium-sized, and 8 specimens are large, adult otoliths; coll. RGM 176 602 - 176 609.

(L: 11.25 mm	H: 5.81 mm	T: 2.94 mm)			(pl. 2, fig. 1)
L:10.08 mm	H: 5.34 mm	T: 2.10 mm	L/H: 1.89	L/T: 4.8	(pl. 3, fig. 1)
L: 9.68 mm	H: 5.25 mm	T: 2.47 mm	L/H: 1.84	L/T: 3.92	(pl. 2, fig. 4)
L: 5.65 mm	H: 3.03 mm	T: 1.43 mm	L/H: 1.86	L/T: 3.95	
L: 1.96 mm	H: 1.14 mm	T: 0.59 mm	L/H: 1.72	L/T: 3.32	(pl. 1, fig. 2)
L: 1.58 mm	H: 0.96 mm	T: 0.41 mm	L/H: 1.65	L/T: 3.85	(pl. 1, fig. 3)
L: 1.18 mm	H: 0.76 mm	T: 0.39 mm	L/H: 1.55	L/T: 3.03	(pl. 1, fig. 4)

Description - This species is the most common one in the limonitic sandstone of Siadło Górne. A complete ontogenetic series from very small juvenile to full-grown adult otoliths is available. However, most specimens are worn and/or broken; therefore they can not be measured and they are not very valuable for studying the characteristics of the species. Only the specimens of which measurements are given are preserved satisfactorily, even the dimensions of the largest specimen are not completely reliable because this otolith is somewhat eroded; that is the reason why these measurements are placed between brackets.

Most larger specimens (for instance pl. 2, fig. 1, 4) correspond nicely with the type material described by Koken (1884, 1891) from the Middle Oligocene of Süldorf and Neustadt near Magdeburg in the German Democratic Republic. They have the same characteristical egg- to pear-shape and the same sulcus as the lectotype (see Gaemers, 1976b). One of these specimens, however, is rather aberrant (pl. 3, fig. 1). It is much finer ornamented, both along the rims and on the outer surface. It is also much thinner than other specimens of about the same size. The fine and distinct

ornamentation is also present on the specimen figured by Koken (1884, pl. 11, fig. 1). The shape of the sulcus of the aberrant otolith agrees well with that of the other specimens. Therefore my conclusion is that the differences represent only intraspecific variation.

Small and medium-sized specimens are oval in shape. It is worth mentioning that the smallest specimens have relatively the smallest sulcus: their ostium and cauda are rounder and are close to each other, so that the sulcus as a whole is shorter than in larger otoliths (see pl. 1, fig. 2, 3 and 4).

It is difficult to distinguish the badly preserved medium-sized otoliths from those of *P. latisulcatus* and some of these otoliths therefore may be included incorrectly in the material of *P. tuberculosus*. For more details see the description of *P.* aff. *latisulcatus*.

Discussion – I have studied the type material of *P. tuberculosus*, *P. latisulcatus* and *P. planus*. These otoliths are kept in the 'Museum für Naturkunde an der Humboldt-Universität zu Berlin' in East-Berlin. Judging from Koken's publications he must have had at his disposal many more otoliths of these species than the ones left in museum collections. In an earlier paper (Gaemers, 1976b) I designated the most well-preserved specimen of *Raniceps tuberculosus* from Süldorf as the lectotype for this species. It is not very likely that this specimen actually is the same as the otolith illustrated in Koken (1884, pl. 11, fig. 1), but the latter specimen has not appeared up to now; probably it has been lost. The choice of the lectotype can be justified because Koken mentions the locality Süldorf in his original publication (1884, p. 541) and because he adds the important note in his 1891 publication (p. 88) that the specimen figured in 1884 also comes from Süldorf.

The remaining type material of Koken's three *Palaeoraniceps* species is not only a small number of otoliths but also represents very heterogeneous collections. For lack of enough comparison material in the collections that I studied in 1976 I arrived at the conclusion that 1. all three species were extremely variable in the shape of their otoliths, 2. large overlaps were present between all species, 3. no reason existed anymore to maintain all three species, and 4. one species, *Palaeoraniceps tuberculosus*, was enough for the denomination of Koken's material.

Fortunately I could study a large number of *Palaeoraniceps* otoliths from the 'Unterer Meeressand' at Weinheim, a village in the Mainz Basin in the Federal Republic of Germany, and from the Berg Sand at Borgloon in Belgium. Koken (1891) mentions large numbers of *P. latisulcatus* from another village in the Mainz Basin, Waldböckelheim, not far from Weinheim. The otoliths that I studied from the latter locality represent a fine ontogenetic series and appeared to be quite different from *P. tuberculosus*. On the contrary, they were strikingly similar to the description and some of the pictures of *P. latisulcatus*.

I studied the photographs of Koken's *Palaeoraniceps* species present in my files again, and after a careful and painstaking comparison of all otoliths I found out that an unpleasant mixing of species had occurred in all three species. Probably some of this mixing was already done by Koken himself: a specimen of *P. latisulcatus* from the Early Oligocene of Lattorf was placed erroneously under the type material of *P. tuberculosus*. In his 1884 paper Koken namely mentions the latter species from Lattorf. In his 1891 publication the locality Lattorf is not repeated for *P. tuberculosus*; I presume that Koken had discovered his mistake, but the label for the Lattorf specimen was not changed unfortunately.

The type material of *P. latisulcatus* is even more confusing. No less than three species are represented: the real *P. latisulcatus* (a worn specimen of which the outer surface is almost completely smoothed belongs to this species; probably this otolith is an authentic Lattorf specimen), *P. tuberculosus* (a well-preserved specimen belongs to this species) and *'Macrurus' latisulcus* Leriche which is also a member of the subfamily Ranicipinae (a moderately eroded specimen belongs to this spe-

cies). Preservation and coloration of these otoliths are so different that it is higly unlikely, not to say impossible, that they all come from exactly the same stratigraphic level. It is thinkable that two or more different horizons were exposed at Lattorf, perhaps even in different exposures around this village. *P. latisulcatus* is known from the Early Oligocene (= Lattorfian, named after the village) and the Middle Oligocene. Up to now there is no evidence that *P. tuberculosus* occurs in other deposits then those of Middle Oligocene age; the same holds for *'Macrurus' latisulcus*. My conclusion is that these otoliths erroneously are united to one sample. The question remains whether this happened before or after Koken studied this material.

The status of the type material of *P. planus* is not yet completely clear to me. In any case one specimen has to be placed with *P. latisulcatus*, judging from the shape of the sulcus and the outline; moreover, the preservation of this otolith is again different from the other specimens.

Judging from the good photographs of 'Stettiner Gestein' otoliths in Martini (1964, 1968), all his specimens described as *Raniceps tuberculosus, R. latisulcatus* and *R. planus* belong to the first species. Allometric growth of otoliths was unknown when Martini wrote his papers, and this is certainly one of the reasons of Martini's partial misidentifications. It can not yet entirely be excluded that *P. latisulcatus* occurs in the Stettin Sand, but it is certainly important to note that Richter (1928) did not find this species among more than 3000 otoliths.

Palaeoraniceps latisulcatus (Koken, 1884)

1884 *Otolithus* (Gadidarum) *latisulcatus* Koken, p. 545, pl. 11, fig. 5.
1891 *Otolithus (Raniceps) latisulcatus* (Koken, 1884). - Koken, p. 86, pl. 3, fig. 2, 2a (non pl. 4, fig. 4, 4a).
1942 *Raniceps latisulcatus* (Koken, 1884). - Weiler, p. 83 (partim).
1972 *Raniceps latisulcatus* (Koken, 1884). - Gaemers, p. 76, pl. 2, fig. 3a-b.
non: 1910 *Macrurus latisulcus* Leriche, p. 352, fig. 152, 152a, 152b.
1957 *Raniceps latisulcatus* (Koken, 1884). - Weiler, p. 137.
1958 *Raniceps latisulcatus* (Koken, 1884). - Weiler, p. 332, pl. 1, fig. 17, 18.
1964 *Raniceps latisulcatus* (Koken, 1884). - Martini, p. 53, fig. 1 (4).

Palaeoraniceps aff. **latisulcatus** (Koken, 1884)
Pl. 1, fig. 5a-c; Pl. 2, fig. 2a-d, 3a-b; Pl. 3, fig. 2a-d, 7a-b

Material - 9 sagittas, of which 2 specimens are small, 5 are medium-sized, and 2 specimens are large, adult otoliths; coll. RGM 176 610 - 176 614.

L: 6.47 mm	H: 3.30 mm	T: 1.55 mm	L/H: 1.96	L/T: 4.17
(L: 2.69 mm	H: 1.47 mm	T: 0,65 mm)	L/H: ca. 1.83	L/T: ca. 4.14

Description - All sagittas except the smallest one (Pl. 1, fig. 5a-c) and a medium-sized one (Pl. 3, fig. 2a-d) are eroded and/or broken.

The medium-sized otoliths are the most difficult specimens to identify because of the allometric growth of this species and *P. tuberculosus*, and because of the different maximum sizes which can be attained by these species. *P. tuberculosus* grows to a larger size than *P. latisulcatus* and *P.* aff. *latisulcatus*. The ontogenetic curves of the L/H and L/T ratios of the otoliths of both species are concave with a short convex part at the beginning of growth. *P. latisulcatus* and *P.* aff. *latisulcatus* start earlier in their ontogeny with the concave part of the curves than *P. tuberculosus*. So, the small juvenile otoliths of *P. latisulcatus* and *P.* aff. *latisulcatus* are more slender than otoliths of the same size of *P. tuberculosus*, and the large adult otoliths are shorter and thicker. The ontogenetic curves of both species intersect somewhere at intermediate sizes and this means that their proportions

resemble each other very much. This creates severe problems of identification if the otoliths are badly preserved.

Large specimens of *P. latisulcatus* and *P.* aff. *latisulcatus* have a wide sulcus with wide and short colliculi. This very feature was used by Koken to name the species in an appropriate way. Especially the caudal colliculum is wide and short compared with that of other *Palaeoraniceps* species. Unfortunately the differences in the shape of the sulcus are less obvious in smaller specimens. The smallest specimens of *P. latisulcatus* and *P.* aff. *latisulcatus* show even a reversed tendency in the shape of the sulcus: it is more slender and longer than that of small juvenile otoliths of *P. tuberculosus*, and the colliculi are more separated.

The specimens of Siadło Górne differ in some respects from *P. latisulcatus* known from Lattorf, Waldböckelheim, Weinheim and Borgloon. The ventral rim is less sharp and the sulcus is less characteristic than the typical otoliths. Therefore the otoliths of Siadło Górne are put as affinity of *P. latisulcatus.*

Genus Igecepeia n. gen.

Type species – *Macrurus latisulcus* Leriche, 1910.
Diagnosis – An extinct genus of the subfamily Ranicipinae with relatively thin otoliths. Outline oval; a well-developed predorsal angle in adult specimens. Postdorsal angle more weakly developed or absent. Sulcus acusticus wide and slightly bent toward the ventral rim or straight. Sulcus medial or slightly inframedial. Ostial and caudal colliculum rather widely separated. Collum narrow, dorsally and ventrally constricted. Ostial colliculum subrounded. Caudal colliculum regular, with a trapezoid to parallelogram shape; all rims of the caudal colliculum are regularly shaped.
Derivatio nominis – *Igecepeia*: artificial word, from I.G.C.P. Named after the International Geological Correlation Programme, because of the contribution of the gadid otoliths to the biostratigraphy of I.G.C.P. project 124.
Distribution – Middle Oligocene (Rupelian).
Discussion – *Palaeoraniceps* is distinguished by its closely placed colliculi from the new genus. *Raniceps* is distinguished from the new genus by its rounded and somewhat irregular caudal colliculum. The dorsal rim in adult otoliths of *Palaeoraniceps* and *Raniceps* is more rounded than in *Igecepeia*, as the predorsal angle in adult otoliths of the new genus is much better developed than in *Palaeoraniceps* and *Raniceps.*

Igecepeia latisulcus (Leriche, 1910)

1910 *Macrurus latisulcus* Leriche, p. 352, fig. 152, 152a, 152b.
1942 ?*Raniceps latisulcatus* (Koken, 1884). – Weiler, p. 83 (partim).
1968 *Raniceps latisulcatus* (Leriche, 1910). – Weiler, p. 35.
1968 *Macrurus latisulcatus* (Leriche, 1910). – Weiler, p. 39.
1978 *Palaeoraniceps tuberculosus* (Koken, 1884). – Gaemers & van Hinsbergh, p. 18, pl. 6, fig. 2, 3.

Discussion – Leriche (1910) described the species on the basis of only one, very large specimen. Judging from his photographs this otolith is in a good state of preservation. It shows the characteristiscs of an otolith of a very old fish: the outer surface has no clear knobs anymore and is irregularly sculptured; the rims are rather smooth and somewhat irregular. Another character often found in otoliths of elderly fish is the extremely wide sulcus. Therefore Leriche's name for the species is well-

chosen from this point of view, but is on the other hand very confusing because of the existence of the allied species *Palaeoraniceps latisulcatus* (Koken, 1884). Maybe this misled Weiler when he put Leriche's species in the synonymy of *P. latisulcatus*. Viewed in that light it is striking that Leriche's species was misspelled in the Fossilium Catalogus (Weiler, 1968) as *Macrurus* and *Raniceps latisulcatus*. All otolith workers after Weiler, including myself, forgot the existence of this species. It is, however, not really a rare species in the Middle Oligocene septaria clays, although it never has been found in large numbers in one sample. The specimens known to me are smaller than the holotype and have a narrower sulcus, which as a matter of fact still is relatively wide.

Igecepeia and *I. latisulcus* do not occur in the limonitic sandstone of Siadło Górne, but are described here in connection with the taxonomy of *Palaeoraniceps* and its species.

Subfamilia LOTINAE
Genus *Palaeogadus* von Rath, 1859

Palaeogadus compactus Gaemers & van Hinsbergh, 1978
Pl. 3, fig. 5a-b, 6a-b

1964 *Palaeogadus (Palaeogadus) emarginatus* (Koken, 1884). - Martini, p. 58, fig. 1 (3).
1968 *Palaeogadus (Palaeogadus) emarginatus* (Koken, 1884). - Martini, p. 65, pl. 2, fig. 3.

Material - 4 juvenile sagittas, of which two are strongly eroded; coll. RGM 176 615 - 176 617.
Description - Although all otoliths are more or less damaged, it is not difficult to identify these specimens. The dorsal rim and the shape of the sulcus, especially the wide and obliquely oriented caudal colliculum, are characteristic for the species.
Discussion - The outline of the otoliths figured in Martini (1964, 1968) as *P. (P.) emarginatus* betrays their belonging to *P. compactus*. Almost certainly the otoliths mentioned by Richter (1928) as *Merluccius esculentus* also belong to *P. compactus*.

Subfamilia GADINAE
Genus *Colliolus* Gaemers & Schwarzhans, 1973

Colliolus minutulus Gaemers, 1978
Pl. 1, fig. 6a-c, 7a-c

1978 *Colliolus minutulus* Gaemers, p. 154, pl. 1, fig. 3a-d - 6a-b.

Material - 5 sagittas, coll. RGM 176 618 - 176 620.
Description - These tiny otoliths show all characteristics of the type specimens. The variability in the shape of the dorsal rim can be demonstrated with the help of the two figurus drawn after both most well-preserved specimens. Most striking is the development of the postdorsal angle, which is very pronounced in one specimen and weakly developed in the other specimen. This variation also occurs among the type material.

Genus *Trisopterus* Rafinesque, 1814

Trisopterus elegans (Koken, 1884)
Pl. 3, fig. 4a-d

Material - 5 sagittas, of which one is a juvenile and the remaining four are adult specimens; coll. RGM 176 621, 176 622.
Description - One specimen is well-preserved, it is even in an excellent condition; the others are badly eroded. The first otolith is the only one that may reliably be measured. It is a pity therefore that the outer surface of this specimen for a large part is covered by a lump of lithified sediment strongly attached to the otolith. Ornamentation is present all over the surface, also on the dorsal part of the inner surface where many shallow grooves cross the entire area. The otolith is relatively slender with a distinct postdorsal angle.

Gadidarum sp. indet.

One sagitta is so strongly eroded that an identification beyond family level is impossible. It could either be a juvenile otolith of *Palaeoraniceps* or *Colliolus minutulus*. Coll. RGM 176 623.

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continued on p. 126

EXPLANATION OF PLATE 1

1 Clupeidarum sp.
Coll. RGM 176 600.
31.25 x.

2a-c *Palaeoraniceps tuberculosus* (Koken, 1884).
Juvenile specimen. Coll. RGM 176 606.
31.25 x.

3a-c *Palaeoraniceps tuberculosus* (Koken, 1884).
Juvenile specimen. Coll. RGM 176 607.
31.25 x.

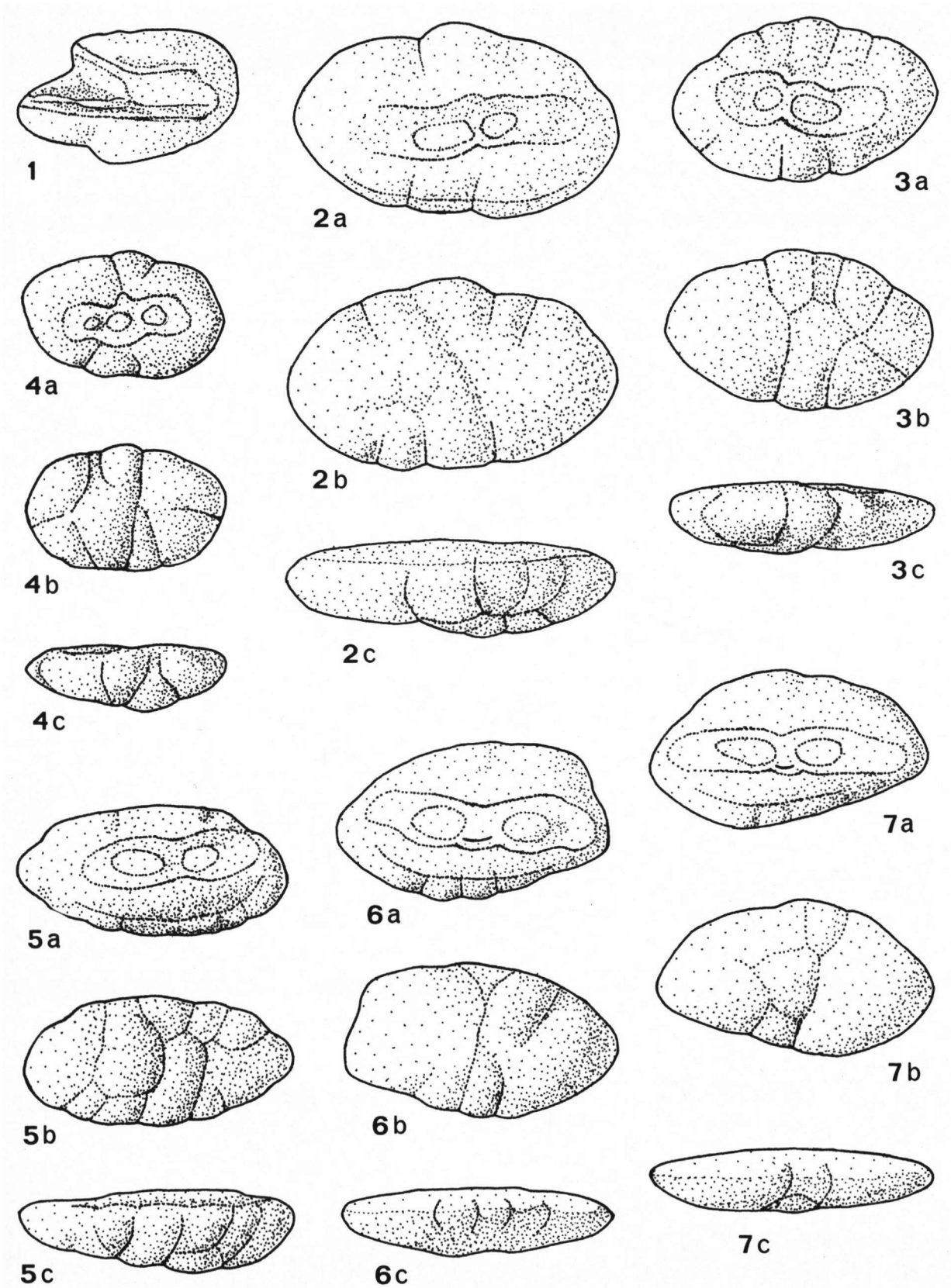
4a-c *Palaeoraniceps tuberculosus* (Koken, 1884).
Juvenile specimen. Coll. RGM 176 608.
31.25 x.

5a-c *Palaeoraniceps* aff. *latisulcatus* (Koken, 1884).
Juvenile specimen. Coll. RGM 176 613.
31.25 x.

6a-c *Colliolus minutulus* Gaemers, 1978.
Coll. RGM 176 618.
31.25 x.

7a-c *Colliolus minutulus* Gaemers, 1978.
Coll. RGM 176 619.
31.25 x.

All specimens from the West side of a former railway cut at Siadło Górne near Szczecin, Poland, from the early Middle Oligocene.
Drawings made by the author with a Wild M5 binocular microscope.


1
2a
3a
4a
2b
3b
4b
3c
2c
4c
7a
6a
5a
7b
6b
5b
7c
6c
5c

EXPLANATION OF PLATE 2

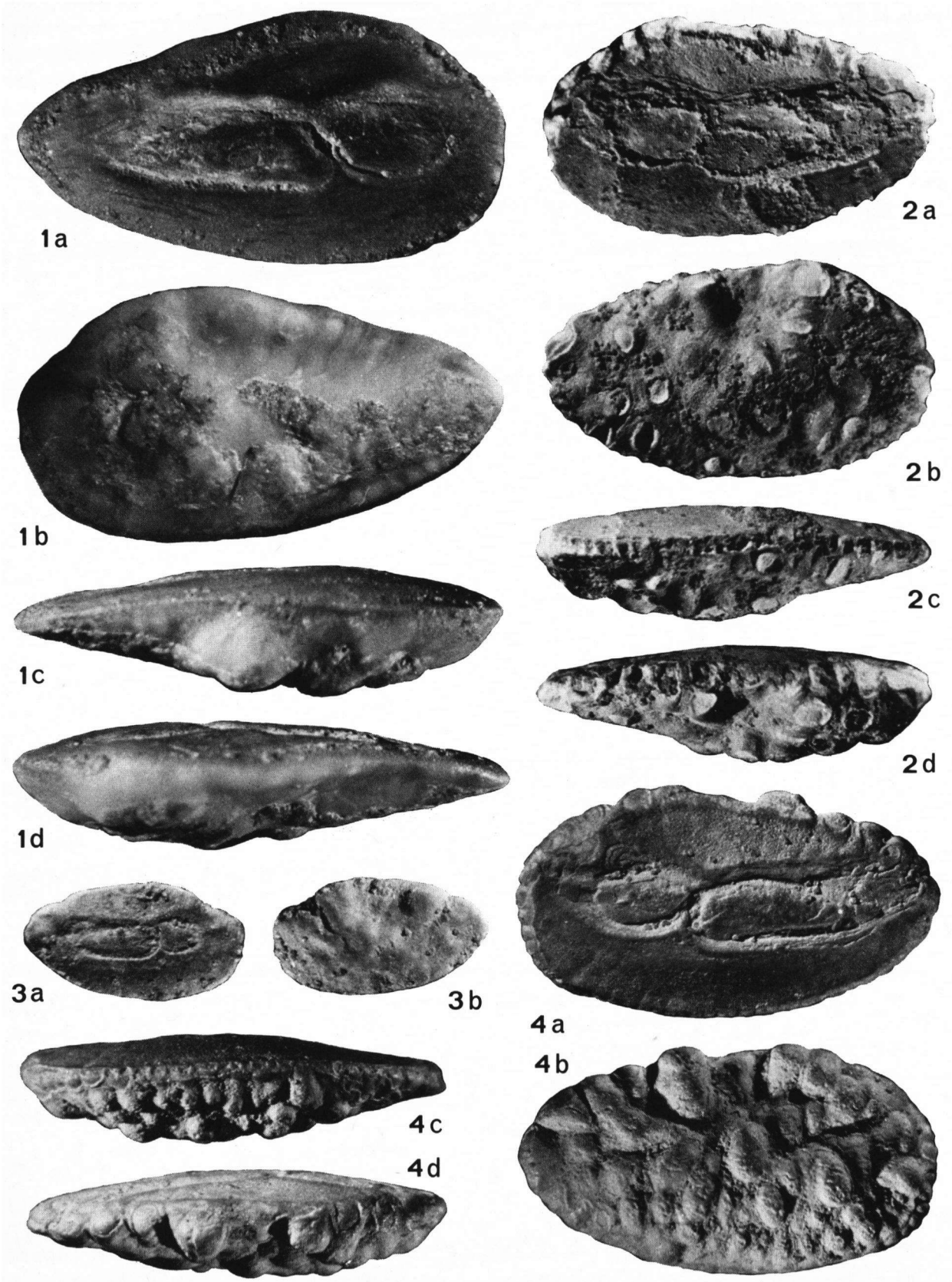
1a-d *Palaeoraniceps tuberculosus* (Koken, 1884).
Coll. RGM 176 602.
7.5 x.

2a-d *Palaeoraniceps* aff. *latisulcatus* (Koken, 1884).
Coll. RGM 176 610.
7.5 x.

3a-b *Palaeoraniceps* aff. *latisulcatus* (Koken, 1884).
Coll. RGM 176 612. See also pl. 3, fig. 7a-b.
7.5 x.

4a-d *Palaeoraniceps tuberculosus* (Koken, 1884).
Coll. RGM 176 603.
7.5 x.

All specimens from the West side of a former railway cut at Siadło Górne near Szczecin, Poland, from the early Middle Oligocene.


1a
1b
1c
1d
3a
3b
4c
4d
2a
2b
2c
2d
4a
4b

EXPLANATION OF PLATE 3

1a-d *Palaeoraniceps tuberculosus* (Koken, 1884).
Coll. RGM 176 604.
7.5 x.

2a-d *Palaeoraniceps* aff. *latisulcatus* (Koken, 1884).
Coll. RGM 176 611.
7.5 x.

3a-d *Palaeoraniceps tuberculosus* (Koken, 1884).
Coll. RGM 176 605.
7.5 x.

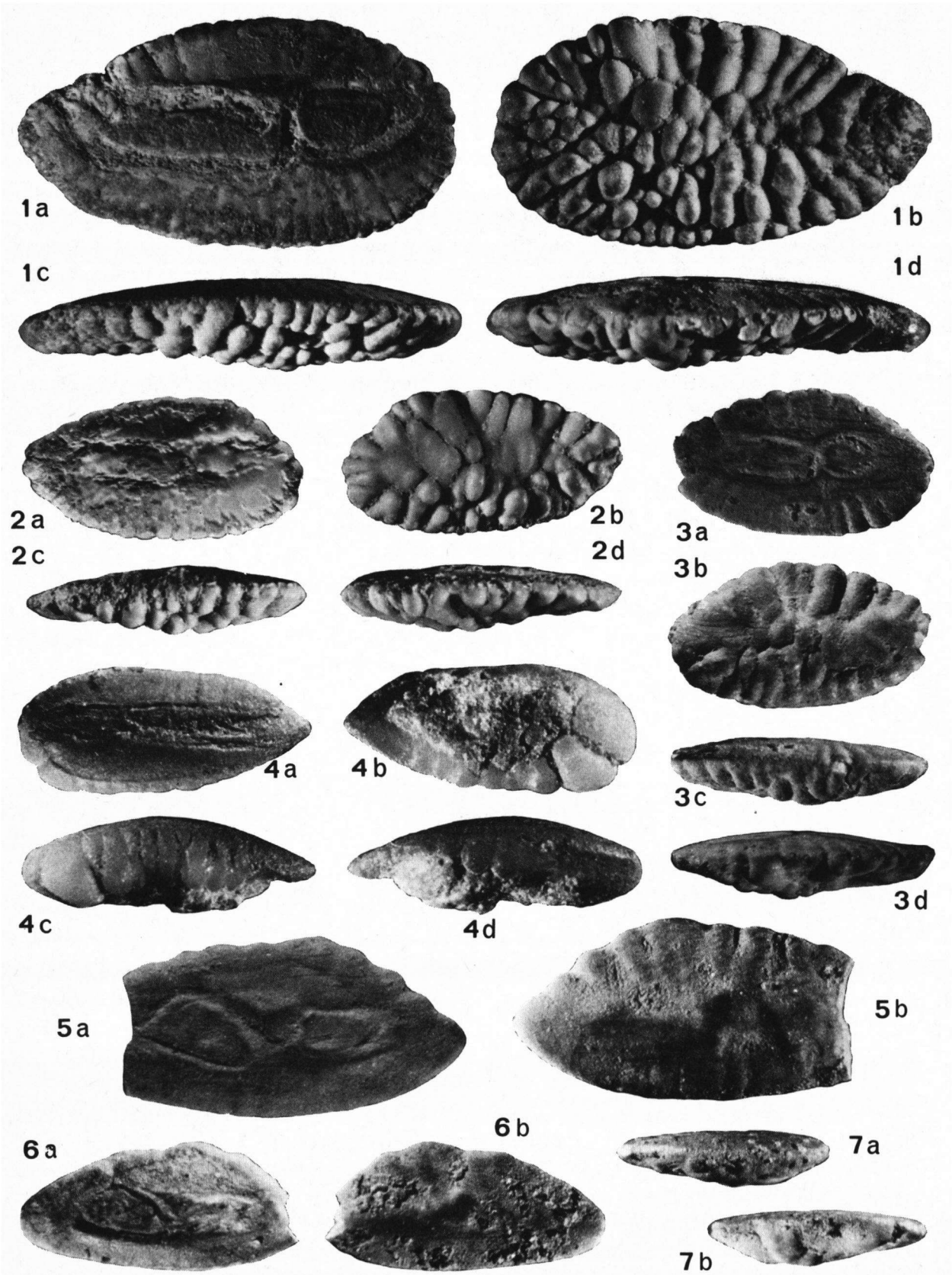
4a-d *Trisopterus elegans* (Koken, 1884).
Coll. RGM 176 621.
10 x.

5a-b *Palaeogadus compactus* Gaemers & van Hinsbergh, 1978.
Coll. RGM 176 615.
10 x.

6a-b *Palaeogadus compactus* Gaemers & van Hinsbergh, 1978.
Coll. RGM 176 616.
10 x.

7a-b *Palaeoraniceps* aff. *latisulcatus* (Koken, 1884).
Ventral and dorsal view of the same otolith figured on pl. 2, fig. 3a-b. Coll. RGM 176 612.
7.5 x.

All specimens from the West side of a former railway cut at Siadło Górne near Szczecin, Poland, from the early Middle Oligocene.


1a
1b
1c
1d
2a
2b
2c
2d
3a
3b
3c
3d
4a
4b
4c
4d
5a
5b
6a
6b
7a
7b

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