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Fish otoliths in the Middle Miocene (Badenian) deposits of southern Poland

ABSTRACT: The otoliths of teleost fishes from the Middle Miocene (Badenian) marine deposits (Upper Langhian – Lower Serravalian, 15 MY ago) of southern Poland, studied in the six key sections (Korytnica Basin, Nawodzice, and Rybnica in the Holy Cross Mountains; Łychów area in the Lublin Upland; Bęczyn at the Carpathian margin; Niskowa in the Carpathians), appear to be significant components of diversified organic assemblages which may be interpreted in terms of the composition and trophic structure of particular communities. These communities are indicative of a broad spectrum of facies that ranges from these near-shore ones, confined either to rocky (Korytnica) or to flat sandy shores (Nawodzice, Niskowa), through the variable offshore facies (Rybnica, Łychów), to those approaching a deep neritic or even bathyal zone (Bęczyn). The systematically accounted forms, totaling over 22,600 specimens, represent 145 taxa distinguishable at their species level, the three of which are new, viz. *Micromesistius arcuatus* sp. n., "genus *Bythitinarum*" *wenglinensis* sp. n., and *Sciaena rybnicensis* sp. n. The richest numerically and the most diversified taxonomically assemblage is that of the world-famous Korytnica Basin which contains 105 taxa belonging to 47 families. A comparison with otoliths of the present-day fishes (NOLF's Collection) allowed to revise a number of taxa of ancient forms, and to recognize the presence of some forms formerly unknown from the fossil state. Of the revised taxa, noticeable is the well-known species "*Gadus*" vel "*Colliolus*" *friedbergi*, established upon the Polish material by CHAINE & DUVERGIER in 1928, and which is revealed to be identical with *Trisopterus sculptus* (KOKEN, 1891). Moreover, highlighted is the occurrence of species indicative of tropical and/or subtropical climatic conditions and of the Indo-Pacific bioprovince affinities. Of such forms, significant are i.a. rare representatives of the families Chaetodontidae BONAPARTE, 1832, and Scaridae RAFINESQUE, 1810, which are typical coral-reef dwellers in modern faunas.

INTRODUCTION

The subject of the present paper is a taxonomic and ecologic analysis of the teleost fish otoliths occurring in the Middle Miocene (Badenian) marine deposits of the Fore-Carpathian Depression and connected areas, and of the Carpathian range as well, the both regions within the frames of the state frontiers of Poland (*see* Text-fig. 1).

The Middle Miocene (Badenian; formerly, prior to 1977 regarded as Tortonian) deposits of the Fore-Carpatian Depression and connected areas in southern Poland have long been known world-wide due to their ubiquitous occurrence of fossils. Besides the much diversified invertebrates (*see* BAŁUK & RADWAŃSKI1977, RADWAŃSKI 1977a), also the vertebrates, primarily the fishes, are an important component of particular marine communities.

The presence of fish otoliths in the Middle Miocene (Badenian) deposits of southern Poland has been recognized relatively lately, as the first report on their occurrence is that by FRIEDBERG (1924). That report was soon followed by the two others, by CHAINE & DUVERGIER (1928) and by KOWALEWSKI (1930).

The more detailed taxonomic studies have been performed in the sixties and seventies by ŚMIGIELSKA (1966, 1973, 1979) who described the Middle Miocene (Badenian) otoliths from many new localities, and coming mostly from the collections. The otolith material presented by ŚMIGIELSKA was a matter which paid an attention of the present author to these very fossils and their distribution in particular sections, to recognize their frequency and biological significance in successive organic communities. Such researches have been undertaken initially in the well known Korytnica Basin where the presence of much richer and more common assemblages of fish otoliths has soon become apparent (*see* RADWAŃSKA 1982, 1984). The fieldworks, kept to search for some rare elements of faunistic communities, such as e.g. inarticulate brachiopods (*see* RADWAŃSKA & RADWAŃSKI 1984) and free-living crinoids (*see* RADWAŃSKA 1987), have resulted in the recognition of much more profuse fish-otolith assemblages both within the Korytnica Basin and in some other sections of the Middle Miocene (Badenian) deposits of southern Poland.

The collected material allowed not only to enrich the number of the otolith species distinguished by ŚMIGIELSKA (1966, 1973, 1979), but also to reexamine quite a reasonable part of the formerly reported taxa. The latter task has apparently been required when, in the mid-seventies and through the eighties, a series of paramount monographs of the Tertiary otoliths from western Europe was published by D. NOLF, E. STEURBAUT, and their collaborators, who had at their disposal a rich comparative material of the present-day fishes, and thus offered a new insight into the taxonomy of ancient forms. Moreover, these authors (NOLF 1970, 1981; NOLF & STEURBAUT 1983) performed systematic revisions of classical collections described by KOKEN (1884-1891), SCHUBERT (1902-1916), and BASSOLI (1906), which through almost a century were the basis of taxonomic recognition of the European Tertiary otoliths, those from Poland including.

The present paper is an abridged version of the Ph.D. thesis (RADWAŃSKA 1991) performed, under supervision of Prof. Dr. W. BAŁUK, at the Faculty of Geology, Universisty of Warsaw.

The suiting of the presented thesis to its final meritorious shape was possible due to the courtesy of the Belgian *Ministerie van de Vlaamse*

Gemeenschap in Brussels. A scientific grant from this Ministry enabled the author to a profitable stay (December 1990 – January 1991) at the *Koninklijk Belgisch Instituut voor Natuurwetenschappen* in Brussels, where due to the kindness of Dr. Dirk NOLF she was able to acquaint with the greatest collections of Tertiary otoliths from various regions of Europe, and to undertake comparative studies on otoliths of the present-day fishes.

The otolith specimens discussed in this paper, and coming from the private collection of Dr. Dirk NOLF, will be indicated in the text as those of the NOLF'S Collection.

GEOLOGIC SETTING AND STRATIGRAPHY OF THE OTOLITH-BEARING DEPOSITS

To the readers abroad Poland, some basic data are herein revealed on the two subjects, as follows: (i) Regional setting of the otolith-bearing deposits, and (ii) Age of the otolith-bearing deposits.

Regional setting

The Middle Miocene (Badenian) transgression in southern Poland, progressing from the Mediterranean region and bearing tropical and/or subtropical elements of the Indo-Pacific bioprovince (*see* BAŁUK & RADWAŃSKI

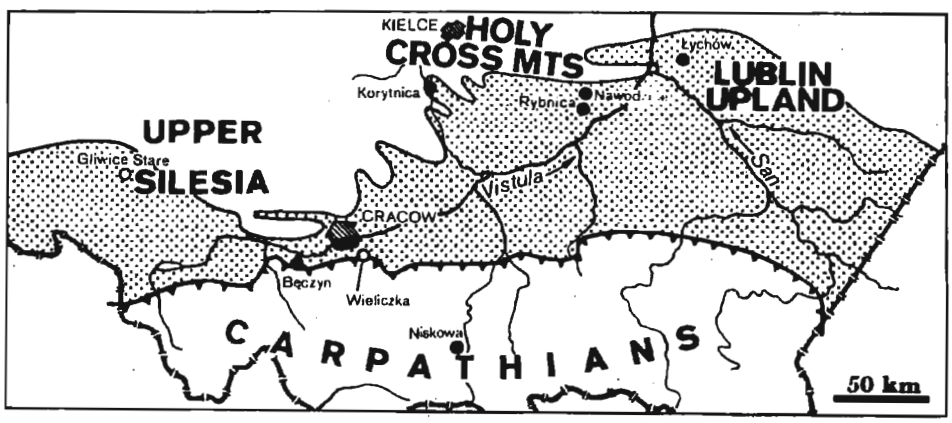


Fig. 1

Geologic sketch-map of southern Poland, to show the extent of the Middle Miocene (Badenian) transgression (*stippled*), and location of the investigated otolith-bearing localities (*black circles*); indicated are also some localities reported by ŚMIGIELSKA (1966), at present not accessible (*white circles*), but referenced and/or discussed in the present paper

The map adopted *from* RADWAŃSKI (1977a, Fig. 169)

1977), when encroached the area forelanding the Carpathian range, was borederd to the north by the belt of the Central Polish Uplands embracing from the west to the east (*see* Text-fig. 1): Upper Silesia, Cracow Upland, the Holy Cross Mountains, and Lublin Upland. Into this belt the advancing sea penetrated along the pre-Miocene valleys transformed into a system of bays during the transgression (*see* stippled areas *in* Text-fig. 1). Thus, along the Central Polish Uplands the coastal zone is distinctly dismembered and it is well recognizable in the present-day morphology (*see* RADWAŃSKI 1969, 1970, 1977a), as evidenced close to the otolith-bearing deposits in the Korytnica Basin.

The Middle Miocene (Badenian) deposits developed along the shores of the Central Polish Uplands are not disturbed tectonically: they all lie horizontally, being dependant only on the morphology of substratal rocks (*see* Text-figs 2-5).

The extent of the Carpathian range onto the Fore-Carpathian Depression is tectonic: it represents an overthurst zone along which successive fold structures (nappes) were transported to the north at the time when sedimentation in the Fore-Carpathian Depression had already commenced. All the Middle Miocene (Badenian) deposits exposed along the Carpathian margin are thus tectonically disturbed to a variable, usually great extent, as it is exemplified in the sections exposed in the world-famous salt mine at Wieliczka (*see* KOLASA & ŚLĄCZKA 1985) and in the studied locality Bęczyn.

Within the mountain range of the Carpathians, the Middle Miocene (Badenian) deposits are known from quite numerous occurrences. They are situated either upon, or at the front of particular fold structures (nappes). Such a situation is well demonstrated in the studied locality Niskowa, where the discussed deposits are tilted and faulted, but not overthurst (*see* Text-fig. 7).

Age of the deposits

The discussed Miocene deposits of southern Poland have been precisely dated, by the use of calcareous nannoplankton, only in the Korytnica Basin, where MARTINI (1977) indicated the presence of the biozones NN5 and the beginning of NN6. This places the age of deposits of the Korytnica Basin in the Middle Miocene, about 15 million years ago, precisely in the Badenian stage of the Central Paratethys basins in Central Europe, or in the Upper Langhian – Lower Serravalian interval according to the Mediterranean stage division.

Within the frames of the Badenian stage, the sequence deposited in the Korytnica Basin represents a higher part of the Lower, and the Middle Badenian (*see* MARTINI 1977, p. 132; PERYT 1987; SPIEGLER & RÖGL 1992, pp. 74-75 and 95).

All the studied otolith-bearing deposits of southern Poland are correlated to those of the Korytnica Basin, and thus their stratigraphic age is regarded

as identical. A remarkable facies diversity of these deposits involves, however, serious problems when a more detailed correlation is attempted.

The general vertical succession of the Middle Miocene (Badenian) facies in southern Poland, as taken in a commonly used lithostratigraphic scheme (*see* RADWAŃSKI 1969, 1970, 1977a), progresses from these variable facies containing open-marine, usually ubiquitous fossils which are often referred to as of the Korytnica type. The open-marine regime was followed by the progressing evaporation, the final effect of which were the chemical deposits of the Gypsum Member, still of Middle Miocene (Badenian) age. Overlying are various clastic deposits, primarily more or less non-marine, which are traditionally referred to as "*the Grabovian*" succeded by "*the Sarmatian*", whose position in the chronostratigraphic scale remains still unclear.

It is finally to indicate, that the whole sequence of the marine and evaporatic deposits has long been called in the Polish papers as "*the Tortonian*", leaving the name of "*the Sarmatian*" for the overlying non-marine deposits. In the light of the data presented by MARTINI (1977) it is evident that this sequence is really much older than the Tortonian stage in Italy. Thus, the deposits named as *Tortonian* in all Polish papers published before 1977, are to be understood as being of Badenian (i.e., Upper Langhian – Lower Serravalian) age. It should also be added, that the evaporation of the Middle Miocene (Badenian) sea of southern Poland has stratigraphically nothing in common with the Messinian crisis of the Mediterranean realm.

THE INVESTIGATED MATERIAL

The material for this study has been collected from the Middle Miocene (Badenian) deposits of southern Poland either personally or with a help of many colleagues and collaborators during the fieldworks performed throughout the last decade (1980-1990). The fieldworks were established in all the most fossiliferous localities, both these from the otoliths had ever been reported, and those which were expected to yield the new occurrences.

The richest otolith material has been obtained in various localities of the Korytnica Basin and in the sections of Rybnica and Nawodzice situated on the southern slopes of the Holy Cross Mountains. In the Lublin Upland, a rather scant material has been recognized in several sections exposed near Łychów. Of the exposures located along the Carpathian margin, the otoliths have been collected in a few temporary exposures at Bęczyn. Finally, of the exposures of the Middle Miocene (Badenian) deposits in the Carpathians, the otoliths have been collected in a remarkably well exposed section at Niskowa.

It is to note that the fish otoliths, as composed of aragonite, are preservable only in some types of deposits. Thus, the positive samples have come from sections, or from their selected parts, which yield the

aragonite-bearing fossils. The other sections which underwent diagenetic dissolution processes, although are much fossiliferous but possessing only calcite-bearing fossils, have appeared to be completely devoid of the otoliths. The latter situation concerns i.a. the famous organodetrital limestones called the Pińczów Limestones, as exposed primarily near Pińczów (15 km south of Korytnica), from where remains of various fishes, both teleosts and elasmobranchs, are commonly known.

Besides the newly collected otolith material, into the subject of the present paper included is also a material kindly donated by the late Professor K. Pożaryska (Institute of Paleobiology, Polish Academy of Sciences, Warsaw) and by Ass.-Professor T. Czyżewska (Department of Paleozoology, University of Wrocław), and which comes from older fieldworks done in the Korytnica Basin.

Of the localities in southern Poland from which the otoliths were reported by Śmigielska (1966), the present author had no material from the sections located in Upper Silesia which are now not accessible (abandoned exposures, boreholes), and from the temporary sections exposed in the salt mine at Wieliczka (*see* Text-fig. 1).

All the otolith material presented in this paper is housed at the collection of the Department of Paleontology, Faculty of Geology, University of Warsaw. It is kept under the collection numbers open for particular localities, which are preceded by an abbreviation *Ra* followed by lettered symbols used for particular localities as follows: **Ra-K** – Korytnica Basin, **Ra-N** – Nawodzice, **Ra-R** – Rybnica, **Ra-B** – Bęczyn, **Ra-Ni** – Niskowa, **Ra-W** – Węglinek.

THE OTOLITH-BEARING LOCALITIES

The description of the otolith-bearing localities begins with that of the **Korytnica Basin**, where the quantity and diversity of the collected material is the greatest, and it is followed by characteristics of the two other localities, **Nawodzice** and **Rybnica**, in the same region of the Holy Cross Mountains. Successive descriptions concern the **Łychów area** in the Lublin Upland, and localities situated along the Carpathian margin (**Bęczyn**) and within the Carpathian range (**Niskowa**).

The presented succession allows to start with the description of the region of the Korytnica Basin, the paleoenviroment and paleogeography of which is recognized the best, to represent the near-shore facies, often confined to the rocky shores. The locality Nawodzice represents an extremely shallow-marine facies of flat, sandy shores, while the nearby locality Rybnica does an offshore facies, more distant to the shoreline.The same offshore zone is displayed by diverse facies of the Łychów area (localities Węglinek, Węglin, Łychów). The succession is completed by localities whose sedimentary environment may be interpreted, as open-marine (Bęczyn) or as nearshore (Niskowa), but the

paleogeographic (palinspastic) position of which is not quite clear due to the tectonic transport at the front or within the Carpathian range.

THE KORYTNICA BASIN

The world-famous locality Korytnica, situated on the southern slopes of the Holy Cross Mountains (*see* Text-fig. 1) is one of the most paramount sites of the Miocene fauna in Europe. An extreme wealth of fossils, representing almost all the invertebrate phyla and, to a lesser extent, of vertebrates and marine algae was known from here already in the middle of 18*th* century (*see* JAŚKIEWICZ 1787). In the past century, the most outstanding fossils of Korytnica, the mollusks (gastropods and bivalves), were reported and/or monographed by PUSCH (1837), MURCHISON (1853), HÖRNES (1856), R. HOERNES & AUINGER (1879), and KONTKIEWICZ (1882).

In the first half of this century, the mollusks were thoroughly monographed by W. FRIEDBERG in his life paper "*Mollusca miocaenica Poloniae*", published successively as follows: gastropods and scaphopods (1911–1928), bivalves (1934–1936), and a guide to the collection (1938). On the other hand, one of his collaborators, KOWALEWSKI (1930) presented an outline of the geologic structure of the area, and comprehensive study of its faunal content and stratigraphy. Both W. FRIEDBERG and K. KOWALEWSKI reported the occurrence of, and collected the fossils other than mollusks which were partly studied before the Second World War.

All these former faunistic studies, as well as those performed successively until the seventies, are reviewed by BAŁUK & RADWAŃSKI (1977, pp. 96-99; *and* 1979, pp. 230-231). The results of newer studies are contained in special volumes of ACTA GEOLOGICA POLONICA, namely in Vol. 27, No. 2, issued 1977; Vol. 29, No. 3, issued 1979; Vol. 34, No. 3/4, issued 1984; and parts of Vol. 37, No. 3/4, issued 1987, and of Vol. 40, No. 3/4, issued 1990. Of the plant remains, analyzed were also the red algae (PISERA & STUDENCKI 1989).

This state of recognition of the Korytnica fossils has recently been supplemented by comprehensive studies of corals, both solitary (STOLARSKI 1988, 1991, 1992) and colonial (RONIEWICZ & STOLARSKI 1991), as well as of acrothoracican barnacles commensal to hermit crabs living in emptied gastropods shells (BAŁUK & RADWAŃSKI 1991), and of common acorn barnacles (ŚWIERCZEWSKA-GŁADYSZ 1993). A few faunistic groups are still under investigations, i.a. the tube-dwelling polychaetes, and ophiuroids (RADWAŃSKA, *in prep.*).

The whole of that famous fauna was coming from many, temporarily exposed sites around the eastern part of the village Korytnica where it was collected after spring thawings and/or late-summer plowings allover the cropland reaching the nearby villages of Karsy, Lipa, Jawor, and Chomentów. All these sites lie within the Korytnica Basin, the frames of which are indicated by the preserved spots of various littoral structures (*see* RADWAŃSKI 1969, BAŁUK & RADWAŃSKI 1977).

Within the Korytnica Basin, the Middle Miocene (Badenian) deposits are developed primarily as the most famous, yellow colored Korytnica Clays, which locally bear brown-coal deposits at their bottom, and which are covered by marly sands and red-algal limestones. The samples positive for otoliths come all from the facies of the Korytnica Clays solely; marly sands and red-algal limestones are completely lacking in otoliths due to diagenetic dissolution of aragonite.

In the area where the Korytnica Clays are exposed over the cropland, a few sites appeared to be more important in regard to the frequency of otoliths and/or their diversity. These sites, which were also noticed in some former reports, are distinguished (*see* Text-fig. 2) as follows:

Mt. Lysa (*Ly* in Text-fig. 2), along the slopes of which exposed are oyster shellbeds forming a shore-confined facies of the Korytnica Clays;

Korytnica-Plebania (*Pn* in Text-fig. 2) in the western part of the Korytnica Basin, where a shallow-marine biotope was established over a flat, rocky bottom near the shore;

Korytnica-Forest (*F* in Text-fig. 2) on the slopes of Mt. Grodzisko in the southern part of the Korytnica Basin, where a more steep, rocky shore favored a peculiar clayey deposition;

Temporary exposures near the village **Karsy** (*K* in Text-fig. 2) in the eastern part of the Korytnica Basin.

Fig. 2

Otolith-bearing localities in the Korytnica Basin on the southern slopes of the Holy Cross Mountains (*see* Text-fig. 1)

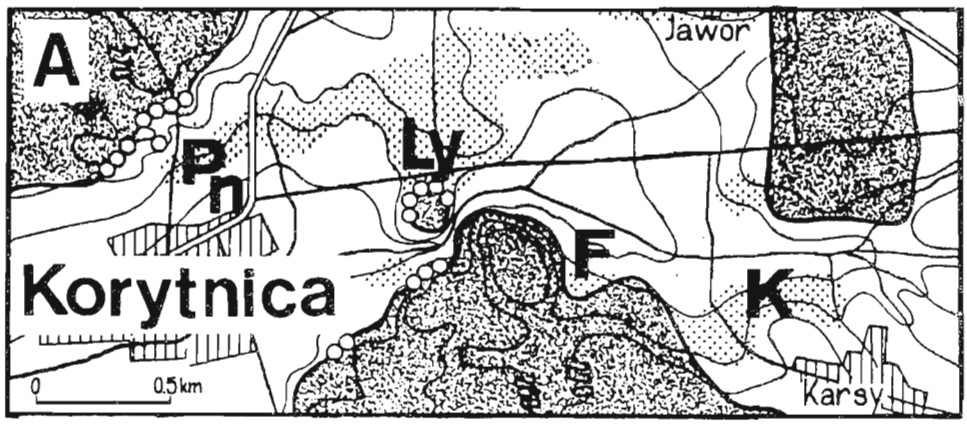
A — Paleoenvironmental sketch of the southern part of the Korytnica Basin, to show localities yielding the investigated teleost-fish otoliths: **Pn** — Korytnica-Plebania, **Ly** — Mt. Lysa, **F** — Korytnica-Forest, **K** — Karsy

Within the sketch indicated are: marine area of the basin during the Middle Miocene (Badenian) transgression (*blank*), present-day outcrops of the Korytnica Clays (*stippled*), preserved fragments of littoral structures (*circled*), and land or island areas along the seashore (*hachured*); adopted *from* BAŁUK & RADWAŃSKI (1977, Fig. 2)

B — Locality Mt. Lysa (marked *Ly*), where the Middle Miocene (Badenian) deposits are onlapping the rocky substrate (Upper Jurassic limestones, marked *J*); within the Middle Miocene (Badenian) deposits indicated is the zone of littoral oyster shellbeds (*os*) and the depositional area of the Korytnica Clays (*compare* Fig. C); arrowed is the location place of trenches excavated during the fieldworks in 1981 (sampling site *3a* in RADWAŃSKA 1982) and 1990-1991

C — Restored shorescape at Mt. Lysa, to show the environmental conditions under which the investigated teleost fishes have lived: the rocky bottom (Upper Jurassic limestones), damaged by gregarious rock-borers, is covered by clayey, oyster shellbed containing littoral rubble, and overgrown by seagrass meadows, and by kelp at the water surface; adopted *from* BAŁUK & RADWAŃSKI (1977, Fig. 5) *and* RADWAŃSKA (1987, Fig. 1)

Within the oyster bank community indicated are: *Ostrea frondosa* DE SERRES, associated with corals *Dendrophyllia*, stalked cirripedes *Scalpellum*, acorn barnacles *Balanus*, and free-living crinoids *Sievertsia polonica* RADWAŃSKA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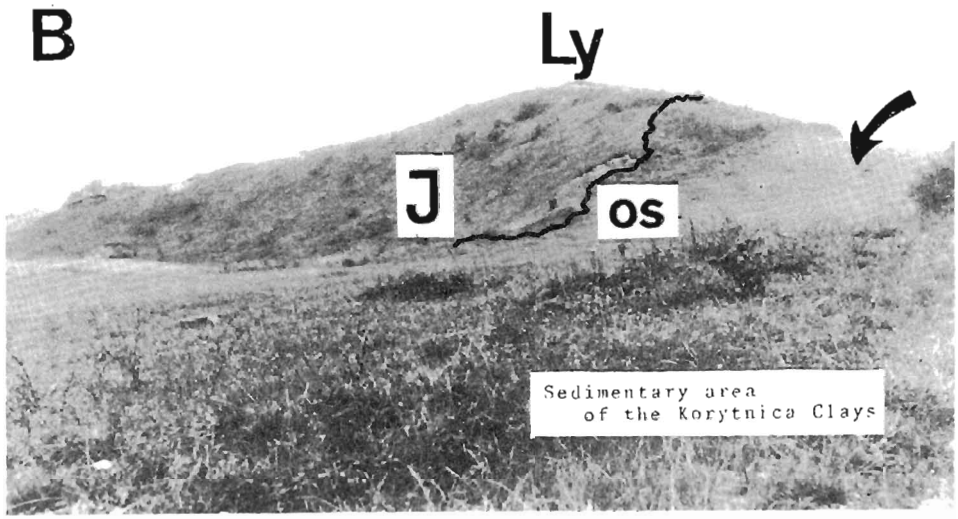
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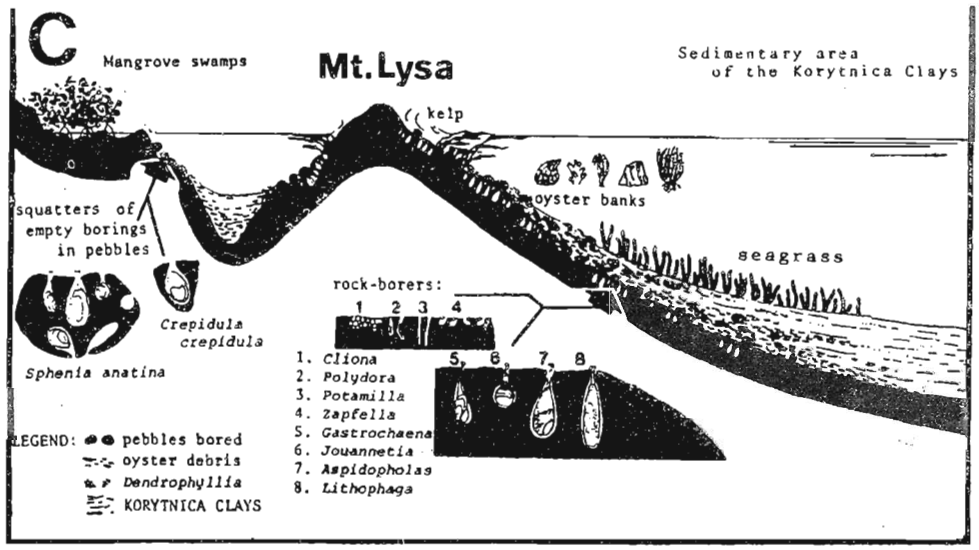
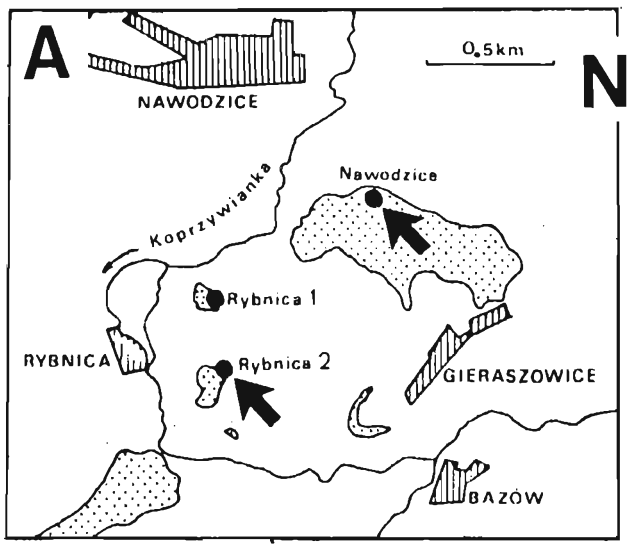
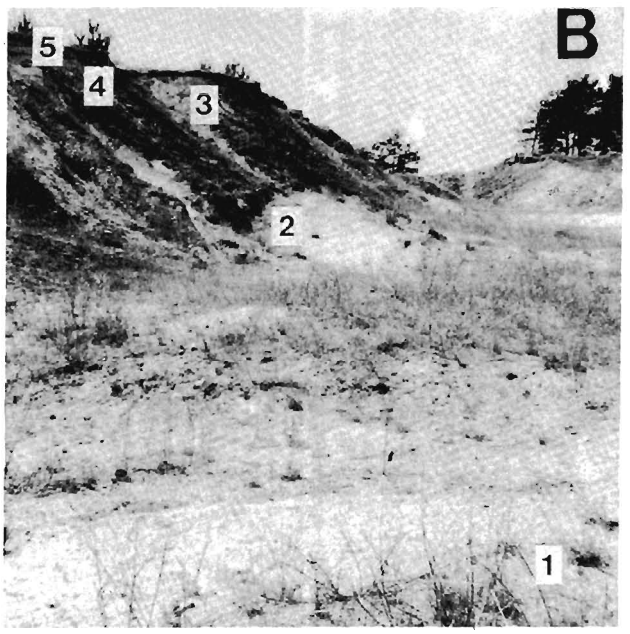
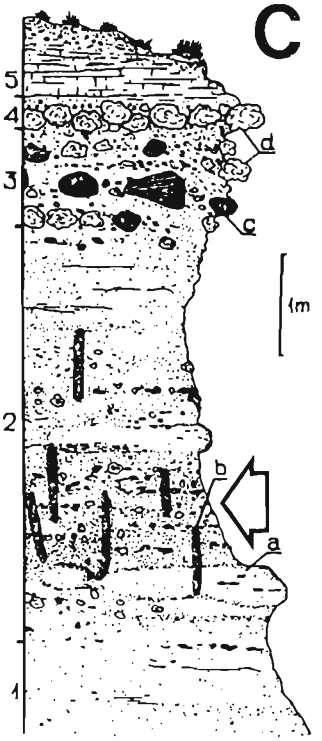

C
Mangrove swamps
Mt.Lysa
Sedimentary area
of the Korytnica Clays
kelp
oyster banks
seagrass
squatters of
empty borings
in pebbles
Crepidula
crepidula
Sphenia anatina
rock-borers:
1 2 3 4
5, 6
7, 8
1. Cliona
2. Polydora
3. Potamilla
4. Zapfella
5. Gastrochaena
6. Jouannetia
7. Aspidopholas
8. Lithophaga
LEGEND:
pebbles bored
oyster debris
Dendrophyllia
KORYTNICA CLAYS







Geological profile of the sand complex at Nawodzice

The individual sets (numbered 1—5) described in the text; besides: *a* calcitic cementations, *b* burrows *Ophiomorpha nodosa* Lundgren, *c* pebbles and cobbles, *d* nodular colonies of *Lithothamnium*

Otolith-bearing locality Nawodzice near Klimontów on the south-eastern slopes of the Holy Cross Mountains (*see* Text-fig.1)

A – Geologic sketch of the region, to show the extent (outliers) of the Middle Miocene (Badenian) deposits (*stippled*), and their exposures at Nawodzice and Rybnica (adopted *from* STUDENCKA 1986, Fig. 2);

B – General view of the sand-pit at Nawodzice (as seen in 1967; *see* BAŁUK & RADWAŃSKI 1968, Fig. 1); the numbers of successive layers as in the profile (*see* Fig. C);

C – Lithologic profile of the deposits exposed in the sand-pit at Nawodzice (adopted *from* BAŁUK & RADWAŃSKI 1968, Fig. 2), to indicate the position of the otolith-yielding sands (*arrowed*)

The occurrence of otoliths in the Korytnica Basin was first recognized by FRIEDBERG (1924), who collected a poor material described soonafter by CHAINE & DUVERGIER (1928). A few species were separately noted by KOWALEWSKI (1930), whose earlier material had already been included by CHAINE & DUVERGIER (1928) into their report. In the present paper, discussed will be the specimens illustrated by CHAINE & DUVERGIER (1928), whereas those reported by KOWALEWSKI (1930, p. 166) escape from examination as having been lost during the war. In the subsequent years, the otoliths from the Korytnica Basin were studied by T. ŚMIGIELSKA, who earlier recognized their wealth when studying other sites in southern Poland (ŚMIGIELSKA 1966; localities Korytnica and Karsy, distinguished as separate), and who afterwards monographed (ŚMIGIELSKA 1979) the new material collected by W. BAŁUK and A. RADWAŃSKI.

The present author has undertaken investigations of fish remains from the above-indicated locality Mt. Lysa during her M.Sc. study (RADWAŃSKA 1982), when both otoliths as well as teeth of teleosts and elasmobranchs were recognized to be a prominent component of particular communities. A few otolith species, unknown to the former students, subjected to a preliminary report (RADWAŃSKA 1984), the matter of which will be reexamined in this paper.

LOCALITY NAWODZICE

The locality Nawodzice near Klimontów on the south-eastern slopes of the Holy Cross Mountains (*see* Text-fig. 1) was first reported, under the name of the nearby village Gieraszowice, by MAŁECKI (1962) who described an assemblage of bryozoans encrusting red-algal colonies. A concise survey on the faunal content and its environmental conditions was given by BAŁUK & RADWAŃSKI (1968), whose report was supplemented by HOFFMAN & SZUBZDA (1976) with an account on ecology of mollusk assemblages. The much diversified fauna, recognized by BAŁUK & RADWAŃSKI (1968) has soon subjected to thorough descriptions, a series of which is still in progress. The hitherto monographed groups are such as the decapod crustaceans (FÖRSTER 1979), bivalves (STUDENCKA 1986, 1987), chitons (STUDENCKA & STUDENCKI 1988), echinoids (MĄCZYŃSKA 1988), and starfishes (NOSOWSKA 1990, 1993). The latter group, the starfishes, are herein represented by a unique material of wholly preserved skeletons what has recently provoked the fame of the locality (*see* JAGT 1991).

The section is exposed in a sand-pit, abandoned since a couple of decades, and situated at the toppart of an unnamed, now forested hill, on the left side of the Koprzywianka river, east of the village Nawodzice.

The section comprises (*see* Text-fig. 3) fine-grained quartz sands with lenses enriched in fossils, and featured by the decapod burrows *Ophiomorpha nodosa* LUNDGREN. The fauna in particular lenses is preserved either in life position, or it is redeposited (*see* BAŁUK & RADWAŃSKI 1968, Fig. 3; RADWAŃSKI 1970, Fig. 3; HOFFMAN & SZUBZDA 1976, pp. 316-319). The sands are covered by sandy gravelstones with red-algal nodules, then by a red-algal residual lag, and finally by thin-bedded organodetrital limestones.

The sedimentary environment of the Nawodzice Sands is interpreted as extremely shallow subtidal, almost intertidal, which was seriously influenced by stormy agitation and by a changing extent of the shoreline (*see* BAŁUK & RADWAŃSKI 1968; RADWAŃSKI 1970, 1973).

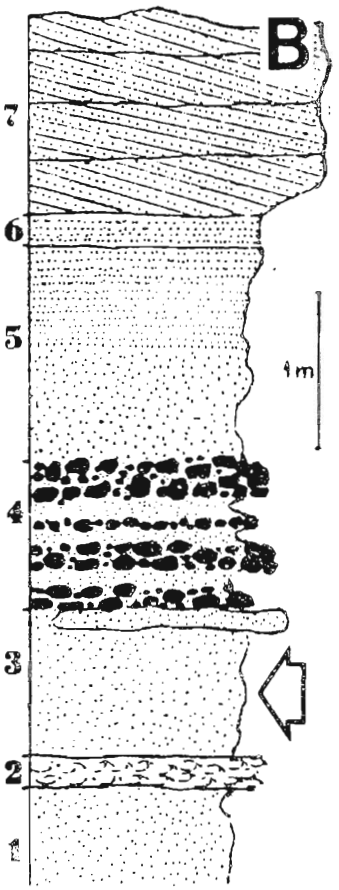
The presence of otoliths in this locality was recognized by BAŁUK & RADWAŃSKI (1968, p. 452). All the otoliths collected here through some twenty years by successive investigators have been included into the present study.

LOCALITY RYBNICA

The nearby locality Rybnica on the south-eastern slopes of the Holy Cross Mountains (*see* Text-fig. 1) was discovered by J. SAMSONOWICZ at the beginning of the century. The first report was given by KOWALEWSKI (1918), who continued his research upon that locality through forty years (*see* KOWALEWSKI 1930, 1950, 1958) and presented its detailed lithologic characteristics and malacologic content (KOWALEWSKI 1950). The mollusk fauna of the locality was compared with that of the preceding locality Nawodzice by BAŁUK & RADWAŃSKI (1968), and its ecology was studied by HOFFMAN & SZUBZDA (1976) in regard to the structure of particular communities and their trophic web, as well as the mortality patterns of some species (HOFFMAN & SZUBZDA-STUDENCKA 1982). A systematic study of particular invertebrate groups has recently been performed for the bivalves (STUDENCKA 1986), chitons (STUDENCKA & STUDENCKI 1988), and echinoids (MĄCZYŃSKA 1988).

Within the locality Rybnica, two sections of a similar sequence are exposed (section Rybnica *1* and Rybnica *2* in STUDENCKA 1986), and all the otolith material was collected in the section Rybnica *2*.

This section reveals (*see* Text-fig. 4) fine-grained quartz sands with more or less irregular intercalations of gravels which form more regular, although lenticular bodies in the middle part of the sequence. The ubiquitous fauna, the otoliths including, comes primarily from these gravelous lenses and intercalations. The sands are covered by red-algal gravels and coarse-grained organodetrital sandstones.



Otolith-bearing locality Rybnica near Kliмontów on the south-eastern slopes of the Holy Cross Mountains (*see* Text-fig. 1)

A – General view of the Koprzywianka river valley, along which the Middle Miocene (Badenian) deposits are exposed, and the studied section (*see* Fig. B) in a tributary ravine (*arrowed*) is situated;

B – Lithologic profile of deposits accessible in the ravine (section Rybnica *2* and numbering as *in* STUDENCKA 1986), to indicate the position of the otolith-yielding gravelous sands (*arrowed*)

Fig. B adopted *from* STUDENCKA (1986, Fig. 3)

C – Close-up of the section exposed during the fieldworks in 1988

During fieldworks for the otolith material, the present author recognized within that ubiquitous fauna, the occurrence of some elements new for this locality. Of such elements, worth noting are inarticulate brachiopods of the genus *Discinisca* which represent a new taxon at the species rank, as well as cirripedes *Lepas* and *Verruca*, and finally various isolated chelae of decapod crustaceans.

The sedimentary environment of the Rybnica Sands is interpreted as subtidal, permanently submerged, and more distant to the shore as compared to the preceding locality of Nawodzice (BAŁUK & RADWAŃSKI 1968; RADWAŃSKI 1970, 1973). As most of the fauna in this locality is redeposited, and usually mixed with coarser gravelous material, it is assumed that accumulation was caused by temporary stormy agitations and transportation.

The otoliths from the Rybnica Sands have first been reported by CHAINE & DUVERGIER (1928) who studied the material collected by K. KOWALEWSKI, and described four species. One of these species was also mentioned by KOWALEWSKI (1930, p. 166), while ŚMIGIELSKA (1966) enriched the number of recognized species to eight.

LOCALITIES NEAR ŁYCHÓW

A group of exposures in the villages Węglinek, Węglin and Łychów near Zaklików in the western part of the Lublin Upland (*see* Text-fig. 1) comprises various clastic and carbonate deposits of much diversified facies development (*see* Text-fig. 5). Although these deposits have formerly been described more than once (BIELECKA 1959, 1967; KRACH 1962, 1981; MACIOSZCZYK 1988), their lateral distribution and stratigraphic succession are not clarified yet. This certainly results, partly at least, from their emplacement upon a variable, pre-Miocene morphology and from their deposition around and/or(?) amongst the biogenic build-ups, recognized by PISERA (1978; and 1985, Fig. 3) as the algal-vermetid reefs which were growing over the heights of that pre-Miocene morphology.

WĘGLINEK

At Węglinek, below the algal-vermetid reef exposed are glauconitic sands which are absent in places where the reef is settled upon the Cretaceous substrate (*see* BIELECKA 1967, PISERA 1985). This reef interfingers with marl-sandy deposits containing calcareous algae (*see* PISERA 1985, p. 93) and a rich fauna (MACIOSZCZYK 1988, p. 48). Of faunal elements, significant are diverse herbiverous gastropods, the bivalved species *Berthelinia krachi* BAŁUK & JAKUBOWSKI including, as well as chitons (MACIOSZCZYK 1988), brachiopods (BITNER 1990), and uncommon otoliths.

The studied otolith material, collected by W. MACIOSZCZYK, comes from a small exposure situated east of the Trzydniczanka Stream (locality *I* in MACIOSZCZYK 1988, p. 48 and Fig. 2).

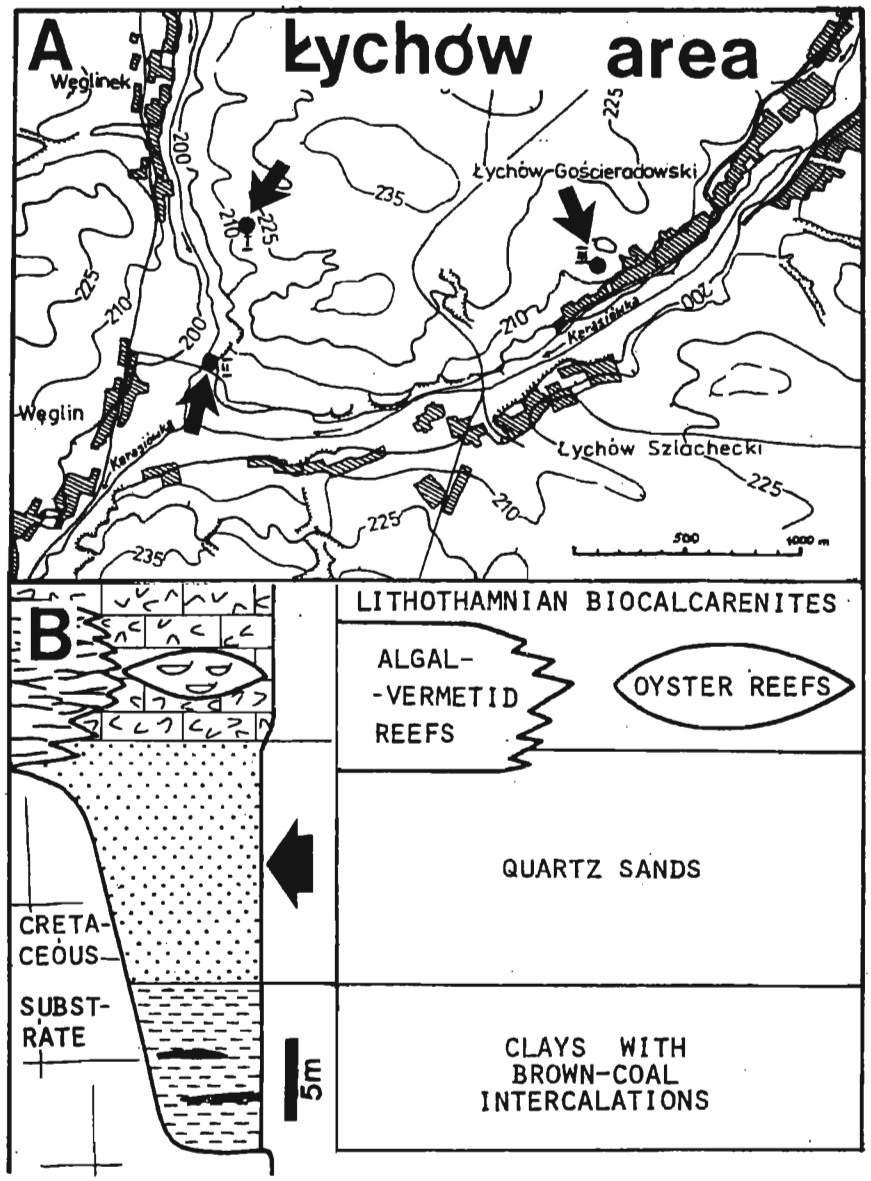


Fig. 5. Otolith-bearing localities of the Łychów area in the Lublin Upland (*see* Text-fig. 1)

A – Topographic sketch, to show the studied localities Węglinek, Węglin, and Łychów (*arrowed*); adopted *from* Macioszczyk (1988, Fig. 2);

B – Bottom part of the general lithologic profile of the Middle Miocene (Badenian) deposits in the investigated area (adopted *from* Pisera 1985, Fig. 3), to indicate the position of the otolith-yielding deposits at Węglinek and Węglin (*arrowed*)

WĘGLIN

At Węglin, exposed are deposits of the lithology and vertical succession almost identical to those from Węglinek. A rich mollusk fauna, containing also the chitons, and associated with unfrequent otoliths comes from an exposure situated near the bridge over the Trzydniczanka Stream, and distant about 700 meters SSW of the preceding locality Węglinek (*see* MACIOSZCZYK 1988, p. 48 and Fig. 2). Within the fossil assemblage occurring here, special studies have recently been undertaken on solitary corals (STOLARSKI 1988) and brachiopods (BITNER 1990).

The studied otolith material was collected by W. MACIOSZCZYK from glauconitic sands wich were regarded by him (MACIOSZCZYK 1988) as a facies lateral to the Węglinek reef. However, it seems reasonable to suppose that these sands rest in a local denivelation of the substrate, beneath the reef deposits, and thus in a position identical to that recognized at Węglinek. It is also to note, that at Węglin there also occur detrital algal deposits, the base of which is not exposed now (*see* SZCZECHURA & PISERA 1986, Fig. 2; PERYT 1987, Fig. 2) and which developed, locally at least, directly upon the Cretaceous substrate (*see* BIELECKA 1967, Fig. 18).

ŁYCHÓW

At Łychów, in several small rural quarries and other temporary exposures within the village exposed are deposits much variable in their lithology. These are either reef-like with adjacent facies of detrital talus (PISERA 1985), or sand-clayey ones that contain an ubiquitous, often rock-building fauna (BIELECKA 1967; RADWAŃSKI 1977; HOFFMAN, PISERA & STUDENCKI 1978; FÖRSTER 1979; MACIOSZCZYK 1988; BITNER 1990). The variable facies pattern was here dependant both on the substrate morphology and the development of algal-vermetid reefs (*see* RADWAŃSKI 1977a, p. 750).

The otolith material, collected by W. MACIOSZCZYK and J. CIBOR, is rather very scant and poorly preserved (synsedimentarily or diagenetically corroded); thus, its taxonomic recognition remains far from satisfaction. The scarcity of the otolith specimens within these fossiliferous deposits, some layers of which are of the coquina type composed of the shells of small herbiverous gastropods, may be interpreted as a result of accumulation of the shell material having been derived from the kelp-associated communities (*see* RADWAŃSKI 1977a, p. 750; HOFFMAN, PISERA & STUDENCKI 1978). Such kelp-dominated habitats could be unfavorable for a profuse development of any fishes.

Age of the deposits

The age of all the deposits exposed in the vicinity of Węglinek – Węglin – Łychów has hitherto been interpreted very variably within the frames of

a lithostratigraphic subdivision of the Miocene deposits of southern Poland (*see* HOFFMAN, PISERA & STUDENCKI 1978; KRACH 1981; MACIOSZCZYK 1988).

The investigation of planktic foraminifers and ostracodes from the Węglin section, performed by SZCZECHURA & PISERA (1986) indicates the presence of some species characteristic of cooler waters. This is interpreted by SZCZECHURA & PISERA (1986) as a result of a climatic cooling which these authors date as the Late Badenian. Regardless that stratigraphic interpretation, it is to record that all the investigated otoliths from Węglin are evidently not indicative of any cooler waters (*see* the chapter on environmental interpretation).

The discussed section of Węglin has also acquired a calcareous nannoplankton dating by PERYT (1987) who recognized the presence of the biozones NN5 and NN6, and thus confirmed the isochroneity of the sequence with that of the Korytnica Basin.The same age should be ascribed to the nearby section of Węglinek and Łychów where poor calcareous nannoplankton does not allow for any precise stratigraphic approach.

The above given age is questioned by the authors working on microproblematics *Bolboforma*, and who postulate a Late Badenian age of the section (SZCZECHURA 1982, 1986; SPIEGLER & RÖGL 1992).

It is out of the scope of this paper to discuss the value of the new stratigraphic approach of the *Bolboforma* zonation. It may however be indicated that the boundary of the "Lower Badenian" zone of *Bolboforma reticulata* (erronously identified as *Bolboforma metzmacheri* by ODRZYWOLSKA-BIEŃKOWA 1976 and by SZCZECHURA 1986) and "Upper Badenian" zone of *Bolboforma badenensis* is diachronic to the nannoplankton zone boundary of NN5 and NN6 (*see* SPIEGLER & RÖGL 1992, p. 77, Tables 2 and 4).

Noteworthy is that a precise sampling location in the Węglin section has hitherto been presented only by PERYT (1987, Fig. 2). As indicated above, the otolith-bearing lithology is situated near the base of the sequence, and thus deeply within the NN5 interval of the section. It is thus possible that all the sampling sites for *Bolboforma* come from a higher part of the sequence, the age of which may really reach the Upper Badenian.

LOCALITY BĘCZYN

The Miocene deposits at Bęczyn (formerly written as Benczyn) near Wadowice at the Carpathian margin (*see* Text-fig. 1) were discovered by KSIĄŻKIEWICZ (1932; description in KRACH & KSIĄŻKIEWICZ 1950) who stated that a sequence composed of clays, dipping about 40°, rests here near the front of the Carpathian overthurst; this clay sequence contains a relatively common and diversified, but streak-like distributed fauna which is evidently redeposited.

This locality, thoroughly studied by KRACH & KSIĄŻKIEWICZ (1950), yielded a rich assemblage of fossils which were successively described. The most outstanding component of that assemblage, the mollusks, determinated by

KRACH himself (*in* KRACH & KSIĄŻKIEWICZ 1950) are here associated with bryozoans (MAŁECKI 1951), solitary and colonial corals (MOENKE 1953, STOLARSKI 1988), ostracodes (SCHILLER 1976), and foraminifers (GONERA 1988).

The presence of otoliths at Bęczyn has first been stated by KRACH (*in* KRACH & KSIĄŻKIEWICZ 1950, p. 280), and all the collected material was included into the above-referenced monograph by ŚMIGIELSKA (1966).

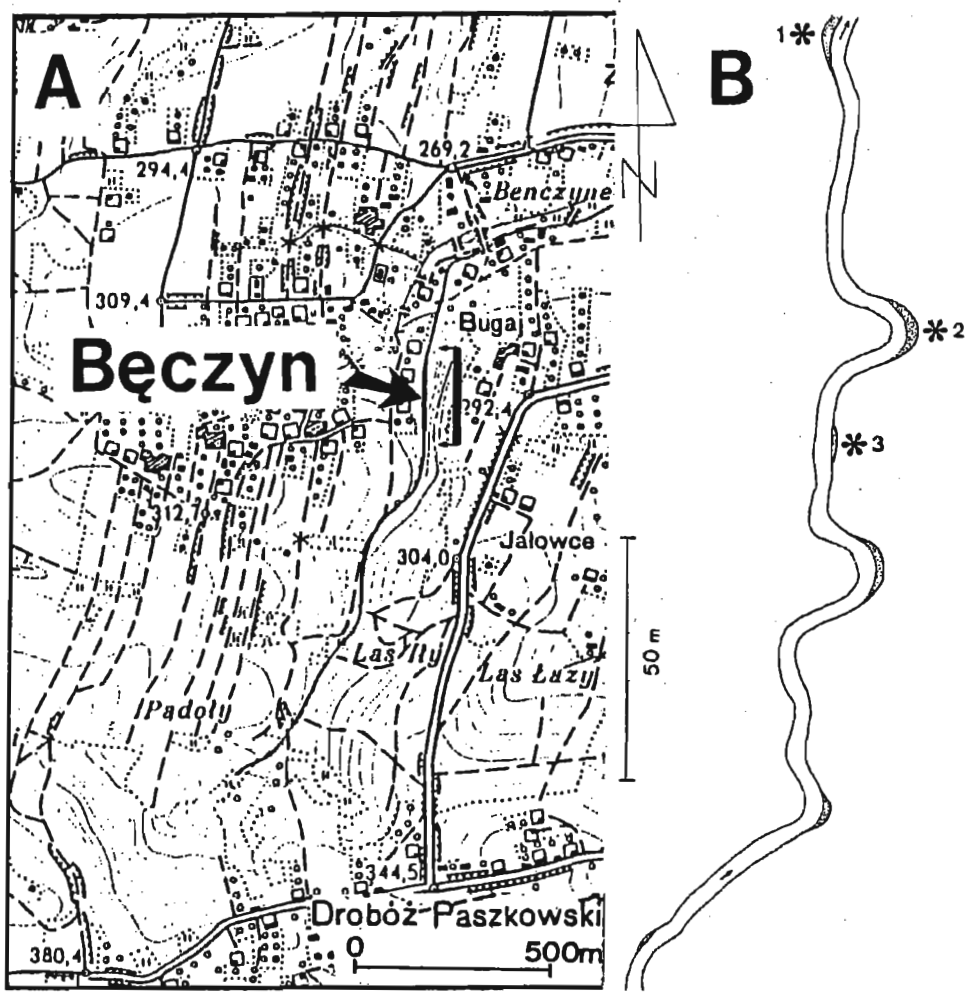


Fig. 6. Otolith-bearing locality Bęczyn near Wadowice at the Carpathian margin (*see* Text-fig. 1)

A – Topographic map of the Bęczyn area, to show the location of the studied exposures (*arrowed* and *bracketed*) situated along the stream (*see* Fig. B);

B – Location of temporary exposures of the Middle Miocene (Badenian) clays in the stream bed (*stippled*; sampling sites are *asterisked* and *numbered* as *1, 2, 3*)

Figs A and B adopted *from* STOLARSKI (1988, Figs 4a *and* 5)

The environmental conclusions, drawn by the above indicated authors, are generally compatible, and they speak about a dominance of more or less deeper-marine forms, associated with those either shallow marine, or even brackich (as recently postulated by GONERA 1988) which are thought to have been redeposited (*see also* ALEXANDROWICZ 1975).

The investigated otolith material comes from the samples taken by STOLARSKI (1988) from three temporary exposures situated along the bed of an unnamed stream running west of the hill indicated on the maps as of a height 304.0 m (*see* Text-fig. 6; *compare* KRACH & KSIĄŻKIEWICZ 1950, Figs 1-2; STOLARSKI 1988).

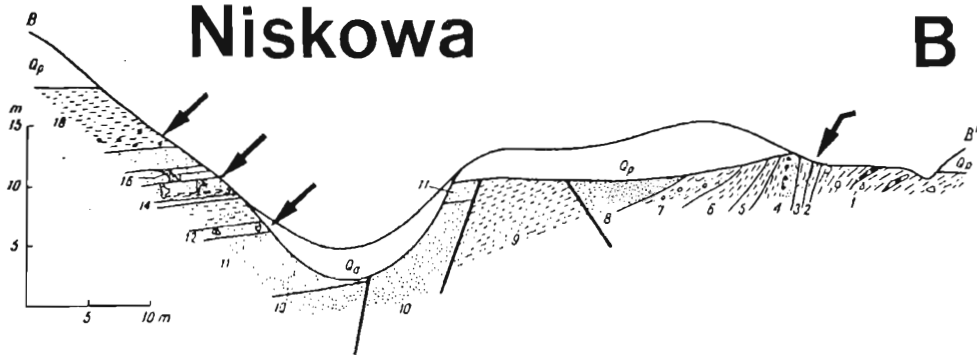
LOCALITY NISKOWA

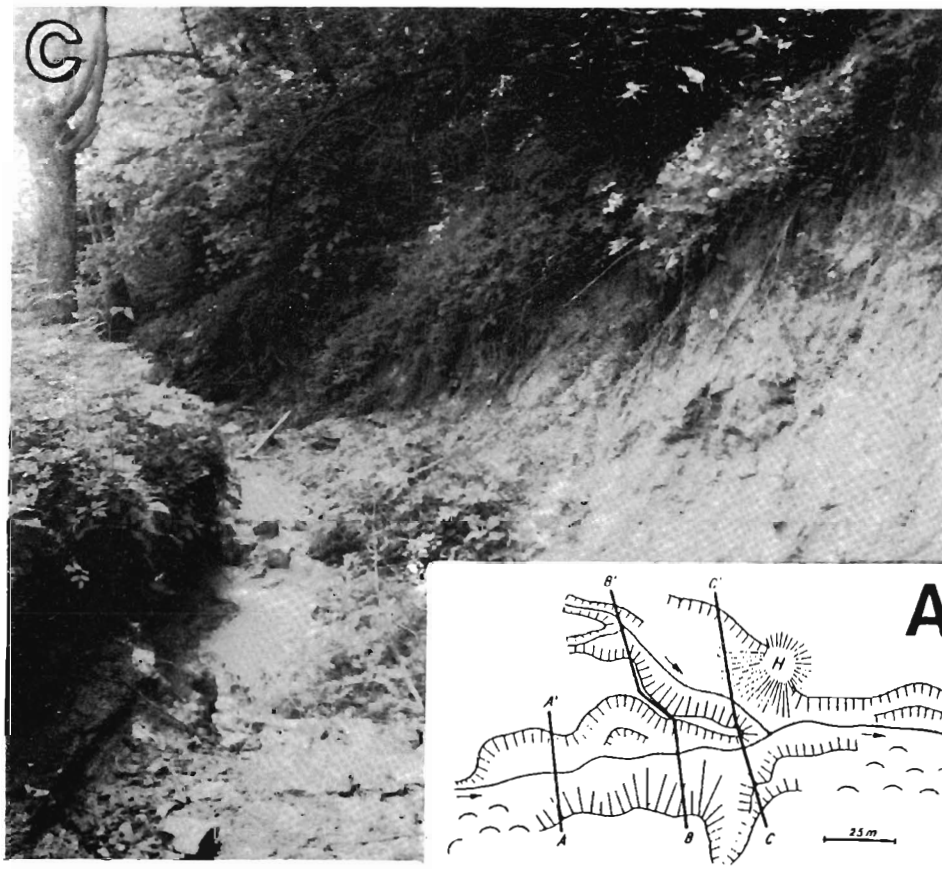
The Miocene deposits exposed at Niskowa near Nowy Sącz in the Carpathians (*see* Text-fig. 1) were discovered by UHLIG (1888), who recognized their age, sedimentary sequence and faunal content. This research was continued by FRIEDBERG (1907, 1911), who paid a special attention to the occurrence of mollusks, the description of which was included into the above-indicated monograph "*Mollusca miocaenica Poloniae*" (FRIEDBERG 1911-1928, 1934-1936). A special study was performed by SKOCZYLASÓWNA (1930) who reported many taxa new for this locality. Still more advanced studies were subsequently commenced by BAŁUK (1966, 1970), who analyzed the tectonic setting of the section entangled between the Carpathian fold structures, the sedimentary sequence and its paleogeographic (palinspastic) position, as well as the composition of the ubiquitous faunal assemblages that also contain the otoliths (*see* BAŁUK 1970, Fig. 2; partly reproduced herein as Text-fig. 7). Of the collected fossils, some groups were monographed by that author himself, viz. the chitons (BAŁUK 1965), or by the other students who dealt with the calcareous green algae (MAŁECKI 1970) and the decapod crustaceans (FÖRSTER 1979). The foraminifers were studied recently by GONERA (1988).

The otolith material collected by W. BAŁUK was preliminarily accounted by ŚMIGIELSKA (*in* BAŁUK 1970), who subsequently performed also its separate systematic description (ŚMIGIELSKA 1973).

The exposure of the Middle Miocene (Badenian) deposits at Niskowa (*see* Text-fig. 7) is situated in the western part of the village, along the ravines of the temporary stream called Pruska, a tributary to the Trzetrzewina Stream. The major part of the section is exposed at the bifurcation of the main ravine, the site being distant about half a kilometer from the mouth of the Pruska Stream.

The whole section, as recognized by BAŁUK (1970), begins with clay deposits containing brown-coal intercalations which once were of local commercial use. These fresh-water deposits (set *I*) are overlain by these clay-sandy ones with brackish and marine fauna, the latter represented





Otolith-bearing locality Niskowa near Nowy Sącz in the Carpathians (*see* Text-fig. 1)

A – Location sketch of the Pruska Stream along which the Middle Miocene (Badenian) deposits are exposed; indicated are lines of sections (*see* section *B-B'* in Fig. B); H – dump of an abandoned brown-coal mine;

B – Geologic section, to show the otolith-yielding layers (*arrowed*), numbered as in the text; Q_p – Pleistocene cover, Q_a – Holocene alluvia

Figs A and B adopted *from* BALUK (1970, Figs 1-2)

C – Present-day state of the exposure, as taken downstream the section *C-C'* in Fig. A; photo by A. SZYMAŃSKI

also by some otoliths (set *II* – layers 2-6), and by unfossiliferous clay-silty deposits (set *III* – layers 7-9) which are followed by a sand-silty member with an ubiquitous marine fauna (set *IV* – layers 10-20).

The sedimentary environment in which this sequence was formed is interpreted by BAŁUK (1970) as one changing throughout the time. Originally, it was an area of nearshore swamps upon which a marine advance produced an oligohaline basin with brackish fauna associated with some marine elements (scaphopods, echinoids, fish otoliths). This was succeded by a presumably fresh-water basin in which unfossiliferous part of the sequence was deposited. Finally, the return of marine conditions progressed to form a successively deepening basin in which sedimentation began with shallow subtidal deposits (layers 11-12 with green algae, colonial corals and chitons; *see* BAŁUK 1965 and 1970, p. 153), through shallow sublittoral (layers 13-15), to those which indicate deeper sublittoral or even neritic conditions (layers 18-20).

Recently, in regard to the stratigraphic studies of the section exposed at Iwkowa, situated more northwardly of Nowy Sącz, it has been suggested by CIESZKOWSKI & *al.* (1988, pp. 324-325) that the lowermost part of the Niskowa section may correspond to the higher Badenian and/or Lower Sarmatian. As apparently results from a thorough stratigraphic analysis given by BAŁUK (1966), such suggestion cannot be regarded as justifible.

The studied material of the otoliths comes from the layers distinguished by BAŁUK (1970) as No. *2* of the set II, and Nos. *12-13, 15,* and *18* of the set IV (*see* Text-fig. 7).

SYSTEMATIC ACCOUNT OF THE FISH OTOLITHS

The investigated fish otoliths from the marine Middle Miocene (Badenian) deposits of southern Poland belong all to the teleosts. The systematics used in the following descriptions of the species is that offered by GREENWOOD, ROSEN, WEITZMAN & MYERS (1966), partly modified and/or amended by subsequent authors (*see* STEURBAUT 1984, NOLF 1985).

Of the three types of the paired (*left* and *right*) otoliths present in the teleost fishes (saccular otolith = **sagitta**, *plural* sagittae; utricular otolith = **lapillus**, *plural* lapilli; lagenar otolith = **asteriscus**, *plural* asterisci), in the investigated material all the specimens, except of one species, represent the saccular otoliths, i.e. the sagittae. Thus, in the following descriptions, any reference to *the otolith* concerns *the sagitta.* The only exeption is that of the single specimen determined as "genus *Ariidarum*" sp. whose collected otolith is a lapillus (*see* Text-fig. 22 and Pl. 4, Fig. 15).

The terminology used in the description of the investigated otoliths (sagittae) is that adapted from the works of former authors (*see e.g.* ŚMIGIELSKA

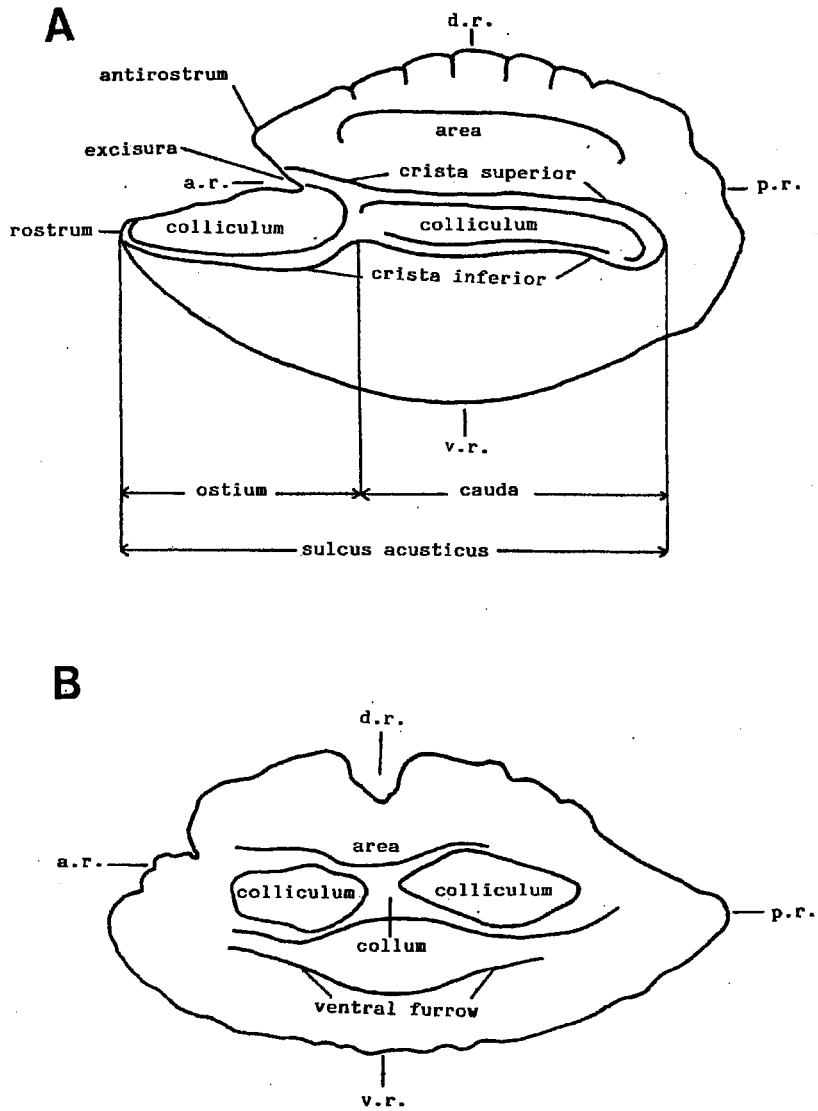


Fig. 8. Morphological nomenclature of the inner face of teleost-fish otoliths

A – Right sagitta of the species "genus *Percoideorum*" *tietzei* (SCHUBERT, 1906), to exemplify otoliths furnished with distinct morphological elements;

B – Right sagitta of the species *Halobatrachus korytnicensis* (ŚMIGIELSKA, 1979), to exemplify otoliths with a well developed collum

In both drawings (*A* and *B*): **a.r.** – anterior rim, **p.r.** – posterior rim, **d.r.** – dorsal rim, **v.r.** – ventral rim

1966, Fig. 1; NOLF 1985, Fig. 6). To avoid any misunderstandings, the adapted nomenclature is shown in the inserted drawings (Text-fig. 8*A-B*).

The localities referenced in the measurement tables, enclosed to the descriptions of particular species, are abbreviated in the way indicated above, in the general characteristics of the investigated material. The other abbreviations used in the measurement tables are as follows (*see* Text-fig. 8):

L – length, measured (*in* mm) along the sulcus acusticus,
H – height, measured (*in* mm) from the dorsal to the ventral rim, perpendicularly to the measured length,
T – thickness, measured (*in* mm) at the maximum dimension between the inner and the outer face of the otolith.

Almost all the recognized taxa are illustrated by line drawings (Text-figs 9-167) and half-tone photos (Pls 1-38). In the case of a remarkable species diversity, its range is demonstrated by line drawings. If a reference is given to a present-day taxon, its example is given in a separate Text-figure.

In all line drawings (Text-figs 9-167), the scale bar equals 1mm, unless otherwise stated.

Order **Anguilliformes** REGAN, 1909
Suborder **Albuloidei** JORDAN, 1923
Superfamily **Albuloidea** BLEEKER, 1859
Family **Pterothrissidae** GILL, 1893
Genus *Pterothrissus* HILGENDORF, 1877

Pterothrissus umbonatus (KOKEN, 1884)
(Text-fig. 9 and Pl. 1, Figs 9-10)

1884. *Otolithus* (*incertae sedis*) *umbonatus*; E. KOKEN, p. 557, Pl. 12, Fig. 12.
1884. *Otolithus* (*incertae sedis*) *minor*; E. KOKEN, p. 558, Pl. 11, Fig. 14.
1891. *Otolithus* (*incertae sedis*) *umbonatus* KOKEN; E. KOKEN, p. 134.
1891. *Otolithus* (*incertae sedis*) *robustus* KOKEN; E. KOKEN, p. 136, Text-fig. 25.
1891. *Otolithus* (*incertae sedis*) *lunaburgensis* KOKEN; E. KOKEN, p. 137, Text-fig. 16.
1914. *Otolithus* (*Gadidarum*) *Peyroti* n. sp.; F. PRIEM, p. 250, Text-fig. 10.
1914. *Otolithus* (*Dentex*) aff. *nobilis*? KOKEN; F. PRIEM, p. 262, Text-fig. 42.
1973. *Pterothrissus umbonatus* (KOKEN) 1884; S. JONET, p. 133, Text-fig. 11 (item 1) and Pl. 2, Figs 1-2.
1973. *Pterothrissus minor* (KOKEN) 1884; S. JONET, p. 134, Text-fig. 11 (item 2) and Pl. 2, Figs 3-5.
1977. *Pterothrissus umbonatus* (KOKEN, E., 1884); D. NOLF, p. 14.
1979. *Pterothrissus* sp.; D. NOLF & E. STEURBAUT, p. 5, Pl. 1, Fig. 12.
1979. *Pterothrissus* sp.; E. STEURBAUT, p. 53, Pl. 1, Figs 1-2.
1979. *Pterothrissus minor* (KOKEN, 1884); T. ŚMIGIELSKA, p. 299, Text-fig. 2 and Pl. 1, Figs 1-3.
1981. *Pterothrissus umbonatus* (KOKEN, 1884); W. SCHWARZHANS, p. 81.
1982. *Pterothrissus umbonatus* (KOKEN, 1884); E. STEURBAUT & S. JONET, p. 196, Pl. 1, Figs 1-2.
1983. *Pterothrissus umbonatus* (KOKEN, 1884); D. NOLF & E. STEURBAUT, p. 148, Pl. 1, Figs 1-2.
1984. *Pterothrissus umbonatus* (KOKEN, 1884); E. STEURBAUT, p. 32, Pl. 1, Figs 5-7.
1985. *Pterothrissus umbonatus* (KOKEN, 1884); D. NOLF, p. 40, Fig. 35D.
1988. *Pterothrissus umbonatus* (KOKEN, 1884); D. NOLF, p. 33, Pl. 1, Fig. 3.

MATERIAL: Korytnica – 18 specimens, in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 9	Pl. 1
RaK-2	7.0	4.3	Fig. 9a	Fig. 10
RaK-1	4.0	2.5	Fig. 9b	Fig. 9

REMARKS: The studied otoliths are consistent with those described by KOKEN (1884) as "*Otolithus* (*incertae sedis*) *umbonatus*". The otoliths of this species have earlier been reported from the Korytnica Basin by ŚMIGIELSKA (1979) as "*Pterothrissus minor* (KOKEN, 1884)". Recently, the latter species is regarded (NOLF 1977, SCHWARZHANS 1981) as a younger synonym of the species

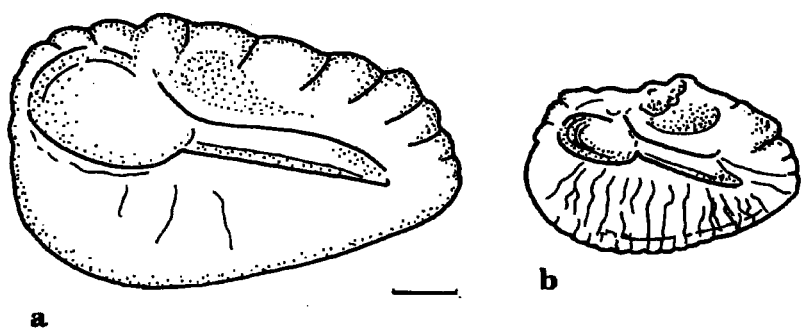


Fig. 9. *Pterothrissus umbonatus* (KOKEN, 1884)

a, b – Right sagitta, inner face

"*umbonatus*". The otoliths described by KOKEN (1884) as "*Otolithus* (*incertae sedis*) *minor*" differ from those of *Pterothrissus umbonatus* (KOKEN, 1884) by their more pronounced sculpture. In the investigated material, a differentiation in sculpture is also well visible (*see* Text-fig. 9 and Pl. 1, Figs 9-10), and the more pronounced sculpture is displayed by juvenile forms (*see* Text-fig. 9b and Pl. 1, Fig. 9).

Suborder **Anguilloidei** REGAN, 1909
Superfamily **Anguilloidea** RAFINESQUE, 1810
Family **Heterenchelyidae** REGAN, 1912
Genus *Panturichthys* PELLEGRIN, 1913

Panturichthys subglaber (SCHUBERT, 1906)
(Text-fig. 10 and Pl. 1, Fig. 4)

1906. *Otolithus* (*Solea*) *subglaber* n. sp.; R. SCHUBERT, p. 672, Pl. 6, Figs 19-26.
1964. *Solea subglaber* R. SCHUBERT; J. BAUZÁ RULLÁN, p. 206, Pl. 4, Fig. 13.
1973. *Rhynorhombus medius* WEILER 1958; S. JONET, p. 227, Text-fig. 12 (item 43) and Pl. 4, Fig. 134.

1973. *Pseudorhombus helvecianus* n. sp.; S. JONET, p. 228, Text-fig. 13 (items 26, 28) and Pl. 4, Fig. 135.
1973. *Eusolea subglabra* (SCHUBERT) 1906; S. JONET, p. 234, Pl. 4, Fig. 147.
non 1973. *Solea subglabra* SCHUBERT; T. ŚMIGIELSKA, p. 29, Pl. 5, Fig. 9.
1979. *Eusolea subglabra* (SCHUBERT); G. ANFOSSI & S. MOSNA, p. 129, Pl. 4, Fig. 16.
1980. *Panturichthys subglaber* (SCHUBERT, 1906); D. NOLF & J. MARTINELL, p. 210, Pl. 1, Figs 3-6.
1980. *Panturichthys subglaber* (SCHUBERT, 1906); D. NOLF & H. CAPPETTA, p. 4, Pl. 1, Figs 1-2.
1981. *Panturichthys subglaber* (SCHUBERT, 1906); D. NOLF, p. 168, Pl. 1, Figs 3-6.
1982. *Panturichthys subglaber* (SCHUBERT, 1906); E. STEURBAUT & S. JONET, p. 196, Pl. 1, Figs 5-8.
1984. *Panturichthys subglaber* (SCHUBERT, 1906); E. STEURBAUT, p. 33, Pl. 1, Fig. 10.
1985. *Panturichthys subglaber* (SCHUBERT, 1906); D. NOLF, p. 41, Fig. 36F.

MATERIAL: Korytnica – one specimen, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 10	Pl. 1
RaK-8	2.8	2.0	0.7	Fig. 10a,a'	Fig. 4

DESCRIPTION: Otolith oval in outline, slightly pentagonal. Dorsal rim is straight, with well developed corners. Anterior rim is straight too, and it passes to the short rostrum. Ventral rim is symmetrically convex. Inner face is regularly convex. Sulcus acusticus is distinctly divided and *S*-likely arched. Ovally shaped ostium is as long as the cauda and slightly obliquely placed. Cauda is slightly arched and horizontally placed. Collicula are badly developed. Outer face is flat.

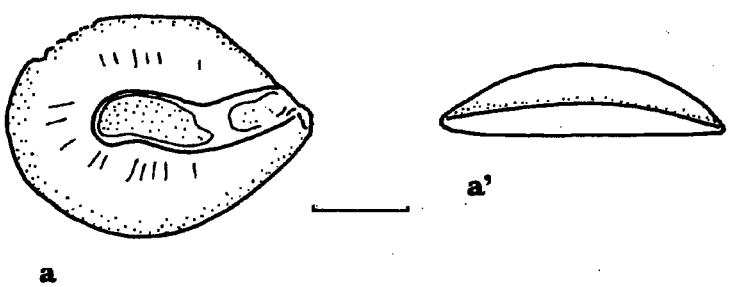


Fig. 10. *Panturichthys subglaber* (SCHUBERT, 1906)

a – Left sagitta, inner face, a' – ventral view

REMARKS: The studied otolith is consistent with those described by SCHUBERT (1906) as "*Otolithus* (*Solea*) *subglabra*". This species is featured by a great variability of the sagitta outline. The specimen from Korytnica is oval in its outline, with its sulcus acusticus strongly arched; it closes the best with one of the specimens illustrated by SCHUBERT (1906, Pl. 6, Fig. 22). The generic assignment of the species was variably treated by the former authors (*see* synonymy). More recently, NOLF & MARTINELL (1980) recognized a great similiarity of discussed forms to the present-day species *Panturichthys mauritanicus* PELLEGRIN, 1913 (*see* NOLF 1985, Fig. 36E), and thus they transferred the species "*subglaber*" to the order Anguilliformes REGAN, 1909.

Otoliths of this species have not hitherto been reported from Poland, although ŚMIGIELSKA (1973) described one specimen from Niskowa as "*Solea subglabra* SCHUBERT". According to the

present author, this determination is incorrect, and the illustrated specimen (ŚMIGIELSKA 1973, Pl. 5, Fig. 9) represents the genus *Lepidorhombus* GÜNTHER, 1862.

Family **Congridae** KAUP, 1856
Genus *Ariosoma* SWAINSON, 1838

Ariosoma balearica (DELAROCHE, 1809)
(Text-fig. 11 and Pl. 1, Figs 5-8)

1938. *Congermuraena balearica* DELAROCHE; J. CHAINE, p. 242, Pl. 18.
1979. *Congermuraena balearica* (DE LA ROCHE); T. ŚMIGIELSKA, p. 303, Text-fig. 7 and Pl. 2, Figs 1-2.
1984. *Ariosoma longicaudatum* sp. n.; U. RADWAŃSKA, p. 301, Text-figs 2-3 and Pl. 1, Figs 1-3.
1984. *Ariosoma* cf. *moravica* (SULC, 1932); U. RADWAŃSKA, p. 303, Text-fig. 5 and Pl. 2, Fig. 2.

MATERIAL: Korytnica – 27 specimens, in majority well preserved.

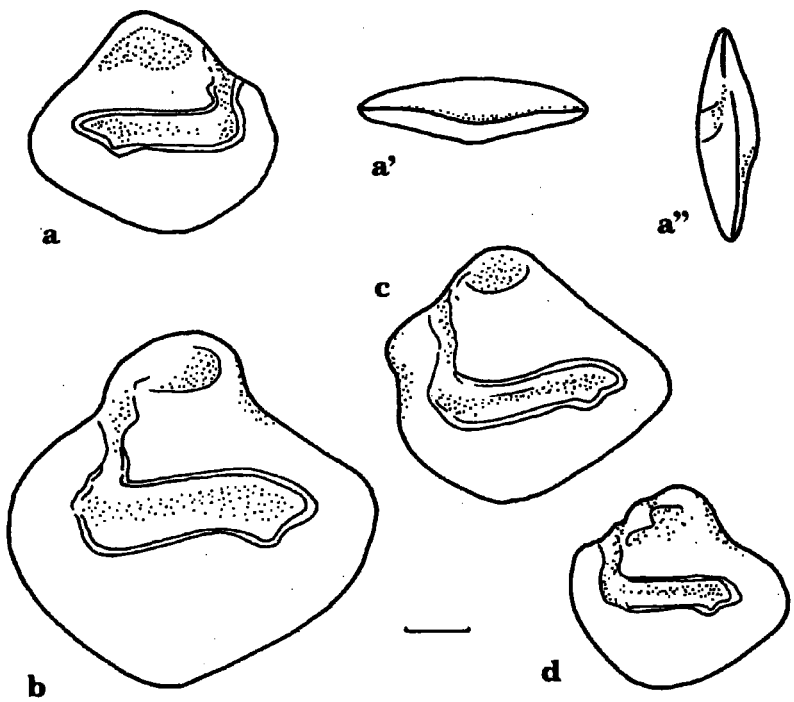


Fig. 11. *Ariosoma balearica* (DELAROCHE, 1809)

a – Left sagitta, inner face, **a'** – ventral view, **a"** – anterior view; the same specimen as illustrated formerly (RADWAŃSKA 1984, Fig. 2a-c),
b, c, d – right sagitta, inner face

Coll. number	L	H	T	Figured in: Text-fig. 11	Pl. 1
RaK-3	5.0	4.5	1.4	Fig. 11a,a'a"	Fig. 7

REMARKS: Otoliths of this species have already been twice reported from the Korytnica Basin (ŚMIGIELSKA 1979, RADWAŃSKA 1984). Formerly, the present author in her paper of 1984 established a new species, *Ariosoma longicaudatum* RADWAŃSKA, 1984, to describe the forms featured by their sulcus acusticus longer, and more distinctly straight. Recently, a good opportunity to compare the Korytnica specimens with those of the present-day (NOLF's Collection) species *Ariosoma balearica* (DELAROCHE, 1809), results in a conclusion, that the former recognition was not well established. The studied otoliths, although rather variable in their general outline, and development of the sulcus acusticus, are well placed within the range of intraspecific variability of modern populations of *Ariosoma balearica* (DELAROCHE, 1809).

It worths noting, that the specimens from the Aquitaine Basin, described by STEURBAUT (1984) as "*Ariosoma* aff. *balearica* (DELAROCHE, 1809)", and formerly included into the synonymy of the species *A. longicaudatum* RADWAŃSKA, 1984, differ distinctly, in their development of the sulcus acusticus, from those of the Korytnica Basin, as well as from otoliths of the present-day fish; it is thought that they certainly represent a separate, new species.

Genus *Conger* OKEN, 1817

Conger aff. *conger* (LINNAEUS, 1758)
(Text-fig. 12 and Pl. 2, Figs 5-9)

1966. *Leptocephalus conger* LINNÉ; T. ŚMIGIELSKA, p. 237, Pl. 14, Fig. 2.
1979. *Conger* aff. *conger* LINNAEUS, 1758; J. LANCKNEUS & D. NOLF, p. 86, Pl. 1, Figs 2-3.
1984. *Conger* aff. *conger* LINNAEUS, 1758; E. STEURBAUT, p. 35, Pl. 1, Figs 12-13.
1985. *Conger* aff. *conger* LINNAEUS, 1758; D. NOLF, p. 44.

MATERIAL: Korytnica – 34 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 12	Pl. 2
RaK-17	6.0	2.5	1.2	Fig. 12c,c'	Fig. 7
RaK-13	4.5	2.0	0.9	--	Fig. 5
RaK-13	3.8	1.7	0.8	--	Fig. 9

REMARKS: Otoliths of this species have already been reported from the Korytnica Basin by ŚMIGIELSKA (1966) as "*Leptocephalus conger* LINNÉ". All the studied specimens, the same as those investigated by ŚMIGIELSKA (1966), represent the juvenile forms. Their juvenile character is expresed by their smaller size and the more convex shape of their faces, both inner and outer (*see* Text-fig. 12c').

The studied otoliths differ from those of the present-day species *Conger conger* LINNAEUS, 1758, by their stronger elongation, what may suggest their specific separateness. Anyway, such a difference does not allow to include the studied specimens into the present-day species.

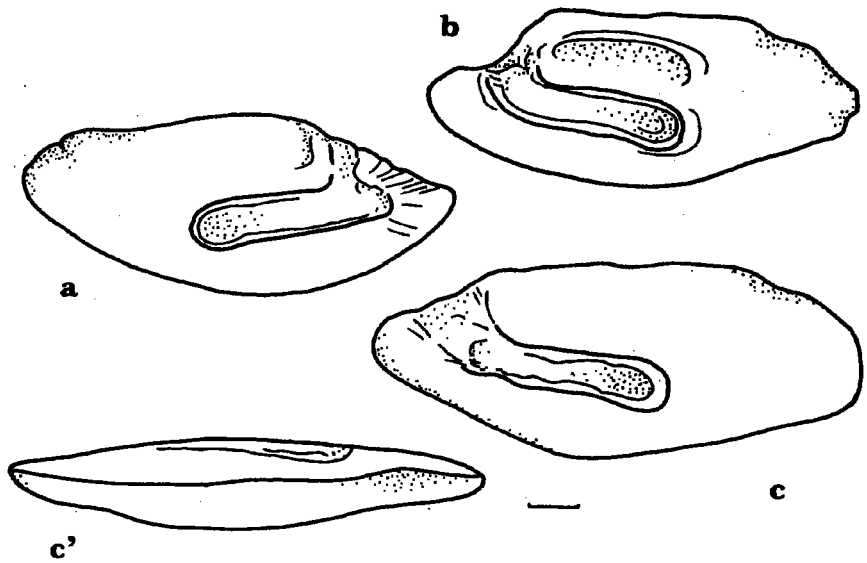


Fig. 12. *Conger* aff. *conger* (LINNAEUS, 1758)

a – Left sagitta, inner face; b, c – right sagitta, inner face, c' – ventral view

Genus *Gnathophis* KAUP, 1860

Gnathophis saubriguensis (STEURBAUT, 1979) (Text-fig. 13 and Pl. 1, Figs 1-3)

1979. "genus aff. *Lemkea*" *saubriguensis* n. sp.; E. STEURBAUT, p. 54, Pl. 1, Figs 8-12 and Pl. 12, Fig. 1.
1984. *Gnathophis saubriguensis* (STEURBAUT, 1979); E. STEURBAUT, p. 36, Pl. 3, Figs 7-8.
1985. *Gnathophis saubriguensis* (STEURBAUT, 1979); D. NOLF, p. 42.

MATERIAL: Korytnica – 7 specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 13	Pl. 1
RaK-9	5.0	2.5	1.0	Fig. 13c	Fig. 2
RaK-10	3.4	2.2	0.9	Fig. 13b	Fig. 3
RaK-11	3.3	2.0	0.7	Fig. 13d	Fig. 1

DESCRIPTION: Otoliths oval in outline, slightly pentagonal. Dorsal rim is smooth and slightly convex. Posterior rim is concave. Ventral rim is asymmetrically convex. Inner face is convex.

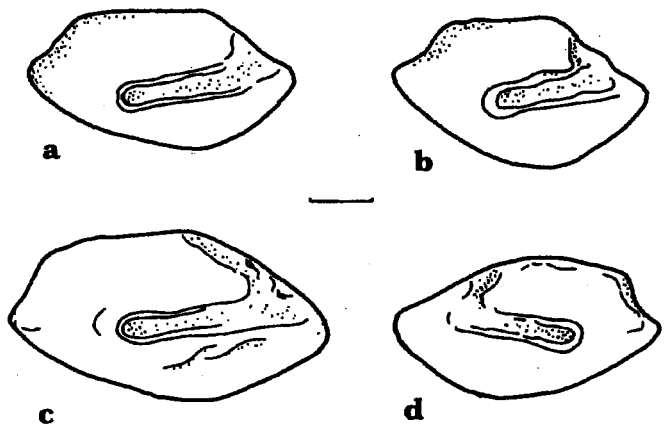


Fig. 13. *Gnathophis saubriguensis* (STEURBAUT, 1979)

a, b, c – Left sagitta, inner face; **d** – right sagitta, inner face

Sulcus acusticus is narrow, and slightly bubble-like, widened in its posterior part. Crista superior and inferior are well developed. Outer face is smooth and slightly convex.

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* STEURBAUT 1979, Pl. 12, Fig. 1). The species *Gnathophis saubriguensis* (STEURBAUT, 1979) is reported for the first time from Poland.

Genus *Hildebrandia* JORDAN & EVERMANN, 1927

Hildebrandia pantanellii (BASSOLI & SCHUBERT, 1906) (Text-fig. 14 and Pl. 2, Figs 2-4)

1906. *Otolithus* (*Ophidium*) *Pantanellii* BASS. et SCHUB.; G. BASSOLI, p. 43, Pl. 1, Figs 41-42.
1906. *Otolithus* (*Ophidium*) *Appendiculatus* BASS.; G. BASSOLI, p. 43, Pl. 1, Figs 37-38.
1906. *Otolithus* (*Ophidium*) *Pulcher* BASS.; G. BASSOLI, p. 44, Pl. 1, Figs 46-47.
1906. *Otolithus* (*Brotulidarum*) *Pantanellii* SCHUB et BASS. nov. sp.; R. SCHUBERT, p. 668, Pl. 5, Figs 31-34.
1914. *Otolithus* (*Congeris*) *Duvergieri* n. sp.; F. PRIEM, p. 249, Text-fig. 9.
1950. *Congermuraena pantanellii* (BASSOLI, 1906); W. WEILER, p. 235, Pl. 5, Fig. 30.
1964. *Congermuraena pantanellii* BASSOLI y SCHUBERT; J. BAUZÁ RULLÁN, p. 203, Pl. 4, Fig. 1.
1970. *Uroconger pantanellii* (BASSOLI, 1906); E. ROBBA, p. 116, Pl. 9, Fig. 9.
1970. *Uroconger* sp.; E. ROBBA, p. 117, Pl. 10, Fig. 1.
1979. *Gnathophis pantanellii* (BASSOLI, 1906); E. STEURBAUT, p. 54, Pl. 1, Fig. 14.
1979. *Uroconger pulcher* (BASSOLI, 1906); T. ŚMIGIELSKA, p. 304, Text-fig. 8 and Pl. 2, Fig. 3.
1981. *Gnathophis pantanellii* (BASSOLI et SCHUBERT, 1906); D. NOLF, p. 140.
1983. *Hildebrandia pantanellii* (BASSOLI & SCHUBERT, 1906); D. NOLF & E. STEURBAUT, p. 149, Pl. 1, Figs 4-9.
1984. *Hildebrandia pantanellii* (BASSOLI & SCHUBERT, 1906); E. STEURBAUT, p. 37, Pl. 3, Figs 1-3.
1985. *Hildebrandia pantanellii* (BASSOLI & SCHUBERT, 1906); D. NOLF, p. 43, Fig. 37E.

MATERIAL: Korytnica – 9 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 14	Pl. 2
RaK-23	7.0	4.1	1.1	Fig. 14d	Fig. 4
RaK-22	6.5	4.2	1.2	Fig. 14b	Fig. 3
RaK-21	5.0	3.5	1.0	Fig. 14a	Fig. 2

REMARKS: The studied otolihs are consistent with those described by BASSOLI (1906) and SCHUBERT (1906). An immanent feature of this species is a great variability of the sagitta outline. In the investigated material one can distinguish the forms of an almost trapezoidal shape and smooth rims (*see* Text-figs 14c-d and Pl. 2, Fig. 4), as well as these the more oval and furnished with their rims variously undulant (*see* Text-figs 14a-b and Pl. 2, Figs 2-3). A similar differentiation is also displayed by the material illustrated by BASSOLI (1906, Pl. 1, Figs 37-38, 41-42 and 46-47) who however regarded the otoliths of varied shapes as representatives of separate species (*see* synonymy).

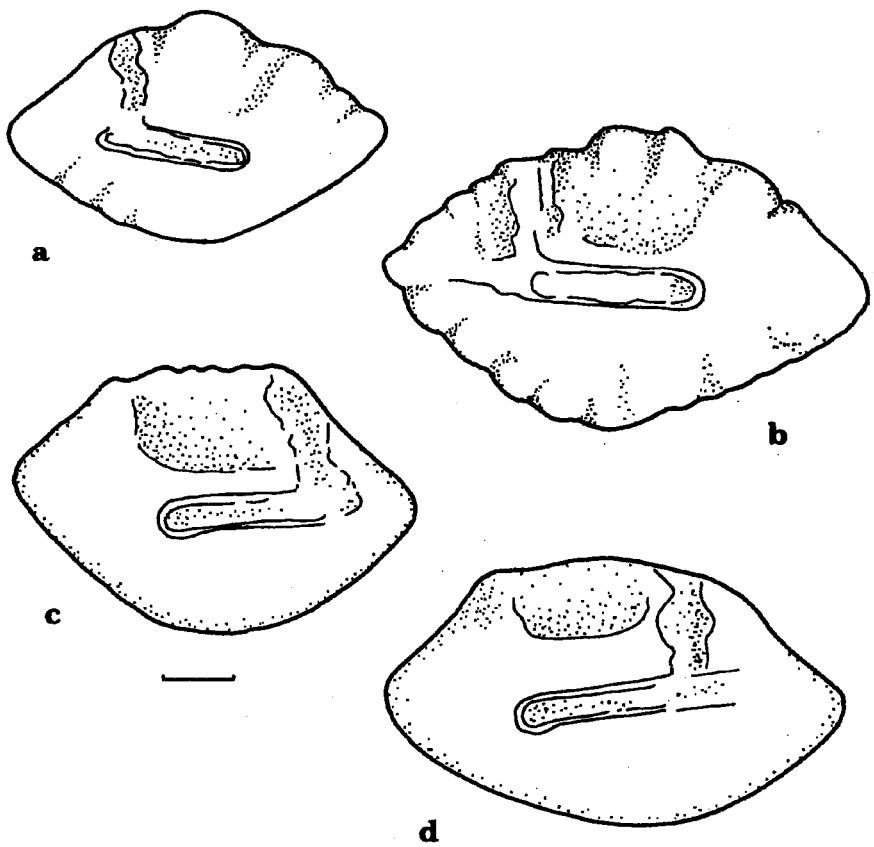


Fig. 14. *Hildebrandia pantanellii* (BASSOLI & SCHUBERT, 1906)

a, b – Right sagitta, inner face; **c, d** – left sagitta, inner face

According to the present author, it is reasonable to accept the statement of NOLF & STEURBAUT (1983) that the outline differentiation results from intraspecific variability and thus the otoliths described by BASSOLI (1906) as "*Ot.* (*Ophidium*) *pantanellii*", "*Ot.* (*Ophidium*) *appendiculatus*" and "*Ot.* (*Ophidium*) *pulcher*" should be regarded as conspecific. The acceptable name for all those herds is evidently the specific name "*pantanellii*".

The species *Hildebrandia pantanellii* (BASSOLI & SCHUBERT, 1906), has already been reported from the Korytnica Basin by ŚMIGIELSKA (1979) as "*Uroconger pulcher* (BASSOLI, 1906)". The reported specimen, according to the present author, represents a morphotype of the species "*pantanellii*", featured by its more oval outline, and the undulant dorsal rim (*see* ŚMIGIELSKA 1979, Pl. 2, Fig. 3).

A generic assessment of the species has also been variously interpreted (*see* synonymy). Recently, the species "*pantanellii*" has been included (NOLF & STEURBAUT 1983) into the genus *Hildebrandia* JORDAN & EVERMANN, 1927, due to its similarity to the present-day species *Hildebrandia gracilior* (GINSBURG, 1951) and *H. flava* (GOODE & BEAN, 1896) living in tropical and subtropical zones of the Atlantic (*see* STEURBAUT 1984).

Genus *Pseudophichthys* ROULE, 1915

Pseudophichthys sp.
(Text-fig. 15 and Pl. 3, Figs 10-12)

MATERIAL: Korytnica – 5 specimens, not well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 15	Pl. 3
RaK-26	5.1	3.0	1.4	Fig. 15a,a'	Fig. 12
RaK-25	4.5	2.5	1.2	Fig. 15c	Fig. 11
RaK-24	3.5	2.0	1.0	Fig. 15b	Fig. 10

DESCRIPTION: Otoliths thick, with ovally elongated outline. Inner face is slightly convex. Sulcus acusticus is rather wide and obliquely placed and, in its anterior part corresponding to the ostium, it is narrow. Cauda is oval, with a well developed colliculum. A shallow area is present in the posterior part of the otolith. Outer face is strongly convex asymmetrically.

REMARKS: The studied otoliths, due to their outline and shape of the sulcus acusticus, are assigned to the genus *Pseudophichthys* ROULE, 1915. They are the most similar to those of the two fossil species: *Pseudophichthys elongatus* (ŠULC, 1932) and *P. ovalis* (WEILER, 1942). The Korytnica specimens differ, however, from those of the species "*elongatus*" by their wider sulcus acusticus and their inner face more convex (*see* Text-Fig. 15a'), and from the species "*ovalis*" by their greater elongation.

The studied otoliths presumably represent quite a new species, but their poor preservation hinders a creation of the new taxon. The genus *Pseudophichthys* ROULE, 1915, has not hitherto been reported from Poland.

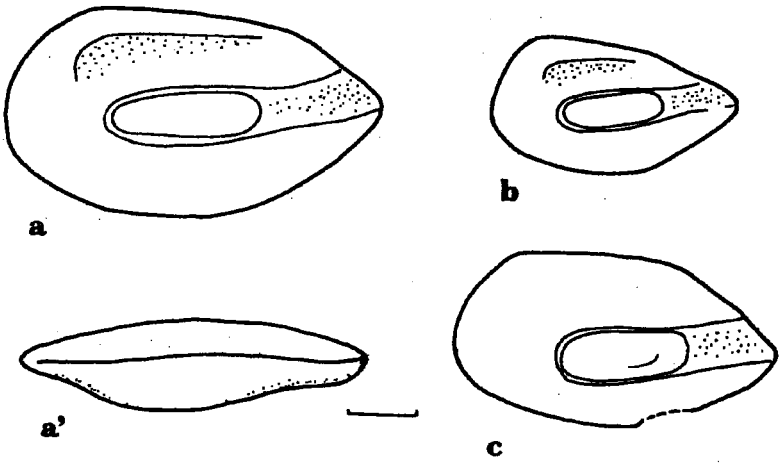


Fig. 15. *Pseudophichthys* sp.

a, b, c – Left sagitta, inner face; **a'** – ventral view

Genus *Rhechias* JORDAN, 1921

Rhechias sp. 1
(Text-fig. 16 and Pl. 2, Fig. 1)

1979. *Congridarum*? *semiapertus* (BRZOBOHATÝ, 1967); T. ŚMIGIELSKA, p. 304, Pl. 2, Fig. 4.

MATERIAL: Korytnica – 19 specimens, the majority worn at their surface.

Coll. number	L	H	T	Figured in: Text-fig. 16	Pl. 2
RaK-27	4.5	3.3	1.4	Fig. 16a,a'	Fig. 1

REMARKS: The studied specimens are assigned to the genus *Rhechias* JORDAN, 1921, due to their similarity to the otoliths of the present-day species *Rhechias thysanochila* (RIED, 1934), known from the Florida offshores (*see* NOLF 1988, Pl. 2, Fig. 8). The Korytnica specimens differ from those of the present-day species by their less projecting rostrum and by their lesser elongation.

The identical forms have already been reported from the Korytnica Basin by ŚMIGIELSKA (1979) as "*Congridarum*? *semiapertus* (BRZOBOHATÝ, 1967)". The present author, due courtesy of Dr. R. BRZOBOHATÝ, had an opportunity to compare the Korytnica specimens with those of the species "*semiapertus*", and coming from their type locality. The comparison apparently shows that the collected specimens differ from those of the species *Rhechias semiapertus* (BRZOBOHATÝ, 1967) by their inner face more convex, lesser length, and their rostrum less projecting.

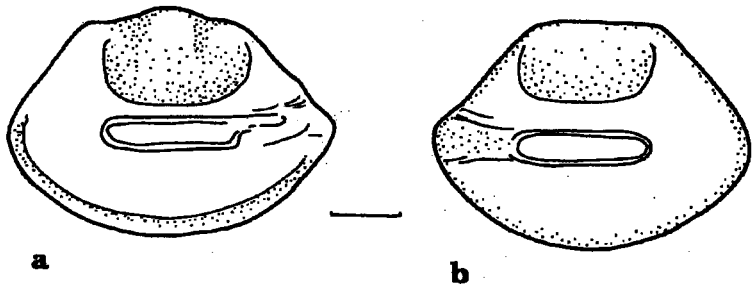


Fig. 16. *Rhechias* sp. 1

a – Left sagitta, inner face; b – right sagitta, inner face

A relatively small number of specimens and their rather poor preservation – when poorly diagnostic character of all features of the present-day species of the genus *Rhechias* JORDAN, 1921, is taken into account – does not permit to establish a separate, new species.

Rhechias sp. 2
(Text-fig. 17 and Pl. 2, Fig. 10)

MATERIAL: Bęczyn – 2 specimens, badly preserved.

Coll. number	L	H	T	Figured in: Text-fig. 17	Pl. 2
RaB-29	3.2	2.3	0.9	Fig. 17a,a'	Fig. 10

DESCRIPTION: Otoliths pentagonal in outline. Dorsal rim is convex and smooth. Ventral rim is asymmetrically convex. There are a shallow excisura and a short rostrum in the anterior rim. Inner face is flat. Sulcus acusticus is not divided; in its anterior part it is much deeper than in the posterior one. Crista superior and inferior are very well developed. Area is large and deep. Outer face is asymmetrically convex (*see* Text-fig. 17a').

REMARKS: The studied otoliths are very close to those of the present-day species *Rhechias bullisi* SMITH & KANAZAWA, 1977 (*see* STEURBAUT 1984), from which they differ by the outline of

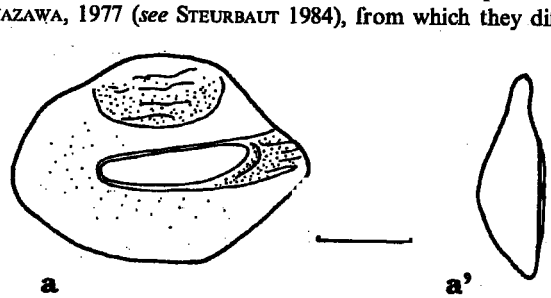


Fig. 17. *Rhechias* sp. 2

a – Left sagitta, inner face, a' – posterior view

their sulcus acusticus, and by a shorter rostrum. The specimens from Bęczyn differ also from those of the Korytnica Basin (*Rhechias* sp. 1) by their sulcus acusticus being wider, outer face less convex, and by configuration of the ventral rim. Such forms have not hitherto been reported from Poland.

"genus *Congridarum*" sp.
(Pl. 3, Fig. 13)

MATERIAL: Korytnica – one specimen, with its posterior part damaged.

DESCRIPTION: This specimen is a half of the left sagitta. Inner face is slightly convex. Sulcus acusticus is well developed and wide, but in its anterior part it is bubble-like widened. This latter part of the sulcus is deeper than the remainder, and it has its aperture in the form of a perpendicular, relatively broad canal running as far as the dorsal rim. Outer face is slightly convex.

REMARKS: The presented otolith, in regard with the character of its sulcus acusticus, is herein assigned to the family Congridae KAUP, 1856. Its poor preservation hinders any generic assessment. It therefore may only be assumed that it belongs to the genus *Hildebrandia* JORDAN & EVERMANN, 1927. The preserved fragment is very close to that of the otoliths of the present-day species *Hildebrandia flava* (GOODE & BEAN, 1896) living along the Atlantic shores of Africa (*see* NOLF & STEURBAUT 1983, Pl. 1, Fig. 10).

Family **Ophichthidae** GILL, 1885

"genus *Ophichthyidarum*" sp.
(Text-fig. 18 and Pl. 3, Fig. 9)

MATERIAL: Rybnica – 2 juvenile specimens, not well preserved.

Coll. number	L	H	T	Figured in: Text-fig.18	Pl. 3
RaR-373	3.5	1.8	0.9	Fig. 18a,a'	Fig. 9

DESCRIPTION: Otoliths tetragonal in outline. Dorsal and ventral rims are almost straight. Posterior rim is irregular. A deep excisura appears in the anterior rim. Inner face is almost flat. Sulcus acusticus is horizontally placed and not very well divided. Ostium is slightly wider and shorter than the cauda. Outer face is convex.

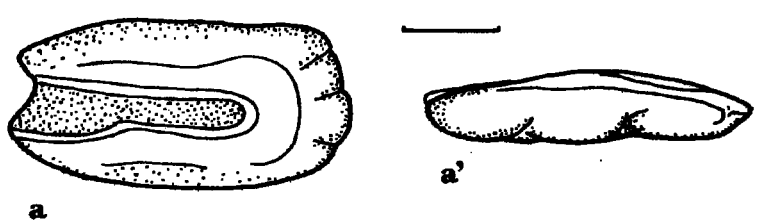


Fig. 18. "genus *Ophichthyidarum*" sp.
a – Right sagitta, inner face, a' – ventral view

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus, are herein assigned to the family Ophichthidae GILL, 1885. The collected specimens are close to those of such present-day species, as *Ophisurus serpens* (LINNAEUS, 1758) living along offshores of Australia (*see* Text-fig. 19), as well as to *Ophichthys triserialis* (KAUP, 1856) from the California offshores (*see*

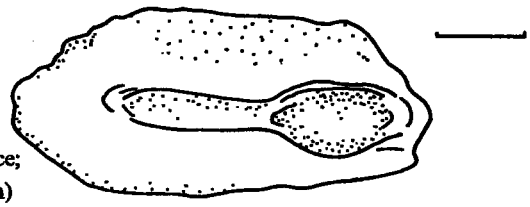


Fig. 19. *Ophisurus serpens* (LINNAEUS, 1758)

Present-day specimen: left sagitta, inner face; Sydney coast, Australia (NOLF's Collection)

NOLF 1985, Fig. 38A), the both having been known to be furnished with the otoliths of much variable morphology dependant, partly at least, on their ontogenic age (*see* NOLF 1985, Fig. 11A). Thus, it is resonable to state, that a very limited number of the collected otoliths, and their juvenile nature do not allow to precise their specific, and even generic attribution. Such forms have not hitherto been reported from Poland.

Order **Clupeiformes** BLEEKER, 1859
Suborder **Clupeoidei** BLEEKER, 1859
Family **Clupeidae** CUVIER, 1817
Genus *Etrumeus* BLEEKER, 1853

Etrumeus weileri (ŚMIGIELSKA, 1966) (Text-fig. 20 and Pl. 3, Figs 5-8)

1966. *Clupea weileri* n. sp.; T. ŚMIGIELSKA, p. 227, Pl. 12, Figs 3-4.
1979. *Clupea weileri* ŚMIGIELSKA, 1966; T. ŚMIGIELSKA, p. 301, Text-fig. 4 and Pl. 1, Fig. 6.
1984. "genus aff. *Etrumeus*" *weileri* (ŚMIGIELSKA, 1966); E. STEURBAUT, P. 43, Pl. 5, Figs 1-5.
1985. "genus aff. *Etrumeus*" *weileri* (ŚMIGIELSKA, 1966); D. NOLF, p. 46, Fig. 39I.

MATERIAL: Korytnica – 16 specimens, in majority with their rostral part damaged.

Coll. numbers	L	H	Figured in: Text-fig. 20	Pl. 3
RaK-31	3.5	1.8	Fig. 20a	Fig. 6
RaK-32	3.0	2.0	Fig. 20b	Fig. 8

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* ŚMIGIELSKA 1966, Pl. 12, Fig. 3). The species *Etrumeus weileri* has been established by ŚMIGIELSKA (1966) upon the material coming from the Korytnica Basin. Subsequently, ŚMIGIELSKA (1979) redescribed this species completing the possessed material with the new specimens regarded as the adults and stating that the original material was composed of the juveniles only (ŚMIGIELSKA 1979,

p. 302). Thus, one of the adults was designated by ŚMIGIELSKA (1979, Pl. 1, Fig. 6) as the neotype. Such a treatment has no reasonable acceptance as the holotype of the species still exists, and the indicated specimen merely supplements the former material, what was already pointed out by STEURBAUT (1984).

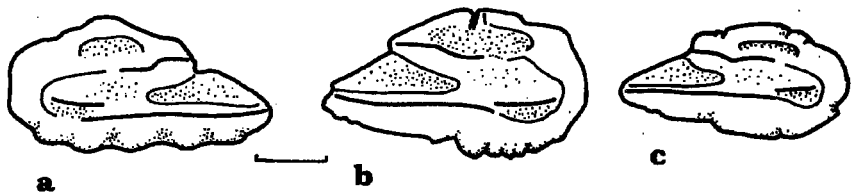


Fig. 20. *Etrumeus weileri* (ŚMIGIELSKA, 1966)

a – Left sagitta, inner face; **b, c** – right sagitta, inner face

The otoliths of this species were assigned by ŚMIGIELSKA (1966, 1979) to the genus *Clupea* LINNAEUS, 1758. A thorough analysis performed by STEURBAUT (1984) upon the otoliths of the present-day forms of the family Clupeidae CUVIER, 1817, resulted in the assessment of the species "*weileri*" within a genus very close to *Etrumeus* BLEEKER, 1853. In consequence STEURBAUT (1984) described the otoliths coming from the Aquitaine Basin as "genus aff. *Etrumeus*" *weileri* (ŚMIGIELSKA, 1966), and showed their great similarity to the present-day species *Etrumeus teres* (DEKAY, 1842).

When comparing the collected material (*see* Text-fig. 20 and Pl. 3, Figs 5-8) containing a larger number of the adult forms, and the otoliths (NOLF's Collection) of the present-day species *E. teres* (DEKAY, 1842), it is apparent that the species "*weileri*" evidently belongs to the genus *Etrumeus* BLEEKER, 1853. Differences in the outline of the sulcus acusticus of these species are only of an intraspecific nature.

"genus *Clupeidarum*" *pulcher* (ŚMIGIELSKA, 1966) (Text-fig. 21 and Pl. 3. Figs 1-4)

1966 *Clupea pulchra* n. sp.; T. ŚMIGIELSKA, p. 226, Pl. 12, Figs 1-2.
1979. *Clupea pulchra* ŚMIGIELSKA, 1966; T. ŚMIGIELSKA, p. 299, Text-fig. 3 and Pl. 1, Fig. 4.
1985. "genus *Clupeidarum*" *pulcher* ŚMIGIELSKA, 1966; D. NOLF, p. 46.

MATERIAL: Korytnica – 166 specimens, in majority with their rostral part damaged; Rybnica – 6 specimens, all with their rostral part damaged.

Coll. numbers	L	H	Figured in: Text-fig. 21	Pl. 3
RaK-33	2.0	1.1	Fig. 21a	Fig. 2
RaK-34	2.2	1.2	Fig. 21c	Fig. 3

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* ŚMIGIELSKA 1966, Pl. 12, Fig. 1). This species has been established upon a material coming from the Korytnica Basin, and called by ŚMIGIELSKA (1966) as "*Clupea pulchra* n. sp.". It is to state,

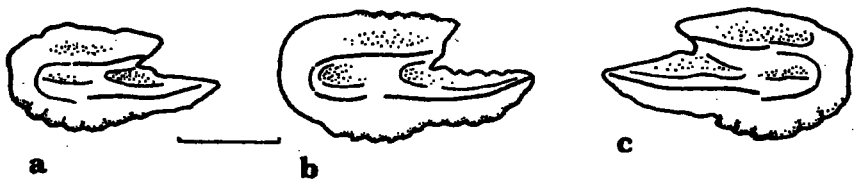


Fig. 21. "genus *Clupeidarum*" *pulcher* (ŚMIGIELSKA, 1966)

a, b – Left sagitta, inner face; **c** – right sagitta, inner face

however, that there are too distinct differences in the sagitta outline and development of the sulcus acusticus in the studied forms and the otoliths of other species of genus *Clupea* LINNAEUS, 1758. Thus, there is no reason to accept a former generic assessment of the discussed species. The same is true for all otoliths representing the other genera of the family Clupeidae CUVIER, 1817. The present-day state of recognition of all the genera and species of this family makes a definite generic assessment impossible. Thus, the discussed species, accordingly with a suggestion of NOLF (1985), should only generally be ascribed to the family Clupeidae CUVIER, 1817.

Order **Siluriformes** CUVIER, 1817
Family **Ariidae** GÜNTHER, 1864

"genus *Ariidarum*" sp.
(Text-fig. 22 and Pl. 4, Fig. 15)

MATERIAL: Korytnica – one specimen (lapillus), well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 22	Pl. 4
RaK-41	5.0	4.0	1.5	Fig. 22a,a'a"	Fig. 15

DESCRIPTION: Otolith oval, slightly pentagonal in outline, in its anterior part sharpened. Inner face is slightly convex, with distinct, concentric growth lines on the surface. In the anterodorsal part there is a *V*-shaped groove, which is shallow, and accenuated with three radial edges. Outer face is regularly convex and smooth.

REMARKS: The studied otolith, being the lapillus, due to its characteristic outline has been assigned to the family Ariidae GÜNTHER, 1864. This specimen differs from the lapilli of the present-day species of the genus *Arius* CUVIER & VALENCIENNES, 1840 (*see* NOLF 1976), by its more elongated, pentagonal outline, and a less convex inner face. The studied lapillus is close the most to the fossil species distinguished as "genus *Ariidarum*" *danicus* (KOKEN, 1891) from the Paleocene of Denmark, from which it differs with its lateral profile (*see* Text-fig. 22a"). Such an otolith has not hitherto been reported from Poland.

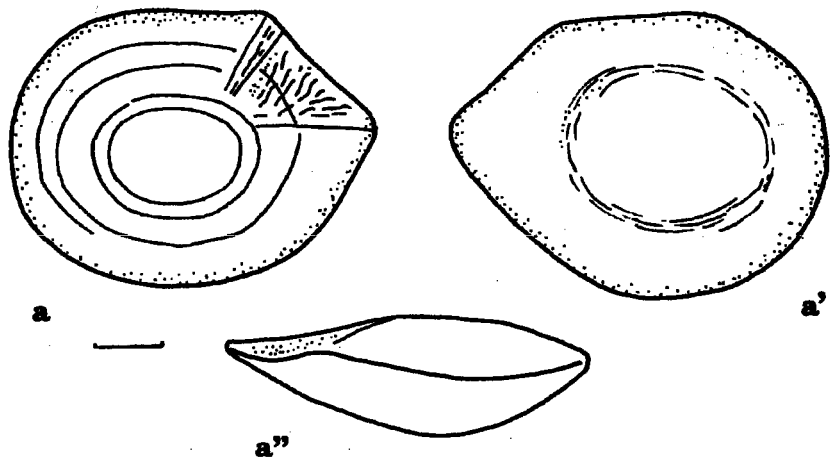


Fig. 22. "genus *Ariidarum*" sp.

a – Left lapillus, inner face; a' – outer face; a" – dorsal view

Order **Stomiiformes** REGAN, 1909
Suborder **Gonostomatoidei** WEITZMANN, 1974
Family **Sternoptychidae** DUMERIL, 1806
Genus *Valenciennellus* JORDAN & EVERMANN, 1896

Valenciennellus weinfurteri (BRZOBOHATÝ & SCHULTZ, 1978) (Text-fig. 23 and Pl. 4, Fig. 11)

1950. *Otolithus inc. sed.* sp. 5; W. WEILER, p. 251, Pl. 8, Fig. 61.
1978. *Argyropelecus weinfurteri* n. sp.; R. BRZOBOHATÝ & O. SCHULTZ, p. 449, Pl. 4, Figs 7-9.
1982. *Valenciennellus weinfurteri* (BRZOBOHATÝ & SCHULTZ, 1978); R. BRZOBOHATÝ, Pl. 1, Fig. 11.
1983. *Valenciennellus weinfurteri* (BRZ. & SCHULTZ); R. BRZOBOHATÝ, p. 249, Pl. 6, Fig. 6.
1985. *Valenciennellus weinfurteri* (BRZOBOHATÝ & SCHULTZ 1978); D. NOLF, p. 52.

MATERIAL: Korytnica – one specimen, well preserved.

Coll.			Figured in:	
number	L	H	Text-fig. 23	Pl. 4
RaK-42	1.0	1.4	Fig. 23a,a'	Fig. 11

DESCRIPTION: Otolith oval, slightly rectangular in outline, and elongated perpendicularly to the sulcus acusticus. Dorsal rim steep, at the beginning flat and towards its posterior rim it passes into two flat swellings. Ventral rim is asymmetrically convex. Anterior rim is straight with

Fig. 23. *Valenciennellus weinfurteri* (BRZOBOHATÝ & SCHULTZ, 1978)
a – Left sagitta, inner face; a' – ventral view

a rather deep excisura, and short rostrum. Inner face is flat. Sulcus acusticus is relatively deep and slightly obliquely placed. Ostium is deeper than the cauda. Ventral furrow is well developed, and the same concerns the area. Outer face is convex.

REMARKS: The studied otolith is almost identical with the holotype of the species (*see* BRZOBOHATÝ & SCHULTZ 1978, Pl. 4, Fig. 7). This species is very close to the present-day one, *Valenciennellus tripunctulatus* (ESMARK, 1871), known from the eastern Atlantic (*see* STEURBAUT 1984, Pl. 6, Fig. 14), and thus it is herein assigned to the genus *Valenciennellus* JORDAN & EVERMANN, 1896. Neither the genus nor the species have hitherto been reported from Poland.

Order **Aulopiformes** ROSEN, 1973
Suborder **Alepisauroidei** REGAN, 1911
Family **Synodontidae** GILL, 1872
Genus *Saurida* VALENCIENNES, 1849

Saurida germanica (WEILER, 1942)
(Text-fig. 24 and Pl. 4, Figs 12-14)

1942. *Cottus germanicus* n. sp.; W. WEILER, p. 67, Pl. 4, Figs 20-21 and Fig. 38.
1959. *Cottus germanicus* WEILER; W. WEILER, p. 102.
1977. *Saurida* sp.; D. NOLF, p. 18, Pl. 2, Fig. 3.
1979. *Saurida rectilineata* n. sp.; E. STEURBAUT, p. 59, Pl. 2, Figs 23-24 and Pl. 12, Fig. 3.
1979. *Saurida germanica* (WEILER *in* WEINFURTER, 1952); T. ŚMIGIELSKA, p. 302, Text-fig. 6 and Pl. 1, Figs 7-9.
1983. *Saurida germanica* (WEILER, 1942); D. NOLF & R. SMITH, p. 90, Pl. 1, Figs 11-14.
1984. *Saurida germanica* (WEILER, 1942); E. STEURBAUT, p. 41, Pl. 7, Figs 15-16.
1985. *Saurida germanica* (WEILER, 1942); D. NOLF, p. 53, Fig. 46J.

MATERIAL: Korytnica – 53 specimens, in majority with their rostral part damaged.

Coll. numbers	L	H	T	Figured in: Text-fig. 24	Pl. 4
RaK-44	6.5	2.2	0.8	Fig. 24d	Fig. 13
RaK-43	5.3	2.1	0.8	Fig. 24a	Fig. 12
RaK-45	3.0	1.3	0.5	Fig. 24c	Fig. 14

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* WEILER 1942, Pl. 4, Fig. 38). This species has already been noted in the Korytnica Basin (ŚMIGIELSKA 1979),

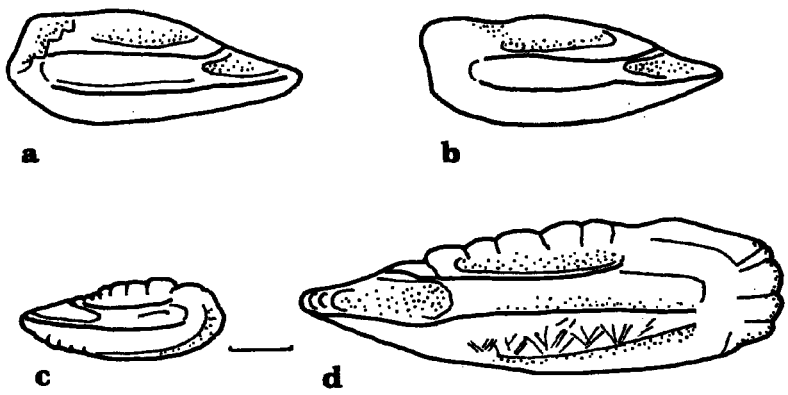


Fig. 24. *Saurida germanica* (WEILER, 1942)
a, b – Left sagitta, inner face; c, d – right sagitta, inner face

and the newly collected, much greater material allows to demonstrate the range of the intraspecific variability of the species (*see* Pl. 4, Figs 12-14).

Order **Myctophiformes** REGAN, 1911
Family **Myctophidae** GILL, 1893

The family Myctophidae GILL, 1893, in the present-day faunas is represented by very numerous genera and species. In modern environments, these fishes are confined to deeper oceanic zones, although in the fossil state they are known from much shallower areas which have had good connections with open seas.

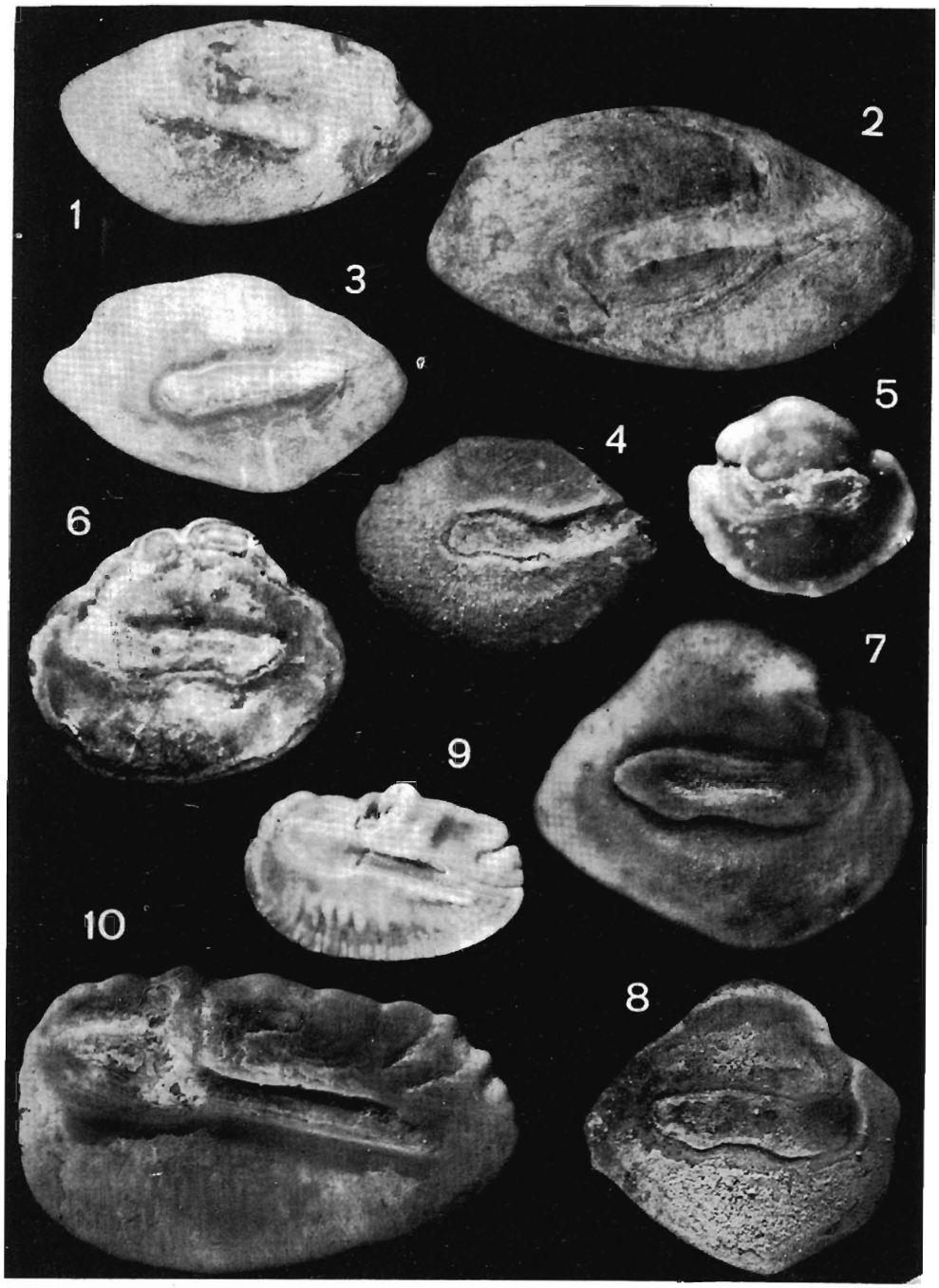
The systematics of the fossil species of this family is still under discussion. This certainly results partly from a reasonably great number of species, created mostly upon either poorly preserved specimens or juvenile forms, and partly from unsatisfactory recognition of the present-day species and their variability.

In the whole of the investigated material, the otoliths of fishes of the family Myctophidae GILL, 1893, in the majority of exposures (excluding Bęczyn), are of a minor importance quantitatively. All of them are represented primarily by the juveniles, what makes their specific attribution very problematic.

Genus *Benthosema* GOODE & BEAN, 1896

Benthosema aff. *suborbitale* (GILBERT, 1913)
(Text-fig. 25 and Pl. 4, Figs 7-10)

MATERIAL: Bęczyn – 16 specimens, in majority badly preserved.

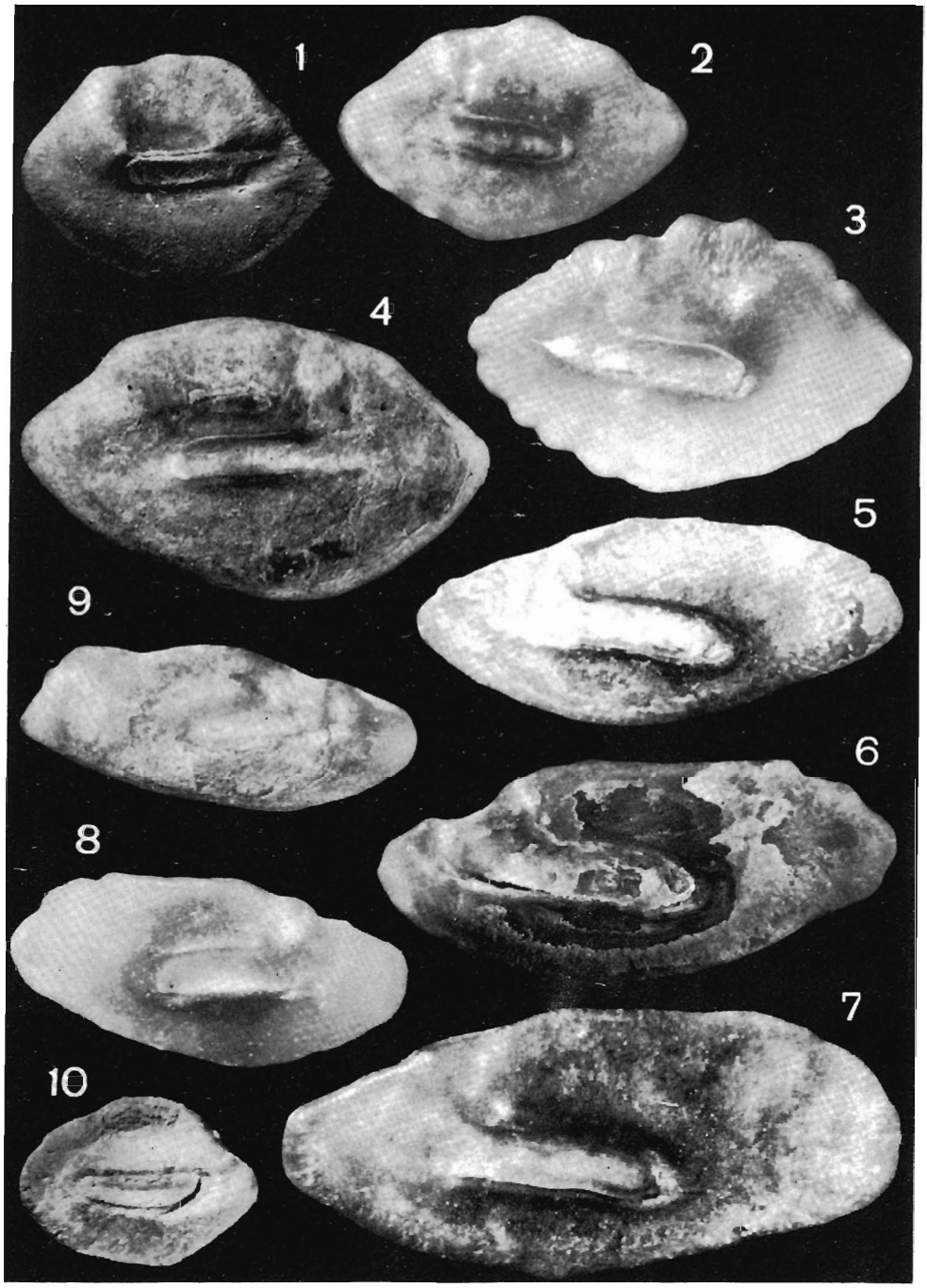


1-3 — *Gnathophis saubriguensis* (STEURBAUT, 1979); 1 — right sagitta, inner face; 2-3 — left sagitta, inner face; × 15

4 — *Panturichthys subglaber* (SCHUBERT, 1906); left sagitta, inner face; × 15

5-8 — *Ariosoma balearica* (DELAROCHE, 1809); 5-6 — right sagitta, inner face; 7-8 — left sagitta, inner face; × 10; the same specimens (7-8) as illustrated formerly (*see* RADWAŃSKA 1984, Pl. 1, Figs 1-2)

9-10 — *Pterothrissus umbonatus* (KOKEN, 1884); right sagitta, inner face; × 10

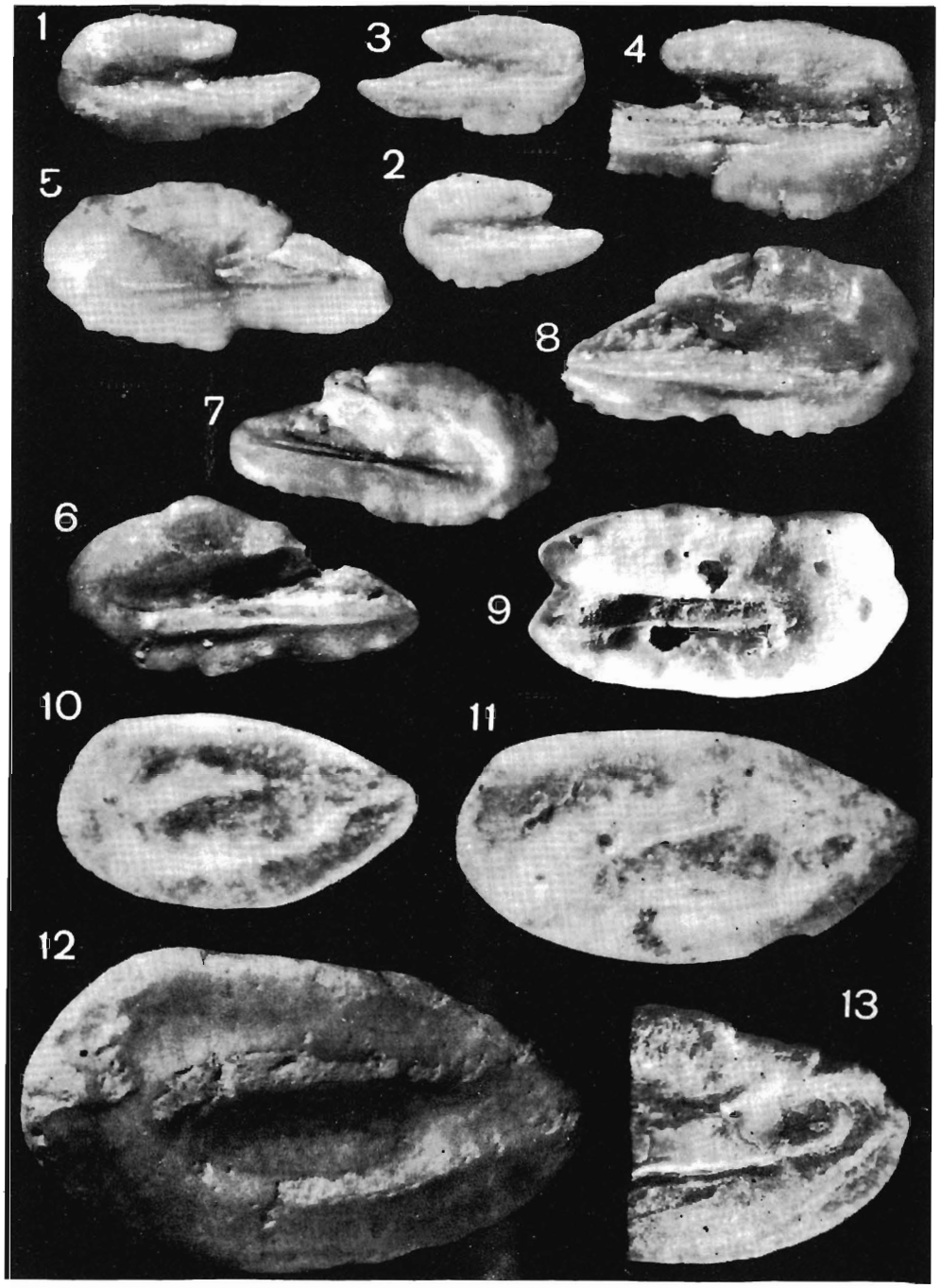


1 — *Rhechias* sp. 1; left sagitta, inner face; × 10

2-4 — *Hildebrandia pantanellii* (BASSOLI & SCHUBERT, 1906); 2-3 — right sagitta, inner face; 4 — left sagitta, inner face; × 10

5-9 — *Conger* aff. *conger* (LINNAEUS, 1758); 5-7 — right sagitta, inner face; 8-9 — left sagitta, inner face; × 15

10 — *Rhechias* sp. 2; left sagitta, inner face; × 10



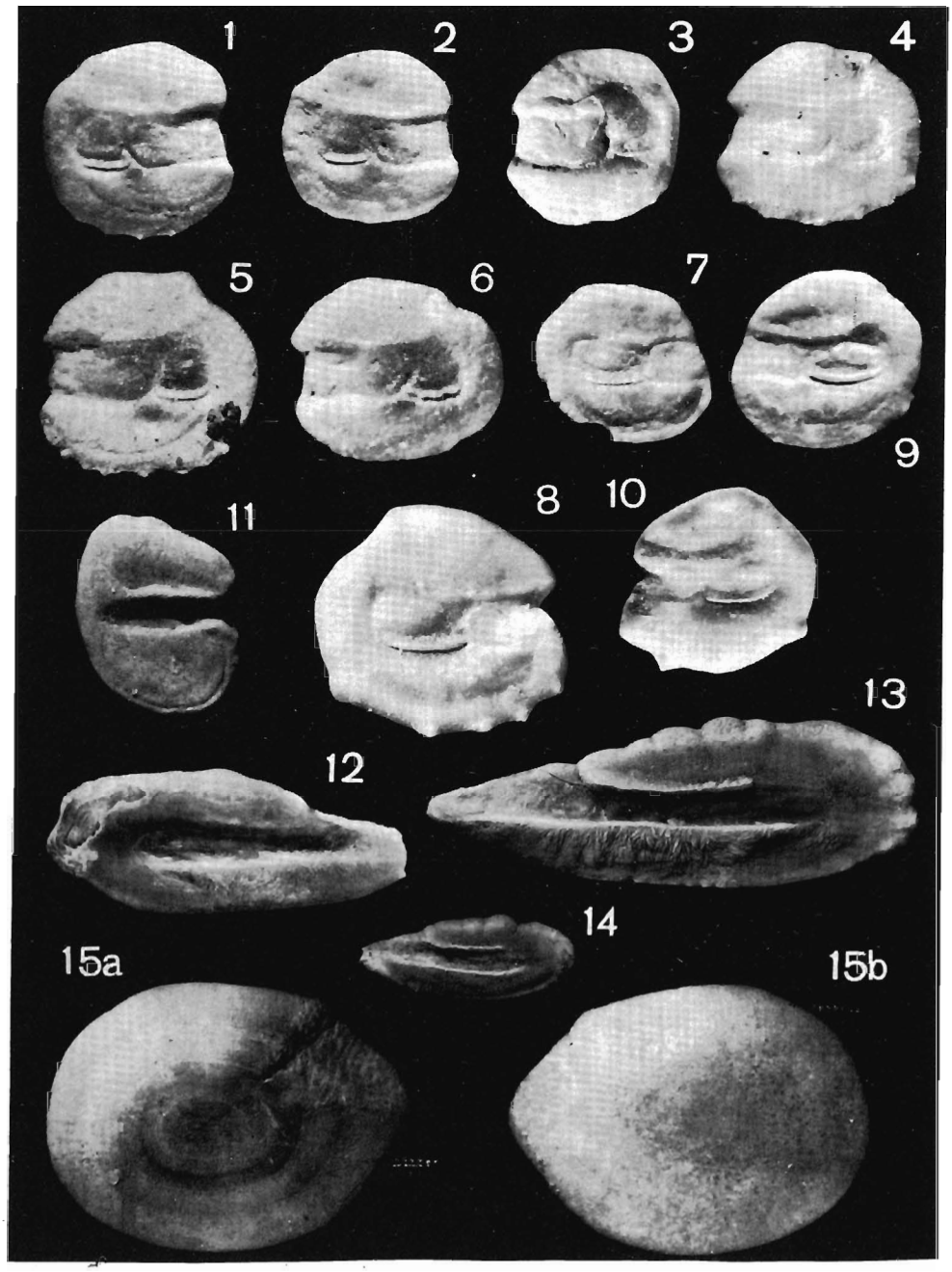
1-4 — "genus *Clupeidarum*" *pulcher* (ŚMIGIELSKA, 1966); 1-2 — left sagitta, inner face; 3-4 — right sagitta, inner face; × 15

5-8 — *Etrumeus weileri* (ŚMIGIELSKA, 1966); 5-6 — left sagitta, inner face; 7-8 — right sagitta, inner face; × 15

9 — "genus *Ophichthyidarum*" sp.; right sagitta, inner face; × 15

10-12 — *Pseudophichthys* sp.; left sagitta, inner face; × 15

13 — "genus *Congridarum*" sp.; left sagitta, inner face; × 10



1-3 — *Diaphus* sp. 6; 1-2 — left sagitta, inner face; 3 — right sagitta, inner face; × 12
4-6 — *Diaphus cahuzaci* STEURBAUT, 1979; right sagitta, inner face; × 15
7-10 — *Benthosema* aff. *suborbitale* (GILBERT, 1913); 7-8 — left sagitta, inner face; 9-10 — right sagitta, inner face; × 15
11 — *Valenciennellus weinfurteri* (BRZOBOHATÝ & SCHULTZ, 1978); left sagitta, inner face; × 20
12-14 — *Saurida germanica* (WEILER, 1942); 12 — left sagitta, inner face; 13-14 — right sagitta, inner face; × 10
15 — "genus *Ariidarum*" sp.; left lapillus, *15a* inner face, *15b* outer face; × 10

Coll. numbers	L	H	Figured in: Text-fig. 25	Pl. 4
RaB-47	2.3	2.2	Fig. 25a	Fig. 8
RaB-48	2.0	1.9	Fig. 25b	Fig. 10

DESCRIPTION: Otoliths polygonal in outline, with a well developed posterodorsal corner. On the anterior rim, there are: a pronounced antirostrum, a deep excisura, and a short, rounded rostrum. Ventral rim is distinctly denticulated, and the number of denticles is variable. Inner face is flat. Cauda is a bit shorter than the ostium. Colliculum caudale is distinctly marked with a long ridge. Ventral furrow is well developed. Outer face is convex.

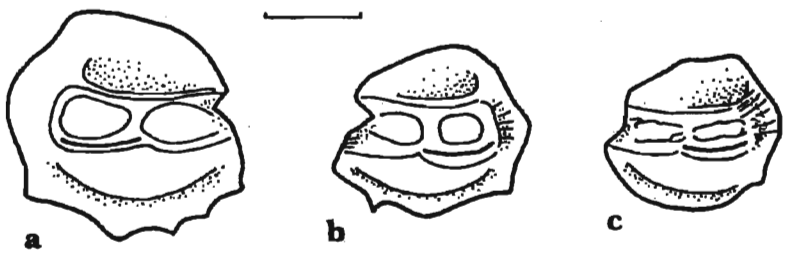


Fig. 25. *Benthosema* aff. *suborbitale* (GILBERT, 1913)

a – Left sagitta, inner face; b, c – right sagitta, inner face

REMARKS: The studied otoliths are very close to those of the present-day species *Benthosema suborbitale* (GILBERT, 1913) living along the Atlantic coast of northern Africa and Europe (*see* SCHWARZHANS 1986, Pl. 2, Figs 19-21), but they differ by their more pronounced antirostrum and a shorter, more rounded rostrum, what may indicate their specific separateness.

The investigated specimens differ also from those of the fossil species *Benthosema fitchi* BRZOBOHATÝ & SCHULTZ, 1978, primarily by their more pronounced posterodorsal corner, and a shorter and more rounded rostrum. Neither the genus nor the species have hitherto been reported from Poland.

Genus *Diaphus* EIGENMANN & EIGENMANN, 1890

The majority of the studied otoliths assigned to the genus *Diaphus* EIGENMANN & EIGENMANN, 1890, have been determined to the genus rank only. This simply results from the juvenile nature of the specimens, the specific characters of which have not as yet been individualized.

Diaphus cahuzaci STEURBAUT, 1979
(Text-fig. 26 and Pl. 4, Figs 4-6)

1965. *Myctophum excavatum* (ŠULC, 1932); R. BRZOBOHATÝ, p. 111, Pl. 1, Fig. 10.
1966. *Myctophum excavatum* (ŠULC); T. ŚMIGIELSKA, p. 234, Pl. 13, Figs 4-6.
1967b. *Myctophum excavatum* (ŠULC, 1932); R. BRZOBOHATÝ, p. 234, Pl. 1D, Fig. 6a-b.
1973. *Myctophum debile* (KOKEN), 1891; S. JONET, p. 137, Pl. 2, Figs 9-10 (*non* Fig. 8).
1973. *Myctophum pulchrum* (PROCHÁZKA) 1893; S. JONET, p. 139, Pl. 2, Figs 11-13.

1979. *Diaphus cahuzaci* n. sp.; E. Steurbaut, p. 61, Pl. 4, Figs 1-6 and Pl. 12, Fig. 11.
1982. *Diaphus cahuzaci* Steurbaut, 1979; E. Steurbaut & S. Jonet, p. 197, Pl. 1, Fig. 12.
1984. *Diaphus cahuzaci* Steurbaut, 1979; E. Steurbaut, p. 52, Pl. 8, Figs 15-17.
1986. *Diaphus cahuzaci* Steurbaut, 1979; W. Schwarzhans, p. 222, Pl. 3, Fig. 32.

MATERIAL: Bęczyn — 18 specimens, in majority badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 26	Pl. 4
RaB-56	2.0	1.8	Fig. 26c	Fig. 6
RaB-477	2.0	1.7	Fig. 26b	Fig. 5

DESCRIPTION: Otoliths almost rounded in outline. Dorsal rim has a well developed posterodorsal corner. Ventral rim bears a few denticles. On the anterior rim, there are: a pronounced antirostrum, a shallow and widely opened excisura, and a short rostrum. Inner face is slightly convex. Sulcus acusticus is wide. Ostium is twice longer than the cauda. Collicula are well developed. Outer face is strongly convex.

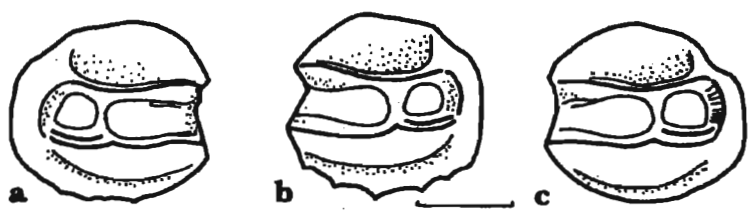


Fig. 26. *Diaphus cahuzaci* Steurbaut, 1979

a — Left sagitta, inner face; b, c — right sagitta, inner face

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* Steurbaut 1979, Pl. 12, Fig. 11). It is to note, that in the investigated material there occur both almost circular forms (*see* Text-fig. 26a and Pl. 4, Fig. 4), as well as forms which are more elongated (*see* Text-fig. 26c and Pl. 4, Fig. 6). The otoliths of this species have formerly been reported from Poland by Śmigielska (1966) under the name of "*Myctophum excavatum* (Šulc)".

Diaphus debilis (Koken, 1891)
(Text-fig. 27 and Pl. 5, Figs 1-6)

1891. *Otolithus* (*Berycidarum*) *debilis* Koken.; E. Koken, p. 122, Pl. 6, Figs 3-3a.
1893. *Otolithus* (*Berycidarum*) *Moravicus* nov. spec.; V. Procházka, p. 8, Pl. 3, Fig. 1.
1893. *Otolithus* (*Berycidarum*) *Kokeni* nov. spec.; V. Procházka, p. 81, Pl. 3, Fig. 3.
1905. *Otolithus* (*Berycidarum*) *austriacus* Kok.; R. Schubert, p. 630, Pl. 17, Figs 1-7.
1905. *Otolithus* (*Berycidarum*) *kokeni* Proch; R. Schubert, p. 631, Pl. 17, Figs 7-11.
1942. *Scopelus debilis* Kok.; W. Weiler, p. 21, Pl. 1, Figs 30-37.
1950. *Scopelus debilis* (Koken, 1891); W. Weiler, p. 211, Pl.1. Fig. 2 and Pl. 9, Figs 66-67.
1966. *Myctophum debile* (Koken); T. Śmigielska, p. 229. Pl. 12, Figs 6-7 and Pl. 13, Fig. 1 (*non* Pl. 12, Fig. 8).
1966. *Myctophum kokeni* (Procházka); T. Śmigielska, p. 232, Pl. 13, Fig. 2.
1966. *Myctophum latirostratum* (Weiler); T. Śmigielska, p. 233, Pl. 13, Fig. 3.
1967a. *Myctophum debile* (Koken, 1891); R. Brzobohatý, p. 127, Pl. 2, Figs 1-2.
1967b. *Myctophum debile* (Koken, 1891); R. Brzobohatý, p. 232, Pl. 1D, Fig. 3.

1967b. *Ot.* (*Myctophidarum*) *kokeni* (PROCHÁZKA, 1893); R. BRZOBOHATÝ, p. 235, Pl. 1D, Fig. 4.
1971. *Myctophum debile* (KOKEN, 1891); P. GAEMERS, p. 241, Pl.1, Fig. 2 and Pl. 4, Fig. 3.
1977. *Diaphus debilis* (KOKEN, E., 1891); D. NOLF, p. 18, Pl. 2, Figs 11-18.
1979. *Diaphus debilis* (KOKEN, 1891); E. STEURBAUT, p. 62, Pl. 3, Figs 9-16.
1982. *Diaphus debilis* (KOKEN, 1891); P. GAEMERS & W. SCHWARZHANS, p. 127, Pl. 1, Fig. 7.
1983. *Diaphus debilis* (KOK.); R. BRZOBOHATÝ, p. 249, Pl. 6, Fig. 2.
1983. *Diaphus kokeni* (KOK.); R. BRZOBOHATÝ, p. 250, Pl. 6, Fig. 3.
1984. *Diaphus debilis* (KOKEN, 1891); E. STEURBAUT, p. 53, Pl. 7, Figs 24-27.
1985. *Diaphus debilis* (KOKEN, 1891); D. NOLF, p. 55, Fig. 47G.

MATERIAL: Bęczyn – 99 specimens, in majority well preserved; Korytnica – 2 specimens, well preserved; Nawodzice – one specimen, badly preserved; Rybnica – one specimen, well preserved.

Coll. numbers	L	T	Figured in: Text-fig. 27	Pl. 5
RaB-58	2.0	1.8	Fig. 27b	Fig. 1
RaB-60	1.7	1.8	Fig. 27c	Fig. 4
RaB-63	1.3	1.5	Fig. 27e	Fig. 5

REMARKS: Otoliths of the species *Diaphus debilis* (KOKEN, 1891), have hitherto been described under various specific names (*see* synonymy), what certainly results from a much variable outline of the sagitta and variable features of their sulcus acusticus. The species, described at first by KOKEN (1891) and based on otoliths, has a counterpart in modern forms, namely in the species *Diaphus taaningi* NORMAN, 1930, which was established upon the morphology of the complete fish. The otoliths of the latter species (*see* STEURBAUT 1979, Pl. 3, Figs 11-16) are of a much variable shape, what allowed to combine a few fossil species into one (*see* NOLF 1985).

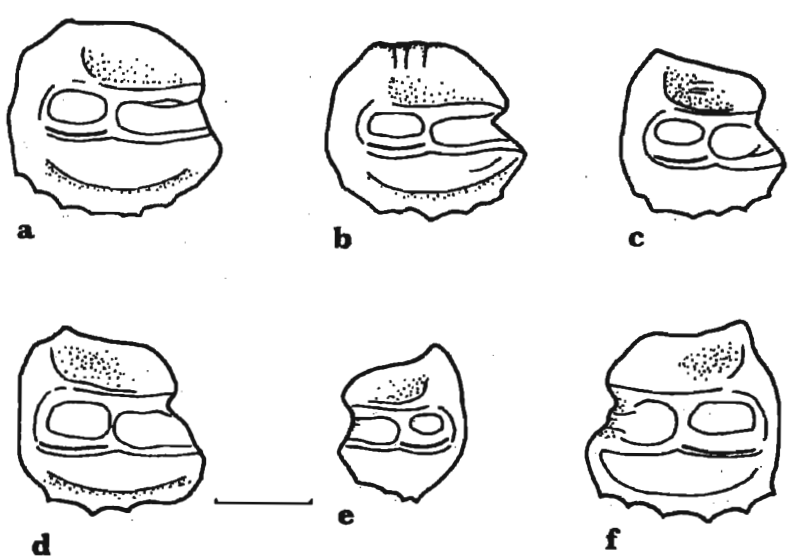


Fig. 27. *Diaphus debilis* (KOKEN, 1891)

a, b, c, d – Left sagitta, inner face; **e, f** – right sagitta, inner face

The investigated assemblage of otoliths is also much variable. It contains both the high forms furnished with the wide sulcus acusticus, and a more or less individualized posterodorsal corner (*see* Text-fig. 27c-f and Pl. 5, Figs 3-6), as well as those slightly lower, with their sulcus acusticus narrower (*see* Text-fig. 27a-b and Pl. 5, Figs 1-2). The development of the rostrum also varies, ranging from a weakly pronounced one (*see* Text-fig. 27e and Pl. 5, Figs 3 and 5) to that much elongated (*see* Text-fig. 27b-c and Pl. 5, Figs 4 and 6).

The otoliths of the species *Diaphus debilis* (KOKEN, 1891) have already been reported from Poland by ŚMIGIELSKA (1966) under the three different specific names, viz. "*Myctophum debile* (KOKEN)", "*Myctophum kokeni* (PROCHÁZKA)", and "*Myctophum latirostratum* (WEILER)". Of these names, "*kokeni*" and "*latirostratum*" (*see* NOLF 1985) are younger synonyms of the species "*debilis*".

Diaphus sp. 1
(Text-fig. 28 and Pl. 5, Figs 12-16)

MATERIAL: Korytnica – 69 specimens, in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 28	Pl. 5
RaK-69	2.5	2.0	Fig. 28a	Fig. 15
RaK-68	2.4	1.9	Fig. 28e	Fig. 13
RaK-66	2.3	1.7	Fig. 28d	Fig. 12

DESCRIPTION: Otoliths oval in outline. Dorsal rim is convex with a well developed posterodorsal corner. On the anterior rim, there are: a pronounced antirostrum, a shallow excisura,

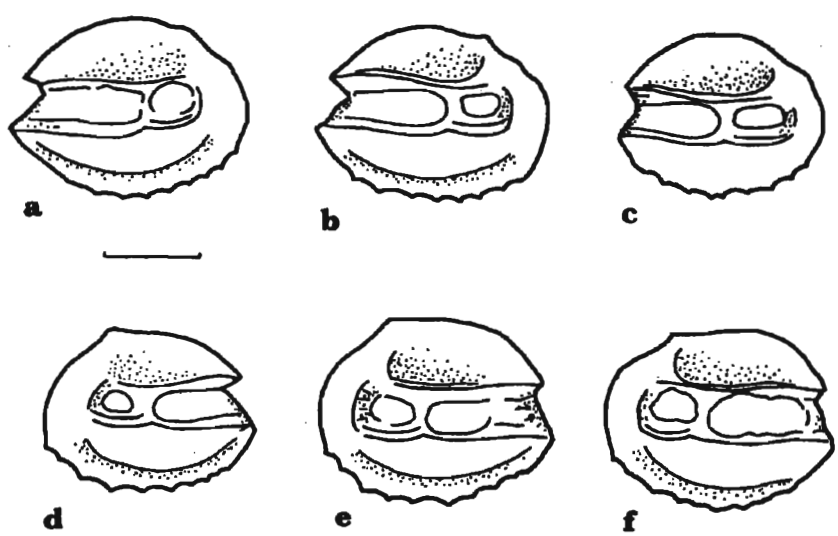


Fig. 28. *Diaphus* sp. 1

a, b, c – Right sagitta, inner face; d, e, f – left sagitta, inner face

and a rostrum slightly longer than the antirostrum. Ventral rim is regularly convex with fine, rather numerous denticles. Inner face is slightly convex. Sulcus acusticus is wide. Ostium is twice longer than the cauda. In majority, collicula are well developed. Outer face is asymmetrically convex.

REMARKS: The studied otoliths are close to those of the present-day species *Diaphus dumerili* (BLEEKER, 1856) and *D. jenseni* TAANING, 1932 (*see* NOLF & CAPPETTA 1988, Pl. 9). Such forms have not hitherto been reported from Poland.

Diaphus sp. 2
(Text-fig. 29 and Pl. 5, Figs 7-11)

MATERIAL: Korytnica — 15 specimens, well preserved; Bęczyn — 7 specimens, in majority badly preserved.

Coll.				Figured in:	
numbers	L	H	T	Text-fig. 29	Pl. 5
RaB-76	2.5	2.0	0.5	Fig. 29b	Fig. 11
RaK-73	2.1	1.9	0.5	Fig. 29a	Fig. 7

DESCRIPTION: Otoliths almost circular in outline. Ventral rim is furnished with numerous denticles. On the anterior rim, there are: a pronounced antirostrum, a deep excisura, and a rostrum a bit longer than the extent of the antirostrum. Inner face is slightly convex. Sulcus acusticus is wide, the collicula are well developed. Outer face is asymmetrically convex.

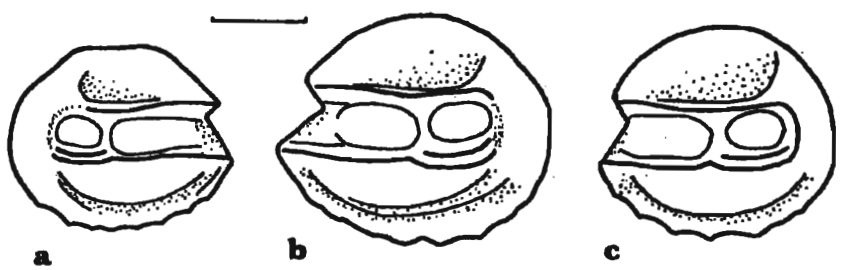


Fig. 29. *Diaphus* sp. 2

a — Left sagitta, inner face; b, c — right sagitta, inner face

REMARKS: The discussed specimens differ from those distinguished as *Diaphus* sp. 1 by their more circular outline. Such forms have not hitherto been reported from Poland.

Diaphus sp. 3
(Text-fig. 30 and Pl. 6, Figs 7-9)

MATERIAL: Bęczyn — 27 specimens, in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 30	Pl. 6
RaB-80	3.0	2.4	Fig. 30c	Fig. 9
RaB-79	1.8	1.5	Fig. 30b	Fig. 8
RaB-78	1.6	1.3	Fig. 30a	Fig. 7

DESCRIPTION: Otoliths almost circular in outline, slightly elongated. Dorsal rim is furnished with a well developed posterodorsal corner. On the anterior rim, there are: a pronounced antirostrum, a deep excisura, and a long rostrum of the extent larger than the antirostrum. Ventral rim is regularly convex with pronounced denticles. Inner face is almost flat. Ostium is oval and twice longer than the cauda. Collicula are well developed, while the caudale crista superior is developed weakly. Outer face is slightly convex, flattened, sculptured with concentric furrows.

Fig. 30. *Diaphus* sp. 3

a, b, c – Right sagitta, inner face

REMARKS: The studied otoliths are close to those of the present-day species *Diaphus termophilus* TAANING, 1928, and *D. holti* TAANING, 1918 (*see* NOLF 1977, NOLF & CAPPETTA 1988). They differ from those distinguished as *Diaphus* sp. 1 and *Diaphus* sp. 2 by their more projecting rostrum and more pronounced denticles on the ventral rim. Such forms have not hitherto been reported from Poland.

Diaphus sp. 4
(Text-fig. 31 and Pl. 6, Figs 5-6)

MATERIAL: Bęczyn – 17 specimens, in majority badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 31	Pl. 6
RaB-82	2.0	1.4	Fig. 31a	Fig. 5
RaB-83	2.0	1.4	Fig. 31b	Fig. 6

DESCRIPTION: Otoliths elongated, slightly rectangular in outline. Dorsal rim is straight, with a well developed anterodorsal corner. Ventral rim is slightly convex with numerous, fine

denticles. On the anterior rim, there are: a more or less pronounced antirostrum, a shallow excisura, and a long rostrum. Inner face is slightly convex. Sulcus acusticus is narrow. Caudale crista superior is badly developed. Outer face is asymmetrically convex.

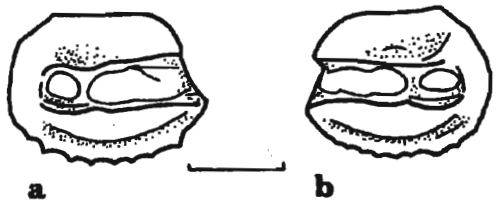


Fig. 31. *Diaphus* sp. 4

a — Left sagitta, inner face; b — right sagitta, inner face

REMARKS: The studied otoliths are close to those referred to as *Diaphus debilis* (KOKEN, 1891), but they differ by their greater elongation, the finer and more numerous denticles on the ventral rim, and a less pronounced posterodorsal corner. Such forms have not hitherto been reported from Poland.

Diaphus sp. 5
(Text-fig. 32 and Pl. 6, Figs 1-4)

MATERIAL: Bęczyn — 33 specimens, in majority badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 32	Pl. 6
RaB-87	2.5	2.0	Fig. 32a	Fig. 4
RaB-86	2.0	1.9	Fig. 32b	Fig. 3

DESCRIPTION: Otoliths oval in outline, with the asymmetrically convex dorsal rim. On the anterior rim, there are: an antirostrum, a shallow excisura, and a rostrum longer than the

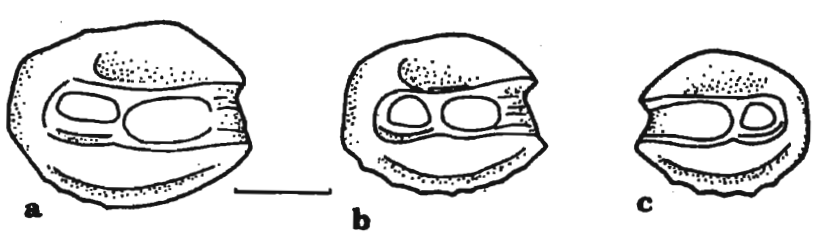


Fig. 32. *Diaphus* sp. 5

a, b — Left sagitta, inner face; c — right sagitta, inner face

antirostrum. Ventral rim with fine denticles. Inner face is convex. Sulcus acusticus is wide. Colliculum caudale is placed a bit higher than the colliculum ostiale. Outer face of larger specimens is flat, and in smaller ones it is relatively high-convex and furnished with a node displaced posteriorly.

REMARKS: The studied otoliths, in majority being the juvenile forms, are in their outline and the development of their sulcus acusticus close to those of the present-day species, *Diaphus fragilis* TAANING, 1928, and *D. problematicus* PARR, 1928, occurring in tropical zones of the Atlantic (*see* NOLF & MARTINELL 1980, Pl. 3, Figs 1-12). The specimens from Bęczyn differ from those of the present-day species by their greater height but smaller length, and the structure of the anterior rim where the excisura is shallower and more widely opened. Such forms have not hitherto been reported from Poland.

Diaphus sp. 6
(Text-fig. 33 and Pl. 4, Figs 1-3)

MATERIAL: Bęczyn — 4 juvenile specimens, in majority badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 33	Pl. 4
RaB-51	2.0	1.9	Fig. 33a	Fig. 1
RaB-52	1.8	1.7	Fig. 33b	Fig. 2

DESCRIPTION: Otoliths small, thick, higher than long, almost circular in outline. Dorsal rim has a well developed posterodorsal corner. On the anterior rim, there are: a shallow, wide excisura, a short antirostrum, and a short rostrum. Inner face is slightly convex. Sulcus acusticus is wide. Ostium is twice longer than the cauda. Outer face is highly convex.

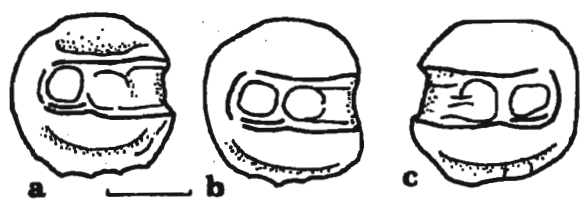


Fig. 33. *Diaphus* sp. 6

a, b — Left sagitta, inner face; c — right sagitta, inner face

REMARKS: The studied otoliths, due to their outline and the structure of their sulcus acusticus, are herein assigned to the genus *Diaphus* EIGENMANN & EIGENMANN, 1890. Of all the *Diaphus* forms collected, these specimens are the closest to those of the species *D. cahuzaci* STEURBAUT, 1979, from which they differ by their smaller length, and their sulcus acusticus relatively wider.

A juvenile nature of these specimens does not allow for their specific recognition. Such forms have not hitherto been reported from Poland.

Genus *Hygophum* Bolin, 1939

Hygophum sp.
(Text-fig. 34 and Pl. 6, Figs 12-13)

MATERIAL: Bęczyn – 4 specimens, badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 34	Pl. 6
RaB-89	2.2	2.0	Fig. 34c	Fig. 13
RaB-88	2.0	1.9	Fig. 34b	Fig. 12

DESCRIPTION: Otoliths oval in outline, a bit higher than long. On the dorsal rim, in its posterior part, there is a fine incision. Ventral rim is slightly asymmetrically convex. On the anterior rim, there are: an antirostrum, a deep and narrow excisura, and a rounded rostrum. Inner face is slightly convex. Sulcus acusticus is shallow. Collicula are well developed. Ostium is twice longer than the cauda. Outer face is flat.

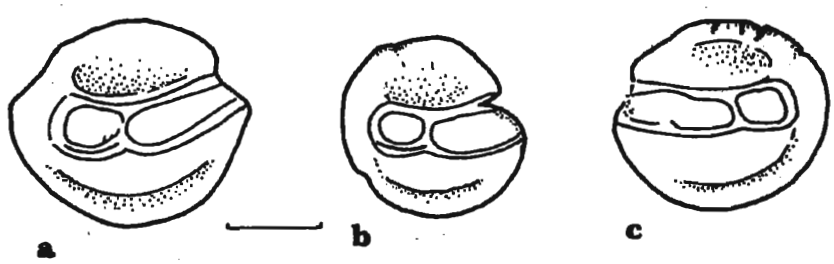


Fig. 34. *Hygophum* sp.
a, b – Left sagitta, inner face; c – right sagitta, inner face

REMARKS: The studied otoliths, due to their general outline and the structure of their sulcus acusticus, are herein assigned to the genus *Hygophum* Bolin, 1939. The collected specimens represent either juvenile forms (*see* Text-fig. 34b and Pl. 6, Fig. 12), or badly preserved adults (*see* Text-fig. 34a,c and Pl. 6, Fig. 13), and thus their specific determination does not seem to be justified.

Genus *Lampadena* Goode & Bean, 1896

Lampadena aff. *dea* Fraser-Brunner, 1949
(Text-fig. 35 and Pl. 6, Fig. 14)

MATERIAL: Bęczyn – one specimen, badly preserved.

Coll. number	L	H	Figured in: Text-fig. 35	Pl. 6
RaB-477	3.0	2.2	Fig. 35	Fig. 14

DESCRIPTION: Otolith oval in outline. Dorsal rim is convex, with the well developed posterodorsal corner. On the anterior rim, there are: a shallow excisura and a long rostrum. Ventral rim with numerous denticles. Inner face is flat. Sulcus acusticus is wide. Collicula are well developed. Ostiale crista superior is strongly convex. Above crista inferior there is a wide area. Outer face is convex.

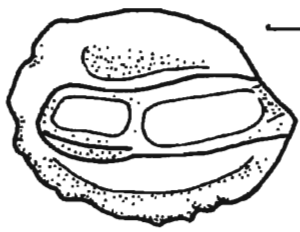


Fig. 35. *Lampadena* aff. *dea* FRASER-BRUNNER, 1949

Left sagitta, inner face

REMARKS: The studied otolith, due to its outline and the structure of its sulcus acusticus is close to those of the present-day species *Lampadena dea* FRASER-BRUNNER, 1949, known from the SE Pacific and Indian Ocean (*see* Text-fig. 36), from which it differs by the shape of the posterior rim and a deeper excisura. Neither the species nor the genus have hitherto been reported from Poland.

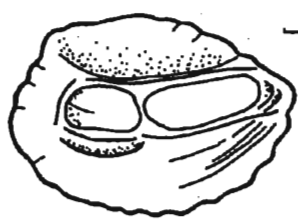


Fig. 36. *Lampadena dea* FRASER-BRUNNER, 1949

Present-day specimen: left sagitta, inner face; SE Pacific (NOLF's Collection)

Genus *Lampichthys* FRASER-BRUNNER, 1949

Lampichthys schwarzhansi BRZOBOHATÝ, 1986 (Text-fig. 37 and Pl. 6, Figs 10-11)

1966. *Myctophum splendidum* (PROCHÁZKA); T. ŚMIGIELSKA, p. 230, Pl. 13, Fig. 10a-b.
1966. *Myctophum mediterraneum* (KOKEN); T. ŚMIGIELSKA, p. 232, Pl. 13, Fig. 12a-b.
1986. *Lampichthys schwarzhansi* n. sp.; R. BRZOBOHATÝ, p. 59. Text-fig. 3 and Pl. 2, Figs 4-8 and Figs 10-12.

MATERIAL: Bęczyn – 3 specimens, badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 37	Pl. 6
RaB-91	3.0	2.0	Fig. 37c	Fig. 11
RaB-90	2.5	2.6	Fig. 37b	Fig. 10

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* BRZOBOHATÝ 1986, Figs 3a-3b). Such otoliths have already been reported from Poland by ŚMIGIELSKA (1966) who assigned them to the two related species, "*Myctophum mediterraneum* (KOKEN)" and "*Myctophum splendidum* (PROCHÁZKA)". According to the present author, the specimens described by ŚMIGIELSKA (1966) differ from those of the species *Diaphus splendidum* (PROCHÁZKA, 1893) by their more elongated outline and a lack of denticles along the ventral rim.

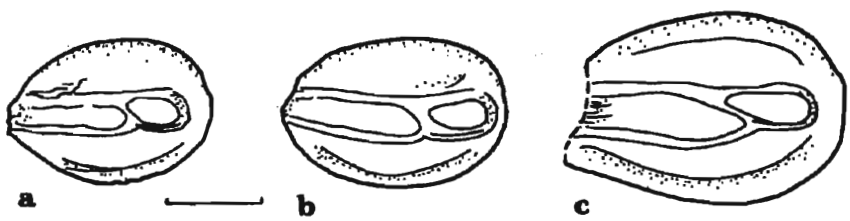


Fig. 37. *Lampichthys schwarzhansi* BRZOBOHATÝ, 1986

a, b, c – Right sagitta, inner face

The species "*mediterraneum*" is presently (*see* STEURBAUT 1979) rejected, and many forms formerly attributed to it have been included into the synonymy of *Symbolophorus meridionalis* STEURBAUT, 1979 (*see* STEURBAUT 1979).

Genus *Notoscopelus* GÜNTHER, 1864

Notoscopelus sp.
(Text-fig. 38 and Pl. 6, Figs 15-16)

1966. *Myctophum insoletum* (PROCHÁZKA); T. ŚMIGIELSKA, p. 231, Pl. 1, Fig. 11a-b.

MATERIAL: Bęczyn – 2 specimens, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 38	Pl. 6
RaB-94	3.2	2.0	0.6	Fig. 38a	Fig. 16
RaB-93	2.8	1.9	0.5	Fig. 38b	Fig. 15

REMARKS: Such forms have previously been noted from Poland by ŚMIGIELSKA (1966) as "*Myctophum insoletum* (PROCHÁZKA)". It is to note, that STEURBAUT (1979) included the specimen described by ŚMIGIELSKA (1966) into the synonymy of the species *Symbolophorus meridionalis* STEURBAUT, 1979, and objected the reality of the species "*insoletum*" of PROCHÁZKA (1893). Anyway, according to the present author, the studied otoliths, that one described by ŚMIGIELSKA (1966) including, represent a species of another genus, viz. *Notoscopelus* GÜNTHER, 1864. A poor material and its preservation hinder any specific determination.

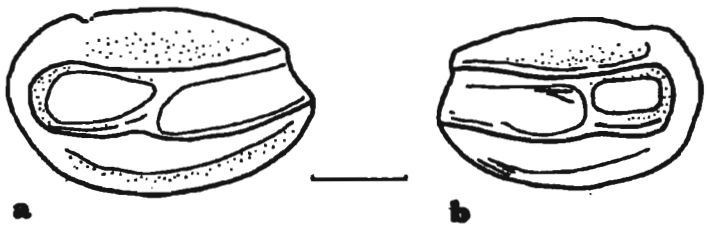


Fig. 38. *Notoscopelus* sp.

a – Left sagitta, inner face; b – right sagitta, inner face

Order **Batrachoidiformes** Goodrich, 1909
Family **Batrachoididae** Jordan & Evermann, 1898
Genus *Halobatrachus* Ogilby, 1908

Halobatrachus korytnicensis (Śmigielska, 1979)
(Text-fig. 39 and Pl. 7, Figs 1-2)

1979. *Thalassophryne korytnicensis* sp. n.; T. Śmigielska, p. 332, Text-fig. 36 and Pl. 8, Fig. 10.
1985. *Perulibatrachus korytnicensis* (Śmigielska, 1979); D. Nolf, p. 57.

MATERIAL: Korytnica – 6 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 39	Pl. 7
RaK-96	5.0	2.5	1.0	Fig. 39b	Fig. 2
RaK-95	4.2	2.3	1.0	Fig. 39a	Fig. 1

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* Śmigielska 1979, Pl. 8, Fig. 10), and they come (the same as those of the type series) from the Korytnica Basin.

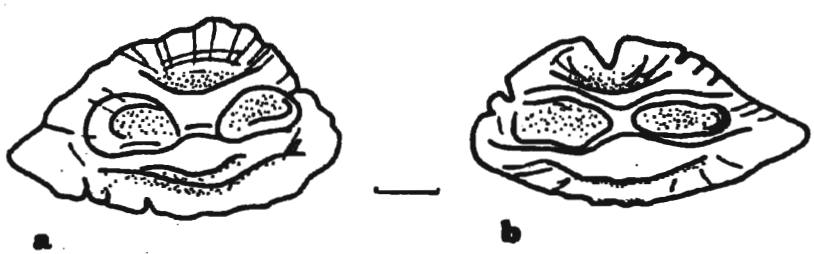


Fig. 39. *Halobatrachus korytnicensis* (Śmigielska, 1979)

a – Left sagitta, inner face; b – right sagitta, inner face

The generic attribution of the species has hitherto been variously treated (*see* synonymy). A comparison with the present-day otoliths (NOLF's Collection) allows to state, that the species "*korytnicensis*" is the closest to those of the species *Halobatrachus didactylus* (SCHNEIDER, 1801) living along the coast of western Africa (*see* NOLF 1985, Fig. 48D).

Order **Lophiiformes** GARMAN, 1899
Suborder **Antennarioidei** BLEEKER, 1859
Family **Chaunacidae** GILL, 1863
Genus *Chaunax* LÖWE, 1846

Chaunax sp.
(Text-fig. 40 and Pl. 7, Fig. 6)

MATERIAL: Korytnica – 2 juvenile specimens, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 40	Pl. 7
RaK-97	2.2	1.4	0.7	Fig. 40a,a'	Fig. 6

DESCRIPTION: Otoliths oval in outline, slightly rectangular. Dorsal rim folded. Inner face is slightly convex. Sulcus acusticus is indistinctly divided. Crista superior is developed along a short distance only. Outer face is convex.

Fig. 40. *Chaunax* sp.

a, b – Left sagitta, inner face, a' – dorsal view

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus, are herein assigned to the genus *Chaunax* LÖWE, 1846. A more precise specific recognition, in regard with the juvenile nature of the specimens, is not easy. They are close the most to those of the fossil species *Chaunax edegemensis* NOLF & SMITH, 1983, discovered in the Miocene deposits of Belgium. The genus has not hitherto been reported from Poland.

Order **Gadiformes** GOODRICH, 1909
Suborder **Gadoidei** GOODRICH, 1909
Family **Moridae** GOODE & BEAN, 1896
Genus *Laemonema* JOHNSON, 1862

Laemonema sp.
(Text-fig. 41 and Pl. 7, Fig. 10)

MATERIAL: Bęczyn — one specimen, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 41	Pl. 7
RaB-98	6.2	2.5	2.5	Fig. 41a,a'	Fig. 10

DESCRIPTION: Otolith of elongated outline and slightly concave inner face. Ostium oval, with a well developed colliculum; cauda is long and slightly arcuate. Both crista superior and crista inferior are well developed. Outer face is strongly convex, with a chracteristic triangular longitudinal profile (*see* Text-fig. 41a').

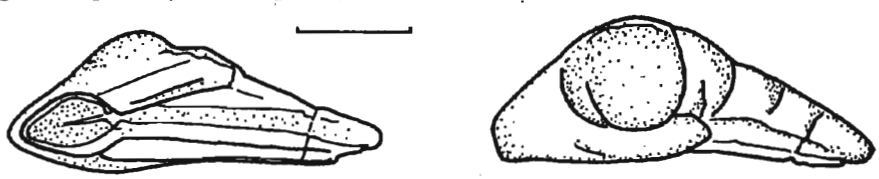


Fig. 41. *Laemonema* sp.

a — Right sagitta, inner face, a' — dorsal view

REMARKS: The studied otolith, due to its outline and longitudinal profile, is herein assigned to the genus *Laemonema* JOHNSON, 1862. A scanty material, as well as a poor recognition of the present-day species, does not allow for any specific attribution. The fossil otoliths, attributed to this very genus, have hitherto been recorded from the Miocene deposits of Italy (STEURBAUT & NOLF 1983) and Tertiary of New Zealand (SCHWARZHANS 1980). The genus has not hitherto been reported from Poland.

Genus *Physiculus* KAUP, 1858

Physiculus aff. *huloti* POLL, 1953
(Text-fig. 42 and Pl. 7, Figs 7-9)

?1973. *Tripterophycis multituberosus* nov. sp.; P. GAEMERS, p. 68, Pl. 2, Fig. 5.
1979. *Physiculus fitchi* sp. n.; T. ŚMIGIELSKA, p. 307, Text-fig. 10 and Pl. 3, Figs 1-2.

1979. *Physiculus* aff. *huloti* POLL, 1953; E. STEURBAUT, p. 63, Pl. 6, Figs 3-5.
1979. *Physiculus* cf. *huloti* POLL, 1953; J. LANCKNEUS & D. NOLF, p. 87, Pl. 1, Figs 4-6.
1979. *Physiculus* aff. *huloti* POLL, 1953; B. HUYGHEBAERT & D. NOLF, p. 71, Pl. 2, Fig. 19
1982. *Physiculus* aff. *huloti* POLL, 1953; E. STEURBAUT & S. JONET, p. 198, Pl. 1, Fig. 16.
1983. *Physiculus* aff. *huloti* POLL, 1953; D. NOLF & E. STEURBAUT, p. 162, Pl. 3, Fig. 17.
1984. *Physiculus* aff. *huloti* POLL, 1953; E. STEURBAUT, p. 55, Pl. 11, Figs 1-4.
1985. *Physiculus* aff. *huloti* POLL, 1953; D. NOLF, p. 59.
1986. *Physiculus* aff. *huloti* POLL, 1953; W. SCHWARZHANS, p. 223, Pl. 5, Figs 57-58.

MATERIAL: Korytnica – 42 specimens, in majority damaged.

Coll. numbers	L	H	T	Figured in: Text-fig. 42	Pl. 7
RaK-101	7.0	2.0	2.0	--	Fig. 9
RaK-100	5.5	1.9	1.5	Fig. 42b	Fig. 8
RaK-99	5.5	1.8	1.7	Fig. 42a	Fig. 7

REMARKS: The studied otoliths are very close to those of the present-day species *Physiculus huloti* POLL, 1953 (*see* STEURBAUT 1979, Pl. 6, Figs 1-2). Small differences in the height and outline of the anterior rim may be ascribed to the intraspecific variability. A limited amount of the comparable present-day material (*see* STEURBAUT 1981) does not allow to recognize adequately this variability.

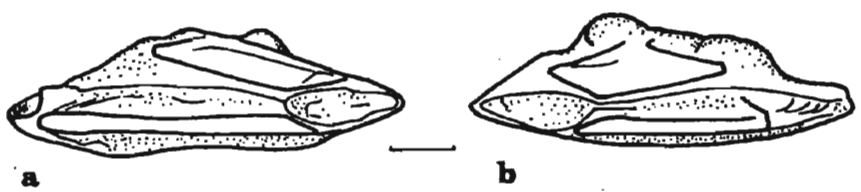


Fig. 42. *Physiculus* aff. *huloti* POLL, 1953

a – Left sagitta, inner face; b – right sagitta, inner face

The species has formerly been reported from the Korytnica Basin by ŚMIGIELSKA (1979) as "*Physiculus fitchi* sp. n.". The creation of a new species seemed to be reasonable at that time, bacause the genus *Physiculus* KAUP, 1858, was poorly known and little was noticed about the variability of its species. At present, when very slight differences between fossil and modern specimens are taken into account, the treatment proposed by STEURBAUT (1979) seems to be the most realistic.

Family **Bregmacerotidae** GILL, 1872
Genus *Bregmaceros* THOMPSON, 1840

Bregmaceros sp.
(Text-fig. 43 and Pl. 7, Figs 3-5)

MATERIAL: Korytnica – 42 specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 43	Pl. 7
RaK-103	1.5	1.7	Fig. 43c	Fig. 3
RaK-104	1.5	1.8	Fig. 43b	Fig. 5
RaK-105	1.3	1.5	Fig. 43d	Fig. 4

DESCRIPTION: Otoliths small, polygonal in outline. Both the postero- and anterodorsal corners are very well developed. Posteroventral corner is developed as a spur. Ventral rim is convex and may be provided with one or two denticles. Inner face is flat. Sulcus acusticus is distinctly divided. Collicula are very well developed. Crista inferior is distinctly marked along the whole sulcus acusticus. Ventral furrow is wide. Area is placed near the dorsal rim. Outer face is convex, provided with a node placed slightly near the ventral rim.

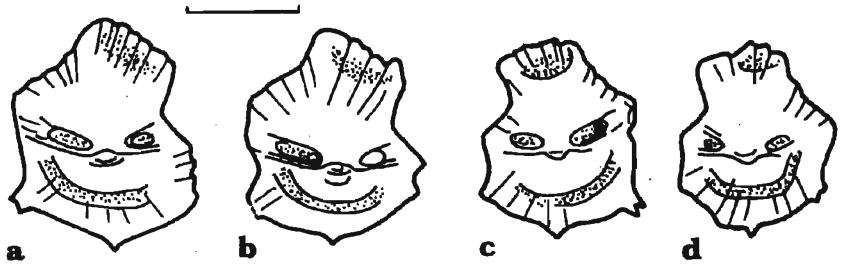


Fig. 43. *Bregmaceros* sp.

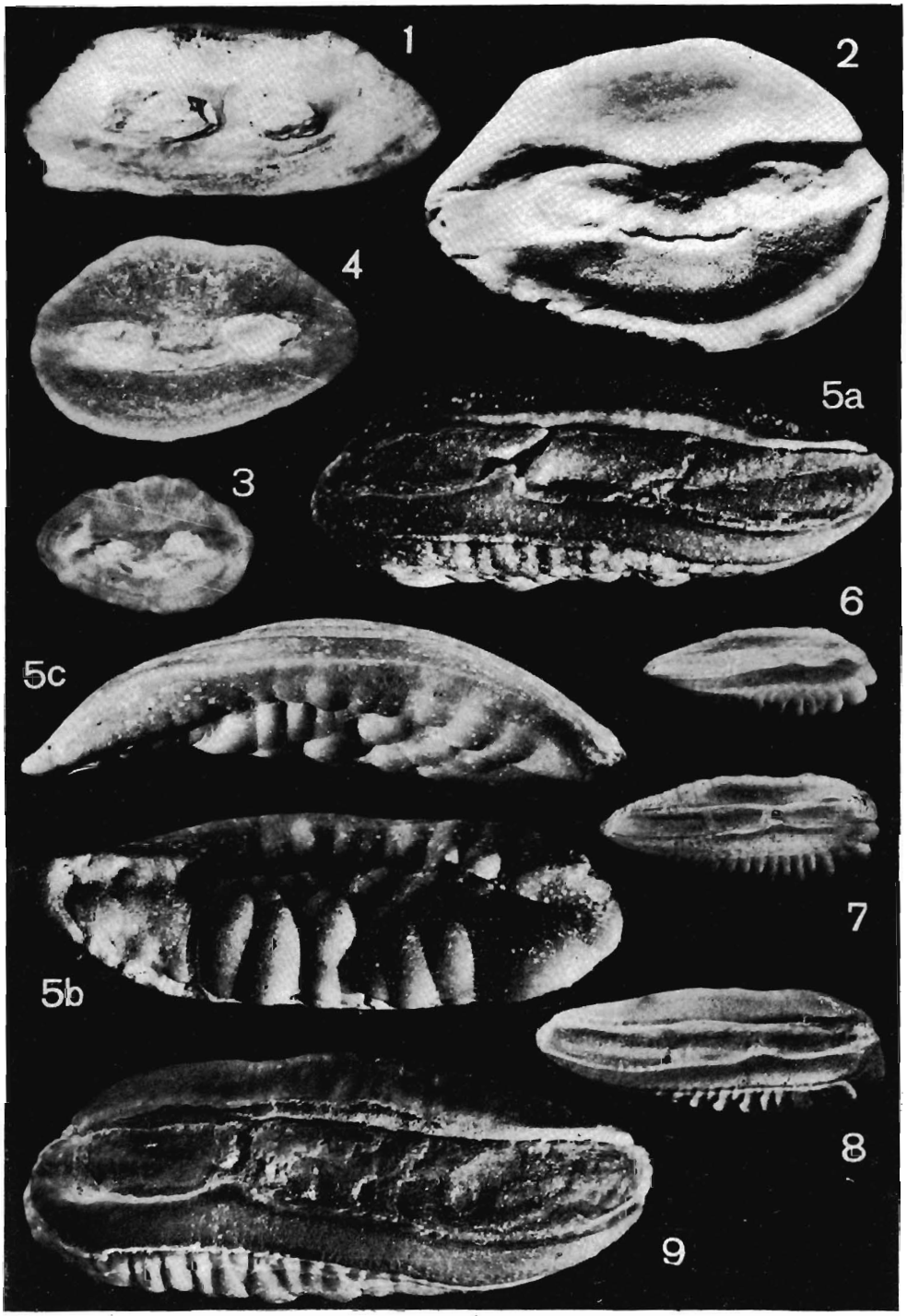
a, b — Left sagitta, inner face; c, d — right sagitta, inner face

REMARKS: The studied otoliths, due to their characteristic outline and development of the sulcus acusticus, are herein assigned to the genus *Bregmaceros* THOMPSON, 1840. A poor recognition of the present-day species of this genus does not allow for a more precise attribution of the collected specimens. The genus has not hitherto been reported from Poland.

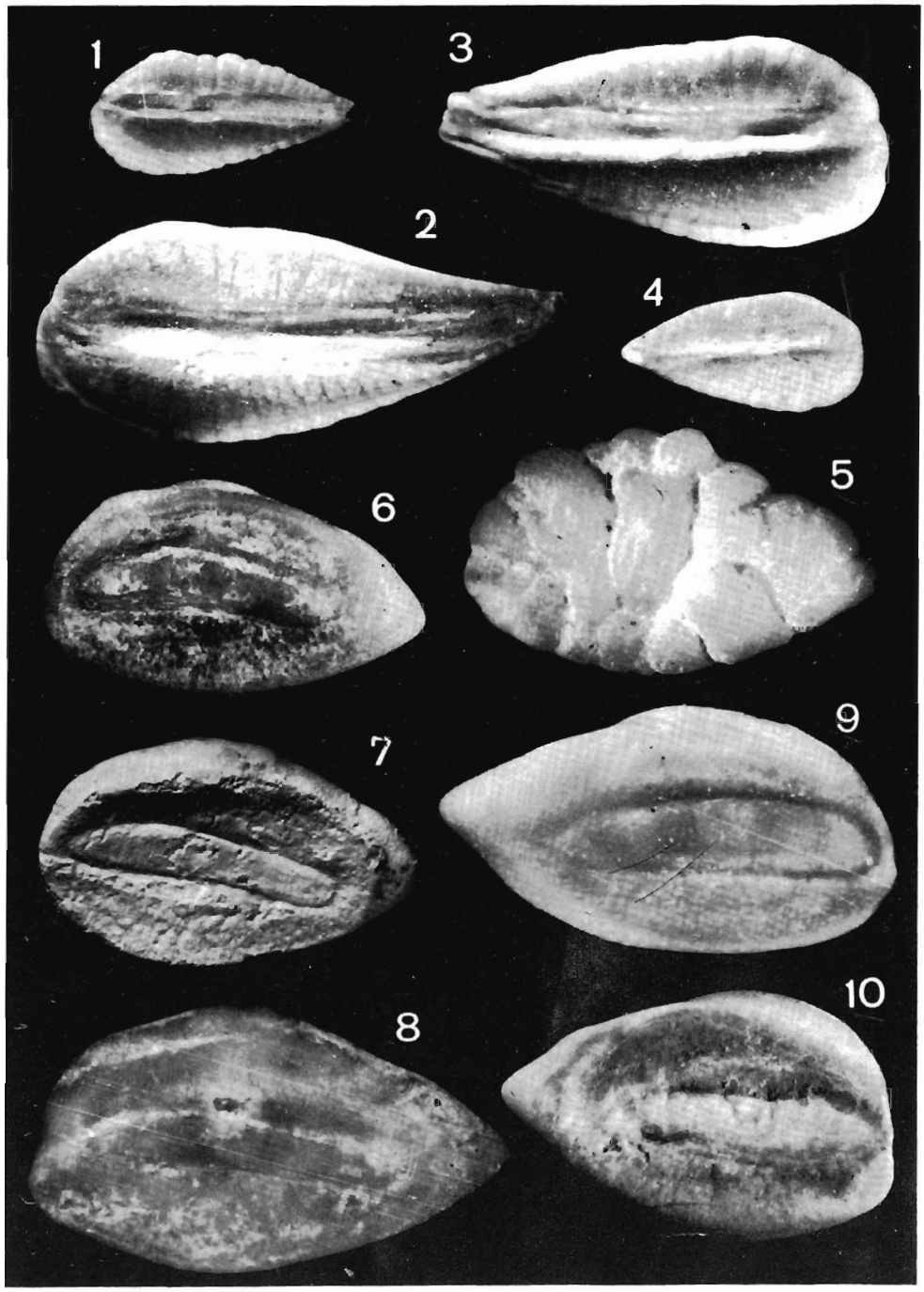
Family **Gadidae** RAFINESQUE, 1810
Subfamily **Merluccinae** ADAMS, 1864
Genus *Merluccius* RAFINESQUE, 1810

Merluccius merluccius (LINNAEUS, 1758)
(Text-fig. 44 and Pl. 8, Figs 6-7)

1884. *Merluccius esculentus*.; E. KOKEN, p. 529, Pl. 9, Fig. 1.
1891. *Otolithus* (*Merluccius*) *miocenicus* KOKEN; E. KOKEN, p. 85, Text-fig. 3.
1906. *Otolithus* (*Merluccius*) *preesculentus* BASS. et SCHUB. n. sp.; R. SCHUBERT, p. 657, Pl. 5, Fig. 29a-b.
1906. *Otolithus* (*Merluccius*) *preesculentus* BASS. et SCHUB.; G. BASSOLI, p. 39, Pl. 1, Figs 7, 9-10.
1942. *Merluccius vulgaris* FL.; W. WEILER, p. 87, Pl. 11, Figs 1a-b, 2, 3a-b, 4, 6-7.



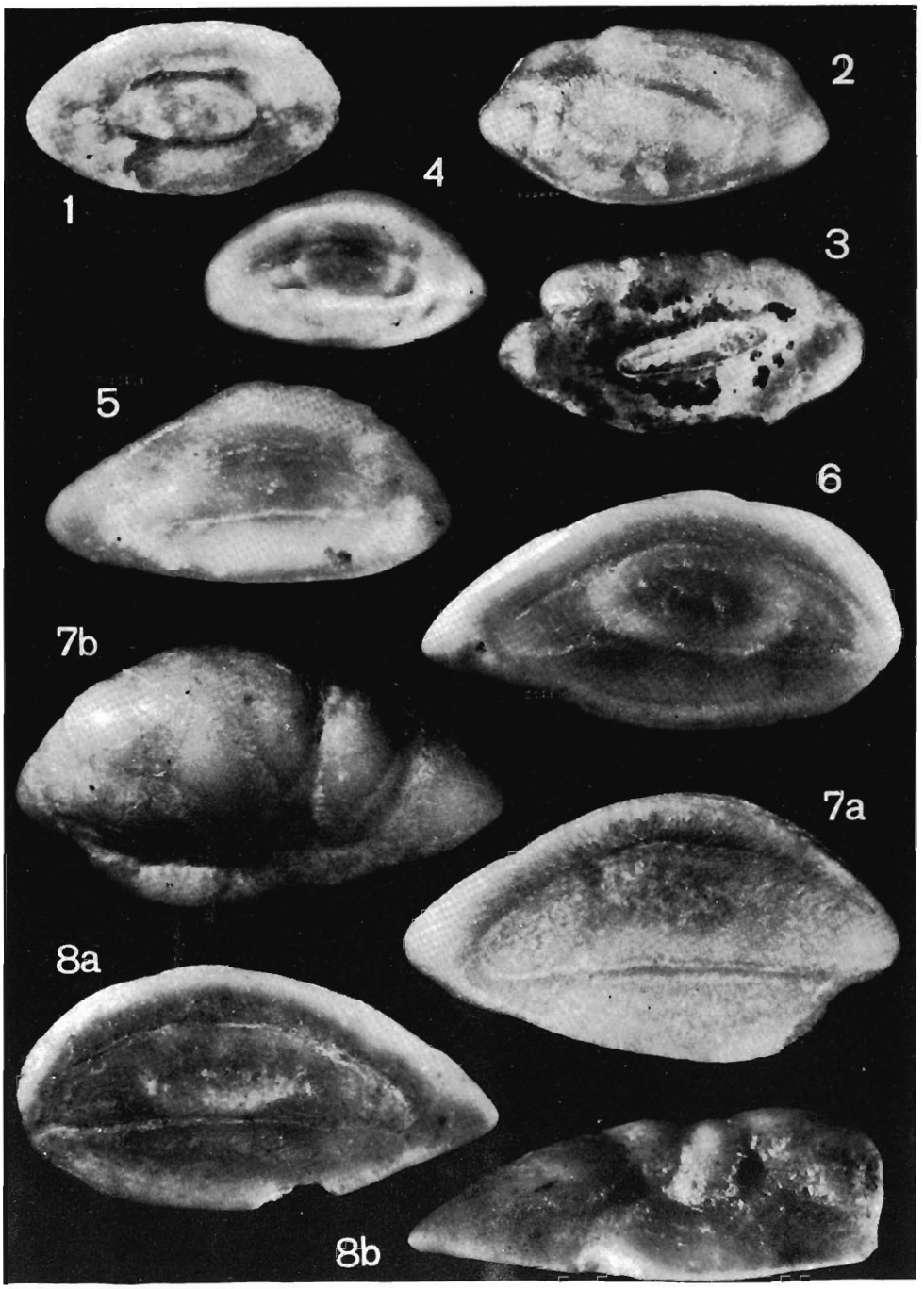
1 – "genus *Bathygadinarum*" sp. 2; right sagitta, inner face; × 10
2-4 – *Gadiculus argenteus* GUICHENOT, 1810; 2-3 – left sagitta, inner face; 4 – right sagitta, inner face; × 15
5-9 – *Micromesistius arcuatus* sp. n.; 5 – **holotype**, right sagitta, *5a* inner face, *5b* outer face, *5c* ventral view; 6-9 – **paratypes**, 6-8 – left sagitta, inner face, 9 – right sagitta, inner face; × 5



1-4 — *Trisopterus sculptus* (KOKEN, 1891); 1-2 — right sagitta, inner face; 3-4 — left sagitta, inner face; × 7.5

5 — *Carapus* cf. *caninus* (GÜNTHER, 1862); left sagitta, outer face; × 15

6-10 — *Carapus* aff. *acus* (BRÜNNICH, 1768); 6-8 — right sagitta, inner face; 9-10 — left sagitta, inner face; × 15



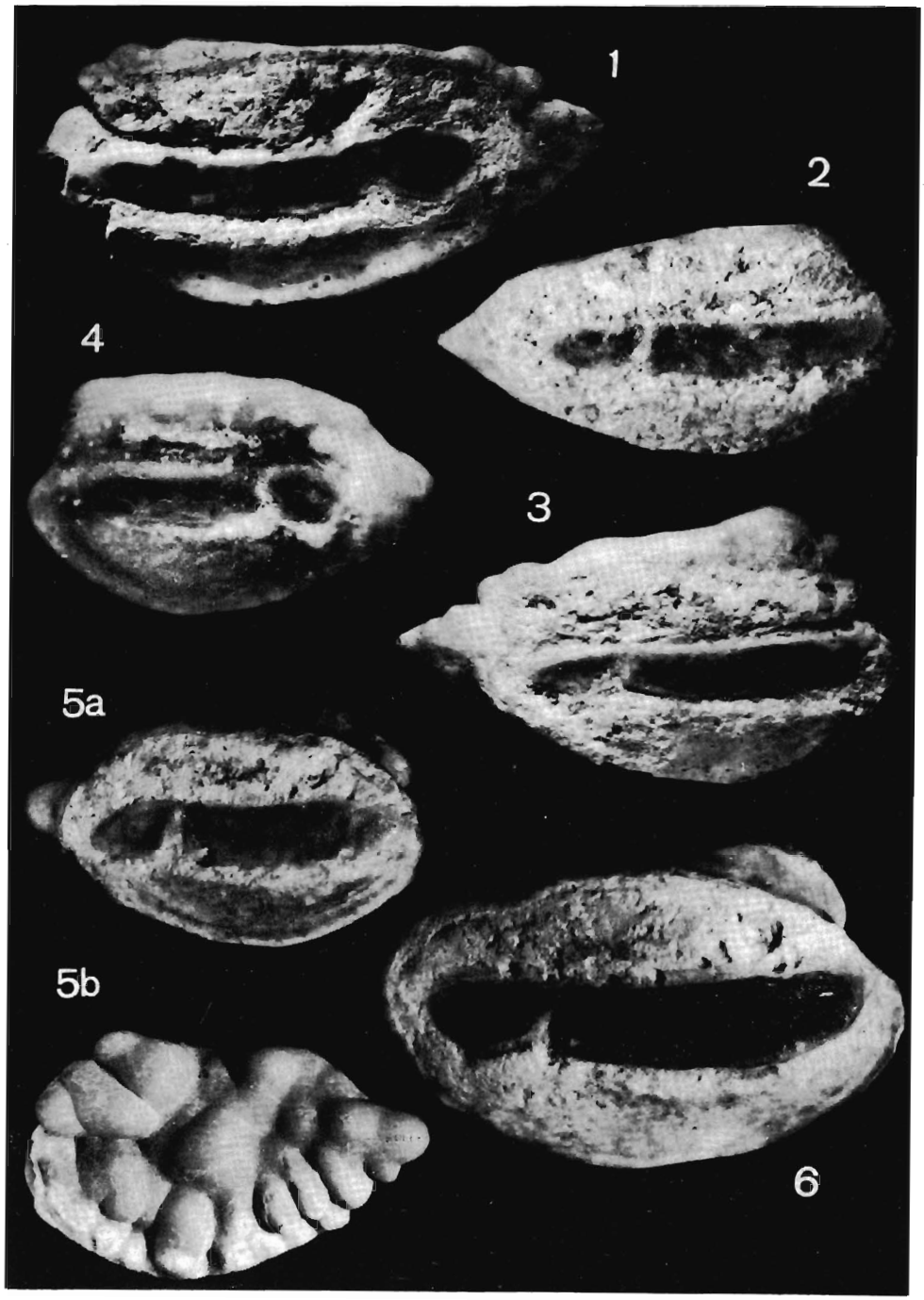
1 — *Oligopus* sp.; right sagitta, inner face; × 15

2-3 — *Oligopus obliquus* (WEILER, 1942); 2 — right sagitta, inner face; 3 — left sagitta, inner face; × 15

4 — *Echiodon* sp. 2; left sagitta, inner face; × 10

5 — *Echiodon nuntius* (KOKEN, 1891); left sagitta, inner face; × 15

6-8 — *Echiodon heinzelini* HUYGHEBAERT & NOLF, 1979; 6 — left sagitta, inner face; 7 — left sagitta, *7a* inner face, *7b* outer face; 8 — right sagitta, *8a* inner face, *8b* ventral view; × 15



1-3 – *Hoplobrotula acutangula* (KOKEN, 1884); 1 – right sagitta, inner face; 2-3 – left sagitta, inner face; 1, 3 × 10; 2 × 7

4-6 – *Hoplobrotula gibba* (BASSOLI, 1906); 4 – right sagitta, inner face; 5-6 – left sagitta, *5a, 6* inner face; *5b* outer face; × 10

1983. *Hoplobrotula elongata* (WEILER, 1942); D. NOLF & E. STEURBAUT, p. 174.
1985. *Hoplobrotula elongata* (WEILER, 1942); D. NOLF, p. 66.

MATERIAL: Korytnica – 17 specimens, in majority superficially corroded.

Coll. numbers	L	H	T	Figured in: Text-fig. 60	Pl. 12
RaK-153	9.0	4.8	2.0	Fig. 60a,a'	Fig. 2
RaK-152	8.0	4.1	1.8	Fig. 60b,b'	Fig. 1
RaK-154	7.2	4.0	1.5	--	Fig. 3

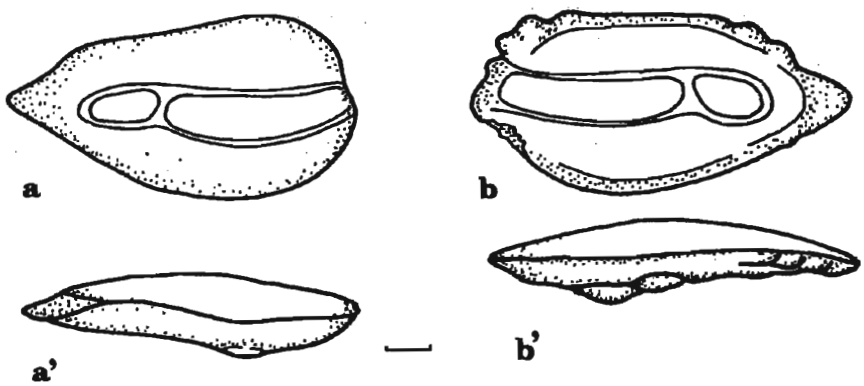


Fig. 60. *Hoplobrotula acutangula* (KOKEN, 1884)

a – Left sagitta, inner face; b – right sagitta, inner face; a', b' – ventral view

REMARKS: The studied otoliths are consistent with the specimen illustrated by KOKEN (1884, Pl. 11, Fig. 13), which has been explained, in the captions of the plate, as "*Otolithus* (*Gadidarum*) *difformis*", although this designation pertains really to the otolith illustrated in Fig. 11 of the same plate. The otolith presented in Pl. 11, Fig. 13 is thus, evidently, the holotype of the species described by KOKEN as "*Otolithus* (*Gadidarum*) *acutangulus*", and not of the "*difformis*". This basic mistake in the captions has already been noticed by KOKEN (1884) himself, who supplied a footnote on the non-paginated page containing the captions of Pl. 11. Repeatedly, a correction was given by KOKEN in another paper, of 1891, on its page 101. It should be remembered, that a mis-numeration concerns only the discussed Plate, whilst the descriptions of the otoliths are concordant with the specimens.

A correction, given by KOKEN (1884), and formerly noted by ŚMIGIELSKA (1979, p. 325), escaped however of the notion by NOLF (1977, 1980) when he revised i. a. all fossil species of the order Ophidiiformes. This latter fact is basically important for further considerations upon the species "*acutangulus*", bacause NOLF (1977) reported, that the specimen illustrated by KOKEN (1884) on his Pl. 11, Fig. 11 [and presenting really the holotype of the species *Hoplobrotula difformis*] is much worn, thus not sufficient for precise determinations, and, consequently, the name "*acutangulus*" should be rejected. As given above, the holotype of the species *Hoplobrotula acutangula* (KOKEN, 1884) is, however, the specimen illustrated by KOKEN on his Pl. 11, Fig. 13, and its state of preservation cannot be objected. Thus, when nomenclatorial validity of the name "*acutangulus*"

is accepted, all taxonomic procedures of NOLF (1977, 1980) and subsequent authors become devoid of legality.

The otolith described by WEILER (1942) as "*Otolithus* (*Ophidiidarum*) *hilgendorfii* KOK. mut. *elongata* n. m." represents a form of a more obtuse shape, but with the other features not differing from those described by KOKEN (1884, 1891) as "*Otolithus* (*Ophidiidarum*) *acutangulus*". Consequently, the taxon established by WEILER (1942) is herein synonymized with the species *Hoplobrotula acutangula* (KOKEN, 1884).

In the investigated material distinguishable are the specimens: (1) Those of a distinctly pentagonal outline, furnished with granules and grooves on both the anterior and posterior rim, and with a distinct sculpture of the outer face (*see* Text-fig. 60b and Pl. 12, Figs 1 and 3), what makes up their almost identity with the holotype; (2) The specimens of more obtuse shape, with their outer face more uniform (*see* Text-fig. 60a and Pl. 12, Fig. 2), and close therefore to the specimen illustrated by WEILER (1942), and which was the type of the taxon "*elongata*". According to the present author, those two morphotypes are falling into the intraspecific variability of *Hoplobrotula acutangula* (KOKEN, 1884). The discussed species has already been reported from the Korytnica Basin by ŚMIGIELSKA (1979).

Hoplobrotula gibba (BASSOLI, 1906)
(Text-fig. 61 and Pl. 12, Figs 4-6; Pl. 13, Fig. 11)

1906. *Otolithus* (*Ophidiidarum*) *gibbus* BASS.; G. BASSOLI, p. 45, Pl. 1, Figs 39-40.
1970. *Bauzaia difformis* (KOKEN, 1884); E. ROBBA, p. 145, Pl. 15, Fig. 8.
1970. *Bauzaia gibba* (BASSOLI, 1906); E. ROBBA, p. 146, Pl. 15, Fig. 9.
1970. *Bauzaia ornatissima* sp. n.; E. ROBBA, p. 148, Pl. 16, Figs 3-5.
1979. *Hoplobrotula? ornatissima* (ROBBA, 1970); T. ŚMIGIELSKA, p. 326, Text-fig. 29 and Pl. 8, Fig. 2.
1980. *Hoplobrotula gibba* (BASSOLI, 1906); D. NOLF, p. 125, Pl. 16, Fig. 3.
1983. *Hoplobrotula gibba* (BASSOLI, 1906); D. NOLF & E. STEURBAUT, p. 174.

MATERIAL: Korytnica — 34 specimens, in majority superficially corroded.

Coll. numbers	L	H	T	Figured in: Text-fig. 61	Pl. 12
RaK-151	7.4	5.0	2.5	–	Fig. 6
RaK-149	6.0	3.5	1.7	–	Fig. 4
RaK-150	6.0	3.5	1.8	Fig. 61a,a'	Fig. 5
					Pl. 13
RaK-155	9.0	6.0	3.0	–	Fig. 11

REMARKS: The studied otoliths, in their basic features, are consistent with the holotype of the species (*see* BASSOLI 1906, Pl. 1, Fig. 39), although they slightly differ in their outline. The general outline in this species ranges from the triangular forms (such as the holotype) to those almost regularly oval, and thus it is regarded as a feature of the intraspecific variability.

This species has already been reported from the Korytnica Basin, but described by ŚMIGIELSKA (1979) as "*Hoplobrotula? ornatissima* ROBBA, 1970". Presently, when a revision of the species known from the Miocene of Italy was done by NOLF & STEURBAUT (1983), the species "*ornatissima*" should evidently be regarded as a younger synonym of the species *Hoplobrotula gibba* (BASSOLI, 1906).

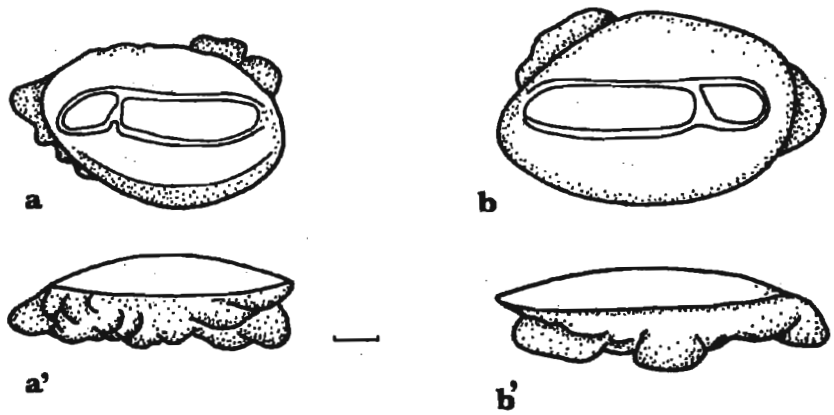


Fig. 61. *Hoplobrotula gibba* (BASSOLI, 1906)

a – Left sagitta, inner face; b – right sagitta, inner face; a', b' – ventral view

Suborder **Bythitoidei** COHEN & NIELSEN, 1978
Family **Bythytidae** GILL, 1861
Subfamily **Bythytinae** GILL, 1861
Genus *Oligopus* RISSO, 1810

Oligopus obliquus (WEILER, 1942)
(Text-fig. 62 and Pl. 11, Figs 2-3)

1942. *Otolithus (Ophidiidarum) obliquus* n. sp.; W. WEILER, p. 107, Pl. 5, Figs 35-37.
1979. *Oligopus obliquus* (WEILER, 1942); J. LANCKNEUS & D. NOLF, p. 89, Pl. 2, Figs 6-8.
1979. *Oligopus obliquus* (WEILER, 1942); B. HUYGHEBAERT & D. NOLF, p. 73, Pl. 3, Figs 17-19.
1980. *Oligopus obliquus* (WEILER, 1942); D. NOLF, p. 127.
1985. *Oligopus obliquus* (WEILER, 1942); D. NOLF, p. 67.

MATERIAL: Korytnica – 2 specimens, well preserved.

Coll.				Figured in:	
numbers	L	H	T	Text-fig. 62	Pl. 11
RaK-147	3.5	1.8	0.5	Fig. 62b,b'	Fig. 3
RaK-146	3.4	1.9	0.7	Fig. 62a,a'	Fig. 2

DESCRIPTION: Otoliths elongated, slightly trapezoidal in outline. Dorsal rim may be almost smooth, or undulant. Ventral rim is slightly convex. Inner face is flat. Sulcus acusticus is not divided, and obliquely placed. Above the crista superior, a bit posteriorly, there is a shallow area. Outer face is flat and slightly corrugated.

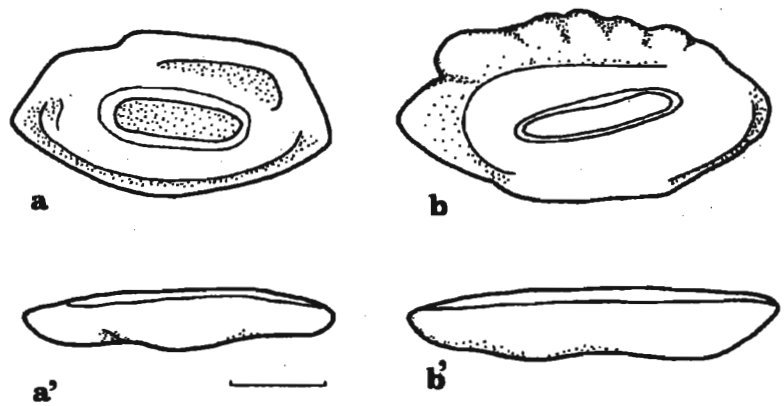


Fig. 62. *Oligopus obliquus* (WEILER, 1942)

a — Right sagitta, inner face; b — left sagitta, inner face; a', b' — ventral view

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* WEILER 1942, Pl. 5, Fig. 37). Otoliths of this species are close to those of the present-day species *Oligopus ater* RISSO, 1810, living in the Mediterranean (*see* NOLF 1980, Pl. 12, Fig. 12), and such a similarity involved their generic attribution to *Oligopus* RISSO, 1810 (*see* synonymy). The otoliths *Oligopus obliquus* (WEILER, 1942) have not hitherto been reported from Poland.

Oligopus sp.
(Text-fig. 63 and Pl. 11, Fig. 1)

MATERIAL: Węglinek — one specimen, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 63	Pl. 11
RaW-148	3.0	1.7	0.8	Fig. 63a,a'	Fig. 1

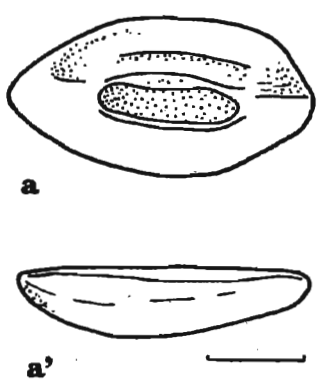


Fig. 63. *Oligopus* sp.

a — Right sagitta, inner face, a' — ventral view

DESCRIPTION: Otolith oval in outline, with its rims smooth. Inner face is slightly convex. Sulcus acusticus is not divided, obliquely placed. Colliculum is well developed. Outer face is slightly asymmetrically convex (*see* Text-fig. 63a').

REMARKS: The studied otolith due to its outline and the structure of its sulcus acusticus is herein assigned to the genus *Oligopus* Risso, 1810. It differs from *Oligopus obliquus* Weiler, 1942, with its outline and thickness. A poor material does not allow for its specific recognition. Such a form has not hitherto been reported from Poland.

"genus *Bythitinarum*" *wenglinensis* sp. n.
(Text-fig. 64 and Pl. 13, Figs 8-10)

HOLOTYPE: The specimen No. RaW-150, presented in Text-fig. 64a,a',a" and Pl. 13, Fig. 8.
TYPE LOCALITY: Węglinek, western part of the Lublin Upland.
TYPE HORIZON: Middle Miocene (Badenian).
DERIVATION OF THE NAME: Referred to a Latinized name of the village in which the section yielding the type series is exposed.

DIAGNOSIS: Otolith pentagonal in outline, sharply terminated anteriorly. Antero- and posterodorsal corners very well developed. Shallow excisura present. Inner face convex. Sulcus acusticus oval, not divided, relatively narrow, oblique. Crista superior and crista inferior well developed. Colliculum developed. A shallow area present. Outer face asymmetrically convex. The swelling displaced towards the ventral rim and anteriorly.

MATERIAL: Węglinek — 4 specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 64	Pl. 13
RaW-156-holotype	3.5	2.2	0.9	Fig. 64a,a',a"	Fig. 8
RaW-158	3.7	2.4	1.0	Fig. 64b	Fig. 10
RaW-157	3.5	2.2	1.0	Fig. 64c	Fig. 9

DESCRIPTION: Otoliths pentagonal in outline, elongated. Antero- and posterodorsal corners are very well developed. Dorsal rim may be straight or slightly concave. Posterior rim is straight. Anterior rim is slightly concave beneath the anterodorsal corner, then convex, and passes into a rounded rostrum. Inner face is slightly convex, but in its posterodorsal part may be concave. Narrow sulcus acusticus is not divided, oval in outline, and obliquely placed. Outer face is asymmetrically convex, and the swelling is displaced towards the ventral rim and anteriorly (*see* Text-fig. 64a").

REMARKS: The studied otoliths are close to those of the present-day species *Cataetyx alleni* (Byrne, 1906) recorded from the offshores of Angola (*see* Nolf 1980, Pl. 12, Fig. 8). The collected specimens differ, however, by their more polygonal outline and the inner face being convex. A reasonable similarity is also observed to those of the present-day species *Diplacanthopoma brachysoma* (Günther, 1887), from which they differ by a slightly different outline, primarily the course of the anterior rim. The two indicated present-day species represent the subfamily Bythitinae Gill, 1861, whose taxonomic recognition at lower levels is not satisfactory yet, and the differences between genera not clearly defined. Counsequently, the otoliths of the newly estabished species "*wenglinensis*" may only be ascribed to the subfamily rank.

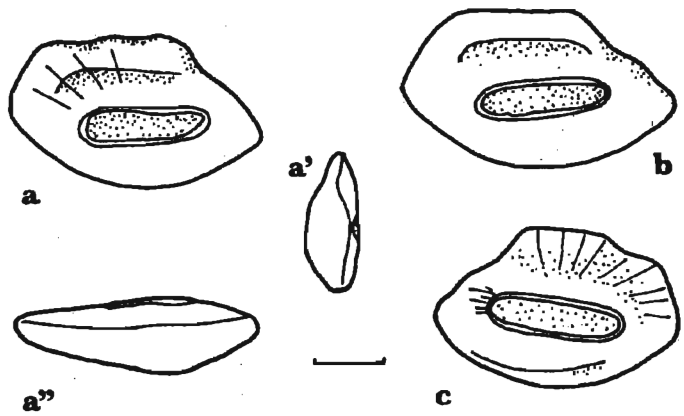


Fig. 64. "genus *Bythitinarum*" *wenglinensis* sp. n.

Holotype: a — left sagitta, inner face, **a'** — posterior view, **a"** — ventral view; **paratypes: b** — left sagitta, inner face; **c** — right sagitta, inner face

Subfamily *incertae sedis*
"genus *Bythitidarum*" sp.
(Text-fig. 65 and Pl. 13, Fig. 7)

MATERIAL: Bęczyn — 2 specimens, well preserved.

Coll.				Figured in:	
number	L	H	T	Text-fig. 65	Pl. 13
RaB-159	2.9	1.8	0.9	Fig. 65a,a'	Fig. 7

DESCRIPTION: Otoliths of a flattened hexagon in outline. Both antero- as well as posterodorsal corner is well developed. Inner face is the most convex along its sulcus acusticus (*see* Text-fig. 65a'). The surface around the sulcus acusticus is flat. Sulcus acusticus is not divided, relatively wide. Outer face is strongly convex, and smooth.

REMARKS: The studied otoliths are close to those of the present-day species of such genera as *Dermatopsis* OGILBY, 1896, and *Brotulina* FOWLER, 1946, the both representing the subfamily Brosmophycinae GILL, 1862 (*see* NOLF 1980). They are, however, similar also to those of the present-day species *Bythites gerdae* NIELSEN & COHEN, 1973 (*see* NOLF 1980, Pl. 12, Fig. 3) belonging to the subfamily Bythitinae GILL, 1861. When the fact, that in the whole family Bythitidae GILL, 1861, the otoliths are poorly differentiated, and even the generic features are not idividualized throughout various subfamilies, is taken into account, for the fossil forms it is almost impossible to recognize their taxonomic assessment at lower levels in many cases. This also results, partly at least, from a poor documentation, as in many species not more than one otolith has ever been illustrated. Consequently, the studied otoliths are herein assigned to the family rank. Such forms have not hitherto been reported from Poland.

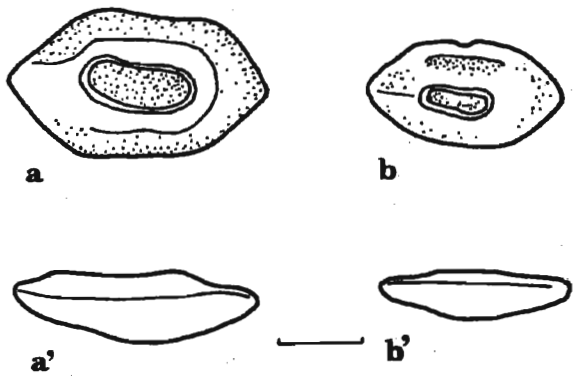


Fig. 65. "genus *Bythitidarum*" sp.

a, b – Right sagitta, inner face; a', b' – ventral view

Order **Atheriniformes** Rosen, 1964
Suborder **Exocoetoidei** Regan, 1911
Family **Hemiramphidae**

"genus *Hemiramphidarum*" *baluki* (Śmigielska, 1979) (Text-fig. 66 and Pl. 13, Figs 1-4)

1979. "genus *Hemiramphidarum*" sp.; D. Nolf & E. Steurbaut, p. 5, Pl. 1, Fig. 15.
1979. "genus *Hemiramphidarum*" sp.; E. Steurbaut, p. 65, Pl. 7, Fig. 1.
1979. *Hyporhamphus baluki* sp. n.; T. Śmigielska, p. 305, Text-fig. 9 and Pl. 2, Figs 5-7.
1984. "genus *Hemiramphidarum*" *baluki* Śmigielska, 1979; E. Steurbaut, p. 64, Pl. 14, Figs 1-2.
1985. "genus *Hemiramphidarum*" *baluki* (Śmigielska 1979); D. Nolf, p. 67.

MATERIAL: Korytnica – 48 specimens in majority well preserved.

Coll.				Figured in:	
numbers	L	H	T	Text-fig. 66	Pl. 13
RaK-160	4.0	3.0	0.4	Fig. 66a	Fig. 1
RaK-161	4.0	2.8	0.4	Fig. 66b	Fig. 3

– REMARKS: The studied otoliths are consistent with the holotype of the species (*see* Śmigielska 1979, Pl. 2, Fig. 5). The species was established, upon the material coming from the Korytnica Basin, by Śmigielska (1979), who attributed it to the genus *Hyporhamphus* Gill, 1859.

A recognition of the otoliths in the present-day species of the family Hemiramphidae demonstrates (Nolf & Steurbaut 1979), that they are poorly differentiated, and differences between

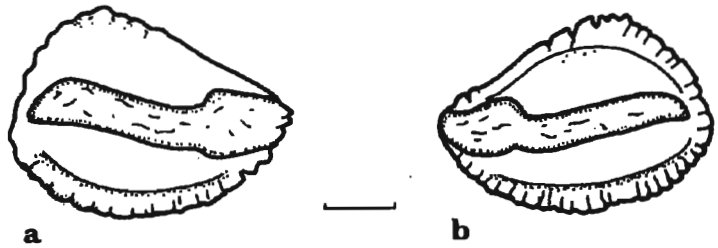


Fig. 66. "genus *Hemiramphidarum*" *baluki* (ŚMIGIELSKA, 1979)

a – Left sagitta, inner face; b – right sagitta, inner face

some genera are not clearly individualized. Thus, it seems justifiable that the fossil forms should be attributed to the family rank only.

Family **Belonidae** GILL, 1872
Genus *Belone* CUVIER, 1817

Belone sp.
(Text-fig. 67 and Pl. 13, Fig. 5)

MATERIAL: Korytnica – one specimen, badly preserved.

Coll. number	L	H	Figured in: Text-fig. 67	Pl. 13
RaK-163	4.4	2.7	Fig. 67	Fig. 5

DESCRIPTION: Otolith oval in outline, relatively thick. Rims are almost smooth. Inner face is convex. Sulcus acusticus is shallow. Ostium is short and wide. Cauda is straight, narrow, and four times longer than the ostium. Area is deep. Outer face is slightly concave and smooth.

REMARKS: The collected specimen is very close to those of the present-day species *Belone belone* (LINNAEUS, 1761), living along the Atlantic coasts of Europe and in the Mediterranean (*see*

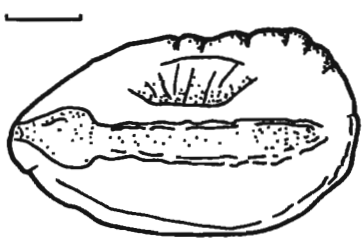


Fig. 67. *Belone* sp.

Right sagitta, inner face

STEURBAUT 1984, Pl. 14, Fig. 5), but from which is slightly differs by its outline and the course of its ostium. A poor material does not allow for its specific determination. The genus *Belone* CUVIER, 1817, has not hitherto been reported from Poland.

"genus *Belonidarum*" sp.
(Text-fig. 68 and Pl. 13, Fig. 6)

1984. "genus *Belonidarum*" sp.; E. STEURBAUT, p. 64, Pl. 14, Figs 3-4.

MATERIAL: Korytnica – one specimen, badly preserved.

Coll. number	L	H	Figured in: Text-fig. 68	Pl. 13
RaK-164	3.5	2.0	Fig. 68	Fig. 6

DESCRIPTION: Otolith elongated, oval in outline. The rims are strongly crenulated. Posterior rim is slightly concave. Inner face is strongly convex. Sulcus acusticus is shallow. Ostium is short. Cauda is straight and four times longer than the ostium. Outer face is strongly concave with numerous furrows and in its central part it is furnished with a node.

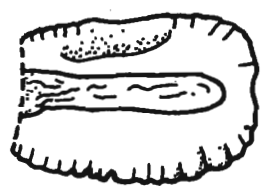


Fig. 68. "genus *Belonidarum*" sp.
Right sagitta, inner face

REMARKS: This specimen is compatible with the otoliths described from the Aquitaine Basin by STEURBAUT (1984) and assigned to the family Belonidae GILL, 1872. The fossil otoliths of this family differ from their present-day confamiliars by a less massive structure and a more pronounced ornamentation of the outer face. Such forms have not hitherto been reported from Poland.

Suborder **Atherinoidei** ROSEN, 1964
Family **Atherinidae** RISSO, 1826
Genus *Atherina* LINNAEUS, 1758

Atherina sp.
(Text-fig. 69 and Pl. 14, Figs 1-9)

MATERIAL: Korytnica – 49 juvenile specimens, well preserved; Niskowa – 5 juvenile specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 69	Pl. 14
RaK-166	2.1	1.7	Fig. 69a	Fig. 6
RaK-171	2.0	1.7	Fig. 69b	Fig. 8
RaK-170	2.0	1.7	Fig. 69f	Fig. 4

DESCRIPTION: Otoliths variable in outline, ranging from these almost circular or slightly rhomboidal to those oval. The rims are usually crenulated. Dorsal rim is strongly convex, but at its anterior part concave. On the anterior rim developed are: a pronounced antirostrum, a shallow excisura, and a short rostrum. Posterior rim may be much variable, ranging from merely convex to distinctly concave. Inner face is slightly convex. Ostium is short and oval in outline. Cauda is straight and narrow. Area is present. Outer face is concave.

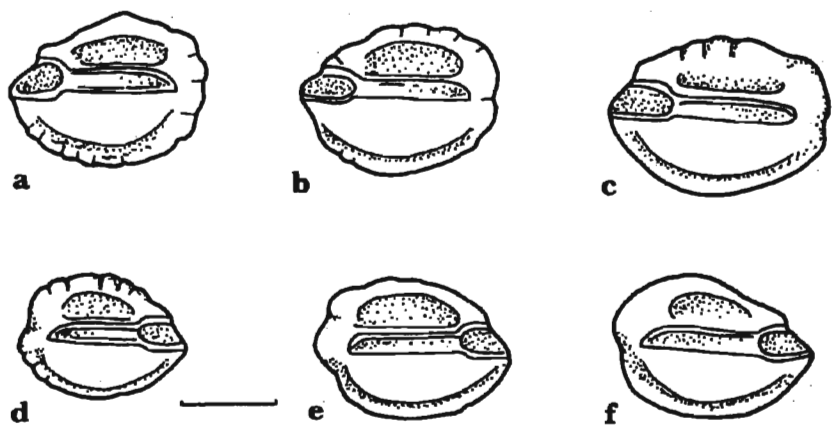


Fig. 69. *Atherina* sp.

a, b, c – Right sagitta, inner face; d, e, f – left sagitta, inner face

REMARKS: The studied otoliths are close to those of the present-day species *Atherina presbyter* VALENCIENNES, 1835, and *A. boyeri* RISSO, 1810, known from Mediterranean and Atlantic offshores of Europe and northern Africa (*see* CHAINE 1958, Pl. 6). Such a similiarity involved their attribution to the genus *Atherina* LINNAEUS, 1758, but a juvenile nature of the specimens does not allow for their specific recognition. The genus *Atherina* LINNAEUS, 1758, has not hitherto been reported from Poland.

Genus *Atherinomorus* FOWLER, 1903

Atherinomorus aquitanicus (PRIEM, 1914) (Text-fig. 70 and Pl. 14, Figs 11-13)

1914. *Otolithus* (*Hymenocephalus*) *aquitanicus*; F. PRIEM, p. 245, Text-fig. 2.
1928. *Ot.*(*Hymenocephalus*) *aquitanicus* PRIEM.; J. CHAINE & J. DUVERGIER, p. 203, Pl. 6, Fig. 15.

1965. *Dentex* cf. *gregarius* (KOKEN, 1891); R. BRZOBOHATÝ, p. 121, Pl. 2, Fig. 5.
1967b. *Dentex* cf. *gregarius* (KOKEN, 1891); R. BRZOBOHATÝ, p. 241, Pl. 2D, Fig. 3.
1979. "genus *Atherinidarum*" sp. II; E. STEURBAUT, p. 65, Pl. 6, Fig. 16.
1979. *Atherinidarum*? sp.; T. ŚMIGIELSKA, p. 313, Text-fig. 16 and Pl. 4, Fig. 5.
1984. "genus *Atherinidarum*" *aquitanicus* (PRIEM, 1914); E. STEURBAUT, p. 66, Pl. 14, Figs 25-27.
1985. "genus *Atherinidarum*" *aquitanicus* (PRIEM, 1914); D. NOLF, p. 6, Fig. 52M.

MATERIAL: Korytnica – 15 specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 70	Pl. 14
RaK-177	3.4	3.0	0.8	Fig. 70a	Fig. 12
RaK-176	3.0	2.8	0.7	Fig. 70b	Fig. 13

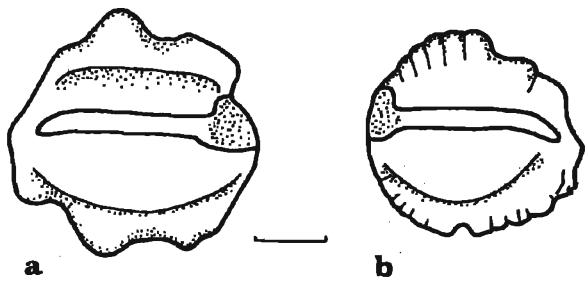


Fig. 70. *Atherinomorus aquitanicus* (PRIEM, 1914)

a – Left sagitta, inner face; **b** – right sagitta, inner face

REMARKS: The studied otoliths are compatible with those described by PRIEM (1914) as "*Otolithus* (*Hymenocephalus*) *aquitanicus*". A generic attribution of this species has hitherto been variously interpreted (*see* synonymy). A comparison with otoliths of the present-day species, (NOLF's Collection) of the family Atherinidae RISSO, 1826 , allows the present author to state (*see* Text-fig. 71) that the species "*aquitanicus*" is closely related to *Atherinomorus insularum* (JORDAN & EVERMANN, 1903), and thus the studied species is herein assigned to the genus *Atherinomorus* FOWLER, 1903. Identical forms were formerly reported from the Korytnica Basin by ŚMIGIELSKA (1979; *see* synonymy) as "*Atherinidarum*? sp.".

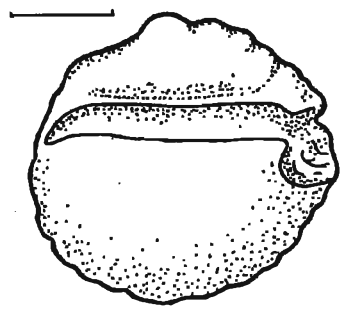


Fig. 71. *Atherinomorus insularum* (JORDAN & EVERMANN, 1903)

Present-day specimen: left sagitta, inner face; Hawaii offshores (NOLF's Collection)

Order **Beryciformes** REGAN, 1909
Suborder **Berycoidei** REGAN, 1909
Family **Berycidae** LÖWE, 1884
Genus *Centroberyx* GILL, 1862

Centroberyx sp.
(Text-fig. 72 and Pl. 14, Figs 14-15)

1966. *Hoplostethus praemediterraneus* SCHUBERT; T. ŚMIGIELSKA, p. 251, Pl. 17, Fig. 1.

MATERIAL: Korytnica – 6 juvenile specimens, in majority badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 72	Pl. 14
RaK-180	3.9	3.8	1.1	Fig. 72b	Fig. 15
RaK-179	2.0	1.8	0.5	Fig. 72a	Fig. 14

DESCRIPTION: Otoliths slightly tetragonal in outline. Rims are rounded, in some specimens slightly crenulated. The crenulation continues, allover the inner face, as the radial striae. On the anterior rim developed are: a shallow excisura and a rounded rostrum. Inner face is slightly convex. Sulcus acusticus is wide. Ostium is large and wide. Cauda is slightly longer and narrower than the ostium, sharply terminated. Crista superior and crista inferior are well developed. Area is deep. Outer face is convex and furnished with a node centrally.

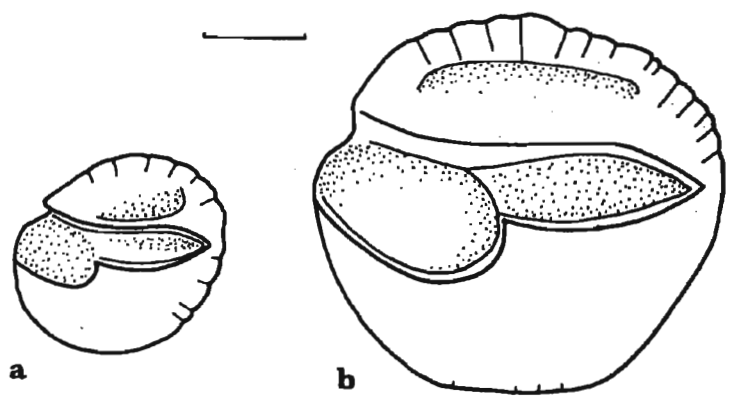


Fig. 72. *Centroberyx* sp.

a, b – Right sagitta, inner face

REMARKS: Such forms have already been noted from the Korytnica Basin by ŚMIGIELSKA (1966) as "*Hoplostethus praemediterraneus* SCHUBERT". According to the present author, the studied otoliths as well as those described by ŚMIGIELSKA (1966), due to the structure of their sulcus acusticus, represent the genus *Centroberyx* GILL, 1862, although the species escapes from more precise recognition.

A juvenile nature of the specimens collected at Korytnica does not, however, allow their specific determination.

Family **Holocentridae** RICHARDSON, 1864
Subfamily **Holocentrinae** RICHARDSON, 1864
Genus *Adioryx* STARKS, 1908

Adioryx sp.
(Text-fig. 73 and Pl. 15, Fig. 5)

1984. *Adioryx* sp.; E. STEURBAUT, p. 68, Pl. 15, Fig. 19.

MATERIAL: Korytnica – one specimen, not very well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 73	Pl. 15
RaK-181	4.7	3.0	0.7	Fig. 73a,a'	Fig. 5a-5b

DESCRIPTION: Otolith oval in outline. Rims are smooth. Inner face is strongly convex. Sulcus acusticus is relatively deep. Ostium is wide, oval in its outline. Cauda is remarkably narrower, distinctly bent in its posterior part and slanting towards the ventral rim. Area is narrow. Outer face is concave, furnished with tiny nodes at its dorsal rim.

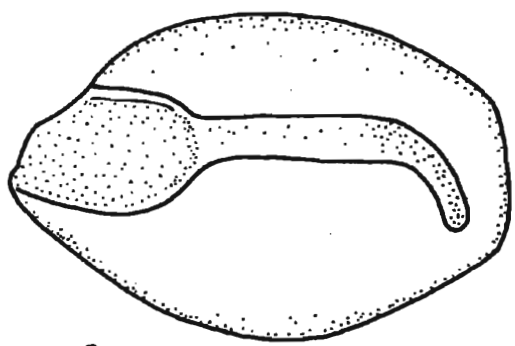


Fig. 73. *Adioryx* sp.
a – Right sagitta, inner face,
a' – ventral view

REMARKS: The studied otolith is close to those of the present-day species *Adioryx hastatus* (CUVIER, 1829) living along the Atlantic shores of northern Africa (*see* STEURBAUT 1984, Pl. 15, Fig. 18). It differs from them by its shorter ostium and the shape of the ventral rim.

The collected specimen is concordant with that described from the Aqutaine Basin (STEURBAUT 1984; *see* synonymy). A very limited number of specimens and their poor preservation in both these regions do not allow for their specific determination. Such a form has not hitherto been reported from Poland.

Subfamily **Myripristinae** NELSON, 1955
Genus *Myripristis* CUVIER, 1829

Myripristis verus STEURBAUT, 1979
(Text-fig. 74 and Pl. 15, Figs 1-4)

1979. *Myripristis verus* n. sp.; E. STEURBAUT, p. 67, Pl. 7, Figs 3-4 and Pl. 12, Fig. 10.
1979. *Myripristis* sp.; T. ŚMIGIELSKA, p. 311, Text-fig. 14 and Pl. 4, Figs 3-4.
1984. *Myripristis verus* STEURBAUT, 1979; E. STEURBAUT, p. 69, Pl. 15, Figs 15-17.
1985. *Myripristis verus* STEURBAUT, 1979; D. NOLF, p. 72, Fig. 54N.

MATERIAL: Korytnica – 8 specimens, in majority badly preserved; Rybnica – 2 specimens, badly preserved; Bęczyn – one specimen, badly preserved; Niskowa – one specimen, badly preserved; Węglinek – one specimen, very well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 74	Pl. 15
RaK-183	4.4	3.2	1.0	Fig. 74b	Fig. 4a-4b
RaW-182	4.0	3.0	1.0	Fig. 74a	Fig. 3

DESCRIPTION: Otoliths triangular in outline. Both anterior and posterior rims are slightly concave. Inner face is slightly convex. Sulcus acusticus is typical of all representatives of the subfamily Myripristinae NELSON, 1955. Ostium is of a characteristic reniform outline. Outer face is convex.

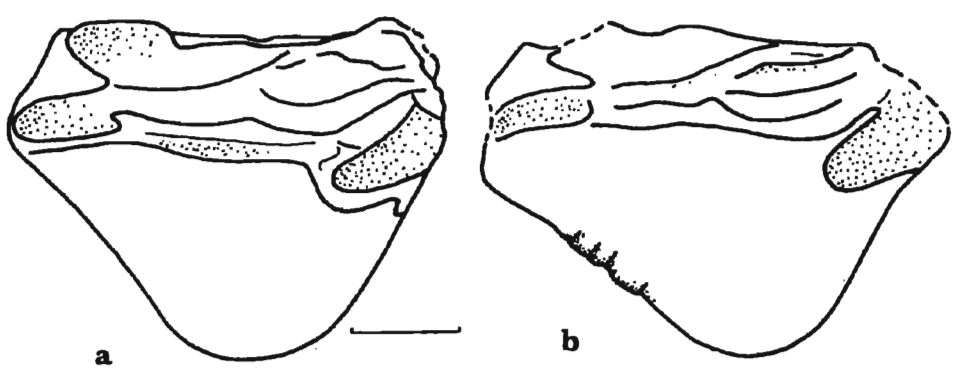


Fig. 74. *Myripristis verus* STEURBAUT, 1979

a, b – Left sagitta, inner face

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* STEURBAUT 1979, Pl. 7, Fig. 4 and Pl. 12, Fig. 10). Otoliths of this species have formerly been noted from the Korytnica Basin (ŚMIGIELSKA 1979), but determined to the genus rank only (*see* synonymy). The new material, which is specifically determinable, comprises also the juvenile forms (*see* Pl. 15, Figs 1-2).

"genus *Myripristinarum*" *banaticus* (WEILER, 1950)
(Text-fig. 75 and Pl. 15, Figs 6-7)

1950. *Myripristis banatica* n. sp.; W. WEILER, p. 217, Pl. 1, Fig. 6 (*non* Pl. 1, Fig. 5).
1979. *Myripristis banatica* WEILER, 1950; T. ŚMIGIELSKA, p. 311, Text-fig. 13 and Pl. 4, Figs 1-2.
1979. "genus *Myripristinarum*" *banaticus* WEILER, 1950; E. STEURBAUT, p. 67, Pl. 7, Fig. 5.
1984. "genus *Myripristinarum*" *banaticus* WEILER, 1950; E. STEURBAUT, p. 69, Pl. 15, Fig. 10.
1985. "genus *Myripristinarum*" *banaticus* (WEILER, 1950); D. NOLF, p. 72.

MATERIAL: Korytnica – 106 specimens, in majority badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 75	Pl. 15
RaK-184	7.0	5.0	1.7	Fig. 75a	Fig. 6
RaK-185	5.2	4.0	1.2	–	Fig. 7

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* WEILER 1950, Pl. 1, Fig. 6). The otolith illustrated by WEILER (1950) as the paratype has been excluded

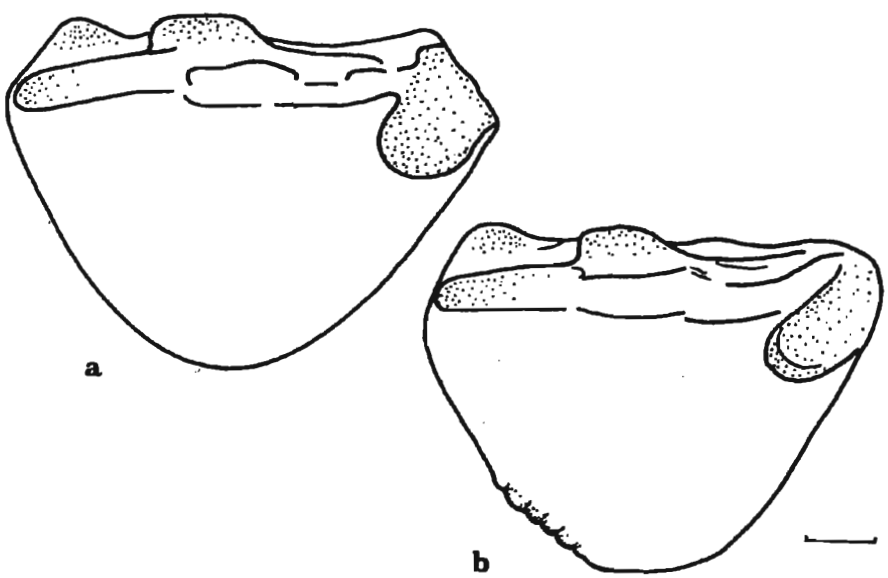


Fig. 75. "genus *Myripristinarum*" *banaticus* (WEILER, 1950)

a, b – Left sagitta, inner face

from the species (ŚMIGIELSKA 1979, STEURBAUT 1979) due to a different outline of its sagitta, and the shape of its ostium. Otoliths of this species have already been known from the Korytnica Basin as reported by ŚMIGIELSKA (1979).

Order **Zeiformes** REGAN, 1909
Family **Caproidae** LÖWE, 1844
Genus *Antigonia* LÖWE, 1843

Antigonia sp.
(Text-fig. 76 and Pl. 14, Fig. 10)

1979. *Antigonia alta* (WEILER, 1950); T. ŚMIGIELSKA, p. 312, Text-fig. 15 and Pl. 4, Fig. 6.

MATERIAL: Korytnica – one juvenile specimen, well preserved.

Coll. number	L	H	Figured in: Text-fig. 76	Pl. 14
RaK-188	2.0	2.4	Fig. 76	Fig. 10

REMARKS: The studied otolith, in regard with the shape of its sulcus acusticus, is attributed to the genus *Antigonia* LÖWE, 1843. Both this otolith, as well as that one described by ŚMIGIELSKA (1979) as "*Antigonia alta* (WEILER, 1950)", represent juvenile forms which may be compared either to the fossil species *Antigonia alta* (WEILER, 1950), or the present-day *Antigonia capros* LÖWE, 1843.

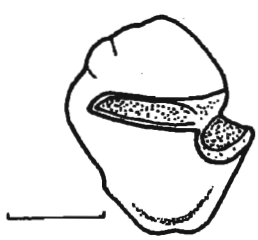
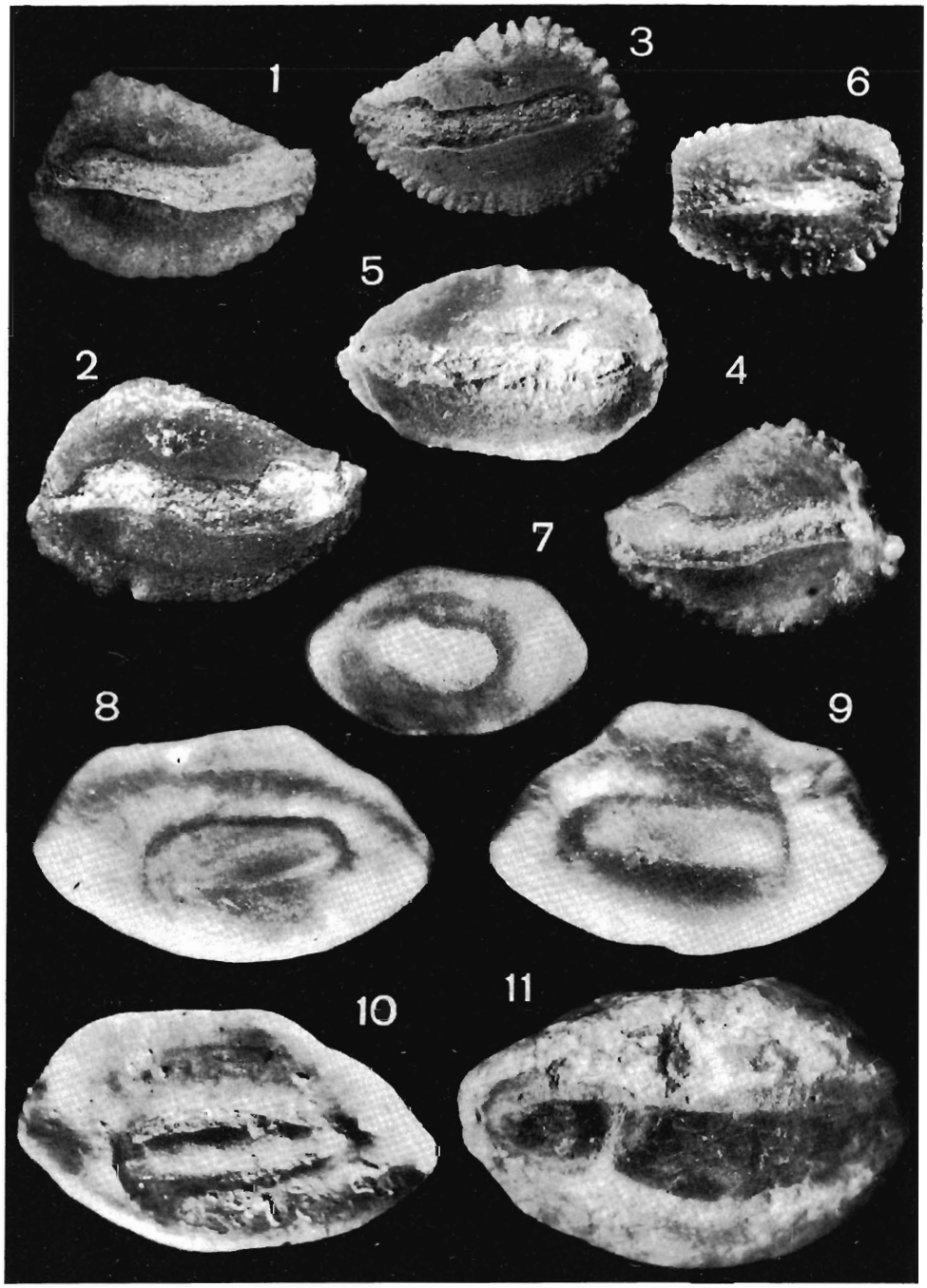
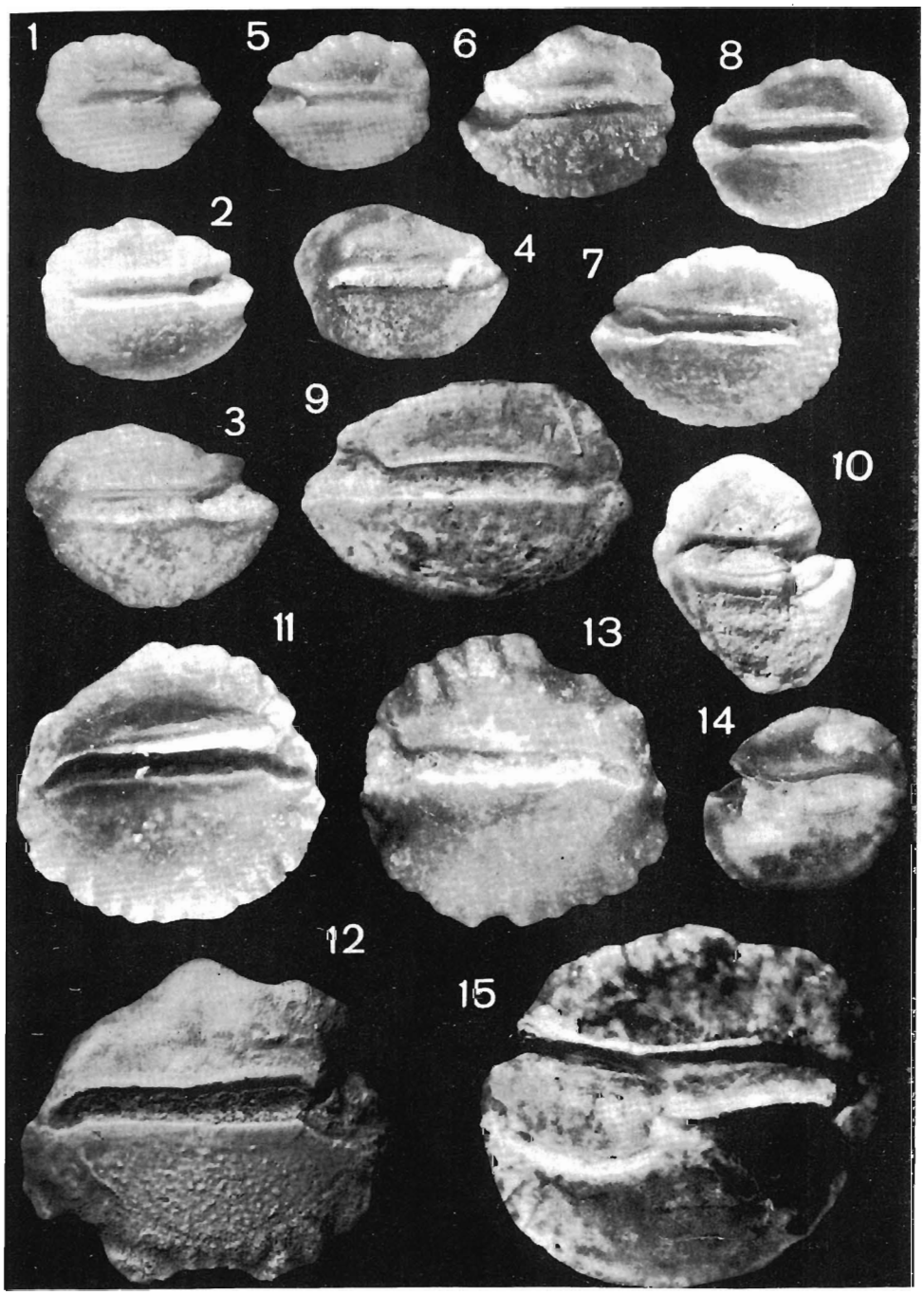


Fig. 76. *Antigonia* sp.
Left sagitta, inner face

The species *Antigonia alta* (WEILER, 1950) has recently been recognized (STEURBAUT 1984) as a younger synonym of the species *A. capros* LÖWE, 1843. However, according to the present author, the species "*alta*" established by WEILER (1950), is a valid taxon, the adult individuals of which are represented only by one of the two specimens illustrated by WEILER (1950, Pl. 2, Fig. 8). That specimen differs from those of the adults of *Antigonia capros* LÖWE, 1843, by its more rhomboidal outline, different ratios of its features and a straight course of its sulcus acusticus. The juvenile forms of both these species are almost identical, practically undistinguishable, and thus the two discussed specimens from Korytnica are herein classified to the genus rank only.



1-4 – "genus *Hemiramphidarum*" *baluki* (Śmigielska, 1979); 1-2 – left sagitta, inner face; 3-4 – right sagitta, inner face; × 15
5 – *Belone* sp.; right sagitta, inner face; × 10
6 – "genus *Belonidarum*" sp.; right sagitta, inner face; × 10
7 – "genus *Bythitidarum*" sp.; right sagitta, inner face; × 15
8-10 – "genus *Bythitinarum*" *wenglinensis* sp. n; 8 – **holotype**, left sagitta, inner face; 9-10 – **paratypes**; 9 – right sagitta, inner face; 10 – left sagitta, inner face; × 15
11 – *Hoplobrotula gibba* (Bassoli, 1906); left sagitta, inner face; × 7

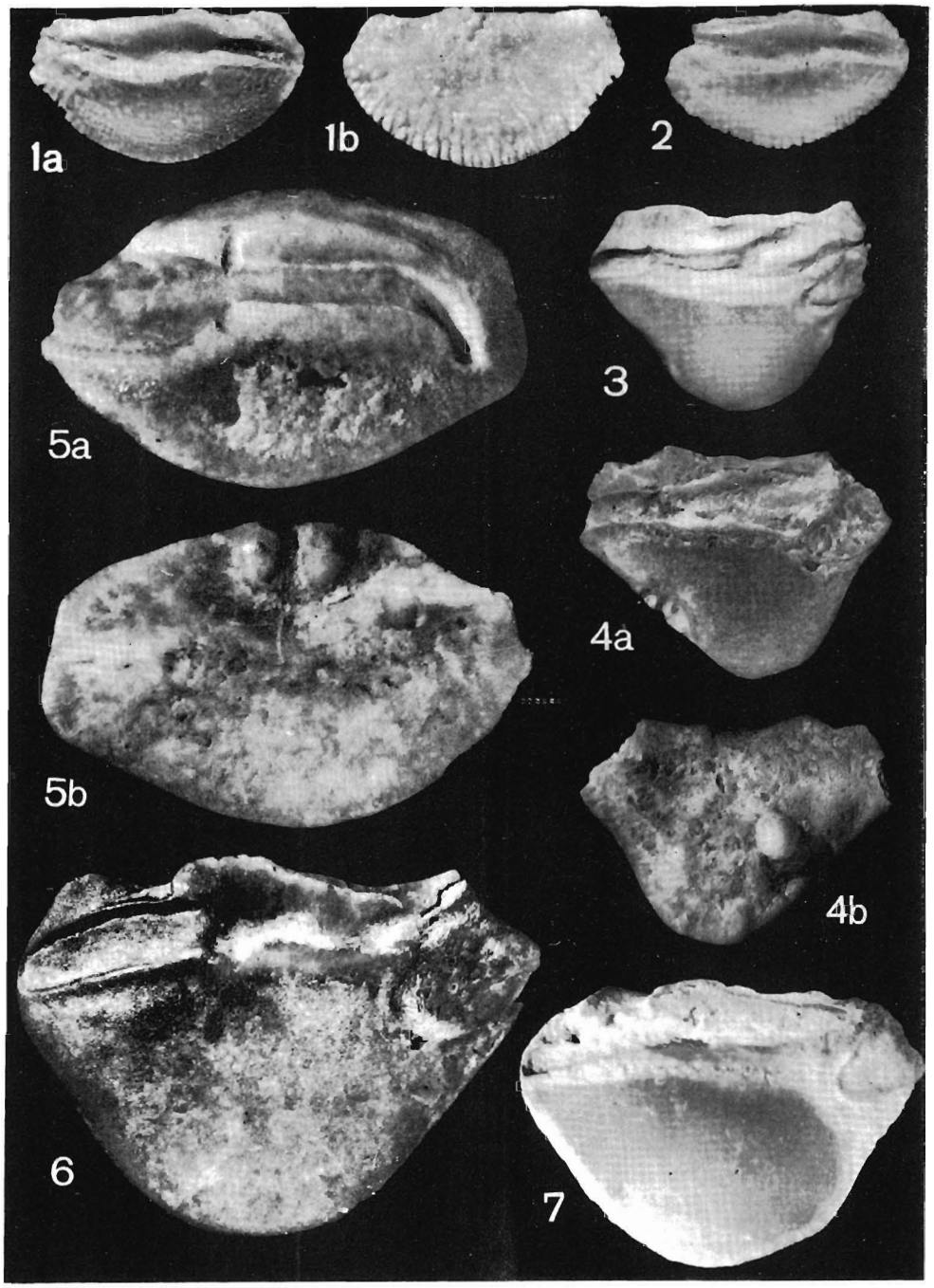


1-9 — *Atherina* sp.; 1-4 — left sagitta, inner face; 5-9 — right sagitta, inner face; 1-8 × 15; 9 × 20

10 — *Antigonia* sp.; left sagitta, inner face; × 15

11-13 — *Atherinomorus aquitanicus* (PRIEM, 1914); 11-12 — left sagitta, inner face; 13 — right sagitta, inner face; × 15

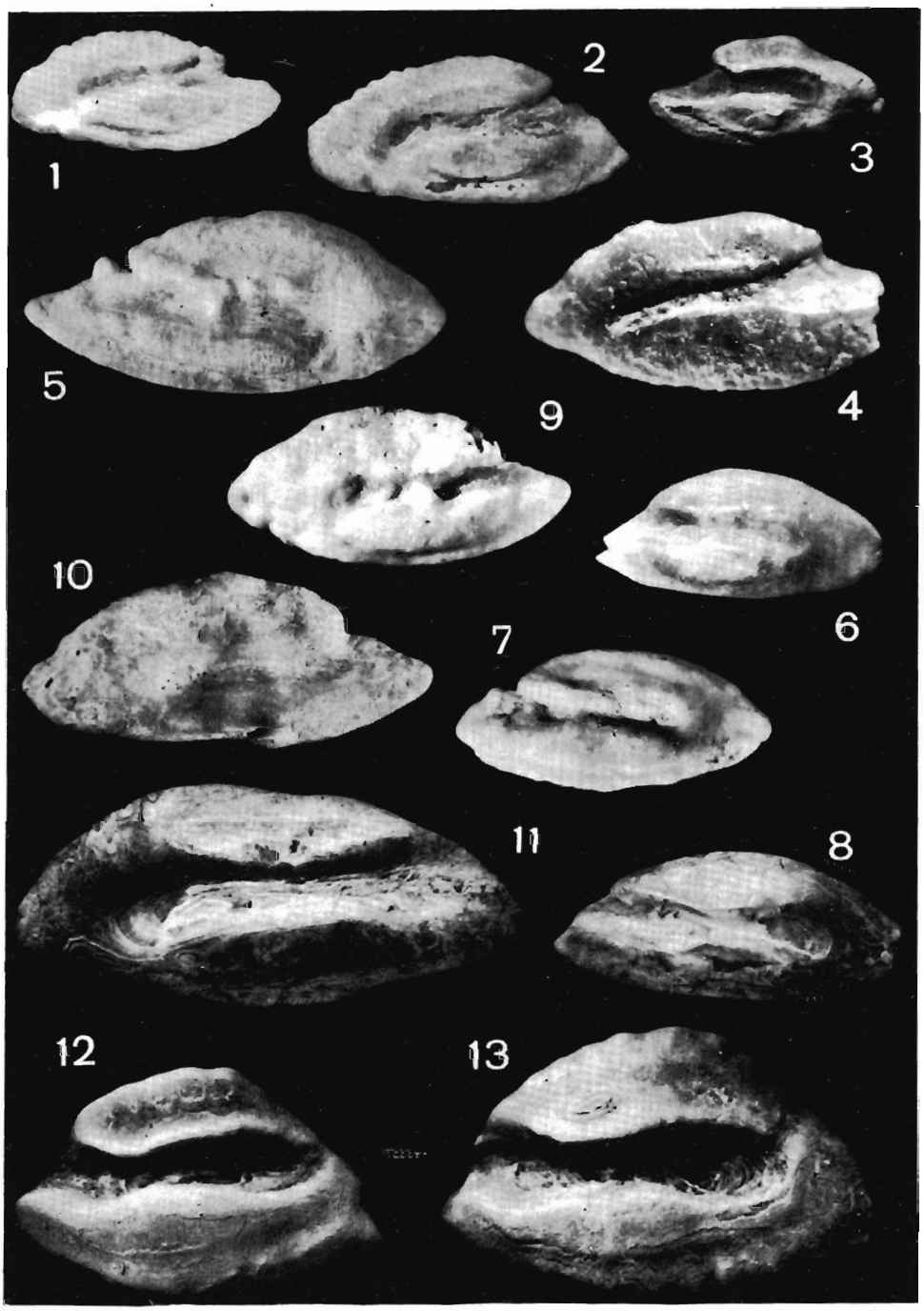
14-15 — *Centroberyx* sp.; right sagitta, inner face; × 15



1-4 – *Myripristis verus* STEURBAUT, 1979; 1-2 – right sagitta, *1a*, *2* inner face; *1b* outer face; 3-4 – left sagitta; *3*, *4a* inner face, *4b* outer face; 1-2 × 15; 3-4 × 10

5 – *Adioryx* sp.; right sagitta, *5a* inner face, *5b* outer face; × 15

6-7 – "genus *Myripristinarum*" *banaticus* (WEILER, 1950); left sagitta, inner face; × 10



1-2 — *Scorpaena edegemensis* GAEMERS, 1973; left sagitta, inner face; × 15

3-4 — "genus *Scorpaenidarum*" sp.: 3 — right sagitta, inner face; 4 — left sagitta, inner face; 3 × 20; 4 × 15

5-11 — *Scorpaena* sp.; 5-8 — right sagitta, inner face; 9-11 — left sagitta, inner face; 5-8 and 10-11 × 10; 9 × 15

12-13 — *Trigla* aff. *lyra* LINNAEUS, 1758; right sagitta, inner face; × 15

Order **Scorpaeniformes** GARMAN, 1899
Suborder **Scorpaenoidei** GARMAN, 1899
Family **Scorpaenidae** RISSO, 1826
Genus *Scorpaena* LINNAEUS, 1758

Scorpaena edegemensis GAEMERS, 1973 (Text-fig. 77 and Pl. 16, Figs 1-2)

1973. *Scorpaena edegemensis* sp. n.; P. GAEMERS, p. 67, Pl. 2, Fig. 6.
?1973. *Otol. (Cottidarum) modestus* n. sp.; T. ŚMIGIELSKA, p. 26, Text-fig. 4 and Pl. 5, Fig. 4.
1979. *Scorpaena edegemensis* GAEMERS, 1973; B. HUYGHEBAERT & D. NOLF, p. 76, Pl. 4, Figs 7-10.
1985. *Scorpaena edegemensis* GAEMERS, 1973; D. NOLF, p. 75, Fig. 59B.

MATERIAL: Niskowa – 15 specimens, in majority with their rostral part damaged.

Coll. numbers	L	H	T	Figured in: Text-fig. 77	Pl. 16
RaNi-190	3.0	1.4	0.5	Fig. 77b	Fig. 2
RaNi-189	2.5	1.2	0.4	Fig. 77a	Fig. 1

DESCRIPTION: Otoliths elongated in outline. Dorsal rim is regularly convex and heavily crenulated. Posterior rim is straight, running obliquely to the dorsal rim. Ventral rim is slightly convex asymmetrically. On the anterior rim developed are: a relatively pronounced antirostrum, a long rostrum, and a deeply incised excisura. Inner face is convex. Sulcus acusticus is deeply incised. Cauda is slightly narrower and longer than the ostium. Ventral furrow and area are well developed. Outer face is concave, furnished with numerous striae and tiny nodes.

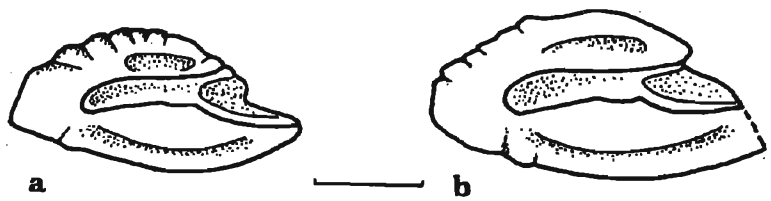


Fig. 77. *Scorpaena edegemensis* GAEMERS, 1973

a, b – Left sagitta, inner face

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* GAEMERS 1973, Pl. 2, Fig. 6), although they represent not fully grown forms. The species *Scorpaena edegemensis* GAEMERS, 1973, is herein for the first time recognized in Poland. The specimens, coming also from Niskowa, and described by ŚMIGIELSKA (1973) as a new species "*Otol. (Cottidarum) modestus* n. sp." represent juvenile forms and they supposedly all belong to the species "*edegemensis*"; anyway, they do not compose of a material which could be a basis to establish a separate species.

Scorpaena sp.
(Text-fig. 78 and Pl. 16, Figs 5-11)

1984. *Scorpaena* sp.; E. STEURBAUT, p. 70, Pl. 16, Figs 1-4.

MATERIAL: Rybnica – 16 specimens, Korytnica – 5 specimens; all of them badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 78	Pl. 16
RaR-192	7.0	2.8	Fig. 78a	Fig. 5
RaR-195	6.0	2.5	Fig. 78d	Fig. 10
RaR-196	4.7	2.5	Fig. 78b	Fig. 7
RaR-193	3.3	1.5	Fig. 78c	Fig. 9

DESCRIPTION: Otoliths elongated, of an oval outline. Rims are smooth. On the anterior rim developed are: a shallow excisura, and a long, usually sharply terminated rostrum. Posterior

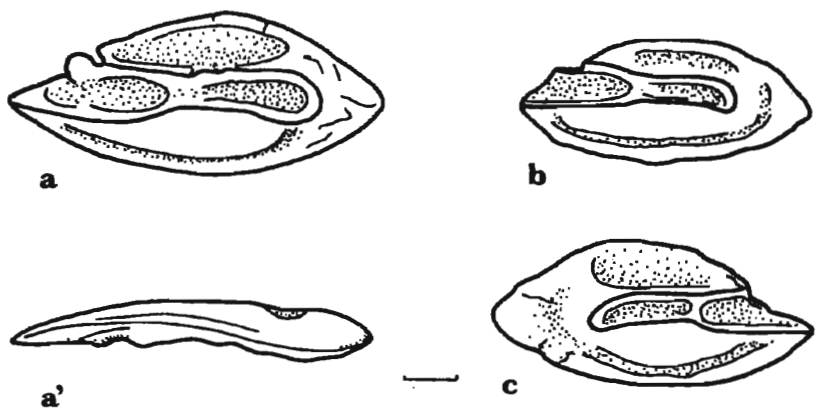


Fig. 78. *Scorpaena* sp.

a, b – Right sagitta, inner face, a' – ventral view; c – left sagitta, inner face

rim is also sharply terminated. Inner face is strongly convex. Ostium is long, and relatively narrow, whereas the cauda is slightly narrower but of a similar length. Area is shallow. Ventral furrow is well developed. Outer face is concave.

REMARKS: The studied otoliths are close to those of the present-day species *Scorpaena notata* RAFINESQUE, 1810 (*see* Text-fig. 79), and are herein attributed to the genus *Scorpaena* LINNAEUS, 1758. Their poor state of preservation allows for a generic assignment only. Such forms have not hitherto been reported from Poland.

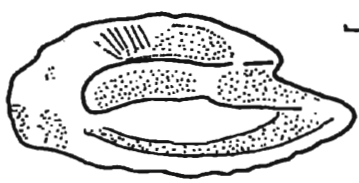


Fig. 79. *Scorpaena notata* RAFINESQUE, 1810

Present-day specimen: left sagitta, inner face; Mediterranean Sea (NOLF's Collection)

"genus *Scorpaenidarum*" sp.
(Text-fig. 80 and Pl. 16, Figs 3-4)

1966. "*Scorpaena* sp. *an nova*"; T. Śmigielska, p. 264, Text-fig. 10 and Pl. 19, Figs 6-7.
1984. "genus *Scorpaenidarum*" sp. 2; E. Steurbaut, p. 71, Pl. 16, Fig. 6.

MATERIAL: Korytnica — 3 juvenile specimens, one of them well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 80	Pl. 16
RaK-200	4.0	1.8	0.7	--	Fig. 4
RaK-199	1.8	0.8	—	Fig. 80a	Fig. 3

DESCRIPTION: Otoliths strongly elongated, of a slightly triangular outline. On the anterior rim developed are: a pronounced antirostrum, a relatively deep excisura, and a long rostrum. Inner face is convex. Sulcus acusticus is deeply incised. Area and ventral furrow are well developed. Outer face is convex.

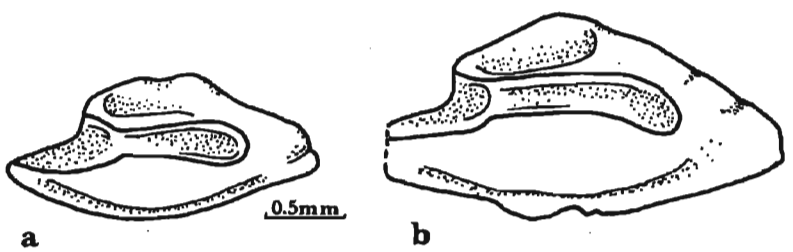


Fig. 80. "genus *Scorpaenidarum*" sp.
a, b — Right sagitta, inner face

REMARKS: The studied otoliths are concordant with those described from the Aquitaine Basin by Steurbaut (1984) as "genus *Scorpaenidarum*" sp. 2. Such forms have already been reported from the Korytnica Basin by Śmigielska (1966) as "*Scorpaena* sp. *an nova*". A juvenile nature of all these specimens does not allow for any specific determination.

Family **Triglidae** Risso, 1826
Genus *Trigla* Linnaeus, 1758

The otoliths attributable to the genus *Trigla* Linnaeus, 1758, are relatively rare in the Miocene deposits of Europe, and in particular localities they are

represented by a limited number of specimens, the majority of which are of very variable morphology. This has evidently resulted in that all these forms were gathered into one species, *Trigla asperoides* SCHUBERT, 1906. It was NOLF (1977) who paid an attention that this is a poke species which includes numerous species ancestral to such present-day ones, as *Trigla lyra* LINNAEUS, 1758, *T. lucerna* LINNAEUS, 1758, *T. gurnardus* LINNAEUS, 1758, *T. cuculus* LINNAEUS, 1758, and *T. lastovitza* BRÜNNICH, 1768. Some of the Miocene forms can easily be attributed to the present-day species, and these are, according to NOLF'S (1977) treatment, designated herein as *affinis*, but the others are either designated to the genus rank only, or even labelled by the name of a present-day species (STEURBAUT, 1984).

The present author is of the opinion, that within the whole collected material, only one specimen, very close in its morphology to the lectotype of SCHUBERT (*see* NOLF 1981, Pl. 2, Fig. 5), may be ascribed to the species *T. asperoides*, although in regard with the state of its preservation it is labelled as *conformis*. All other specimens may be grouped into four categories which supposedly represent separate specific taxa, but only one of them may be regarded as relative (*affinis*) to the present-day species *T. lyra* LINNAEUS, 1758.

Trigla cf. *asperoides* SCHUBERT, 1906
(Text-fig. 81 and Pl. 17, Fig. 3)

MATERIAL: Rybnica – one specimen, badly preserved.

Coll.			Figured in:	
number	L	H	Text-fig. 81	Pl. 17
RaR-203	4.0	3.5	Fig. 81a,a'	Fig. 3

DESCRIPTION: Otolith of an almost circular outline. Dorsal rim is regularly rounded. Ventral rim is slightly convex, crenulated, furnished with a well developed posteroventral corner of a spur shape. On the anterior rim developed are: an antirostrum, a deep excisura, and a pronounced rostrum. Inner face is convex. Sulcus acusticus is wide, and ostium is large and oval in its shape. Cauda is relatively short. Area is shallow. Outer face is concave.

REMARKS: The studied otolith is very close to those of the species *Trigla asperoides* SCHUBERT, 1906. Its state of preservation (both inner and outer faces worn) does not, however, allow to recognize diagnostic features of the species (thickness of the otolith and the structure of its anterior rim). Thus, the collected specimen is assigned to this species only as *conformis*. The specimens formerly reported from the Korytnica Basin (*see* ŚMIGIELSKA 1979) as "*Trigla asperoides* SCHUBERT, 1906", do not belong to this species (*see* remarks beneath, for *Trigla* aff. *lyra*).

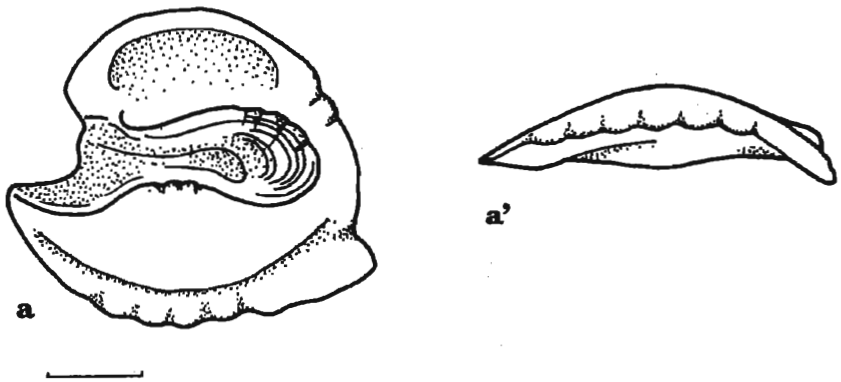


Fig. 81. *Trigla* cf. *asperoides* SCHUBERT, 1906

a – Right sagitta, inner face, a' – ventral view

Trigla aff. *lyra* LINNAEUS, 1758
(Text-fig. 82 and Pl. 16, Figs 12-13; Pl. 17, Figs 1-2)

1979. *Trigla asperoides* SCHUBERT, 1906; T. ŚMIGIELSKA, p. 328, Text-fig. 31 and Pl. 8, Fig. 5.

MATERIAL: Korytnica – 11 specimens, in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 82	Pl. 16
RaK-202	4.0	2.5	Fig. 82d	Fig. 13
RaK-201	3.5	2.3	Fig. 82c	Fig. 12
				Pl. 17
RaK-210	3.8	2.4	Fig. 82b	Fig. 2
RaK-209	3.5	2.5	Fig. 82a	Fig. 1

DESCRIPTION: Otoliths relatively thin, of a triangular outline, strongly elongated in their posterior part. All rims are slightly crenulated. On the anterior rim a short rostrum is developed. Inner face is convex. Sulcus acusticus is relatively narrow. Both area and ventral furrow are well developed. Outer face is slightly concave.

REMARKS: The studied otoliths are very close to those of the present-day species *Trigla lyra* LINNAEUS, 1758, living in the Mediterranean (*see* CHAINE 1934, Pl. 2).

Such very forms have already been noted from the Korytnica Basin by ŚMIGIELSKA (1979) as "*Trigla asperoides* SCHUBERT, 1906". According to the present author, the specimens illustrated by ŚMIGIELSKA (1979) differ from those of the species "*asperoides*" by their stronger elongation and smaller thickness. Thus, they rather fall into the variability of the present-day species *Trigla lyra* LINNAEUS, 1758.

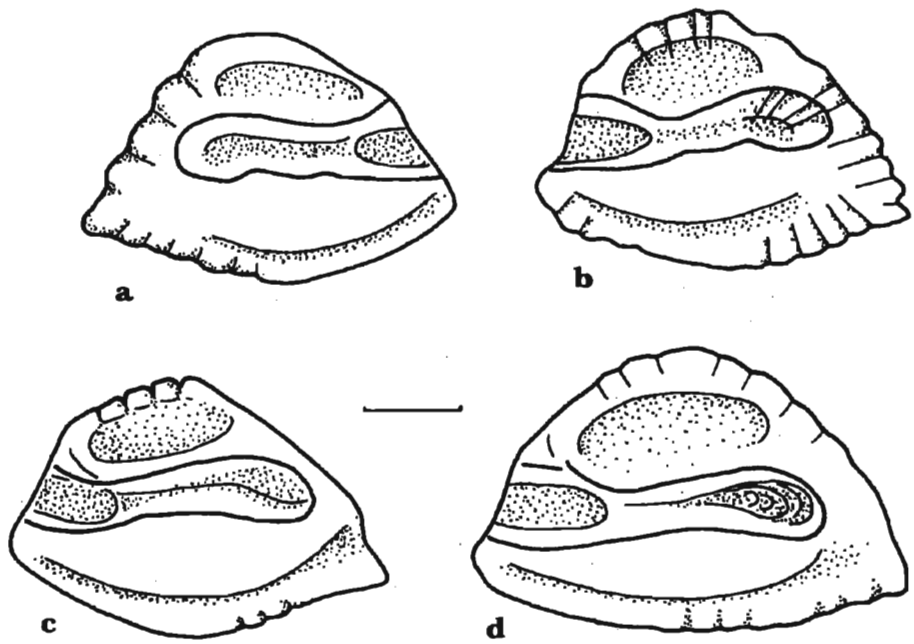


Fig. 82. *Trigla* aff. *lyra* LINNAEUS, 1758

a – Left sagitta, inner face; b, c, d – right sagitta, inner face

Trigla sp. 1
(Text-fig. 83 and Pl. 17, Figs 5-8)

MATERIAL: Korytnica – 13 specimens, in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 83	Pl. 17
RaK-206	3.8	2.9	Fig. 83c	Fig. 7
RaK-207	3.6	2.7	Fig. 83d	Fig. 8
RaK-204	3.0	2.4	Fig. 83a	Fig. 5

DESCRIPTION: Otoliths triangular in outline. Both the posterior and the ventral rim are slightly crenulated. On the anterior rim, a shallow excisura and short rostrum may appear. Posterodorsal and posteroventral corners are well developed in the majority of specimens. Inner face is convex. Sulcus acusticus is deep. Ostium is slightly wider than the cauda, which is widened in its posterior part. Area is well developed. Outer face is slightly concave.

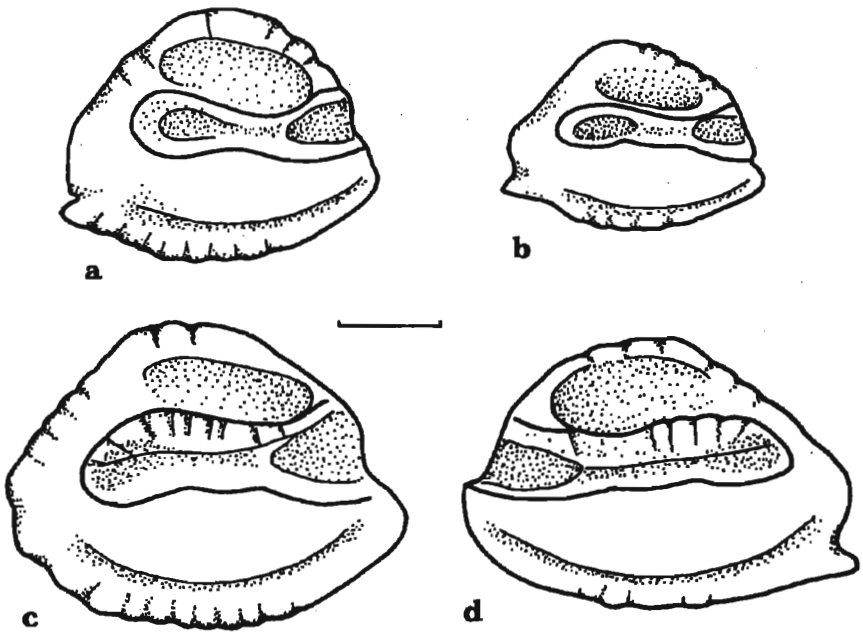


Fig. 83. *Trigla* sp. 1

a, b, c — Left sagitta, inner face; **d** — right sagitta, inner face

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus are herein assigned to the genus *Trigla* LINNAEUS, 1758. The collected specimens differ from otoliths of *Trigla* aff. *lyra* LINNAEUS, 1758, by their greater thickness and lesser elongation of the posterior rim, and from *T. asperoides* (SCHUBERT, 1906) by a lesser height and shallower excisura. Such forms have not hitherto been reported from Poland.

Trigla sp. 2
(Text-fig. 84 and Pl. 17, Figs 9-10)

MATERIAL: Korytnica — 3 specimens, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 84	Pl. 17
RaK-212	4.0	3.0	0.8	Fig. 84b	Fig. 9
RaK-213	3.8	2.8	0.8	Fig. 84a	Fig. 10

DESCRIPTION: Otoliths massive, relatively long. On the anterior rim developed are: a pronounced antirostrum and rostrum, and a deeply incised excisura. Inner face is convex. Sulcus acusticus is wide and also deeply incised. Outer face is slightly concave.

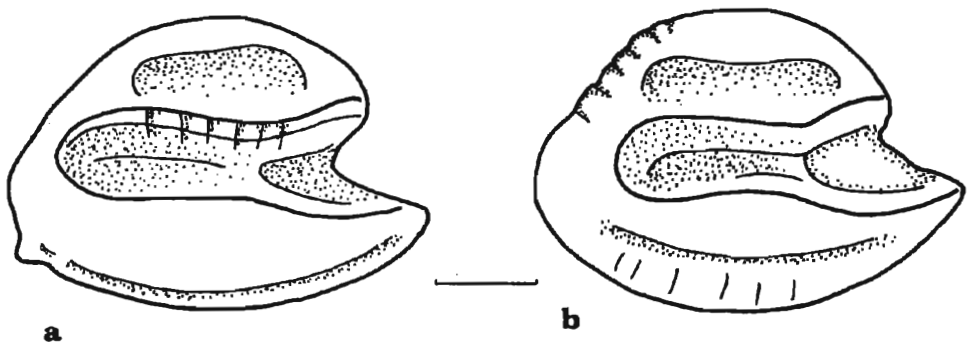


Fig. 84. *Trigla* sp. 2

a, b – Left sagitta, inner face

REMARKS: The studied otoliths are very close to those of the present-day species *Trigla cuculus* LINNAEUS, 1758 (*see* STEURBAUT 1984, Pl. 17, Fig. 2). The collected specimens differ, however, by their more rounded and elongated outline, and by a more pronounced rostrum. Such forms have not hitherto been reported from Poland.

Trigla sp. 3
(Text-fig. 85 and Pl. 17, Fig. 4)

MATERIAL: Korytnica – 7 specimens, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 85	Pl. 17
RaK-214	3.4	2.8	0.9	Fig. 85a,a'	Fig. 4
RaK-215	3.0	2.5	0.8	Fig. 85b,b'	--

DESCRIPTION: Otoliths massive, thick, almost circular in outline. All rims are smooth. On the anterior rim developed are: a short rostrum and a shallow excisura. Inner face is strongly convex. Sulcus acusticus is wide. Area is well developed. Outer face is slightly concave.

REMARKS: The studied otoliths are close to those of the species *Trigla asperoides* SCHUBERT, 1906, from which they differ by their more circular outline, greater thickness, and longitudinal profile (*see* Text-fig. 85a',b'). Such forms have not hitherto been reported from Poland.

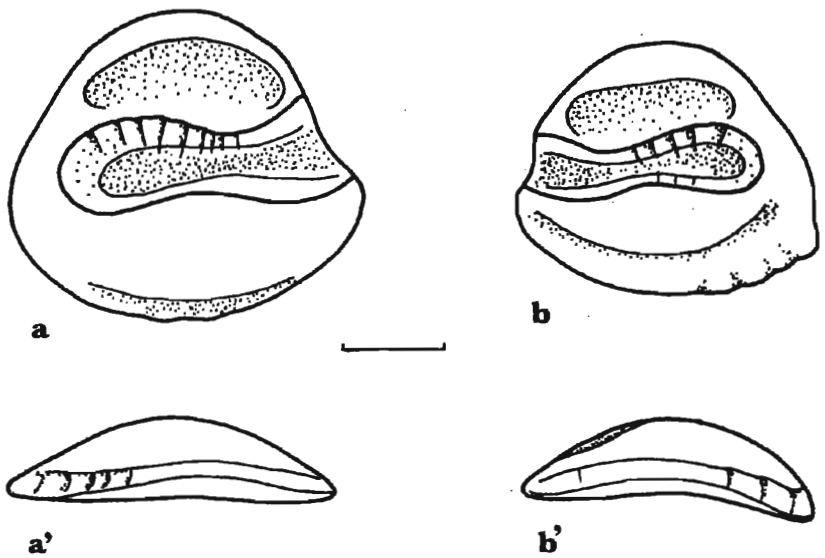


Fig. 85. *Trigla* sp. 3

a – Left sagitta, inner face; b – right sagitta, inner face; a', b' – ventral view

Suborder **Platycephaloidei** GREENWOOD & *al.*, 1966
Family **Platycephalidae** BLEEKER, 1859
Genus *Platycephalus* BLOCH, 1795

Platycephalus fusiculus RADWAŃSKA, 1984
(Text-fig. 86 and Pl. 18, Figs 1-5)

1984. *Platycephalus fusiculus* sp. n.; U. RADWAŃSKA, p. 306, Text-fig. 9 and Pl. 1, Figs 4-5.
1984. *Platycephalus poyartinensis* STEURBAUT, 1981; U. RADWAŃSKA, p. 305, Text-fig. 8 and Pl. 2, Fig. 1a-b.

MATERIAL: Korytnica – 20 specimens, in majority with their rostral part damaged.

Coll. numbers	L	H	Figured in: Text-fig. 86	Pl. 18
RaK-216-holotype	7.0	2.2	–	Fig. 4
RaK-218	5.4	1.8	Fig. 86c,c'	Fig. 3
RaK-219	5.0	1.7	Fig. 86b	Fig. 1

REMARKS: This species has already been known from the Korytnica Basin earlier (*see* RADWAŃSKA 1984). At present, to the synonymy of the species "*fusiculus*" included are also the specimens then described as "*Platycephalus poyartinensis* STEURBAUT, 1981". The newly collected

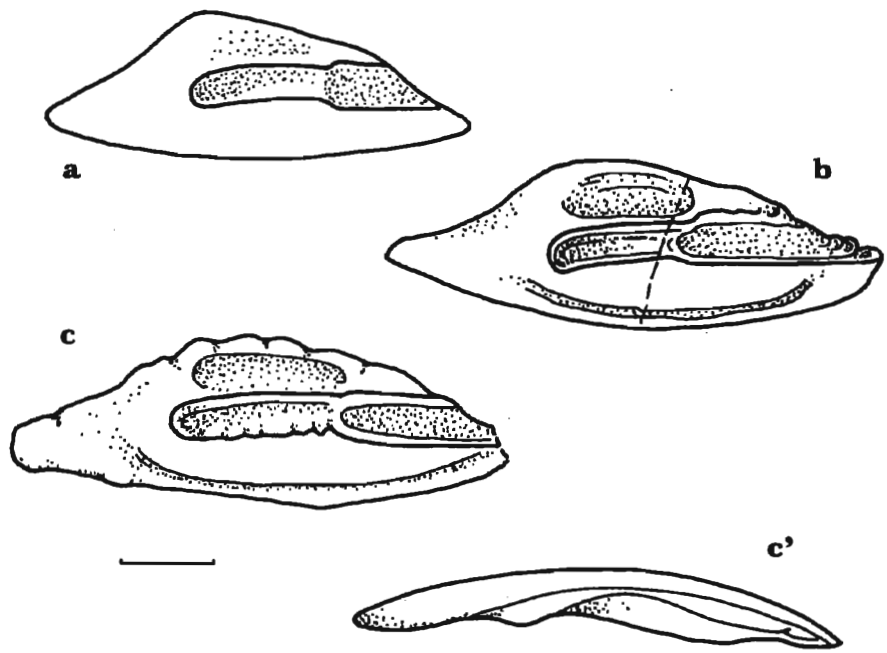


Fig. 86. *Platycephalus fusiculus* RADWAŃSKA, 1984

a, b, c – Left sagitta, inner face, c' – lateral view; the same specimen (c) as illustrated formerly (RADWAŃSKA 1984, Fig. 8 item 1)

material evidences that the specimens attributed formerly to that latter species bear features transitional to the former (*see* Pl. 18, Fig. 1). A comparison with the holotype and the type series (NOLF's Collection) of the species "*P. poyartinensis* STEURBAUT, 1984" clearly indicates that all the Korytnica specimens differ in their larger size, greater elongations, and lateral profile.

Order **Perciformes** BLEEKER, 1859
Suborder **Percoidei** BLEEKER, 1859
Family **Serranidae** SWAINSON, 1839
Genus *Morone* MITCHILL, 1814

Morone aff. *labrax* (LINNAEUS, 1758)
(Text-fig. 87 and Pl. 18, Figs 6-7)

1979. *Morone* cf. *labrax* (LINNAEUS, 1758); D. NOLF & E. STEURBAUT, p. 6, Pl. 2, Fig. 5.
1984. *Morone* cf. *labrax* (LINNAEUS, 1758); E. STEURBAUT, p. 76, Pl. 18, Fig. 16.

MATERIAL: Rybnica – 18 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 87	Pl. 18
RaR-224	9.5	4.7	1.0	Fig. 87a	Fig. 7
RaR-223	4.3	2.3	0.5	Fig. 87b	Fig. 6

DESCRIPTION: Otoliths strongly elongated. Dorsal rim is slightly convex in its anterior part. Posterodorsal corner is well developed. Posterior rim is sharply ended. On the anterior rim developed are: a shallow excisura and a blunt rostrum. All the rims may be crenulated, particularly in the juvenile forms (*see* Text-fig. 87b and Pl. 18, Fig. 6). Inner face is convex. Sulcus acusticus is shallow. Ostium is large, oval in outline, and cauda is much longer but relatively narrow, and bent in its posterior part. Outer face is convex, and furnished with shallow furrows.

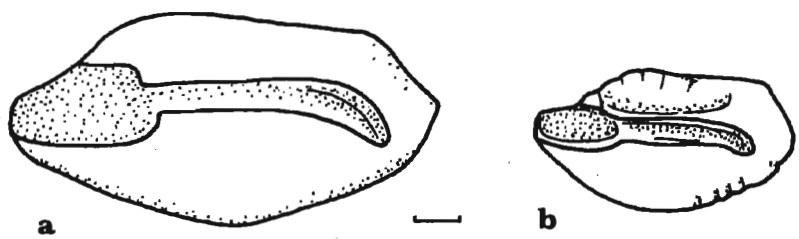


Fig. 87. *Morone* aff. *labrax* (LINNAEUS, 1758)

a, b – Right sagitta, inner face

REMARKS: The studied otoliths are identical with that described from the Aquitaine Basin by NOLF & STEURBAUT (1979) as "*Morone* cf. *labrax* (LINNAEUS, 1758)". The collected specimens are really close to those of the present-day species *Morone labrax* (LINNAEUS, 1758) living in the North Sea (*see* STEURBAUT 1984, Pl. 18, Fig. 17), and from they which differ by a longer cauda and a well developed posterodorsal corner. Otoliths of this species, or any others more or less related to it, have not hitherto been reported from Poland.

Morone sp.
(Text-fig. 88 and Pl. 18, Figs 8-11)

MATERIAL: Niskowa – 9 specimens, Korytnica – one specimen; all well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 88	Pl. 18
RaK-225	5.5	3.5	0.8	–	Fig. 9
RaNi-228	3.3	2.1	–	Fig. 88b	Fig. 11

DESCRIPTION: Otoliths elongated, relatively high. Both dorsal as well as posterior rim is straight. Anterodorsal and posterodorsal corners are well developed. Ventral rim is regularly

convex. On the anterior rim developed are: a shallow excisura and a bluntly-cut rostrum. Inner face is convex. Ostium is short, oval in outline. Cauda is narrow, long, and distinctly bent in its posterior part. Outer face is concave.

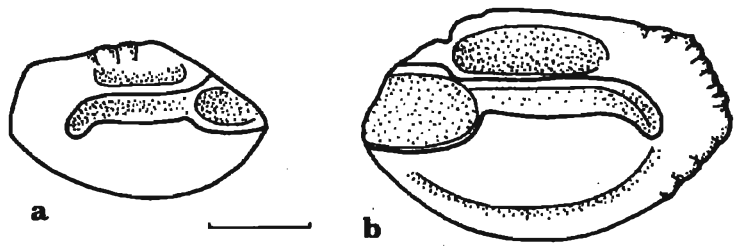


Fig. 88. *Morone* sp.

a – Left sagitta, inner face; **b** – right sagitta, inner face

REMARKS: The studied otoliths are the most similar to those of the present-day species *Morone americana* (GAMELIN, 1789) living along the Atlantic coast of North America (*see* NOLF 1977, Pl. 14, Fig. 3). This similarity allows to assign the collected specimens to the genus *Morone* MITCHILL, 1814. Such forms have also not been reported from Poland.

"genus *Serranidarum*" sp. 1
(Text-fig. 89 and Pl. 19, Fig. 1)

MATERIAL: Korytnica – 2 specimens, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 89	Pl. 19
RaK-229	2.7	1.3	0.7	Fig. 89a,a'	Fig. 1

DESCRIPTION: Otoliths oval in outline, with smooth, rounded rims. On the anterior rim developed are: a shallow excisura and a sharply terminated rostrum. Inner face is strongly convex.

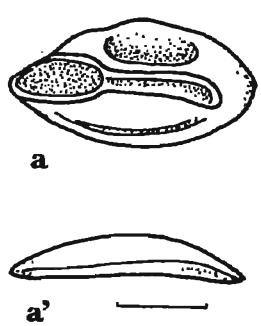


Fig. 89. "genus *Serranidarum*" sp. 1

a – Right sagitta, inner face, **a'** – ventral view

Ostium is widely oval, and cauda is narrower, slightly bent. Area and ventral furrow are well developed. Outer face is slightly concave in its dorsal, and convex in its ventral part.

REMARKS: The studied otoliths, due to the their outline and the structure of their sulcus acusticus, are attributable to the family Serranidae SWAINSON, 1839. Such forms have not hitherto been reporetd from Poland.

"genus *Serranidarum*" sp. 2
(Text-fig. 90 and Pl. 19, Figs 2-4)

MATERIAL: Korytnica – 3 specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 90	Pl. 19
RaK-231	3.0	2.0	Fig. 90a	Fig. 3
RaK-230	2.5	1.5	Fig. 90b	Fig. 2

DESCRIPTION: Otoliths slightly triangular in outline. Dorsal rim is strongly convex, undulant. On the anterior rim developed are: a more or less pronounced antirostrum, a shallow excisura, and a long sharply ended rostrum. Inner face is convex. Sulcus acusticus is deeply incised. Ostium is oval in outline. Cauda is wide and long and in its posterior part it is bent towards the ventral rim. Area is well developed. Outer face is slightly concave.

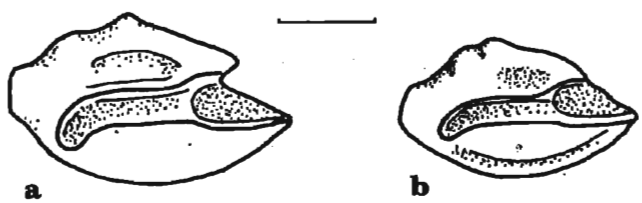


Fig. 90. "genus *Serranidarum*" sp. 2

a, b – Left sagitta, inner face

REMARKS: These otoliths differ from those of the preceding species by their greater height and the structure of their dorsal rim. Such forms have also not been reported from Poland.

Family **Priacanthidae** GILL, 1872
Genus *Pristigenys* AGASSIZ, 1835

Pristigenys rhombica (SCHUBERT, 1906)
(Text-fig. 91 and Pl. 19, Figs 7-10)

1906. *Otolithus (Trigla) rhombicus* SCHUBERT; R. SCHUBERT, p. 641, Pl. 20, Figs 6-7.
1914. *Otolithus (Trigla) rhombicus* SCHUBERT; F. PRIEM, p. 272, Fig. 65.

1971. *Trigla rhombica* SCHUBERT, 1906; P. GAEMERS, p. 248, Pl. 3, Fig. 12 and Pl. 8, Fig. 3.
1973. *Trigla rhombica* SCHUBERT; T. ŚMIGIELSKA, p. 27, Pl. 5, Figs 5-8.
1977. "genus? *Triglidarum*" *schuberti* (POSTHUMUS, 1923); D. NOLF, p. 45, Pl. 13, Fig. 11.
1977. "genus? *Triglidarum*" *rhombicus* (SCHUBERT, 1906); D. NOLF, p. 44.
1979. "genus? *Triglidarum*" *rhombicus* (SCHUBERT, 1906); D. NOLF & E. STEURBAUT, p. 6, Pl. 2, Figs 8-9.
1979. *Pristigenys rhombica* (SCHUBERT, 1906); E. STEURBAUT, p. 69, Pl. 8, Fig. 3.
1979. *Trigla rhombica* (SCHUBERT, 1906); T. ŚMIGIELSKA, p. 329, Text-fig. 32 and Pl. 8, Fig. 4.
1979. *Trigla? schuberti* POSTHUMUS, 1923; T. ŚMIGIELSKA, p.329, Text-fig. 33 and Pl. 8, Fig. 3.
1983. *Pristigenys rhombica* (SCHUBERT, 1906); D. NOLF & R. SMITH, p. 93, Pl. 2, Fig. 2 and Figs 23-25.
1984. *Pristigenys rhombica* (SCHUBERT, 1906); E. STEURBAUT, p. 78, Pl. 20, Figs 1-7.
1985. *Pristigenys rhombicus* (SCHUBERT, 1906); D. NOLF, p. 82.

MATERIAL: Niskowa – 33 specimens, Korytnica – 9 specimens, Rybnica – 9 specimens, Węglinek – one specimen; all of them in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 91	Pl. 19
RaK-236	3.0	2.8	Fig. 91c	Fig. 9
RaNi-237	2.4	2.4	Fig. 91b	Fig. 10
RaW-235	2.0	1.9	Fig. 91a	Fig. 7

REMARKS: The studied otoliths are concordant with the lectotype of the species (*see* NOLF 1981, Pl. 2, Fig. 20). The species has formerly been reported from the Miocene deposits of Poland, both from Niskowa and from the Korytnica Basin (ŚMIGIELSKA 1973, 1979).

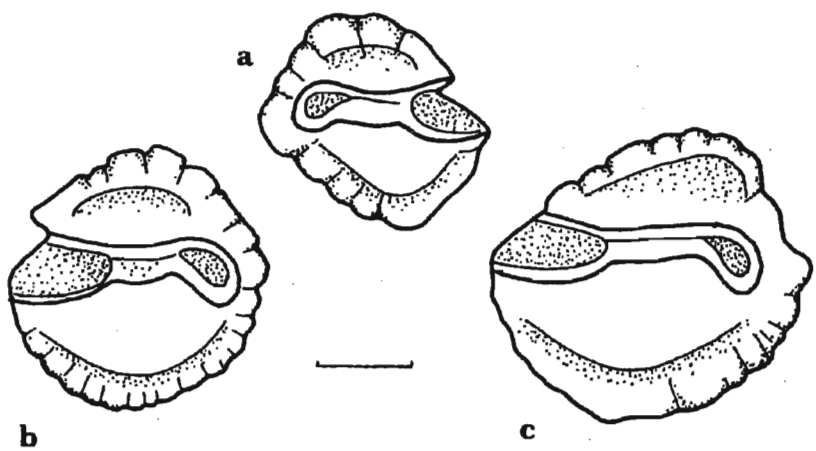


Fig. 91. *Pristigenys rhombica* (SCHUBERT, 1906)

a – Left sagitta, inner face; b, c – right sagitta, inner face

The specimens from the Korytnica Basin were described by ŚMIGIELSKA (1979) under the two specific names: "*Trigla rhombica* SCHUBERT, 1906", and "*Trigla? schuberti* POSTHUMUS, 1923". In the same year, STEURBAUT (1979) recognized the species "*schuberti*" as a younger synonym of the species "*rhombica*", but the whole species *Trigla rhombica* SCHUBERT, 1906, was put by him into the genus *Pristigenys* AGASSIZ, 1835, belonging to the family Priacanthidae GILL, 1872. The generic re-assessment was performed due to similarity of the discussed otoliths to those of the

present-day species *Pristigenys niphonia* (CUVIER, 1829), known from the Japanese offshores (*see* STEURBAUT 1979, Pl. 8, Fig. 2).

Family **Sillaginidae** RICHARDSON, 1846
Genus *Sillago* CUVIER, 1817

Sillago schwarzhansi STEURBAUT, 1984
(Text-fig. 92 and Pl. 19, Figs 11-13)

1979. *Sillago hassovicus* (KOKEN, 1891); T. ŚMIGIELSKA, p. 315, Text-fig. 19, Pl. 4, Fig. 8.
1984. *Sillago schwarzhansi* n. sp.; E. STEURBAUT, p. 83, Pl. 22, Figs 1-4.

MATERIAL: Korytnica — 3 specimens, well preserved; Bęczyn — 2 juvenile specimens, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 92	Pl. 19
RaK-241	5.0	3.0	0.9	Fig. 92a	Fig. 12
RaK-240	4.0	2.3	0.8	Fig. 92c	Fig. 11
RaK-242	3.3	2.0	0.8	Fig. 92b	Fig. 13

DESCRIPTION: Otoliths elongated, oval in outline. Dorsal rim is slightly concave in its anterior part, but convex and crenulated in its middle and posterior parts. Ventral rim is asymmetrically convex. Inner face is strongly convex. Sulcus acusticus is shallow, and granulated on its surface. Ostium is relatively short. Cauda is three times longer than the ostium. Outer face is slightly concave.

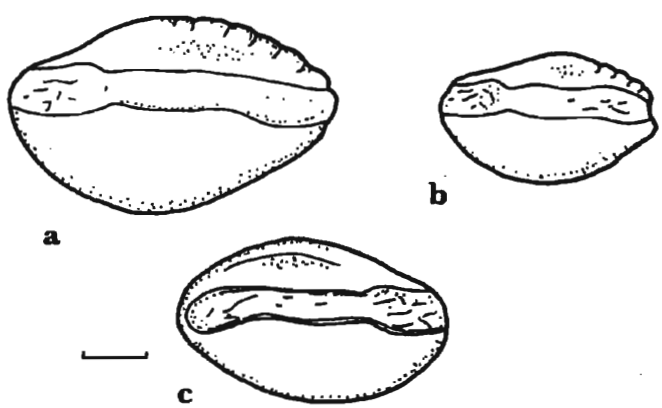


Fig. 92. *Sillago schwarzhansi* STEURBAUT, 1984

a, b — Right sagitta, inner face; c — left sagitta, inner face

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* STEURBAUT 1984, Pl. 22, Fig. 1). Such forms have already been reported from the Korytnica Basin, and described by ŚMIGIELSKA (1979) as "*Sillago hassovicus* (KOKEN, 1891)". According to the present author, the specimen illustrated by ŚMIGIELSKA (1979), represents a juvenile form of the species *Sillago schwarzhansi* STEURBAUT, 1984. This species has not hitherto been reported from Poland.

Family **Carangidae** RAFINESQUE, 1815
Genus *Trachurus* RAFINESQUE, 1810

Trachurus elegans JONET, 1973
(Text-fig. 93 and Pl. 20, Figs 1-6)

1966. *Serranus noetlingi* KOKEN; T. ŚMIGIELSKA, p. 252, Pl. 17, Fig. 2.
1973. *Trachurus elegans* nov. sp.; S. JONET, p. 172, Text-fig. 12 (item 13) and Pl. 3, Fig. 60.
1973. *Serranus noetlingi* KOKEN, 1891; S. JONET, p. 164, Text-fig. 12 (item 5) (*non* item 4) and Pl. 2, Fig. 44 (*non* Figs 43 and 45).
1973. *Allomorone moguntina* (KOKEN) 1891; S. JONET, p. 165, Pl. 2, Fig. 48 (*non* Figs 46-47 and 49).
1979. *Serranus noetlingi* KOKEN, 1891; T. ŚMIGIELSKA, p. 314, Text-fig. 18 and Pl. 5, Figs 1-2.
1982. *Trachurus elegans* JONET, 1973; E. STEURBAUT & S. JONET, p. 201, Pl. 2, Fig. 23.

MATERIAL: Korytnica – 26 specimens, in majority well preserved; Rybnica – 13 specimens, in majority with their rostral part damaged.

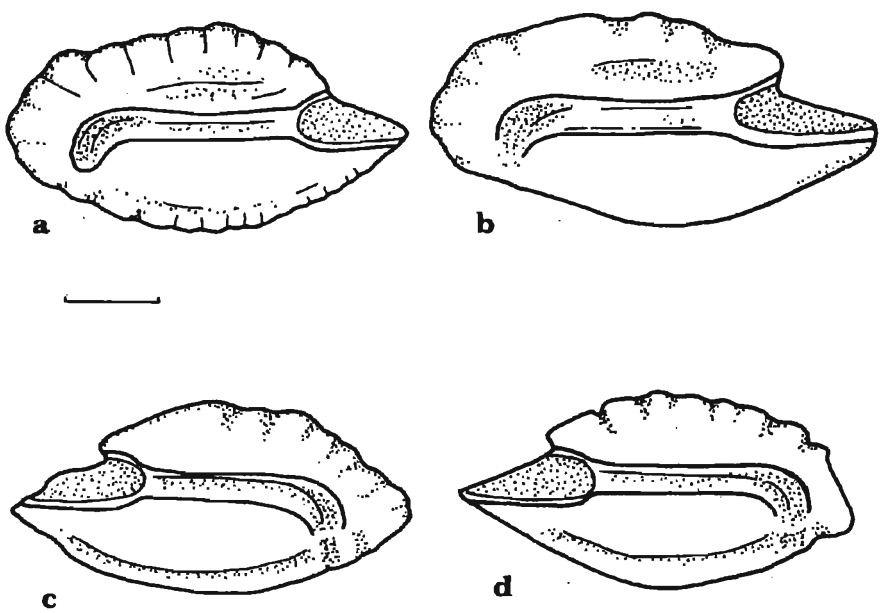
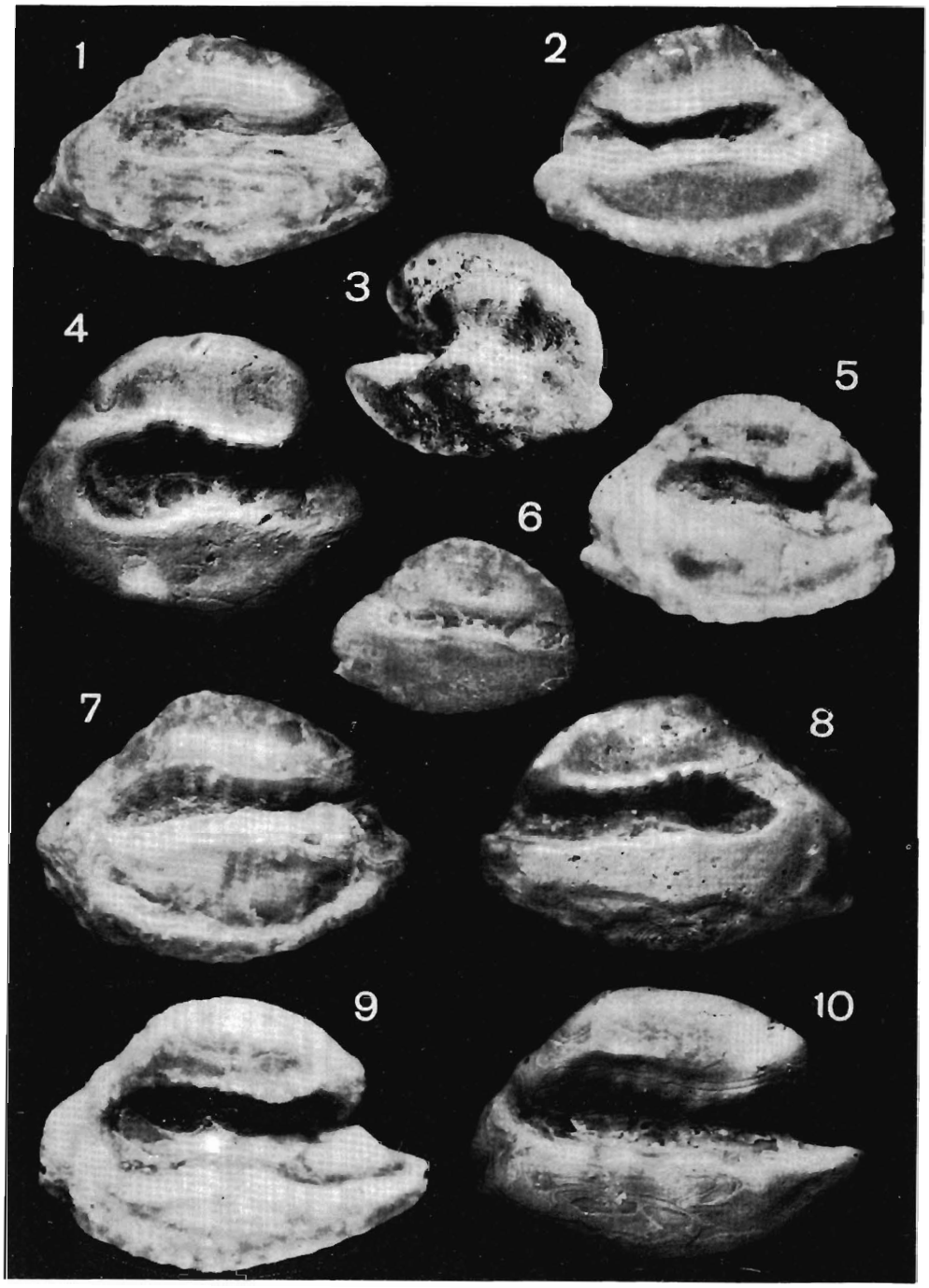
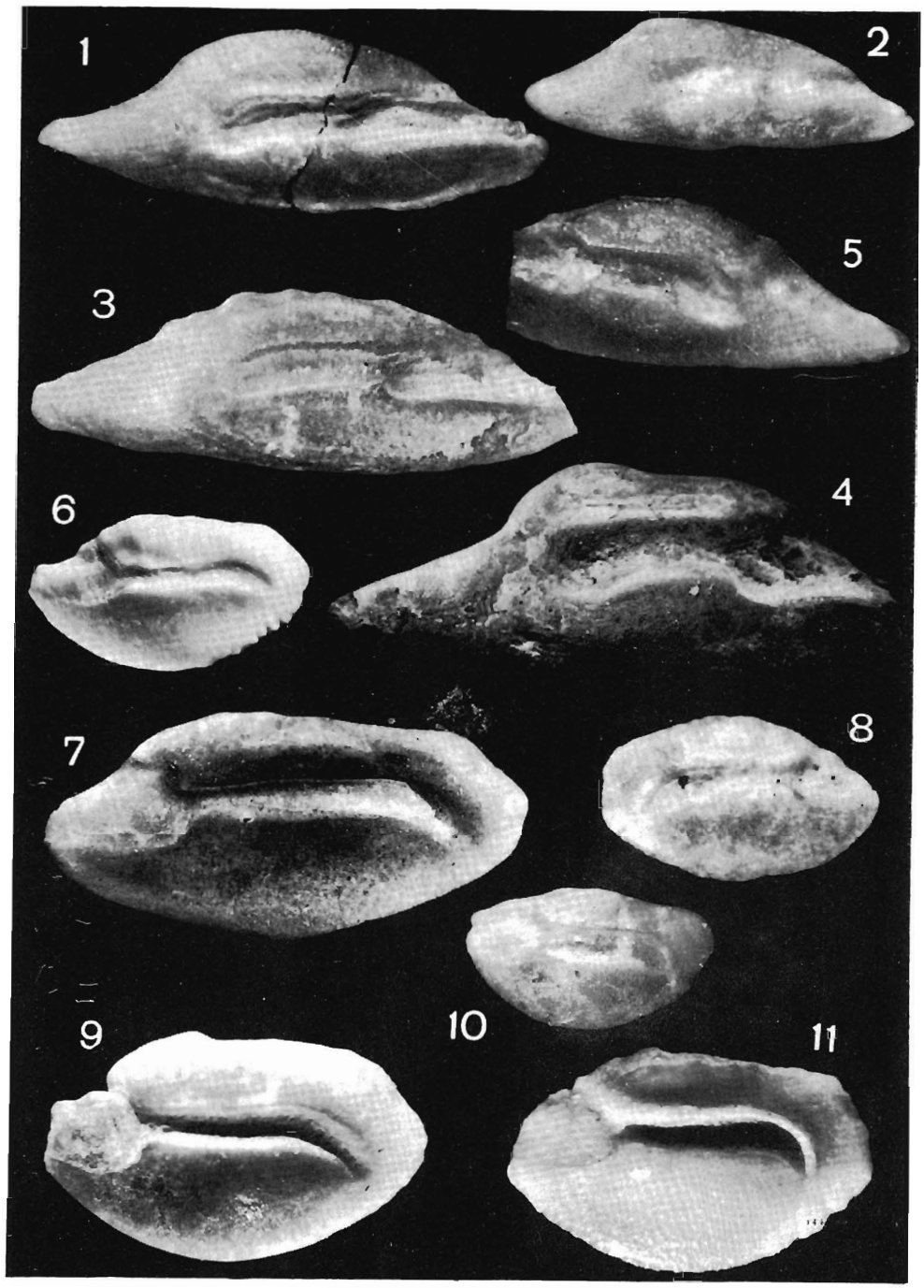


Fig. 93. *Trachurus elegans* JONET, 1973

a, b – Left sagitta, inner face; **c, d** – right sagitta, inner face



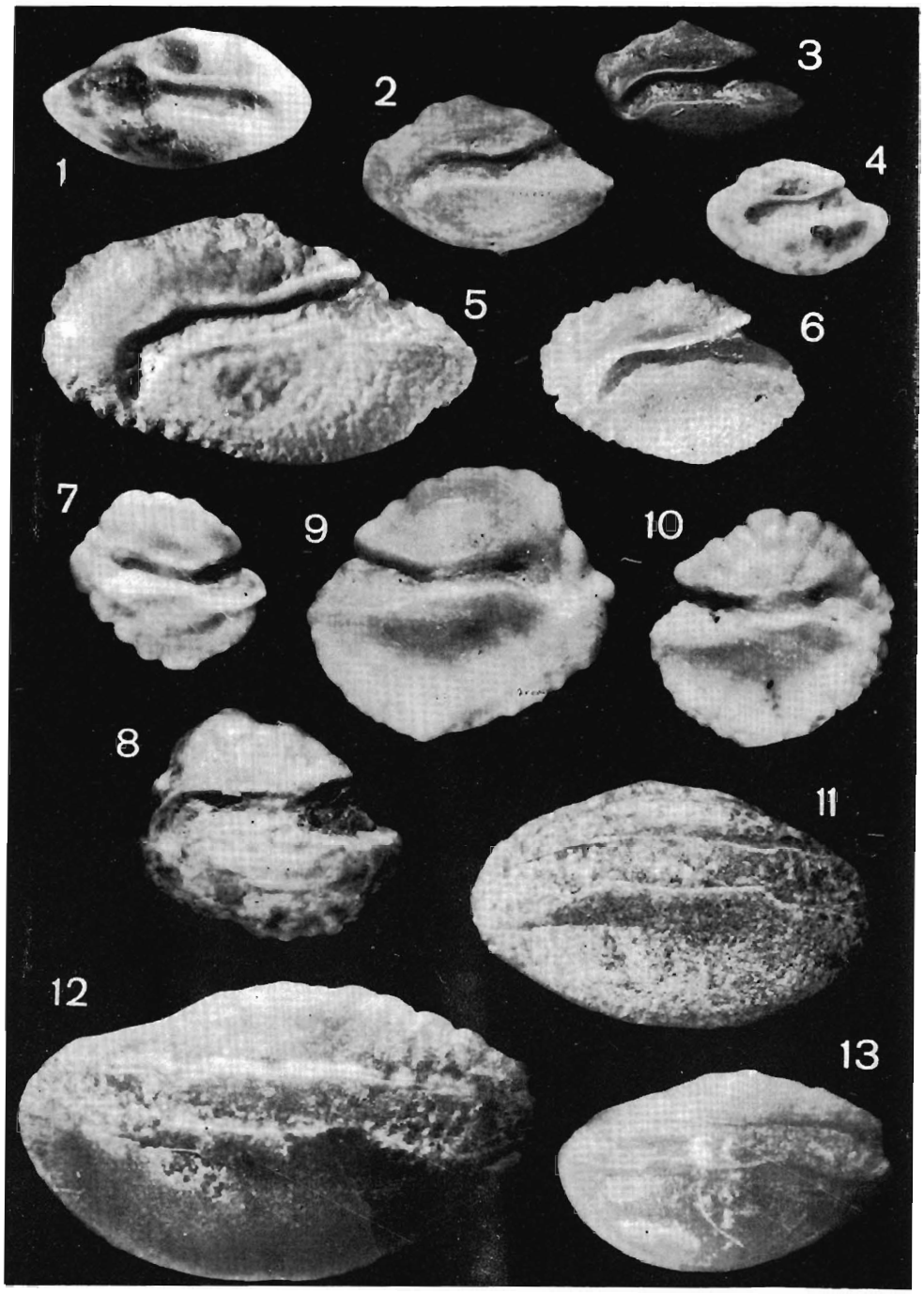
1-2 — *Trigla* aff. *lyra* LINNAEUS, 1758; 1 — left sagitta, inner face; 2 — right sagitta, inner face; × 15
3 — *Trigla* cf. *asperoides* SCHUBERT, 1906; right sagitta, inner face; × 10
4 — *Trigla* sp. 3; left sagitta, inner face; × 15
5-8 — *Trigla* sp. 1; 5-7 — left sagitta, inner face; 8 — right sagitta, inner face; × 15
9-10 — *Trigla* sp. 2; left sagitta, inner face; × 15



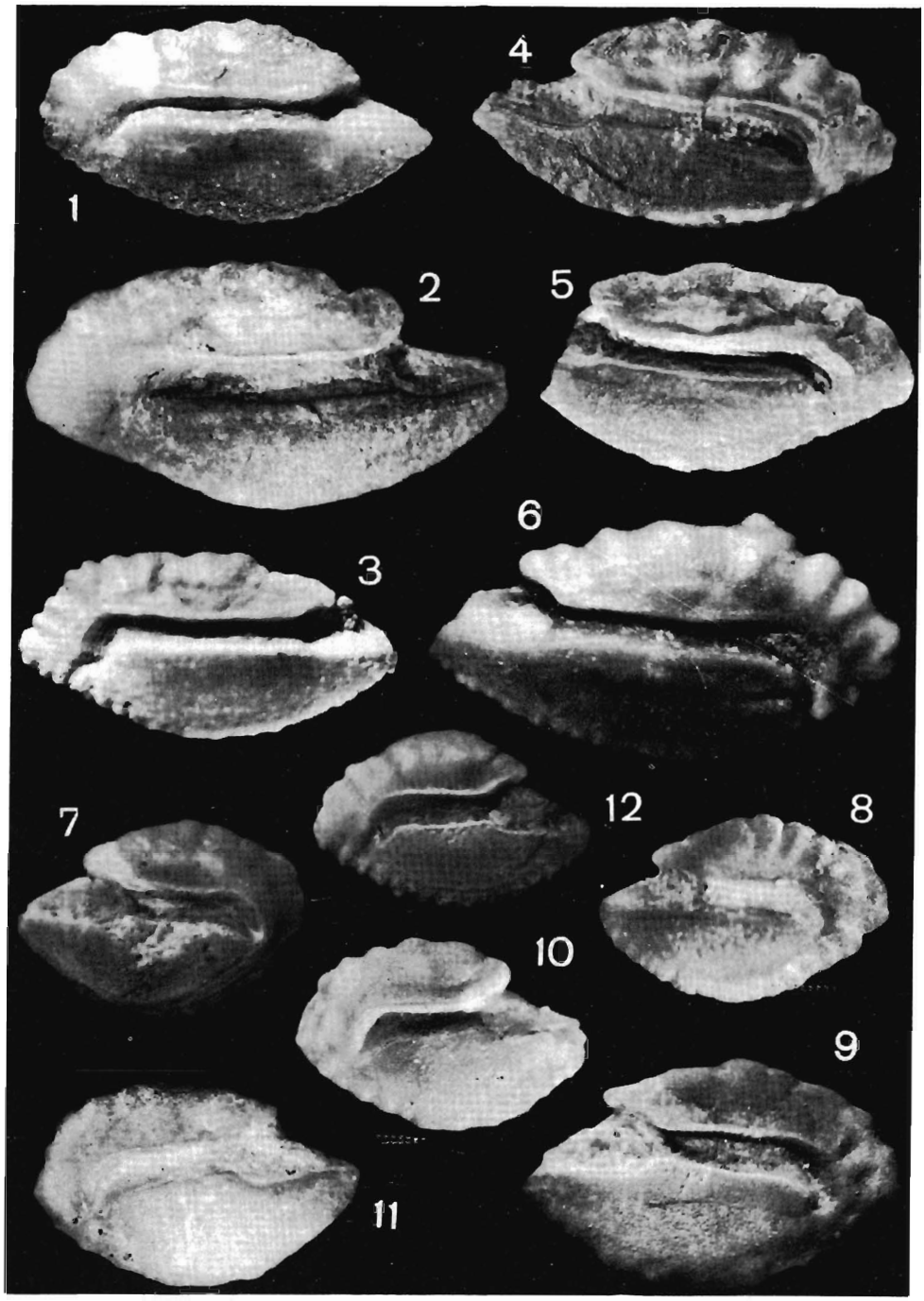
1-5 – *Platycephalus fusiculus* RADWAŃSKA, 1984; 1-4 – left sagitta, inner face; 5 – right sagitta, inner face; × 15; the same specimens (3, 4 – **holotype**) as illustrated formerly (*see* RADWAŃSKA 1984, Pl. 2, Fig. 1a-1b; Pl. 1, Fig. 4a-4b)

6-7 – *Morone* aff. *labrax* (LINNAEUS, 1758); right sagitta, inner face; 6 × 10; 7 × 7

8-11 – *Morone* sp.; 8 – left sagitta, inner face; 9-11 – right sagitta, inner face; 8, 10, 11 × 15; 9 × 10



1 – "genus *Serranidarum*" sp. 1; right sagitta, inner face; × 15
2-4 – "genus *Serranidarum*" sp. 2; left sagitta, inner face; 2, 4 × 15; 3 × 10;
5-6 – *Chaetodon* aff. *hoefleri* STEINDACHNER, 1882; left sagitta, inner face; × 15
7-10 – *Pristigenys rhombica* (SCHUBERT, 1906); 7-8 – left sagitta, inner face; 9-10 – right sagitta, inner face; × 15
11-13 – *Sillago schwarzhansi* STEURBAUT, 1984; 11 – left sagitta, inner face; 12-13 – right sagitta, inner face; × 15



1-6 — *Trachurus elegans* JONET, 1973; 1-3 — left sagitta, inner face; 4-6 — right sagitta, inner face; × 15

7-12 — *Spicara smaris* (LINNAEUS, 1758); 7-9 — right sagitta, inner face; 10-12 — left sagitta, inner face; × 15

Coll. numbers	L	H	Figured in: Text-fig. 93	Pl. 20
RaK-246	4.5	2.3	Fig. 93b	Fig. 2
RaK-244	4.0	2.0	Fig. 93a	Fig. 1
RaK-248	3.5	1.8	--	Fig. 3

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* JONET 1973, Pl. 3, Fig. 60). Otoliths of this fossil species, *Trachurus elegans* JONET, 1973, differ from those of the related species *T. miosensis* NOLF & STEURBAUT, 1979, by their stronger elongation and lesser height.

The otoliths of the discussed species have formerly been reported from the Korytnica Basin (ŚMIGIELSKA 1966, 1979) under the name of "*Serranus noetlingi* KOKEN, 1891". The studied specimens from Korytnica and Rybnica differ from otoliths of the species "*noetlingi*" (*see* KOKEN 1891, Pl. 8, Fig. 1-1a) by their stronger elongation and the outline of their sulcus acusticus, as the cauda is widened and more strongly bent in its posterior part, and the ostiale crista superior is distinctly bent.

Family **Emmelichthyidae** JORDAN, 1923
Genus *Spicara* RAFINESQUE, 1810

Spicara smaris (LINNAEUS, 1758)
(Text-fig. 94 and Pl. 20, Figs 7-12; Pl. 21, Figs 1-3)

1984. *Spicara smaris* (LINNAEUS, 1758); E. STEURBAUT, p. 86, Pl. 23, Figs 16-17.
1984. *Spicara* sp. 1; E. STEURBAUT, p. 86, Pl. 23, Figs 19-20.

MATERIAL: Korytnica – 33 specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 94	Pl. 20
RaK-254	3.6	2.2	Fig. 94f	Fig. 9
RaK-251	2.9	2.0	Fig. 94d	Fig. 7

DESCRIPTION: Otoliths relatively thick, pentagonal in outline. Rims are crenulated in some specimens. On the anterior rim well developed are: an excisura, an antirostrum, and a rostrum. Inner face is strongly convex. Sulcus acusticus is deeply incised. Ostium is oval in outline. Cauda is longer, and slightly bent posteriorly. Outer face in its median part is slightly concave.

REMARKS: The studied otoliths are identical with those of the present-day species *Spicara smaris* (LINNAEUS, 1758) living in the Mediterranean (*see* Text-fig. 95). In the collected assemblage, there are specimens variably elongated, ranging from these shorter ones (*see* Text-fig. 94c,d and Pl. 20, Figs 7, 10 and 12) to those much longer ones (*see* Text-fig. 94a,b and Pl. 21, Figs 1-2). Extremely elongated specimens are close to those described by STEURBAUT (1984, Pl. 23, Figs 19-20) as "*Spicara* sp. 1". As a diversity in the elongation of otoliths is an intraspecific feature (*see* Text-fig. 95), it is reasonable to include these latter otoliths to the synonymy of the species.

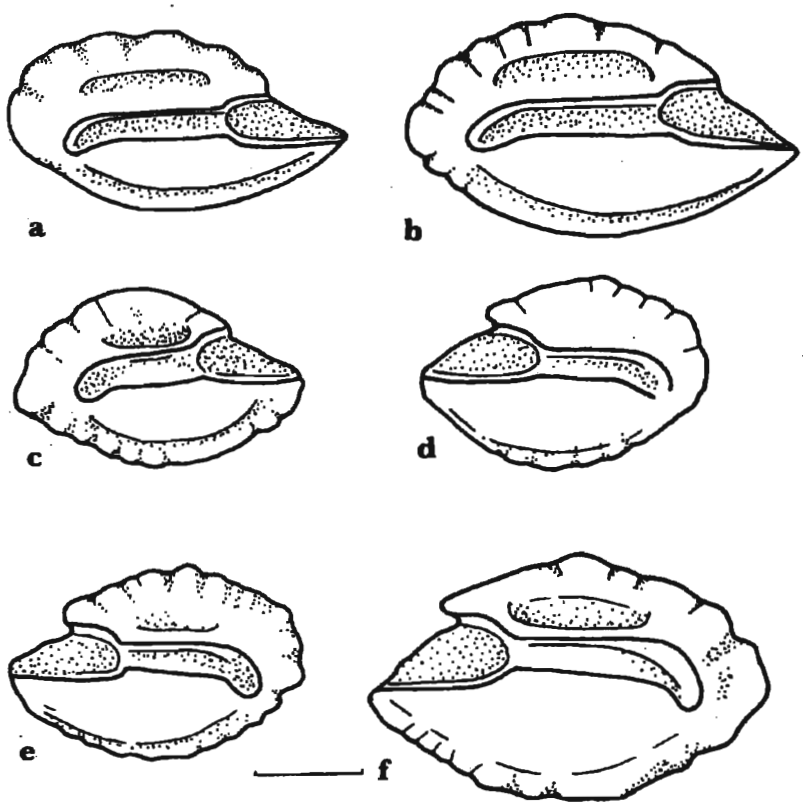


Fig. 94. *Spicara smaris* (LINNAEUS, 1758)

a, b, c — Left sagitta, inner face; d, e, f — right sagitta, inner face

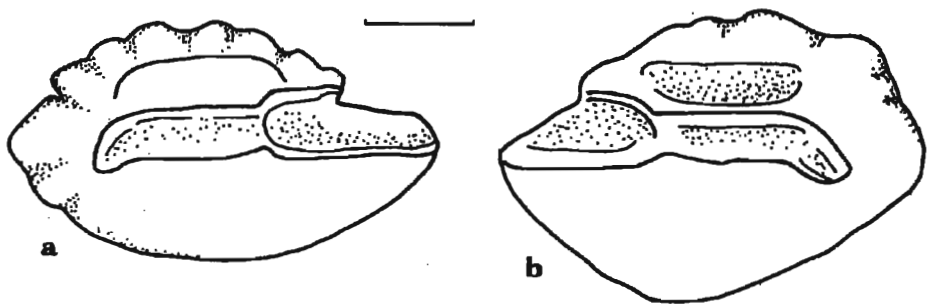


Fig. 95. *Spicara smaris* (LINNAEUS, 1758)

Present-day specimens: a — left sagitta, inner face; b — right sagitta, inner face; Mediterranean Sea (NOLF's Collection)

Family **Gerreidae** Bleeker, 1859
Genus *Gerres* Quoy & Gaimard, 1824

Gerres sp.
(Text-fig. 96 and Pl. 21, Figs 3-8)

1973. *Pagrus* sp.; T. Śmigielska, p. 18, Pl. 3, Figs 1-2.
1984. *Gerres* sp.; E. Steurbaut, p. 87, Pl. 24, Figs 1-5.

MATERIAL: Korytnica – 19 specimens, in majority well preserved; Niskowa – 4 specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 96	Pl. 21
RaK- 265	6.3	4.0	0.9	–	Fig. 7
RaK- 262	3.0	2.3	0.5	Fig. 96c	Fig. 5
RaK- 260	3.0	2.2	0.5	Fig. 96a,a'	Fig. 4

DESCRIPTION: Otoliths of variable outline, changing from almost circular to elongated alongwith their sulcus acusticus. Dorsal rim is concave in its anterior part, but convex and crenulated from the middle towards the posterior rim. Crenulated are also both the posterior and ventral rims. On the anterior rim developed are: a more or less pronounced antirostrum, a shallow excisura, and a short rostrum. Inner face is convex. Sulcus acusticus is deeply incised. Ostium is wide, rectangular in outline. Cauda is narrower, depressed, narrowing in its posterior part and curving there towards the ventral rim. Ostiale crista superior is weakly developed. Outer face is almost flat in juvenile forms, and it becomes concave in the adults.

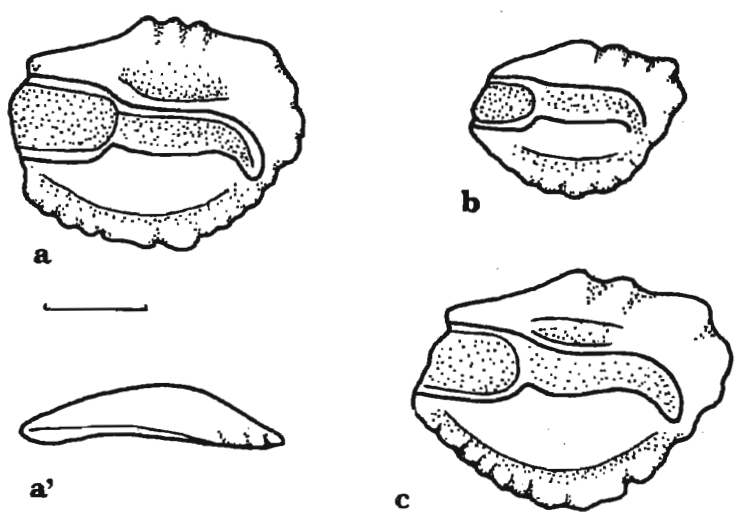


Fig. 96. *Gerres* sp.
a, b, c – Right sagitta, inner face, a' – ventral view

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus, viz. a weakly developed ostiale crista superior, are herein assigned to the genus *Gerres* QUOY & GAIMARD, 1824. This genus is poorly known in the present-day fauna; the majority of its species inhabit primarily warm offshores of the Indian Ocean and of South America. Insofar, only one species has been recognized in the fossil material, namely *Gerres latidens* STINTON, 1980, coming from the Eocene of England.

Unsatisfactory state of recognition of the present-day species, especially those living in the eastern Atlantic, as well as a great similarity of the otoliths in the hitherto investigated species (*see* CHAINE 1938, Pl. 2), allows to determine the collected specimens to the genus rank only. Such forms have already been reported by ŚMIGIELSKA (1973) from Niskowa, and described as "*Pagrus* sp." (*see* synonymy).

Family **Pomadasyidae** REGAN, 1913
Genus *Brachydeuterus* GILL, 1862

Brachydeuterus latior (SCHUBERT, 1906)
(Text-fig. 97 and Pl. 22, Figs 1-11)

1906. *Otolithus* (*Dentex*) *latior* R. SCHUBERT; R. SCHUBERT, p. 627, Pl. 18, Figs 7-9.
1906. *Otolithus* (*Dentex* ?) *subnobilis* sp. n.; R. SCHUBERT, p. 627, Pl. 18, Figs 10-12.
1928. *Ot.* (*Dentex*) *latior* SCHUB.; J. CHAINE & J. DUVERGIER, p. 202, Pl. 6, Figs 7-9.
1950. *Dentex nobilis miocenica* WEILER, 1942; W. WEILER, p. 225, Pl. 3, Fig. 14.
1950. *Dentex latior* SCHUBERT, 1906; W. WEILER, p. 226, Pl. 3, Fig. 14.
1966. *Dentex latior* SCHUBERT; T. ŚMIGIELSKA, p. 254, Pl. 17, Figs 4-5.
1973. *Dentex latior* SCHUBERT; T. ŚMIGIELSKA, p. 16, Pl. 2. Figs 7-8.
1979. *Dentex latior* SCHUBERT, 1906; T. ŚMIGIELSKA, p. 319, Pl. 6, Figs 1-2.
1979. *Brachydeuterus latior* (SCHUBERT, 1906); D. NOLF & E. STEURBAUT, p. 8, Pl. 2, Figs 16-23.
1980. *Brachydeuterus latior* (SCHUBERT, 1906); D. NOLF & H. CAPPETTA, p. 10, Pl. 2, Figs 9-10.
1981. *Brachydeuterus latior* (SCHUBERT, 1906); D. NOLF, p. 144, Pl. 2, Fig. 21.
1983. *Brachydeuterus latior* (SCHUBERT, 1906); D. NOLF & E. STEURBAUT, p. 181, Pl. 6, Fig. 19.
1984. *Brachydeuterus latior* (SCHUBERT, 1906); E. STEURBAUT, p. 87, Pl. 24, Figs 21-24.
1985. *Brachydeuterus latior* (SCHUBERT, 1906); D. NOLF, p. 86, Fig. 65E.

MATERIAL: Korytnica – 3367 specimens, Niskowa – 25 specimens, Węglinek – 5 specimens, Bęczyn – 3 specimens; all of them in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 97	Pl. 22
RaK-268	6.0	4.0	1.2	Fig. 97b	Fig. 6
RaK-272	5.4	3.5	1.0	Fig. 97a	Fig. 9

REMARKS: Otoliths of this species have already been reported from Poland by CHAINE & DUVERGIER (1928) and ŚMIGIELSKA (1966, 1973, 1979) as "*Dentex latior* SCHUBERT, 1906". More recently, NOLF & STEURBAUT (1979) recognized that this species, so commonly ascribed to the genus *Dentex* CUVIER, 1815 (*see* synonymy), should be included into the genus *Brachydeuterus* GILL, 1862.

Otoliths of the species *Brachydeuterus latior* (SCHUBERT, 1906) occur abundantly in the Korytnica Basin. The collected assemblage comprises both juvenile and adult forms. Otoliths of the adult fish display a remarkable variability of their general outline, precisely of the dorsal rim, and of the total length (*see* Text-fig. 97 and Pl. 22, Figs 4-10).

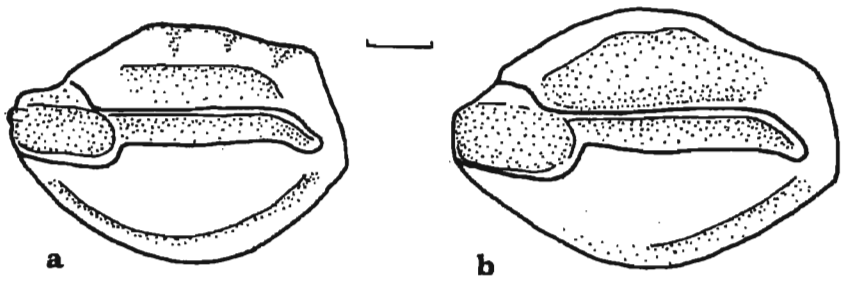


Fig. 97. *Brachydeuterus latior* (SCHUBERT, 1906)

a, b – Right sagitta, inner face

Brachydeuterus speronatus (BASSOLI, 1906)
(Text-fig. 98 and Pl. 21, Figs 9-11)

1906. *Otolithus (Dentex) speronatus* BASS.; G. BASSOLI, p. 51, Pl. 2, Figs 37-38.
1983. *Brachydeuterus speronatus* (BASSOLI, 1906); D. NOLF & E. STEURBAUT, p. 181, Pl. 7, Figs 10-12.
1984. *Brachydeuterus speronatus* (BASSOLI, 1906); E. STEURBAUT, p. 87, Pl. 24, Fig. 19.
1985. *Brachydeuterus speronatus* (BASSOLI, 1906); D. NOLF, p. 86.

MATERIAL: Korytnica – 17 specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 98	Pl. 21
RaK-275	6.7	4.5	1.3	–	Fig. 10
RaK-276	5.5	4.0	1.0	Fig. 98a	Fig. 11

DESCRIPTION: Otoliths thick, almost circular in outline. Dorsal rim is convex (but crenulated in some specimens), with a distinctly individualized posterodorsal corner in the adult

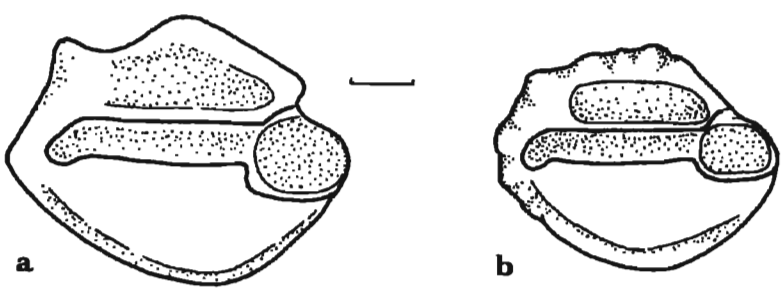


Fig. 98. *Brachydeuterus speronatus* (BASSOLI, 1906)

a, b – Left sagitta, inner face

forms; in the juveniles, this corner is not so significant. On the anterior rim, a shallow excisura, and a short, rounded rostrum may be developed. Posterior rim is slightly concave. Inner face is convex. Sulcus acusticus is deeply incised. Ostium is wide, almost circular in outline. Cauda is narrower, and slightly arching towards the ventral rim posteriorly. Area is well developed. Outer face is convex.

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* BASSOLI 1906, Pl. 2, Fig. 37). This species has formerly been assigned to the genus *Dentex* CUVIER, 1815, but the newer studies (STEURBAUT 1984) show, that its features are typical of those of the genus *Brachydeuterus* GILL, 1862. The otoliths of the species *B. speronatus* (BASSOLI, 1906) are so close to those of the species *B. latior* (SCHUBERT, 1906) that NOLF & STEURBAUT (1983) suggest their conspecifity.

When analyzing the collected material of these two species it may be stated, that the adult forms of the species "*speronatus*" differ from those, almost identical in their size, of the species "*latior*" by their more circular outline and by a shorter rostrum (*compare* Pl. 21, Fig. 11 with Pl. 22. Fig. 5). Such differences are also visible within the juvenile forms (*compare* Text-fig. 98b with Pl. 22, Figs 1-3). Thus, it seems reasonable to treat these two species as separate, as it is done in the present paper. The discussed species has not hitherto been reported from Poland.

Family **Sparidae** BONAPARTE, 1832
Subfamily **Sparinae** BONAPARTE, 1832
Genus *Boops* CUVIER, 1814

Boops neogenicus STEURBAUT & JONET, 1982
(Text-fig. 99 and Pl. 23, Figs 1-4)

1906. *Otolithus* (*Box*) *insignis* PROCH.?; R. SCHUBERT, p. 633, Pl. 18, Fig. 19 (*non* Figs 20, 21, 22).
1979. *Boops insignis* (PROCHÁZKA); G. ANFOSSI & S. MORNA, p. 121, Pl. 11, Fig. 4.
1982. *Boops neogenicus* n. sp.; E. STEURBAUT & S. JONET, p. 203, Pl. 3, Fig. 5 and Pl. 5, Figs 14-17.
1984. *Boops neogenicus* STEURBAUT & JONET, 1982; E. STEURBAUT, p. 89, Pl. 25, Figs 10-15.

MATERIAL: Korytnica – 21 specimens, in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 99	Pl. 23
RaK-282	5.1	3.0	Fig. 99a	Fig. 2
RaK-280	4.0	2.5	Fig. 99d	Fig. 4

DESCRIPTION: Otoliths elongated, slightly rectangular in outline. Dorsal rim is furnished with a characteristic node at its midlength. Posterodorsal corner is well developed. Posterior rim is straight, and ventral rim is regularly convex. All the rims may be crenulated. Inner face is convex. Sulcus acusticus is relatively wide and deeply incised. Ostium is wide, of rectangular outline. Cauda is straight at its beginning, but in its posterior part it bends towards the ventral rim. Area is well developed. Outer face is convex.

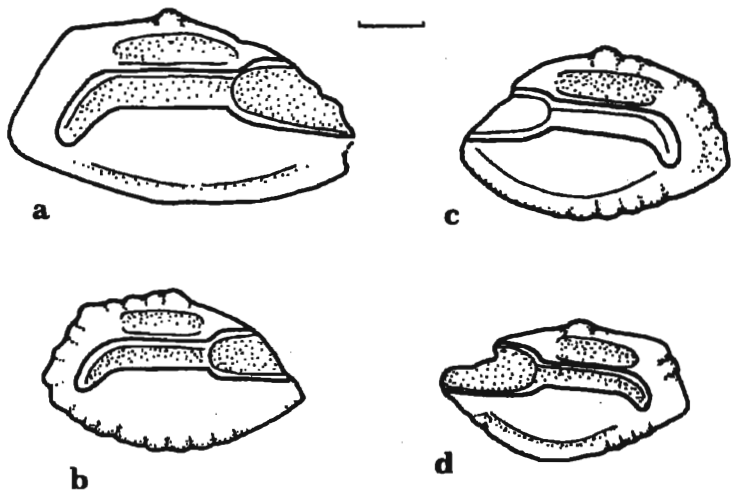


Fig. 99. *Boops neogenicus* STEURBAUT & JONET, 1982

a, b – Left sagitta, inner face; c, d – right sagitta, inner face

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* STEURBAUT & JONET 1982, Pl. 5, Fig. 17). In the collected material, there occur forms much differing in their elongation (*see* Text-fig. 99 and Pl. 23, Figs 2-3) and such variability is also visible within the otoliths of the type series (*see* STEURBAUT & JONET 1982). The species has not hitherto been reported from Poland.

Genus *Diplodus* RAFINESQUE, 1810

Diplodus karrerae NOLF & STEURBAUT, 1979 (Text-fig. 100 and Pl. 23, Figs 5-7)

1973. *Spondyliosoma tietzei* SCHUBERT, 1906; S. JONET, p. 202, Text-fig. 12 (item 25) and Pl. 4, Figs 101-104.
1979. *Diplodus karrerae* n. sp.; D. NOLF & E. STEURBAUT, p. 10, Text-fig. 2 and Pl. 3, Figs 19-21.
1982. *Diplodus karrerae* NOLF & STEURBAUT, 1979; E. STEURBAUT & S. JONET, p. 203, Pl. 2, Fig. 21.
1984. *Diplodus karrerae* NOLF & STEURBAUT, 1979; E. STEURBAUT, p. 89, Pl. 25, Figs 16-18.
1985. *Diplodus karrerae* NOLF & STEURBAUT, 1979; D. NOLF, p. 88, Fig. 65J.

MATERIAL: Korytnica – 8 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 100	Pl. 23
RaK-286	5.5	3.0	1.0	Fig. 100a	Fig. 6
RaK-285	4.0	2.6	0.8	Fig. 100c	Fig. 7
RaK-284	3.3	2.0	0.7	Fig. 100b	Fig. 5

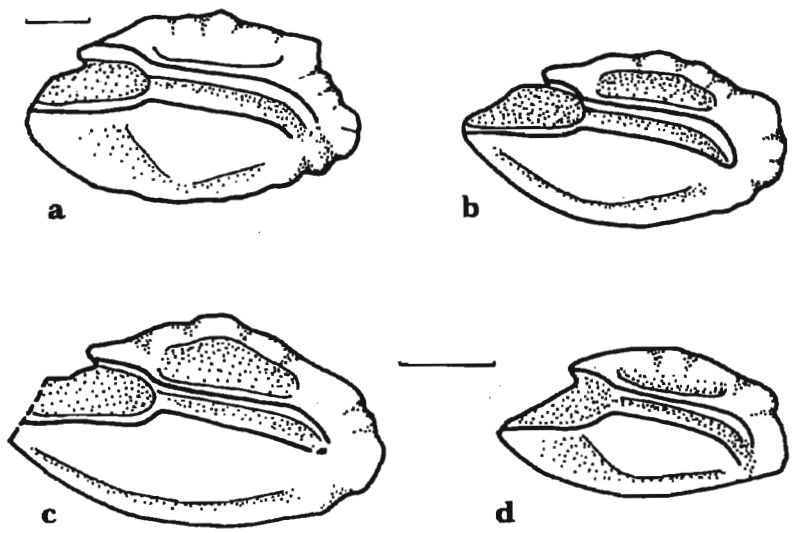


Fig. 100. *Diplodus karrerae* NOLF & STEURBAUT, 1979

a, b, c, d – Right sagitta, inner face

DESCRIPTION: Otoliths relatively thick, elongated. Dorsal rim in its posterior part is slightly concave and flattened. Ventral rim is slightly asymmetrically convex. On the anterior rim developed are: an antirostrum, a shallow excisura, and a pronounced rostrum. Inner face is strongly convex. Sulcus acusticus is deeply incised. Ostium is wide and slightly gaping. Cauda is almost straight, and obliquely descending towards the ventral rim. Area is deep. Outer face is slightly concave.

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* NOLF & STEURBAUT 1979, Text-fig. 2a). The species has not hitherto been reported from Poland.

Diplodus sp. 1
(Text-fig. 101 and Pl. 23, Figs 11-12)

MATERIAL: Rybnica – 5 specimens, badly preserved; Niskowa – 4 specimens, badly preserved; all juvenile.

Coll. numbers	L	H	Figured in: Text-fig. 101	Pl. 23
RaR-187	3.5	2.2	Fig. 101b	Fig. 11
RaR-288	3.0	1.7	Fig. 101a	Fig. 12

DESCRIPTION: Otoliths elongated, slightly pentagonal in outline. Dorsal rim is characteristically bent, and in its posterior part slightly concave and flattened. On the anterior rim

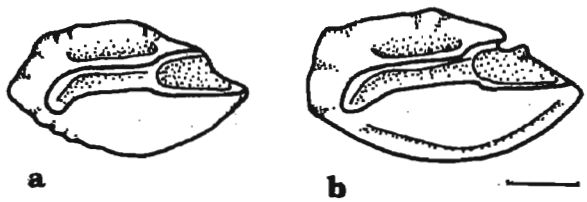


Fig. 101. *Diplodus* sp. 1

a, b – Left sagitta, inner face

developed are: an antirostrum, a shallow excisura, and a long rostrum. Inner face is slightly convex. Sulcus acusticus is relatively deep. Ostium is wide. Cauda is narrow, slightly depressed, and in its posterior part widened and descending towards the ventral rim. Outer face is concave.

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus, and of the dorsal rim, are herein assigned to the genus *Diplodus* RAFINESQUE, 1810. A juvenile nature of the collected specimens hinders their specific determination. Such forms have not hitherto been reported from Poland.

Diplodus sp. 2
(Text-fig. 102 and Pl. 23, Figs 8-10)

MATERIAL: Korytnica – 7 specimens, badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 102	Pl. 23
RaK-290	4.5	2.8	Fig. 102d	Fig. 10
RaK-292	3.4	2.2	Fig. 102a	Fig. 9
RaK-291	2.4	1.5	Fig. 102b	Fig. 8

DESCRIPTION: Otoliths pentagonal in outline. Dorsal rim is asymmetrically bent, slightly flattened at its posterior part. Posteroventral corner is well developed. Ventral rim is regularly convex. Inner face is also convex. Ostium is oval and wide. Cauda is relatively short, narrow, and in its posterior part it is slightly widened, turning towards the ventral rim. Outer face is concave.

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus, and of the dorsal rim, are herein assigned to the genus *Diplodus* RAFINESQUE, 1810. These forms differ from those of *Diplodus* sp. 1 by their lesser length and outline of the dorsal and posterior rims.

In the collected material, the majority of specimens are badly preserved (superficially worn and/or broken), what hinders their taxonomic recognition. It is probable, that these forms may represent a new species.

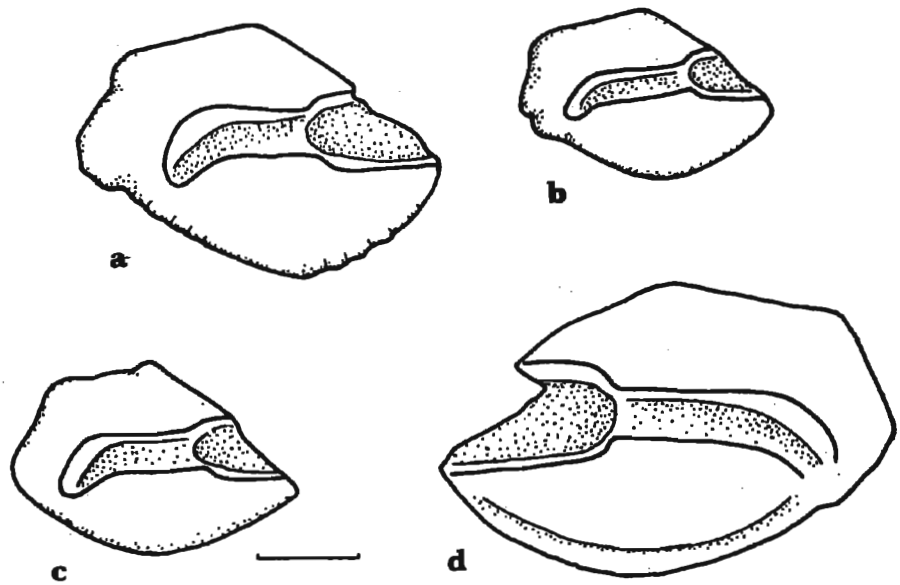


Fig. 102. *Diplodus* sp. 2

a, b, c – Left sagitta, inner face; d – right sagitta, inner face

Genus *Pagellus* Valenciennes, 1830

Pagellus acarne (Risso, 1826)
(Text-figs 103-104 and Pl. 24, Fig. 10; Pl. 25, Fig. 1)

1983. *Pagellus acarne* (Risso, 1826); D. Nolf & E. Steurbaut, p. 185, Pl. 7, Fig. 15.
1984. *Pagellus acarne* (Risso, 1826); E. Steurbaut, p. 91, Pl. 25, Figs 19-23.
1985. *Pagellus acarne* (Risso, 1826); D. Nolf, p. 88.

MATERIAL: Rybnica – 5 specimens, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 103	Pl. 24
RaR-293	7.8	3.8	0.9	Fig. 103a	Fig. 10

DESCRIPTION: Otoliths strongly elongated. Both dorsal as well as posterior rim is irregularly crenulated. On the anterior rim developed are: an antirostrum, a shallow excisura, and a bluntly-ended rostrum. Inner face is strongly convex. Sulcus acusticus is shallow. Ostium is wide and long. Cauda is twice longer than the ostium, and it obliquely descends towards the ventral rim. Outer face is concave.

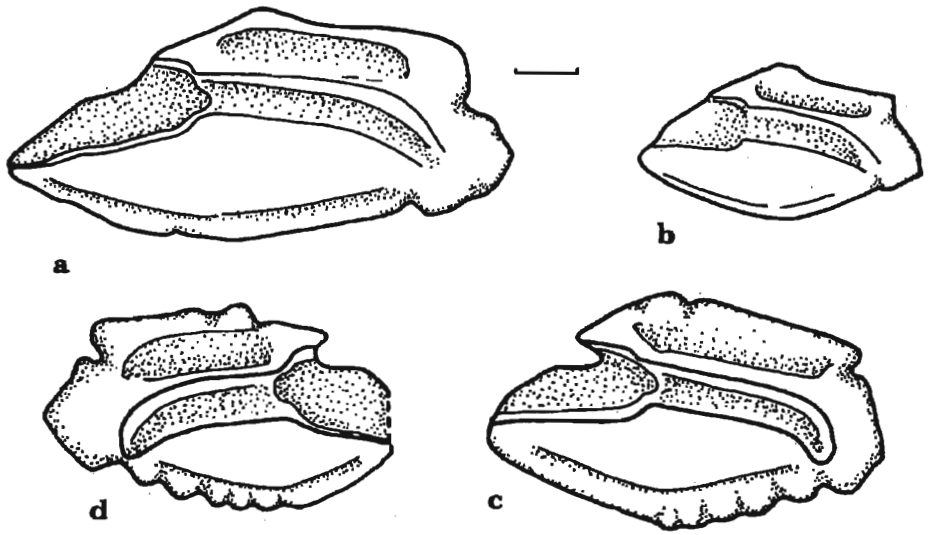


Fig. 103. *Pagellus acarne* (Risso, 1826)

a, b, c — Right sagitta, inner face; d — left sagitta, inner face

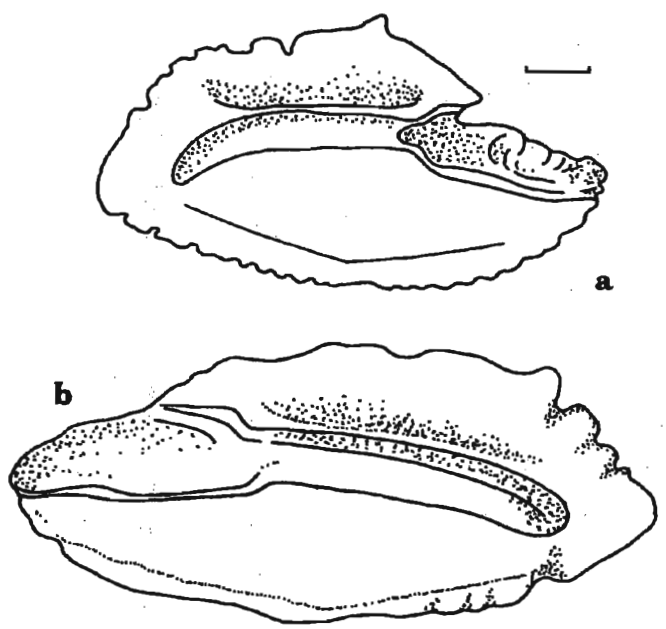


Fig. 104. *Pagellus acarne* (Risso, 1826)

Present-day specimens: a — left sagitta, inner face; b — right sagitta, inner face; Mediterranean Sea (Nolf's Collection)

REMARKS: The studied otoliths are concordant with those of the present-day species *Pagellus acarne* (Risso, 1826) known from the Mediterranean and Atlantic coasts of northern Africa (*see* Text-fig. 104). This species has not hitherto been reported from Poland.

Pagellus albuquerquae Steurbaut & Jonet, 1982
(Text-fig. 105 and Pl. 24, Figs 7-9)

?1973. *Centropristis integer* Schubert; T. Śmigielska, p. 10, Pl. 1, Fig. 8 (*non* Fig. 7).
1979. *Pagellus* sp.; D. Nolf & E. Steurbaut, p. 11, Pl. 3, Figs 17-18.
1982. *Pagellus albuquerquae* n. sp.; E. Steurbaut & S. Jonet, p. 204, Pl. 3, Figs 2-4 and Pl. 26, Figs 1-5.
1984. *Pagellus albuquerquae* Steurbaut & Jonet, 1982; E. Steurbaut, p. 91, Pl. 26, Figs 1-5.

MATERIAL: Korytnica – 23 specimens, not very well preserved; Niskowa – 5 specimens, badly preserved; Węglinek – 2 specimens, badly preserved.

Coll. numbers	L	T	Figured in: Text-fig. 105	Pl. 24
RaK-295	5.0	3.0	Fig. 105c	Fig. 8
RaK-294	3.9	2.3	Fig. 105d	Fig. 7

DESCRIPTION: Otoliths elongated, with dorsal rim straight and crenulated. Posterior rim is also straight, obliquely running towards the dorsal rim. Posterodorsal and posteroventral corners

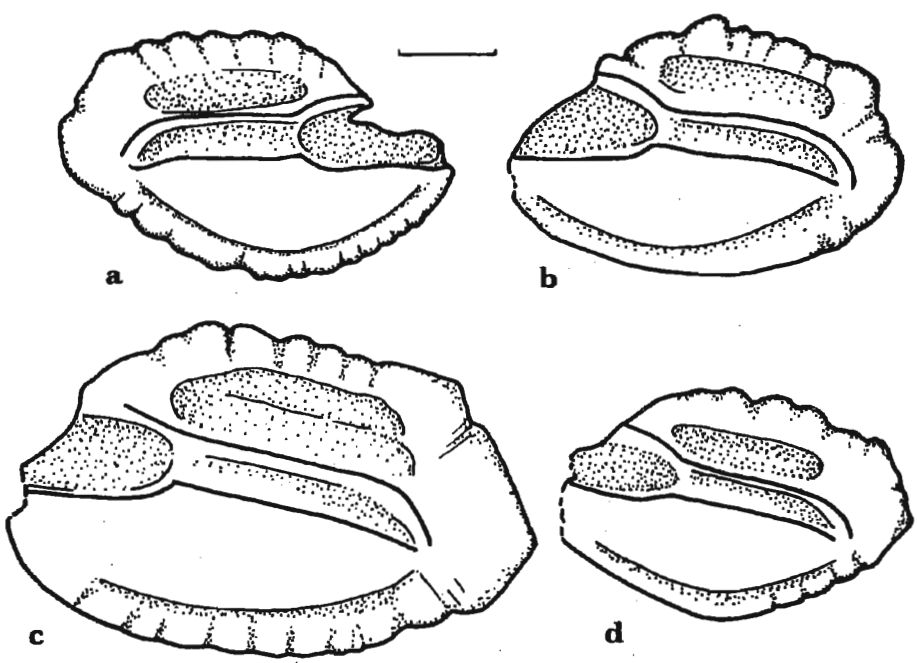
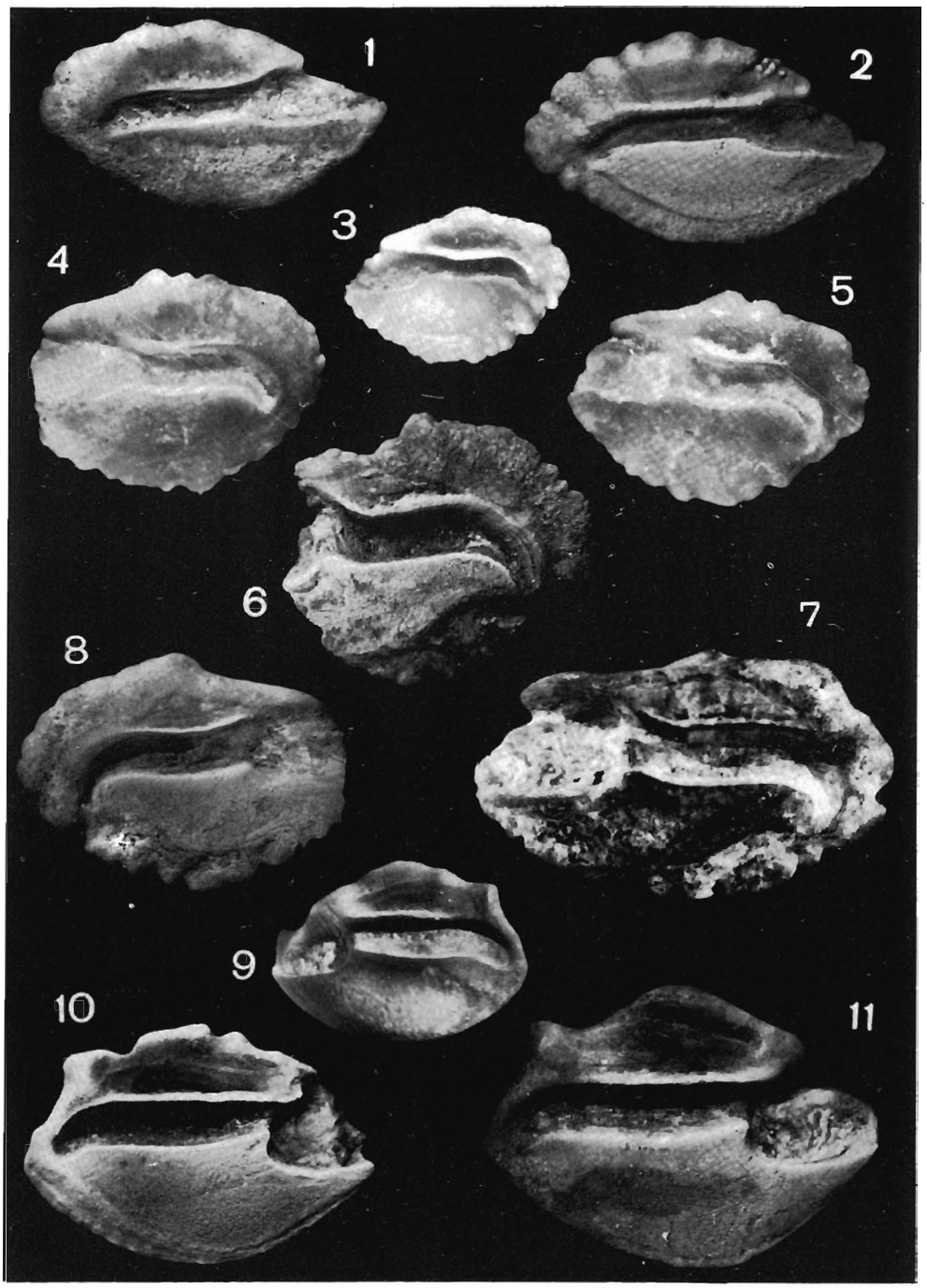


Fig. 105. *Pagellus albuquerquae* Steurbaut & Jonet, 1982

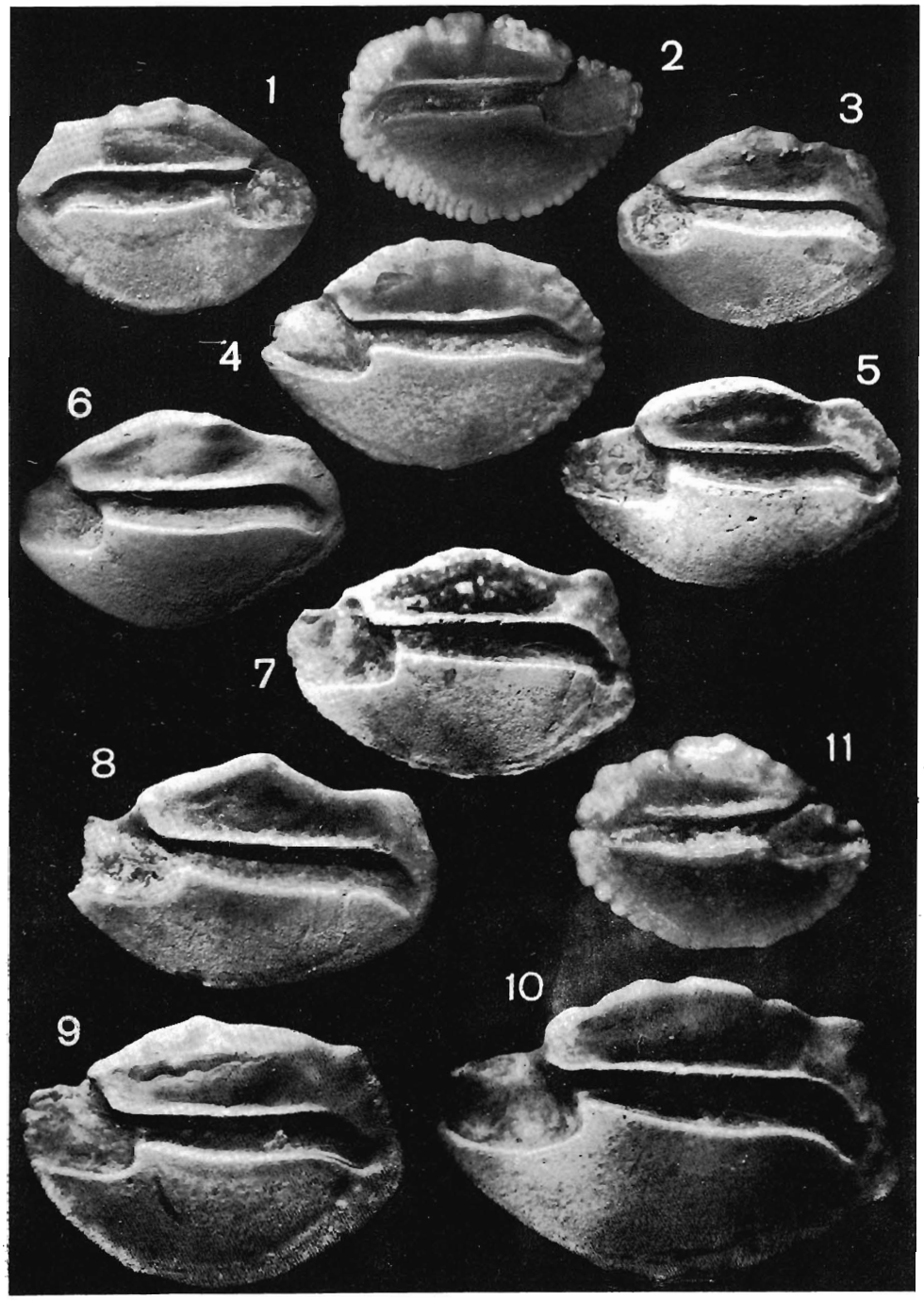
a – Left sagitta, inner face; **b, c, d** – right sagitta, inner face



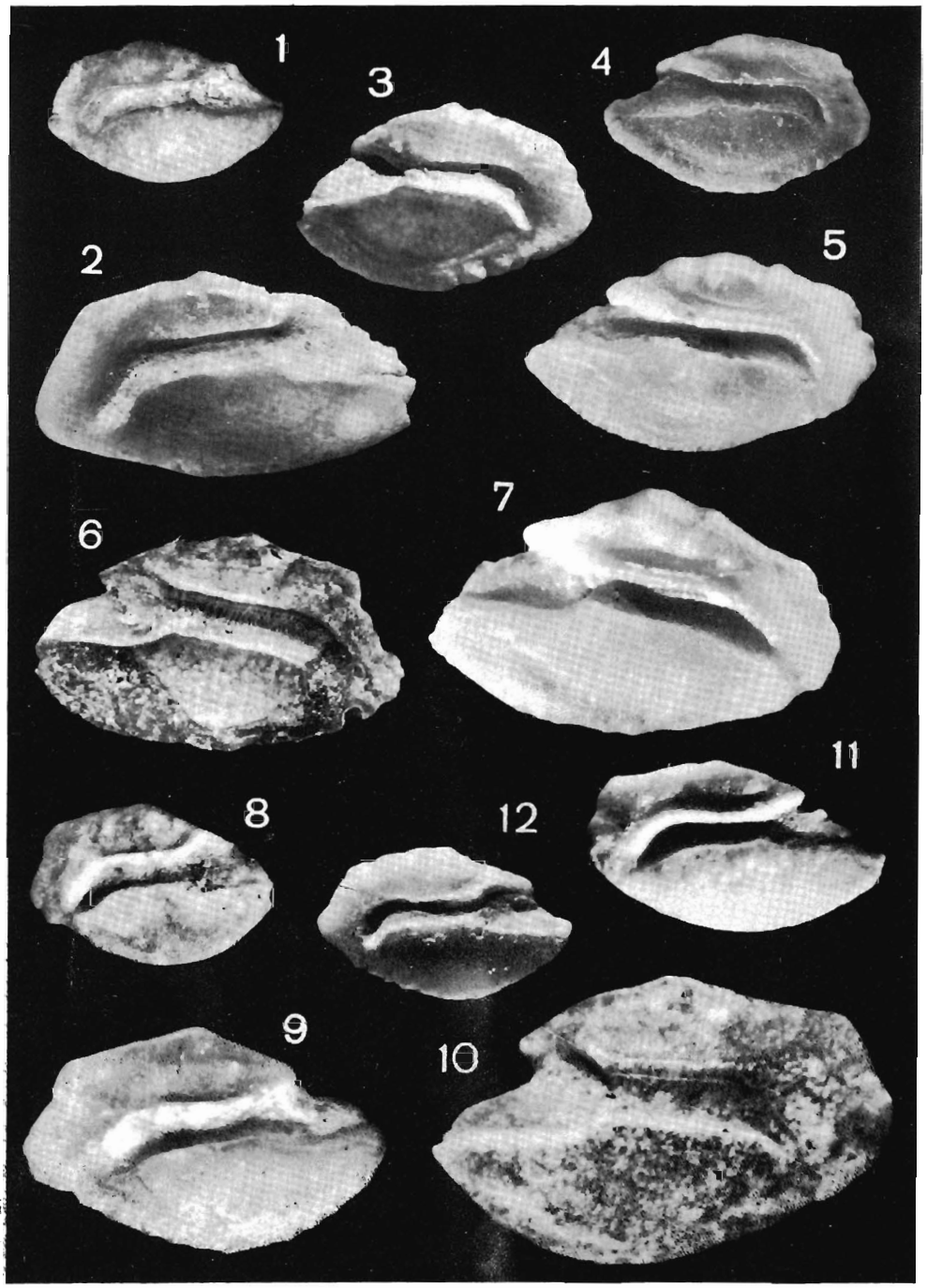
1-2 — *Spicara smaris* (LINNAEUS, 1758); left sagitta, inner face; × 15

3-8 — *Gerres* sp.; 3-7 — right sagitta, inner face; 8 — left sagitta, inner face; 3-5 × 15; 6-8 × 10

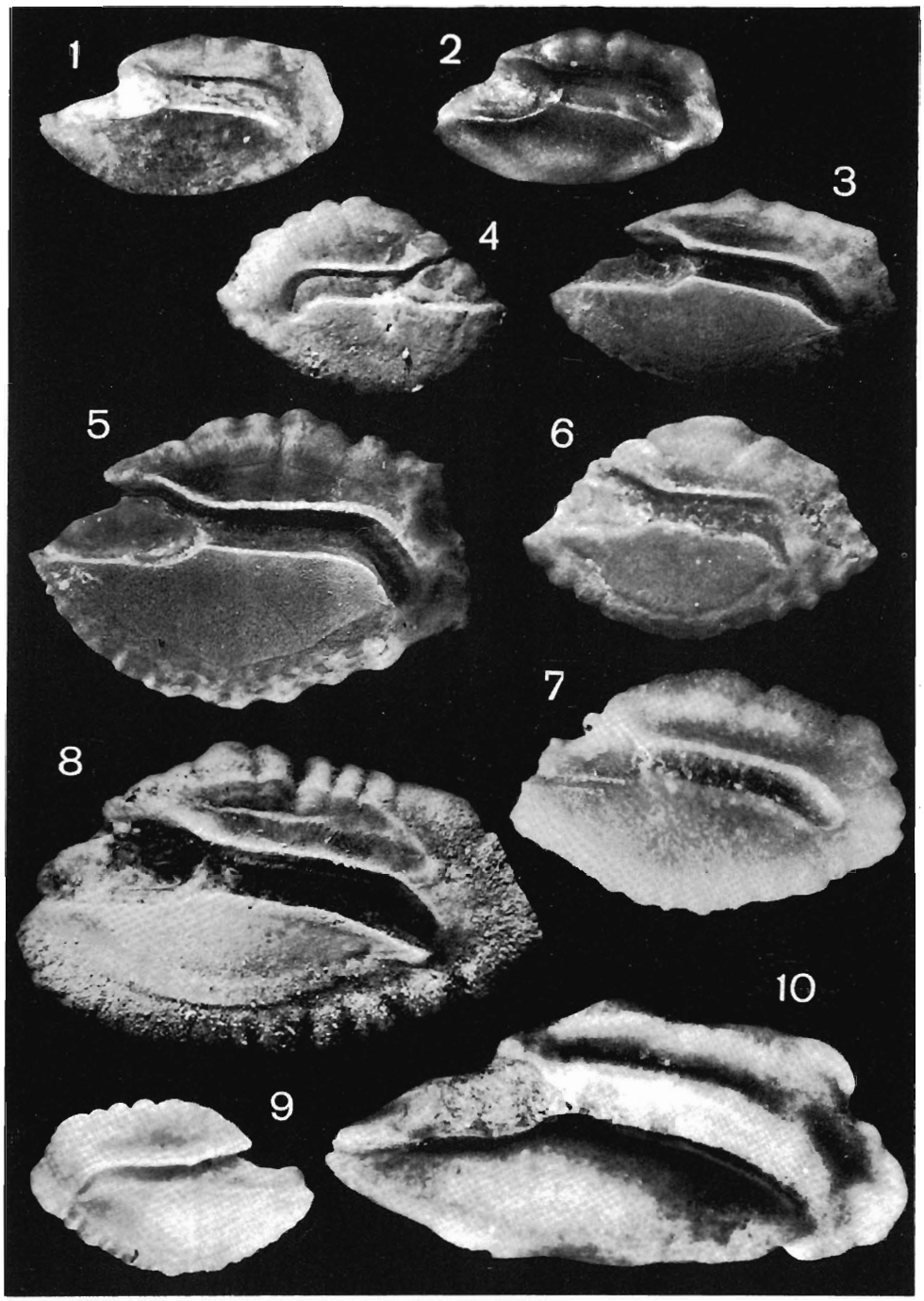
9-11 — *Brachydeuterus speronatus* (BASSOLI, 1906); 9 — right sagitta, inner face; 10-11 — left sagitta, inner face; 9, 11 × 10; 10 × 7.5



1-11 — *Brachydeuterus latior* (SCHUBERT, 1906); 1-2 and 11 — left sagitta, inner face; 3-10 — right sagitta, inner face; 1-2 and 9-11 × 10; 3-8 × 7.5



1-4 — *Boops neogenicus* STEURBAUT & JONET, 1982; 1-2 — left sagitta, inner face; 3-4 — right sagitta, inner face; × 10
5-7 — *Diplodus karrerae* NOLF & STEURBAUT, 1979; right sagitta, inner face; 5, 7 × 15; 6 × 10
8-10 — *Diplodus* sp. 2; 8-9 — left sagitta, inner face; 10 — right sagitta, inner face; × 15
11-12 — *Diplodus* sp. 1; left sagitta, inner face; × 12



1-3 — *Pagellus* sp.; right sagitta, inner face; × 10

4-6 — *Pagellus* aff. *erythrinus* (Linnaeus, 1758); 4 — left sagitta, inner face; 5-6 — right sagitta, inner face; 4, 6 × 15; 5 × 10

7-9 — *Pagellus albuquerquae* Steurbaut & Jonet, 1982; 7-8 — right sagitta, inner face; 9 — left sagitta, inner face; × 15

10 — *Pagellus acarne* (Risso, 1826); right sagitta, inner face; × 10

are well developed. On the anterior rim developed are: an antirostrum, a narrow excisura, and a bluntly-ended rostrum. Inner face is slightly convex. Sulcus acusticus is deeply incised. Ostium is wide. Cauda is narrow and it descends obliquely towards the ventral rim. Area is well developed. Outer face is slightly concave, furnished with radial furrows.

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* STEURBAUT & JONET 1982, Pl. 5, Fig. 8). To the synonymy of this species, one of the specimens described by ŚMIGIELSKA (1973, Pl. 1, Fig. 8) as "*Centropristis integer* SCHUBERT", should certainly be included, although its state of preservation is so poor that such a suggestion cannot be justified.

Pagellus aff. *erythrinus* (LINNAEUS, 1758)
(Text-fig. 106 and Pl. 24, Figs 4-6)

1979. *Pagellus* aff. *erythrinus* (LINNAEUS, 1758); D. NOLF & E. STEURBAUT, p. 11, Pl. 3, Fig. 15.
1979. *Pagellus* aff. *erythrinus* (LINNAEUS, 1758); J. LANCKNEUS & D. NOLF, p. 92, Pl. 3, Fig. 4.
1985. *Pagellus* aff. *erythrinus* (LINNAEUS, 1758); D. NOLF, p. 88.

MATERIAL: Korytnica – 17 specimens, well preserved.

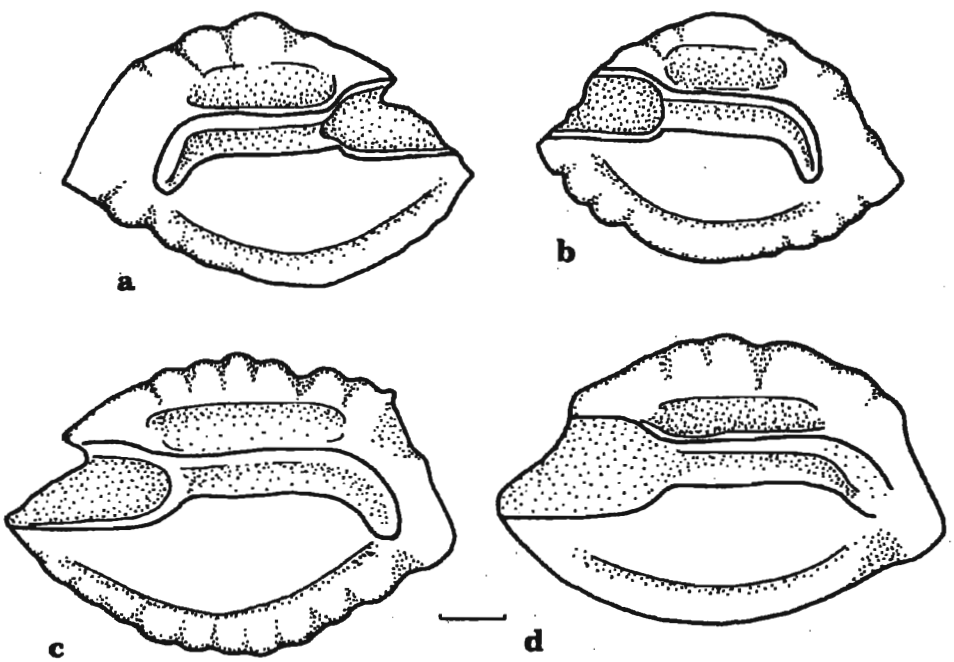


Fig. 106. *Pagellus* aff. *erythrinus* (LINNAEUS, 1758)
a – Left sagitta, inner face; b, c, d – right sagitta, inner face

Coll. numbers	L	H	T	Figured in: Text-fig. 106	Pl. 24
RaK-304	7.0	4.3	1.0	Fig. 106c	Fig. 5
RaK-303	3.3	2.2	0.7	Fig. 106b	Fig. 6

DESCRIPTION: Otoliths large, slightly trapezoidal in outline. Dorsal rim is convex and crenulated. Posterior rim is straight, running obliquely towards the dorsal rim. Posterodorsal and posteroventral corners are distinct. On the anterior rim developed are: a more or less pronounced antirostrum, a shallow excisura, and a relatively short rostrum. Inner face is convex. Sulcus acusticus is deeply incised. Ostium is relatively narrow. Cauda is narrow and long; in its posterior part, it distinctly turns towards the ventral rim. Outer face is concave.

REMARKS: The studied otoliths are very close to those of the present-day species *Pagellus erythrinus* (LINNAEUS, 1758) living in the Mediterranean (*see* LANCKNEUS & NOLF 1979, Pl. 3, Fig. 3). The fossil specimens differ indistinctly from the present-day ones by their lesser height in relation to their elongation. This species has not hitherto been reported from Poland.

Pagellus sp.
(Text-fig. 107 and Pl. 24, Figs 1-3)

MATERIAL: Korytnica – 3 specimens, well preserved; Bęczyn – one specimen, not very well preserved; all juvenile.

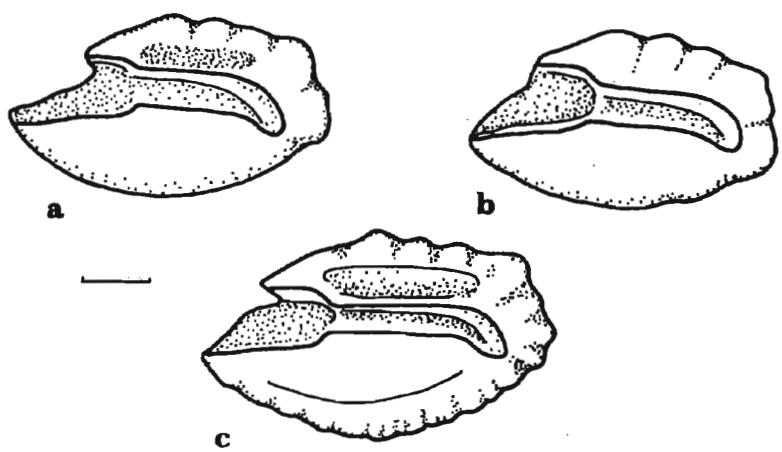


Fig. 107. *Pagellus* sp.

a, b, c – Right sagitta, inner face

Coll. numbers	L	H	Figured in: Text-fig. 107	Pl. 24
RaK-300	5.0	3.0	Fig. 107c	Fig. 3
RaK-298	4.8	2.6	Fig. 107a	Fig. 1
RaB-299	4.5	2.5	Fig. 107b	Fig. 2

DESCRIPTION: Otoliths elongated, slightly rectangular in outline. Dorsal rim is straight, slightly crenulated. Posterodorsal and posteroventral corners are distinct. On the anterior rim developed are: a pronounced antirostrum, a deep excisura, and a long, sharply-ended rostrum. Inner face is slightly convex. Sulcus acusticus is deeply incised. Ostium is wide. Cauda is narrow; in its posterior part, it turns towards the ventral rim. Area is well developed. Outer face is concave.

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus, are herein assigned to the genus *Pagellus* VALENCIENNES, 1830. A juvenile nature of the collected specimens does not allow to recognize their specific attribution. Such forms have not hitherto been reported from Poland.

Genus *Pagrus* CUVIER, 1817

Pagrus distinctus (KOKEN, 1891)
(Text-fig. 108 and Pl. 25, Figs 6-10)

1891. *Otolithus (Serranus) distinctus* KOKEN; E. KOKEN, p. 125, Pl. 10, Fig. 2.
1942. *Pagrus distinctus* KOK.; W. WEILER, p. 43, Pl. 9, Figs 1-5.
1965. *Pagrus distinctus* (KOKEN); A. ZILCH, p. 477, Pl. 37, Fig. 11.
?1973. *Pagrus distinctus* (KOKEN); T. ŚMIGIELSKA, p. 17, Text-fig. 2 and Pl. 3, Fig. 4.
1974. *Pagrus distinctus* (KOKEN, 1891); W. SCHWARZHANS, p. 114, Text-fig. 42.
1974. *Pagrus gaemersi* n. sp.; W. SCHWARZHANS, p. 115, Text-figs 44-45 and Pl. 2, Fig. 10.
1974. *Pagrus* sp.; W. SCHWARZHANS, p. 115, Text-fig. 43.
1977. *Pagrus distinctus* (KOKEN, E., 1891); D. NOLF, p. 52, Pl. 15, Fig. 9.
1985. *Pagrus distinctus* (KOKEN, 1891); D. NOLF, p. 88.

MATERIAL: Rybnica – 98 specimens, in majority well preserved; Korytnica – 4 specimens, well preserved; Nawodzice – 2 specimens, badly preserved; Węglinek – one specimen, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 108	Pl. 25
RaR-311	6.5	4.2	0.8	Fig. 108b	Fig. 10
RaR-310	6.3	4.5	0.8	Fig. 108a	Fig. 9
RaR-312	5.8	3.6	0.8	Fig. 108d	Fig. 8

DESCRIPTION: Otoliths rhomboidal in outline. Dorsal rim is convex, and it may be irregularly folded. Posterior rim is irregularly shaped, in some specimens sharply ended, in

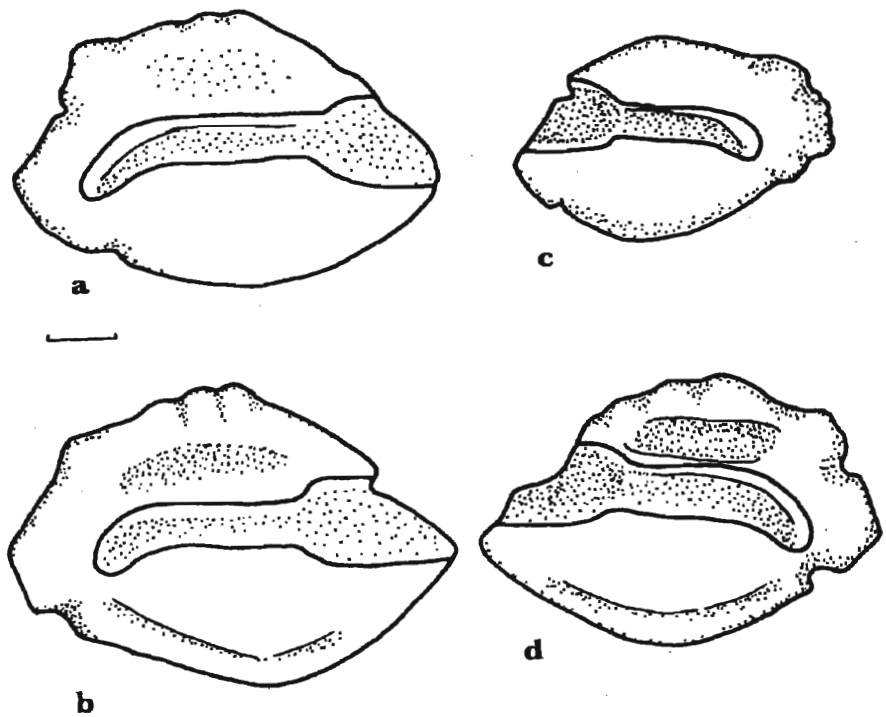


Fig. 108. *Pagrus distinctus* (KOKEN, 1891)

a, b – Left sagitta, inner face; **c, d** – right sagitta, inner face

the others furnished with incisions in the ventral and dorsal faces (*see* Text-fig. 108 and Pl. 25, Figs 7-10). Ventral rim is regularly convex. On the anterior rim developed are: a shallow excisura, and a short, bluntly-ended rostrum. Inner face is convex. Ostium is short, oval in outline. Cauda is also short; and in its posterior part it turns towards the ventral rim. Caudale crista superior is slightly depressed. Outer face is concave.

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* ZILCH 1965, Pl. 37, Fig. 11). The collected assemblage comprises both the juvenile (*see* Text-fig. 108c and Pl. 25, Fig. 6) as well as the adult forms (*see* Text-fig. 108a,b,d and Pl. 25, Figs 7-10), the latter displaying a greater variability of their general outline. Thus, one can distinguish the shorter forms, more rhomboidal in their outline (*see* Text-fig. 108b,d and Pl. 25, Figs 9-10), and the longer, but lower ones (*see* Text-fig. 108a,c and Pl. 25, Figs 7-8). Such a variability is observable also within the specimens coming from other localities in Europe (*see* SCHWARZHANS 1974, NOLF 1977). The species *Pagrus distinctus* (KOKEN, 1891) has already been reported by ŚMIGIELSKA (1973) from Niskowa, and it was represented by two specimens. A poor preservation of those otoliths and their juvenile nature do not allow to include them unequivocally to the synonymy of the species.

Subfamily **Denticinae** Bleeker, 1876
Genus *Dentex* Cuvier, 1814

Dentex gibbosus (Rafinesque, 1810)
(Text-fig. 109 and Pl. 26, Figs 1-2)

non 1906. *Otolithus (Chrysophris) doderleini* Bass. et Schub.; G. Bassoli, p. 52, Pl. 2, Fig. 34.
1906. *Otolithus (Chrysophris) doderleini* Bass. et Schub. n. sp; R. Schubert, p. 631, Pl. 4, Fig. 48 (*non* Figs 46-47).
1979. *Dentex gibbosus* Rafinesque, 1810; D. Nolf, p. 6, Pl. 1, Figs 11-14.
1979. *Dentex (Cheimerius)* aff. *gibbosus* (Rafinesque, 1810); D. Nolf & E. Steurbaut, p. 11, Pl. 4, Fig. 11.
1982. *Dentex gibbosus* (Rafinesque, 1810); E. Steurbaut & S. Jonet, p. 205, Pl. 3, Fig. 7.
1984. *Dentex (Cheimerius) gibbosus* (Rafinesque, 1810); E. Steurbaut, p. 92, Pl. 26, Figs 18-24.
1985. *Dentex* aff. *gibbosus* (Rafinesque, 1810); D. Nolf, p. 88.

MATERIAL: Korytnica — 3 immature specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 109	Pl. 26
RaK-316	5.0	3.7	Fig. 109b	Fig. 1
RaK-317	4.0	2.9	Fig. 109a	Fig. 2

DESCRIPTION: Otoliths elongated in outline. Dorsal rim is irregular, furnished with numerous crenulations, separated by furrows. Both posterodorsal and posteroventral corners are well developed. Ventral rim is regularly convex and, sometimes, it may be either smooth or slightly corrugated. On the anterior rim, a pronounced rostrum is well developed. Inner face is convex. Ostium is large and long. Cauda is narrower, bending posteriorly towards the ventral rim. Outer face is concave.

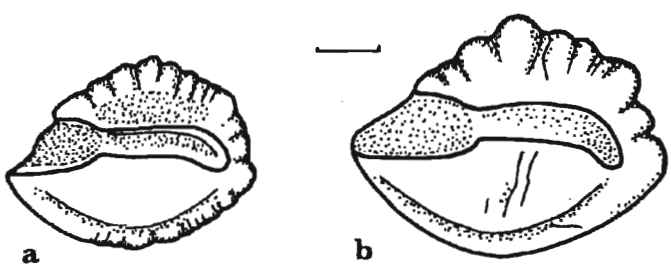


Fig. 109. *Dentex gibbosus* (Rafinesque, 1810)

a, b — Right sagitta, inner face

REMARKS: The studied otoliths are compatible with those of the present-day species *Dentex gibbosus* (Rafinesque, 1810) living in the Mediterranean (*see* Steurbaut 1984, Pl. 26, Fig. 18). All collected specimens are characterized with their small size referrable to their immaturity. The species has not hitherto been reported from Poland.

Dentex gregarius (KOKEN, 1891)
(Text-fig. 110 and Pl. 26, Figs 8-12)

1891. *Otolithus* (*Sparidarum*) *gregarius* KOKEN.; E. KOKEN, p. 128, Text-figs 18-20 and Pl. 7, Figs 7-8.
1906. *Otolithus* (*Pagellus*) *gregarius* KOK.; G. BASSOLI, p. 52, Pl. 2, Fig. 35.
1906. (*Pagellus?*) *gregarius* KOKEN; R. SCHUBERT, p. 630, Pl. 4, Figs 23-29.
1950. *Pagellus gregarius* (KOKEN); W. WEILER, p. 223, Pl. 3, Fig. 18 and Pl. 4, Figs 20-21.
1958. *Dentex gregarius* (KOKEN, 1891); W. WEILER, p. 339, Pl. 2, Figs 19-20.
1966. *Pagellus gregarius* (KOKEN)?; T. ŚMIGIELSKA, p. 255, Pl. 17, Fig. 6.
1971. *Dentex gregarius* (KOKEN) 1891; P. GAEMERS, p. 246, Pl. 2, Fig. 8; Pl. 3, Figs 3, 15 and Pl. 7, Fig. 2.
1973. *Dentex gregarius* (KOKEN) 1891; S. JONET, p. 189, Text-fig. 13 (items 13-14) and Pl. 3, Figs 74-75 (*non* Figs 76-77).
1977. *Dentex gregarius* (KOKEN, E., 1891); D. NOLF, p. 54, Pl. 15, Figs 18-20.
1979. *Dentex gregarius* (KOKEN, 1891); T. ŚMIGIELSKA, p. 319, Text-fig. 22 and Pl. 6, Figs 3-4.
1979. *Smaris elegans* (PROCHÁZKA, 1893); T. ŚMIGIELSKA, p. 320, Text-fig. 23 and Pl. 5, Figs 6-7.
1979. *Dentex* (*Polysteganus*) aff. *gregarius* (KOKEN, 1891); D. NOLF & E. STEURBAUT, p. 12, Pl. 4, Figs 1-6.
1982. *Dentex* aff. *gregarius* (KOKEN, 1891); E. STEURBAUT & S. JONET, p. 206, Pl. 3, Figs 8-9.
1984. *Dentex* (*Polysteganus*) aff. *gregarius* (KOKEN, 1891); E. STEURBAUT, p. 92, Pl. 28, Figs 1-5.
1985. *Dentex gregarius* (KOKEN, 1891); D. NOLF, p. 88.

MATERIAL: Korytnica – 263 specimens, in majority well preserved.

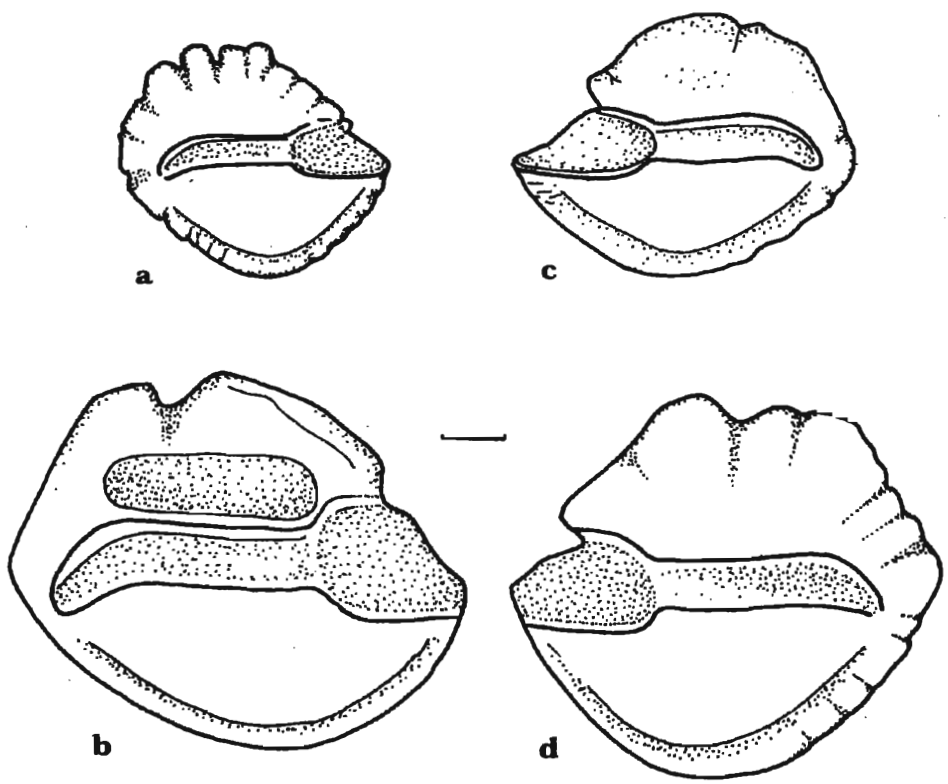


Fig. 110. *Dentex gregarius* (KOKEN, 1891)

a, b – Left sagitta, inner face; c, d – right sagitta, inner face

Coll. numbers	L	H	T	Figured in: Text-fig. 110	Pl. 26
RaK-322	7.8	6.7	1.7	--	Fig. 12
RaK-321	6.2	5.5	1.2	Fig. 110d	Fig. 11

REMARKS: The studied otoliths are concordant with those of the type series which, described by KOKEN (1891) as "*Otolithus* (*Sparidarum*) *gregarius*", represents an assemblage of forms varying in their morphology, particularly in their height and development of the rostrum. A similar variability is displayed by the investigated material, coming from the Korytnica Basin, and containing both otoliths relatively high, with a more or less projecting rostrum (*see* Text-fig. 110a,d and Pl. 26, Figs 11-12), as well as specimens of much lesser height (*see* Text-fig. 110b; *and* ŚMIGIELSKA 1979, Pl. 6, Fig. 4).

A great variability of shapes in the specimens of *Dentex gregarius* (KOKEN, 1891) involved diverse interpretations of their taxonomy. NOLF & STEURBAUT (1979) proposed to include the higher otoliths, with the more projecting rostrum, into a separate species, related to "*gregarius*". This interpretation does seem to be well argued, because the type series (*see* KOKEN 1891) comprises the specimens in which the features distinguished by NOLF & STEURBAUT (1979) appear independently of each other. Of all the otoliths illustrated by ŚMIGIELSKA (1979) from the Korytnica Basin, to the synonymy of the species *Dentex gregarius* (KOKEN, 1891) included are, apart from these designated with this very specific name, also those labelled as "*Smaris elegans* (PROCHÁZKA, 1893)". According to the present author, the latter forms (*see* ŚMIGIELSKA 1979, Pl. 5, Figs 6-7), should be classified as juvenile ones of the species "*gregarius*", as they are well comparable to one of the specimens illustrated by KOKEN (1891, Text-fig. 20) and to some of the personally collected material (*see* Text-fig. 110a,c and Pl. 26, Figs 8-10).

Dentex aff. *macrophthalmus* (BLOCH, 1791)
(Text-fig. 111 and Pl. 26, Figs 4-7)

1906. *Otolithus* (*Smaris?*) *elegans* PROCH.; R. SCHUBERT, p. 632, Pl. 18, Fig. 36 (*non* Figs 38-39).
1979. *Parequula crenata* sp. n.; T. ŚMIGIELSKA, p. 321, Text-fig. 24 and Pl. 5, Figs 4-5.
1982. *Dentex* aff. *macrophthalmus* (BLOCH, 1791); E. STEURBAUT & S. JONET, p. 206, Pl. 3, Fig. 11.
1983. *Dentex* aff. *macrophthalmus* (BLOCH, 1791); D. NOLF & E. STEURBAUT, p. 184, Pl. 7, Fig. 13.
1984. *Dentex* (*Polystegamus*) aff. *macrophthalmus* (BLOCH, 1791); E. STEURBAUT, p. 93, Pl. 28, Figs 10-16.
1985. *Dentex* aff. *macrophthalmus* (BLOCH, 1791); D. NOLF, p. 88.

MATERIAL: Korytnica – 160 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 111	Pl. 26
RaK-327	5.5	4.8	0.9	Fig. 111e	Fig. 4
RaK-324	5.4	4.8	0.8	Fig. 111d	Fig. 7

REMARKS: The studied otoliths are very close to those of the present-day species *Dentex macrophthalmus* (BLOCH, 1791), known from the Mediterranean and from the Atlantic coastal waters of northern Africa (*see* NOLF 1979, STEURBAUT 1984). The fossil specimens differ from those of the present-day fish by their more rhomboidal outline.

Otoliths of this species have formerly been described from the Korytnica Basin by ŚMIGIELSKA (1979) as "*Parequula crenata* sp. n.".

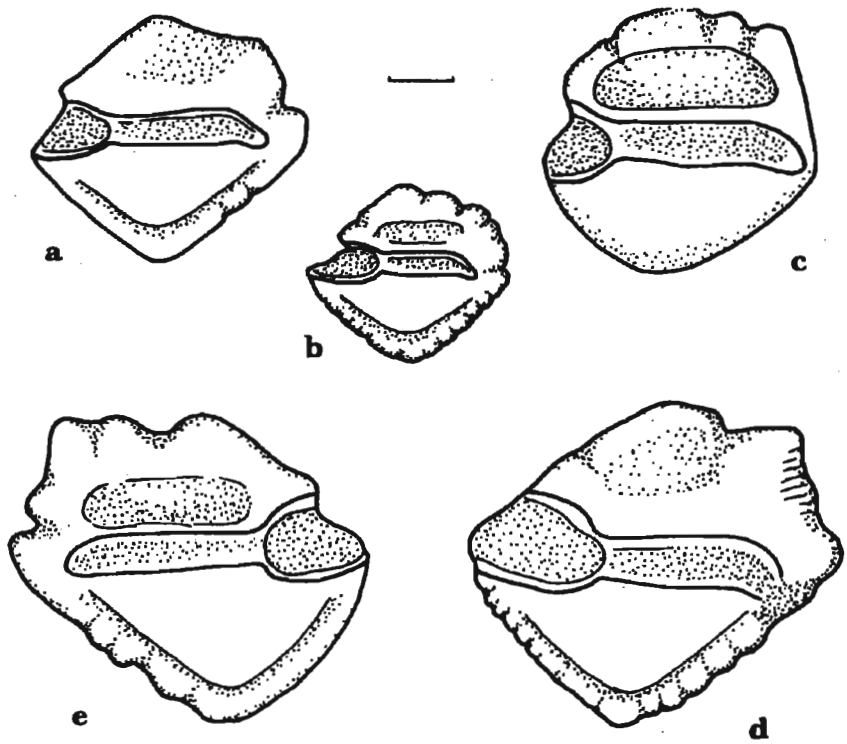


Fig. 111. *Dentex* aff. *macrophthalmus* (BLOCH, 1791)

a, b, c, d – Right sagitta, inner face; e – left sagitta, inner face

A great similarity of the Korytnica specimens, both these presently studied and those reported by ŚMIGIELSKA (1979), to the otoliths of the present-day species *Dentex macrophthalmus* (BLOCH, 1791), indicates that their treatment as the species of a marked affinity to the present-day one is more reasonable than the creation of a new taxon.

Genus *Spondyliosoma* CANTOR, 1849

Spondyliosoma aff. *cantharus* (LINNAEUS, 1758) (Text-fig. 112 and Pl. 25, Figs 2-5)

MATERIAL: Korytnica – 16 juvenile specimens, in majority well preserved.

Coll.				Figured in:	
numbers	L	H	T	Text-fig. 112	Pl. 25
RaK-332	6.8	3.8	0.8	Fig. 112b	Fig. 5
RaK-329	6.5	3.7	0.8	Fig. 112a	Fig. 4

DESCRIPTION: Otoliths relatively thick, strongly elongated. Dorsal rim is convex and slightly undulant. Posterior rim is irregular and sharply ended. Ventral rim is regularly convex, and obtusely angled at its midlength. On the anterior rim developed are: an antirostrum, a more or less deeply set excisura, and a long, bluntly-ended rostrum. Inner face is strongly convex. Sulcus acusticus is deeply incised. Ostium is wide, oval, and slightly gaping. Cauda is narrower, straight or slightly depressed anteriorly, and distinctly turning towards the ventral rim posteriorly. Area is well developed. Outer face is concave.

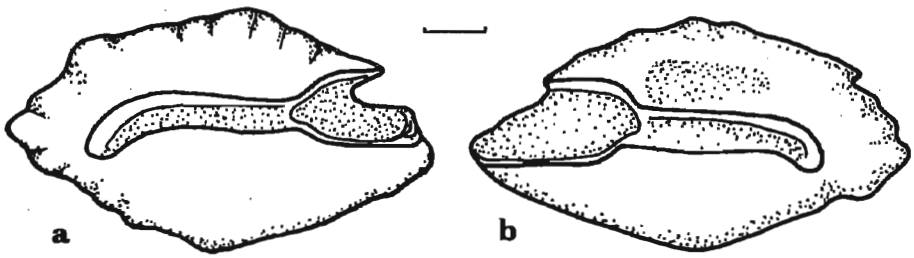


Fig. 112. *Spondyliosoma* aff. *cantharus* (LINNAEUS, 1758)

a — Left sagitta, inner face; b — right sagitta, inner face

REMARKS: The studied otoliths are very close to those of the present-day species *Spondyliosoma cantharus* (LINNAEUS, 1758) living in the Mediterranean (*see* CHAINE 1937, Pl. 16). The Korytnica specimens represent juvenile forms only, and they differ from those of the present-day fish in the outline of their ventral rim. Such forms have not hitherto been reported from Poland.

"genus *Sparidarum*" sp.
(Text-fig. 113 and Pl. 26, Fig. 3)

MATERIAL: Rybnica — 4 juvenile specimens, badly preserved.

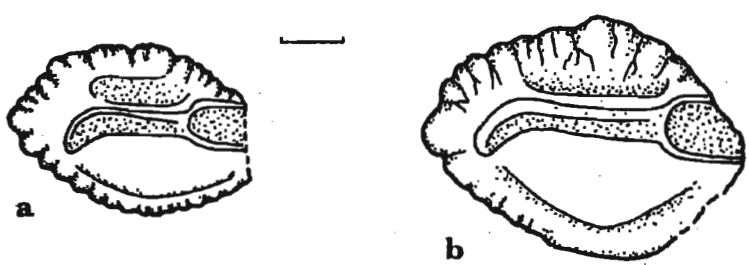


Fig. 113. "genus *Sparidarum*" sp.

a, b — Left sagitta, inner face

Coll. number	L	H	Figured in: Text-fig. 113	Pl. 26
RaR-334	4.0	2.7	Fig. 113a	Fig. 3

DESCRIPTION: Otoliths of an oval outline, with crenulated rims. Both dorsal and as well as ventral rim is regularly convex. Posterior rim is straight, oblique to the dorsal rim. Inner face is convex. Ostium is short, oval. Cauda is narrow, depressed at its midlength, and turning towards the ventral rim posteriorly. Outer face is concave.

REMARKS: The studied otoliths display the features typical of the family Sparidae BONAPARTE, 1832. Their poor state of preservation and juvenile nature do not allow to recognize their more precise taxonomic attribution.

Family **Sciaenidae** CUVIER, 1826
Genus *Argyrosomus* DE LA PYLAIE, 1835

Argyrosomus regius (Asso, 1801)
(Text-fig. 114 and Pl. 27, Figs 1-3)

1973. *Sciaena aquila* RISSO, 1826; S. JONET, p. 176, Text-fig. 12 (item 12) and Pl. 3, Fig. 65.
1973. *Sciaena pyrenaica* (PRIEM) 1911; S. JONET, p. 177, Text-fig. 12 (item 16) and Pl. 3, Fig. 66.
1973. *Sciaena* sp.; S. JONET, p. 179, Text-fig. 12 (item 18) and Pl. 3, Fig. 70.
1979. *Sciaena* cf. *aquila* LACÉPÈDE; T. ŚMIGIELSKA, p. 318, Pl. 7, Fig. 1.
1982. *Argyrosomus regius* (ASSO, 1801); E. STEURBAUT & S. JONET, p. 206, Pl. 3, Fig. 12.
1984. *Argyrosomus incisus* sp. n.; U. RADWAŃSKA, p. 307, Text-fig. 11 and Pl. 3, Figs 1-2.
1984. *Argyrosomus regius* (ASSO, 1801); E. STEURBAUT, p. 94, Pl. 28, Figs 17-19.
1985. *Argyrosomus regius* (ASSO, 1801); D. NOLF, p. 89.

MATERIAL: Korytnica — 7 juvenile specimens, not very well preserved (with their inner face worn).

Coll. number	L	H	T	Figured in: Text-fig. 114	Pl. 27
RaK-487	12.0	7.0	6.0(max)	Fig. 114a,a'	Fig. 1a-1b

REMARKS: Otoliths of this species have already been described twice from the Korytnica Basin (ŚMIGIELSKA 1979, RADWAŃSKA 1984). Although the present author has formerly (RADWAŃSKA 1984) established a separate species, *Argyrosomus incisus*, a comparison with the otoliths (NOLF's Collection) of the present-day species *A. regius* (Asso, 1801) allows to state that all the collected specimens from the Korytnica Basin represent juvenile forms of the latter species. All Korytnica specimens are much smaller than those of the adult forms of the present-day fish, and most of them display their inner face worn. These very disopportunities have formerly caused an inproper taxonomic recognition of the discussed specimens.

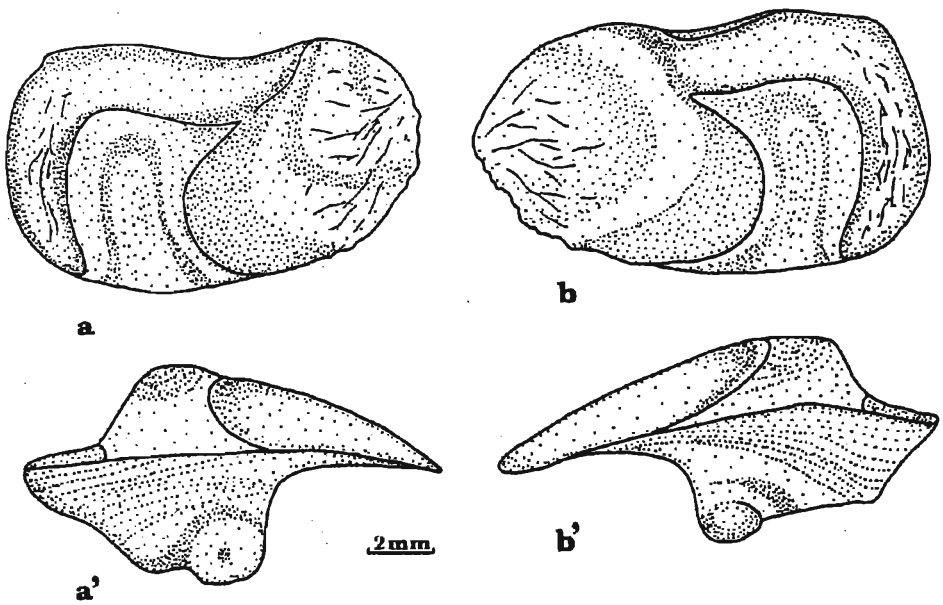


Fig. 114. *Argyrosomus regius* (Asso, 1801)

a — Left sagitta, inner face; b — right sagitta, inner face; a', b' — ventral view; the same specimens as illustrated formerly (Radwańska 1984, Fig. 11)

Genus *Sciaena* Linnaeus, 1758

Sciaena polonica (Radwańska, 1984) (Text-fig. 115 and Pl. 28, Figs 1-2)

?1950. *Sciaena pecchioli* Lawley, 1876; W. Weiler, p. 224, Pl. 3, Fig. 1.
1979. *Sciaena pecchioli* Lawley, 1876; T. Śmigielska, p. 317, Text-fig. 21 and Pl. 7, Fig. 2.
1984. *Argyrosomus polonicus* sp. n.; U. Radwańska, p. 309, Text-figs 13-14 and Pl. 4, Figs 1-3.

MATERIAL: Korytnica — 6 specimens, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 115	Pl. 28
RaK-483-holotype	9.5	6.0	4.0(max)	Fig. 115a,a'	Fig. 1a-1c

REMARKS: This species has originally been assigned (Radwańska 1984) to the genus *Argyrosomus* De La Pylaie, 1835. A comparison with otoliths (Nolf's Collection) of the present-day

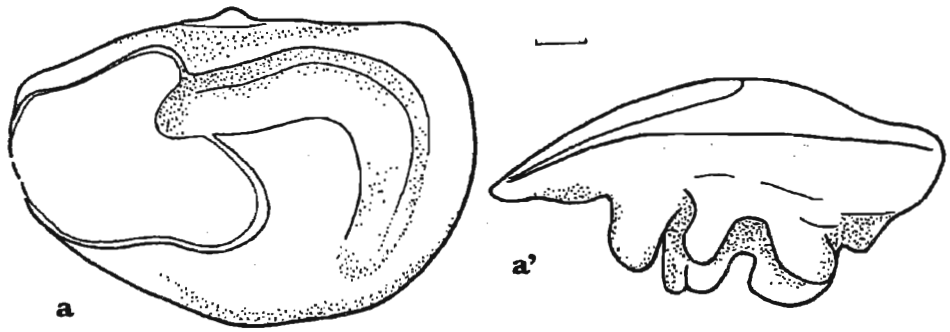


Fig. 115. *Sciaena polonica* (RADWAŃSKA, 1984)

Holotype reillustrated (*see* RADWAŃSKA 1984, Fig. 13 item 1a-1b): **a** — right sagitta, inner face, **a'** — ventral view

species of the genus *Sciaena* LINNAEUS, 1758, clearly indicates that this ancient species should be transferred to that very genus.

Sciaena rybnicensis sp. n.
(Text-fig. 116 and Pl. 29, Figs 1-5)

HOLOTYPE: The specimen No. RaR-481, presented in Text-fig. 116a,a',a" and Pl. 29, Fig. 2.
TYPE LOCALITY: Rybnica, southern slopes of the Holy Cross Mountains.
TYPE HORIZON: Middle Miocene (Badenian).

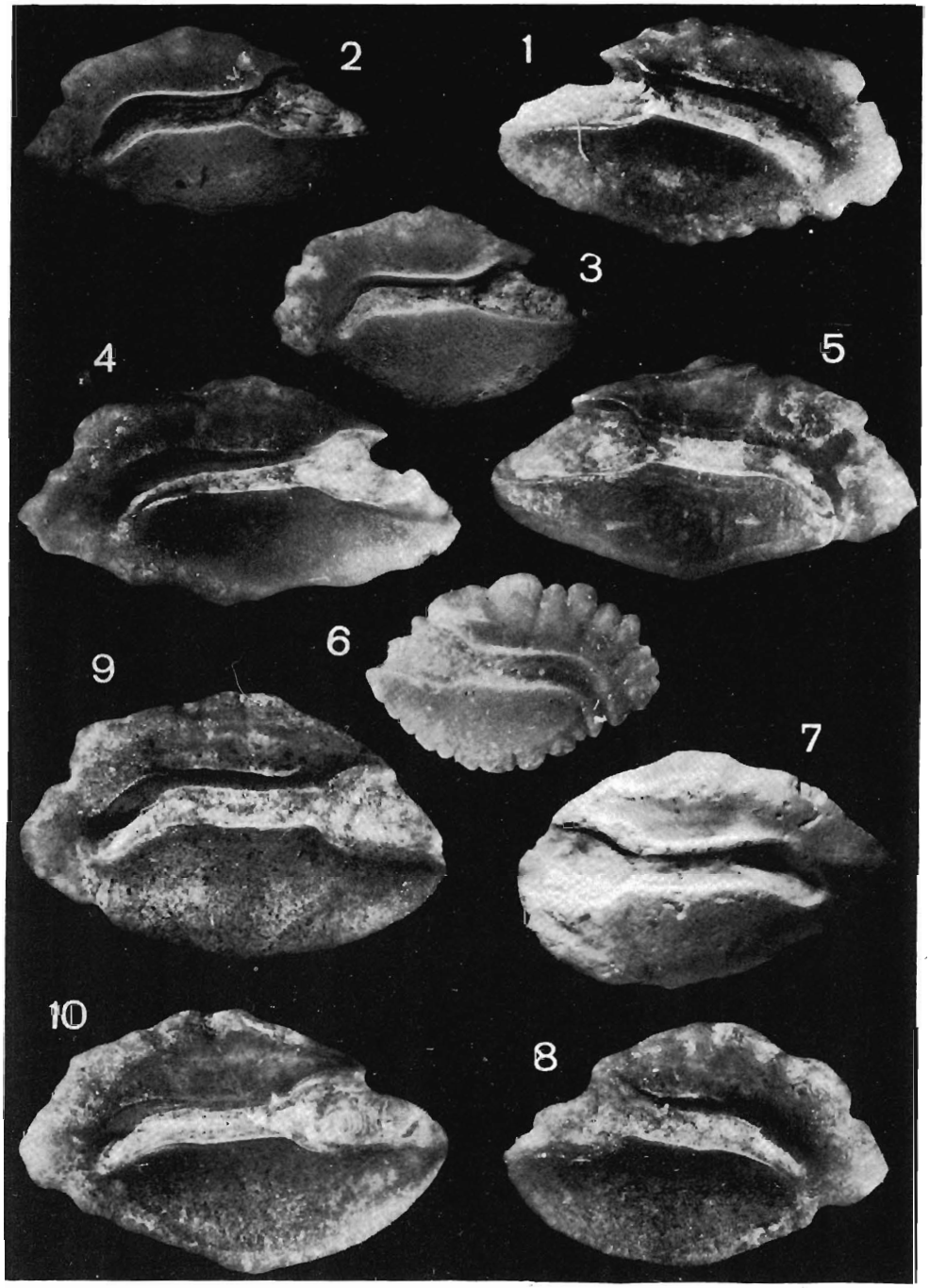
DERIVATION OF THE NAME: Referred to a Latinized name of the village in which the section yielding the type series is exposed.

DIAGNOSIS: Otolith relatively thin, semicircular in outline. Dorsal rim straight, slightly concave posteriorly. Posterodorsal corner very well developed. Ventral rim strongly convex asymmetrically. Inner face convex. Ostium wide, rectangular in outline. Cauda slightly incised. Outer face concave, alongwith elongation of the otolith, and furnished with small, flat nodes.

MATERIAL: Rybnica — 9 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 116	Pl. 29
RaR-481-holotype	9.5	8.0	2.5	Fig. 116a,a'a"	Fig. 2a-2c
RaR-482	11.5	8.0	3.0	–	Fig. 5a-5c
RaR-336	6.5	5.2	1.2	–	Fig. 4

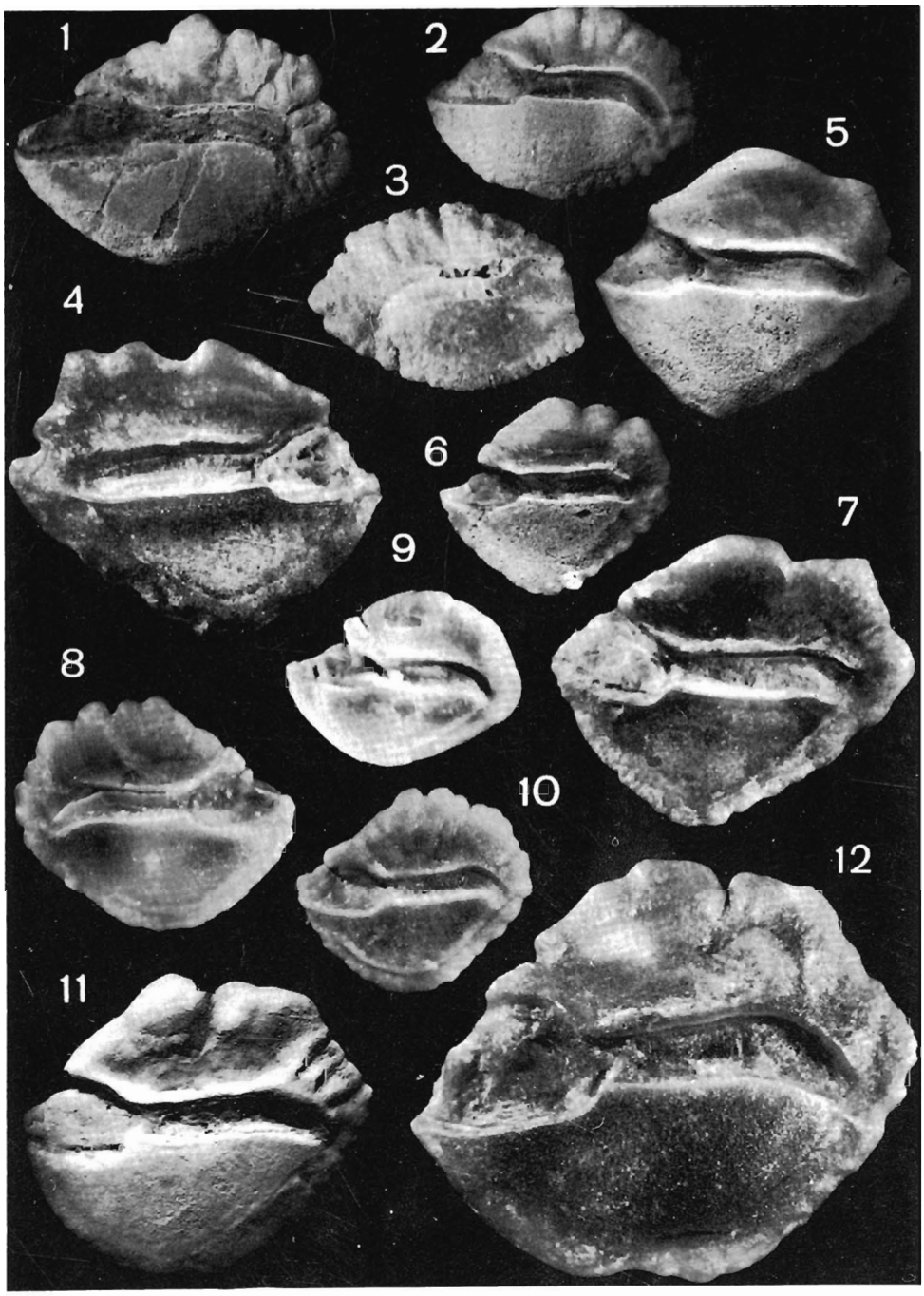
DESCRIPTION: Otoliths relatively thin, semicircular in outline. Dorsal rim is straight, sometimes furnished with a small node at its midlength, and then concave towards its posterior. In juvenile forms (*see* Pl. 29, Figs 1 and 3-4), the posterior part of the dorsal rim may be crenulated. Posterodorsal corner is very well developed. Ventral rim is asymmetrically convex. Inner face is



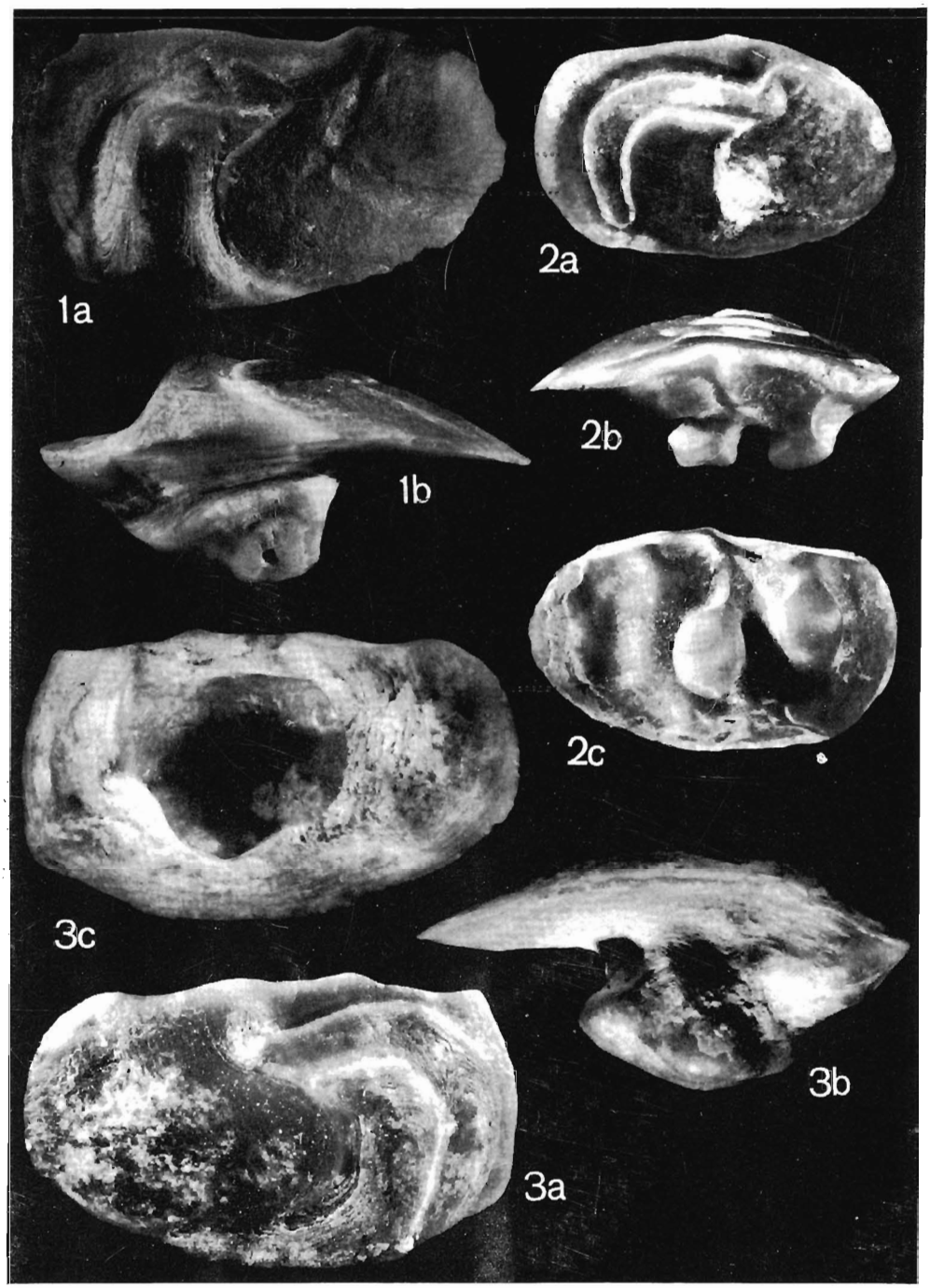
1 – *Pagellus acarne* (Risso, 1826); right sagitta, inner face; × 10

2-5 – *Spondyliosoma* aff. *cantharus* (Linnaeus, 1758); 2-4 – left sagitta, inner face; 5 – right sagitta, inner face; × 10

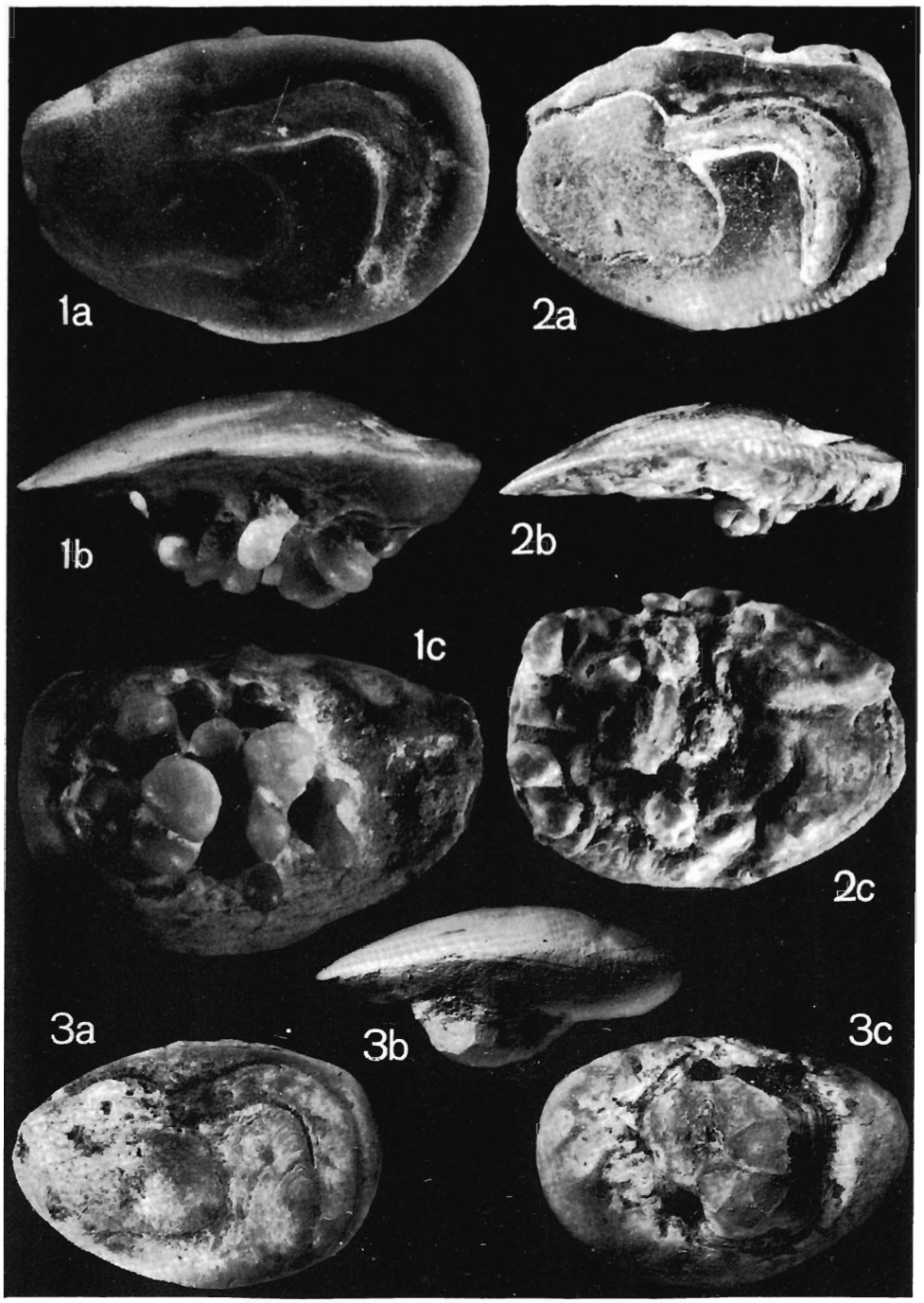
6-10 – *Pagrus distinctus* (Koken, 1891); 6-8 – right sagitta, inner face; 9-10 – left sagitta, inner face; × 10



1-2 – *Dentex gibbosus* (RAFINESQUE, 1810); right sagitta, inner face; × 10
3 – "genus *Sparidarum*" sp.; left sagitta, inner face; × 10
4-7 – *Dentex* aff. *macrophthalmus* (BLOCH, 1791); 4 – left sagitta, inner face; 5-7 – right sagitta, inner face; × 10
8-12 – *Dentex gregarius* (KOKEN, 1891); 8 – left sagitta, inner face; 9-12 – right sagitta, inner face; × 10



1-3 — *Argyrosomus regius* (Asso, 1801); 1-2 — left sagitta, *1a*, *2a* inner face, *1b* ventral view, *2b* dorsal view, *2c* outer face; 3 — right sagitta, *3a* inner face, *3b* ventral view, *3c* outer face; × 7.5; the same specimen (Fig. 1) as illustrated formerly (*see* RADWAŃSKA 1984, Pl. 3, Fig. 1a-1c)



1-2 – *Sciaena polonica* (RADWAŃSKA, 1984); right sagitta, *1a*, *2a* inner face, *1b*, *2b* ventral view, *1c*, *2c* outer face; × 7.5; the same specimen (1 – **holotype**) as illustrated formerly (*see* RADWAŃSKA 1984, Pl. 4, Fig. 1)

3 – "genus *Sciaenidarum*" sp.; right sagitta, *3a* inner face, *3b* ventral view, *3c* outer face; × 10

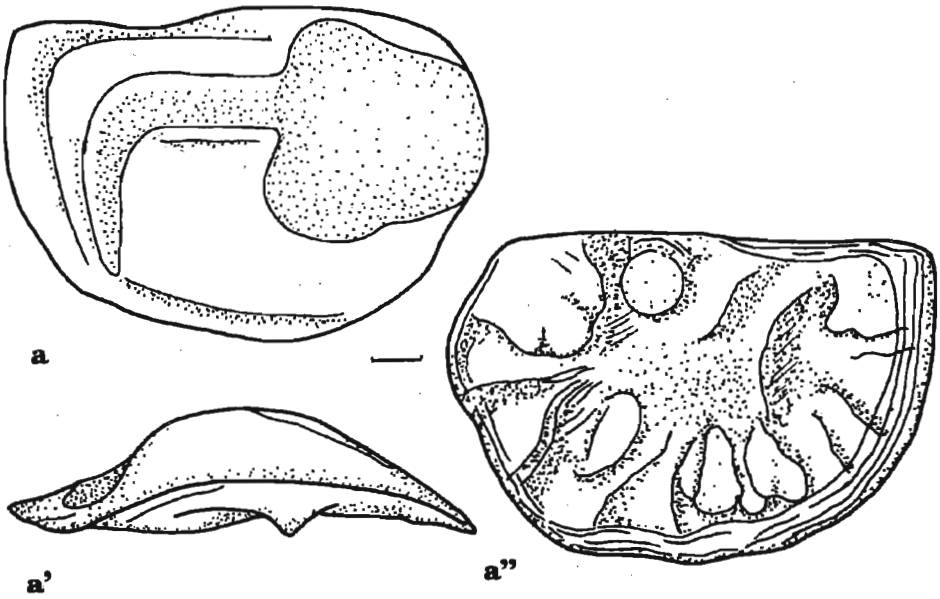


Fig. 116. *Sciaena rybnicensis* sp. n.

Holotype: a – left sagitta, inner face, **a'** – ventral view, **a"** – outer face

convex (*see* Text-fig. 116a' and Pl. 29, Figs 2b and 5b). Ostium is wide, rectangular in outline. Cauda is much narrower and slightly incised. Outer face is concave, alongwith elongation of the otolith; furnished with small, flat nodes separated by radial furrows (*see* Text-fig. 116a" and Pl. 29, Figs 2c and 5c).

REMARKS: The studied otoliths are close to those of the present-day species *Sciaena umbra* LINNAEUS, 1758, living in the Mediterranean and along the Atlantic coasts of western Africa (*see* NOLF 1977, Pl. 16, Fig. 6). The otoliths of the newly established species, *Sciaena rybnicensis* sp. n., differ from those of the indicated present-day one in their general outline, dorsal rim straight, and ventral rim more convex.

"genus *Sciaenidarum*" sp.
(Text-fig. 117 and Pl. 28, Fig. 3)

MATERIAL: Korytnica – one juvenile specimen, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 117	Pl. 28
RaK-486	6.3	4.4	3.0(max)	Fig. 117a,a'	Fig. 3a-3c

DESCRIPTION: Otolith regularly oval in outline. Inner face convex. Sulcus acusticus is weakly incised. Ostium is wide, long as far as the midlength of the otolith. Cauda is much narrower, and bent parallelly to the dorsal and posterior rims. Outer face is convex, ornamented with one, well defined and rounded node centrally.

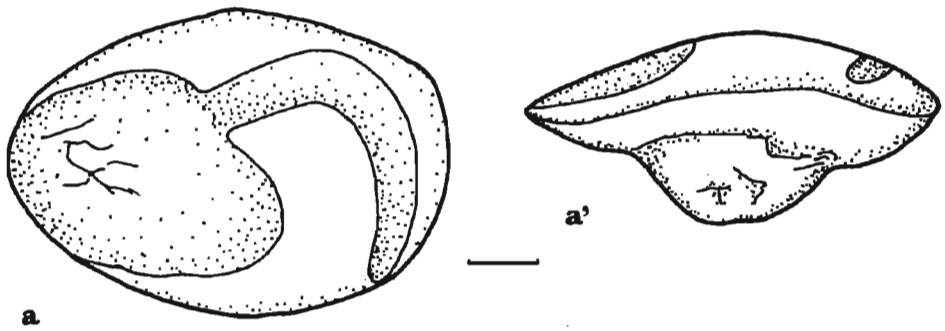


Fig. 117. "genus *Sciaenidarum*" sp.

a – Right sagitta, inner face, a' – ventral view

REMARKS: The studied otolith, due to the structure of its sulcus acusticus, is herein assigned to the family Sciaenidae CUVIER,1826. A juvenile nature of the single specimen does not allow for any more precise recognition. Such a form has not hitherto been reported from Poland.

Family **Mullidae** CUVIER & VALENCIENNES, 1828
Genus *Mullus* LINNAEUS, 1758

Mullus elongatus STEURBAUT, 1984
(Text-fig. 118 and Pl. 30, Fig. 9)

1984. *Mullus elongatus* sp. n.; E. STEURBAUT, p. 95, Pl. 29, Figs 8-12.

MATERIAL: Korytnica – 2 specimens, badly preserved.

DESCRIPTION: Otoliths elongated, triangular in outline. Dorsal rim is asymmetrically convex. All rims are crenulated. On the anterior rim, a shallow excisura may be developed. Inner

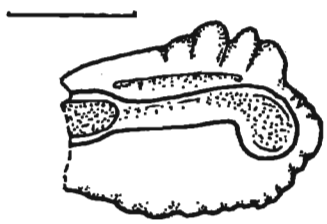


Fig. 118. *Mullus elongatus* STEURBAUT, 1984

Right sagitta, inner face

face is convex. Sulcus acusticus is typical of the genus *Mullus* LINNAEUS, 1758, as it is featured by a funnel-shaped ostium, and a narrow cauda, widened bubble-like posteriorly and deeply incised. Outer face is concave.

REMARKS: The studied otoliths, although incomplete, are consistent with the holotype of the species (*see* STEURBAUT 1984, Pl. 29, Fig. 8). Such forms have not hitherto been reported from Poland.

Mullus sp.
(Text-fig. 119 and Pl. 30, Fig. 8)

MATERIAL: Niskowa – one juvenile specimen, well preserved.

Coll. number	L	H	Figured in: Text-fig. 119	Pl. 30
RaNi-338	1.9	1.4	Fig. 119	Fig. 8

DESCRIPTION: Otolith relatively thin, triangular in outline. All rims are weakly crenulated. On the anterior rim, a deep excisura is developed. Sulcus acusticus is typical of the genus *Mullus* LINNAEUS, 1758. Area is well developed. Outer face is concave.

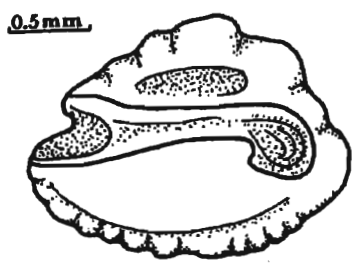


Fig. 119. *Mullus* sp.
Right sagitta, inner face

REMARKS: The studied otolith shows a marked affinity to those of the two present-day species, *Mullus barbatus* LINNAEUS, 1758, and *M. surmuletus* LINNAEUS, 1758, known from the Mediterranean (*see* CHAINE 1938, Pl. 1); its juvenile nature does not allow to recognize its specific identity.

Family **Chaetodontidae** BONAPARTE, 1832
Genus *Chaetodon* LINNAEUS, 1758

Chaetodon aff. *hoefleri* STEINDACHNER, 1882
(Text-fig. 120 and Pl. 19, Figs 5-6)

MATERIAL: Korytnica – 4 specimens, two of which are well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 120	Pl. 19
RaK-233	4.0	2.5	0.7	Fig. 120a	Fig. 5
RaK-234	2.8	1.8	0.5	Fig. 120b	Fig. 6

DESCRIPTION: Otoliths elongated, slightly rhomboidal in outline. Dorsal rim is crenulated and bent in its midlength. Ventral rim is also crenulated, particularly near to its posterior rim. At the anterior rim developed are: a pronounced antirostrum, a deeply incised excisura, and a long rostrum. Inner face is strongly convex. Sulcus acusticus is narrow. Ostium is slightly gaping. Ostiale crista superior is weakly developed. Cauda is deeply incised, narrow, and in its posterior part it distinctly bends towards the ventral rim. Area is well developed. Outer face is concave, furnished with tiny grooves along its rims.

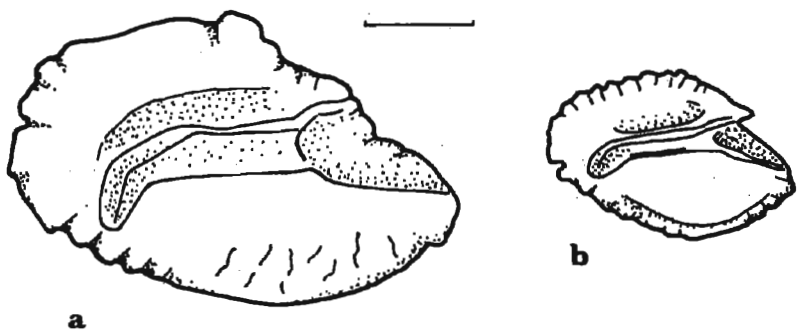


Fig. 120. *Chaetodon* aff. *hoefleri* STEINDACHNER, 1882

a, b — Left sagitta, inner face

REMARKS: The studied otoliths are close to those of the present-day species *Chaetodon hoefleri* STEINDACHNER, 1882, living in the coastal waters of Angola (*see* Text-fig. 121), from which they differ in their inner face less convex. Neither that species nor the genus of these tropical fish have hitherto been reported from Poland.

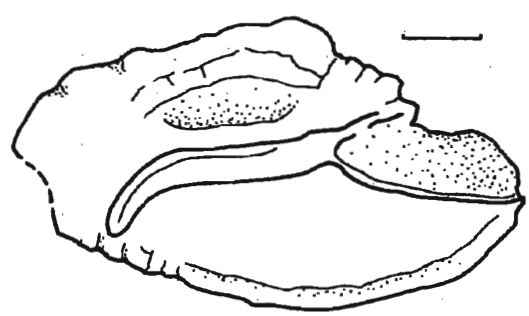


Fig. 121. *Chaetodon hoefleri* STEINDACHNER, 1882

Present-day specimen: left sagitta, inner face; Western Africa (NOLF's Collection)

"genus *Chaetodontidarum*" sp.
(Text-fig. 122 and Pl. 32, Figs 5-6)

MATERIAL: Korytnica – 4 specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 122	Pl. 32
RaK-459	4.0	2.8	Fig. 122a,a'	Fig. 5
RaK-458	3.0	2.0	--	Fig. 6

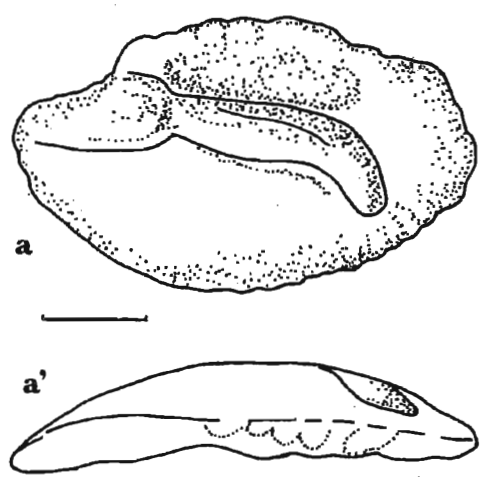


Fig. 122. "genus *Chaetodontidarum*" sp.
a – Right sagitta, inner face, a' – ventral view

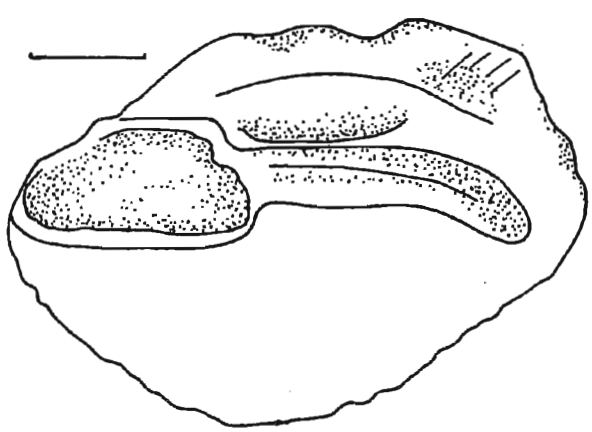


Fig. 123. *Euxiphipops xenthometopon* (BLEEKER, 1853)
Present-day specimen: right sagitta, inner face; Indian Ocean (NOLF's Collection)

DESCRIPTION: Otoliths relatively thick. Dorsal rim is slightly arched and crenulated. Posterodorsal corner is well developed. Posterior rim is short and straight. On the anterior rim developed are: a rounded antirostrum, a shallow excisura, and a rounded rostrum. Inner face is convex. Sulcus acusticus is deeply incised. Ostium is oval. Cauda is slightly *S*-shaped, with very well developed crista inferior. Area is well developed. Outer face is concave.

REMARKS: The studied otoliths are herein assigned to the family Chaetodontidae BONAPARTE, 1832, due to their similarity to those (*see* Text-fig. 123) of the present-day species *Euxiphipops xenthometopon* (BLEEKER, 1853) known from the Indian Ocean. A poor recognition of otoliths in this family does not allow to suggest a more precise classification.

Family **Cepolidae** BONAPARTE, 1832
Genus *Cepola* LINNAEUS, 1764

Cepola rubescens LINNAEUS, 1766
(Text-figs 124-125 and Pl. 30, Figs 1-7)

1906. *Otolithus (Cepola) praerubescens* BASSOLI et SCHUBERT sp. nov.; R. SCHUBERT, p. 642, Pl. 19, Figs 1-5.
1906. *Otolithus (Cepola) praerubescens* BASSOLI; G. BASSOLI, p. 54, Pl. 2, Fig. 43.
1942. *Cepola praerubescens* SCHUB.; W. WEILER, p. 54, Pl. 4, Figs 41 and 53-54.
1950. *Cepola praerubescens* BASSOLI & SCHUBERT, 1906; W. WEILER, p. 230, Pl. 4, Fig. 23.
1966. *Cepola praerubescens* BASSOLI et SCHUBERT; T. ŚMIGIELSKA, p. 256, Pl. 18, Fig. 2.
1977. *Cepola rubescens* LINNAEUS, C., 1764; D. NOLF, p. 56, Figs 10-11.
1969. *Cepola praerubescens* BASSOLI e SCHUBERT; G. ANFOSSI & S. MOSNA, p. 43, Pl. 9, Fig. 1.
1979. *Cepola rubescens* LINNAEUS, 1764; T. ŚMIGIELSKA, p. 322, Text-fig. 25 and Pl. 6, Figs 5-7.
1981. *Cepola macrophthalma* (LINNAEUS, 1758); D. NOLF, p. 141, Pl. 2, Figs 9-12.
1983. *Cepola macrophthalma* (LINNAEUS, 1758); D. NOLF & E. STEURBAUT, p. 186, Pl. 7, Fig. 7.
1984. *Cepola macrophthalma* (LINNAEUS, 1758); U. RADWAŃSKA, p. 311, Text-fig. 15 and Pl. 5, Figs 1-4.
1984. *Cepola yprieuensis* STEURBAUT, 1981; U. RADWAŃSKA, p. 312, Text-fig. 16 and Pl. 5, Figs 5-7.
1984. *Cepola multicrenata* sp. n.; U. RADWAŃSKA, p. 313, Text-fig. 17 and Pl. 5, Figs 8-10.
1984. *Cepola* sp.; U. RADWAŃSKA, p. 315, Text-fig. 18 and Pl. 5, Fig. 11.
1985. *Cepola macrophthalma* (LINNAEUS, 1758); D. NOLF, p. 92, Fig. 68J.
1988. *Cepola rubescens* LINNAEUS, 1766; D. NOLF & H. CAPPETTA, p. 229, Pl. 16, Fig. 4.

MATERIAL: Korytnica – 505 specimens, in majority well preserved; Bęczyn – one juvenile specimen, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 124	Pl. 30
RaK-349	5.0	3.1	0.8	Fig. 124c	Fig. 6
RaK-341	5.0	3.0	0.8	Fig. 124a	Fig. 1

REMARKS: The species *Cepola rubescens* LINNAEUS, 1766, has already been reported from the Korytnica Basin (ŚMIGIELSKA 1966, 1979; RADWAŃSKA 1984). To this species are herein included the specimens described formerly by the present author (RADWAŃSKA 1984) as "*Cepola yprieuensis* STEURBAUT, 1984", "*Cepola multicrenata* sp. n.", and "*Cepola* sp.", because their comparison with a big assemblage of otoliths (NOLF's Collection; *see* Text-fig. 125) of various populations of the present-day forms of *Cepola rubescens* LINNAEUS, 1766, shows apparently that this species displays a remarkable individual variability of the otoliths, and all the investigated specimens fall well into the range of this intraspecific variability.

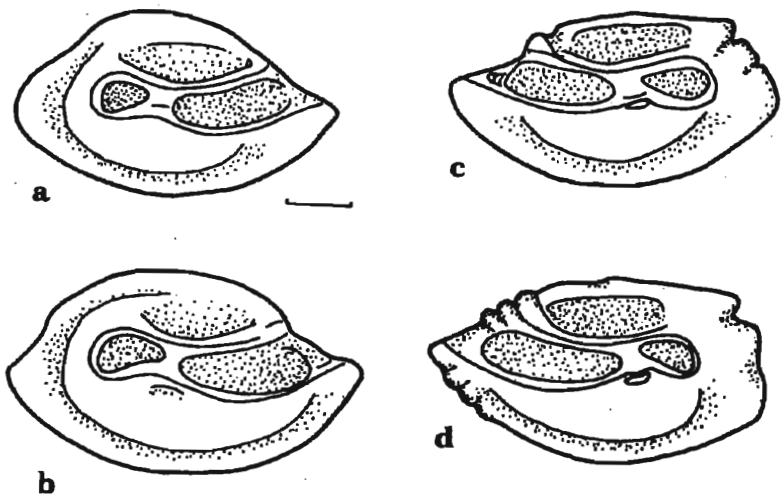


Fig. 124. *Cepola rubescens* LINNAEUS, 1766

a, b — Left sagitta, inner face; **c, d** — right sagitta, inner face; the same specimens (**a, c, d**) as illustrated formerly (RADWAŃSKA 1984, Fig. 15 item 3; Fig. 17 items 3 and 1, respectively)

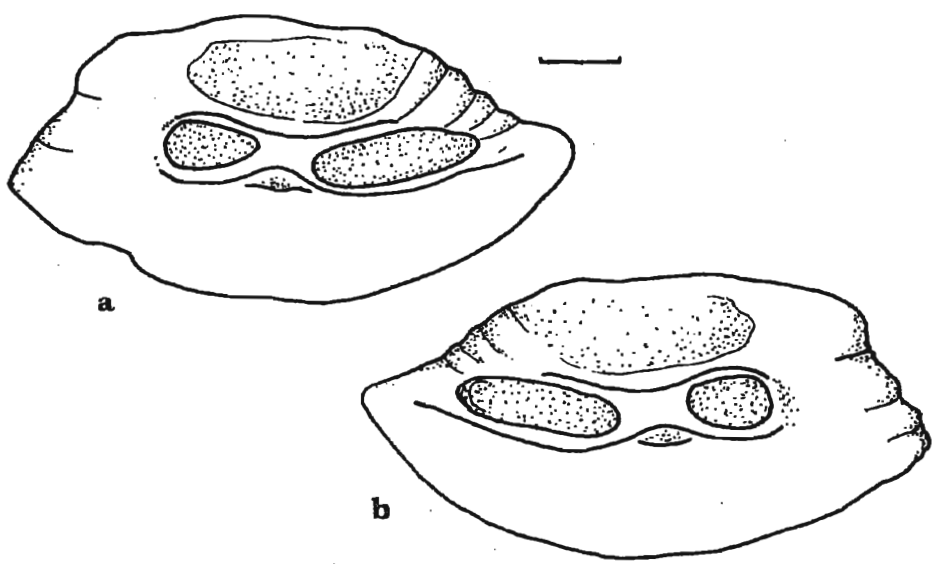


Fig. 125. *Cepola rubescens* LINNAEUS, 1766

Present-day specimens: **a** — left sagitta, inner face; **b** — right sagitta, inner face; Mediterranean Sea (NOLF's Collection)

It is notable that the priority name of the present-day fish is "*macrophthalma* LINNAEUS, 1758", but in a common use is a younger one, "*rubescens* LINNAEUS, 1766" which was accepted by the International Commission on Zoological Nomenclature (*see* NOLF & CAPPETTA 1988, p. 229).

Family *incertae sedis*

"genus *Percoideorum*" *tietzei* (SCHUBERT, 1906)
(Text-fig. 126; Pl. 30, Figs 10-11 and Pl. 31, Figs 1-2)

1906. *Otolithus* (*Cantharus*?) *tietzei* sp. n.; R. SCHUBERT, p. 632, Pl. 4, Figs 13-18.
1928. *Ot.* (*Cantharus*?) *tietzei* SCHUB.; J. CHAINE & J. DUVERGIER, p. 202, Pl. 4, Figs 10-12.
1966. *Cantharus*? *tietzei* SCHUBERT; T. ŚMIGIELSKA, p. 253, Pl. 17, Fig. 3.
1981. "genus *Percoideorum*" *tietzei* (SCHUBERT, 1906); D. NOLF, p. 14, Pl. 2, Fig. 22.
1985. "genus *Percoideorum*" *tietzei* (SCHUBERT, 1906); D. NOLF, p. 92.

MATERIAL: Rybnica – 120 specimens, in majority well preserved; Węglinek – 8 specimens, badly preserved; Nawodzice – 4 specimens, well preserved; Korytnica – one specimen, damaged.

Coll. numbers	L	H	T	Figured in: Text-fig. 126	Pl. 31
RaR-353	4.0	2.4	0.5	Fig. 126c	Fig. 2
RaR-352	3.8	2.4	0.5	Fig. 126a	Fig. 1

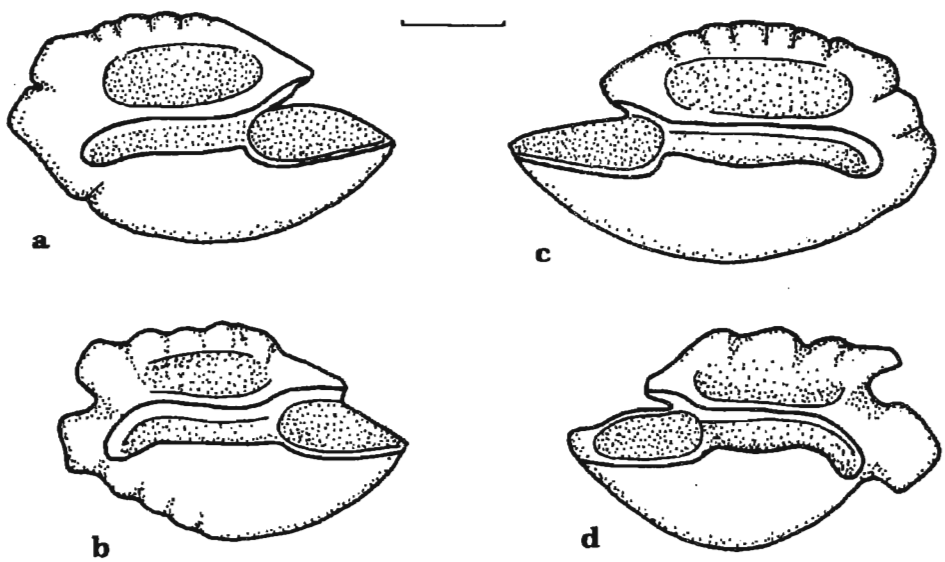


Fig. 126. "genus *Percoideorum*" *tietzei* (SCHUBERT, 1906)

a, b – Left sagitta, inner face; **c, d** – right sagitta, inner face

REMARKS: This species has formerly been known from the Miocene of Poland, as reported i. a. from Rybnica and Gliwice Stare (CHAINE & DUVERGIER 1928, ŚMIGIELSKA 1966), where it was represented by very innumerous specimens. The newly collected material, especially that from Rybnica, is sufficiently rich to recognize the variability range of this fossil species (*see* Text-fig. 126).

Suborder **Mugiloidei** REGAN, 1909
Family **Mugilidae** CUVIER, 1829
Genus *Liza* JORDAN & SWAIN, 1884

Liza steurbauti RADWAŃSKA, 1984
(Text-fig. 127 and Pl. 31, Fig. 7)

1984. *Liza steurbauti* sp. n.; U. RADWAŃSKA, p. 315, Text-fig. 19, Pl. 2, Fig. 4.

MATERIAL: Korytnica – 3 specimens, 2 of which with rostral part damaged.

Coll. number	L	H	T	Figured in: Text-fig. 127	Pl. 31
RaK-354-holotype	7.0	3.0	0.4	Fig. 127	Fig. 7

REMARKS: This species has fully been demonstrated in the earlier paper (RADWAŃSKA 1984).

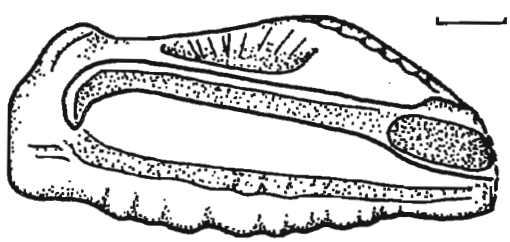


Fig. 127. *Liza steurbauti* RADWAŃSKA, 1984

Holotype reillustrated (*see* RADWAŃSKA 1984, Fig. 19 item 1): left sagitta, inner face

"genus *Mugilidarum*" sp.
(Text-fig. 128 and Pl. 31, Fig. 6)

1973. *Mugil applanatus* (RZEHAK); T. ŚMIGIELSKA, p. 8. Pl. 1, Figs 3-5.

MATERIAL: Niskowa – 11 juvenile specimens, in majority badly preserved.

Coll. number	L	H	T	Figured in: Text-fig. 128	Pl. 31
RaNi-355	7.5	1.9	0.5	Fig. 128a,a'	Fig. 6

REMARKS: This species has already been reported from Niskowa by ŚMIGIELSKA (1973) as "*Mugil applanatus* (RZEHAK)". According to the present author, both the specimens illustrated by ŚMIGIELSKA (1973), as well as these personally collected represent the juvenile forms. Such forms within various species of the family Mugilidae CUVIER, 1829 (*see* CHAINE 1938, Pls 14-15) are very similar, and they do escape from a more precise recognition. The specimens from Niskowa may thus be attributed to the family rank only.

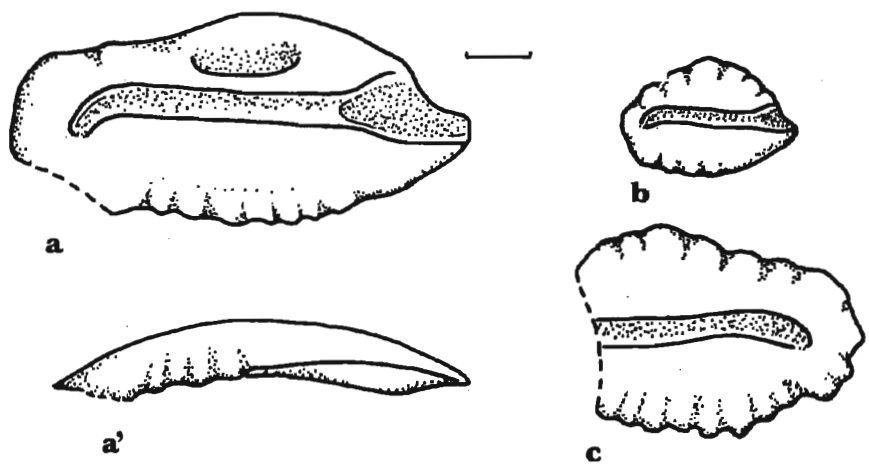


Fig. 128. "genus *Mugilidarum*" sp.

a, b — Left sagitta, inner face, a' — ventral view; c — right sagitta, inner face

Suborder **Sphyraenoidei** BERG, 1937
Family **Sphyraenidae** RAFINESQUE, 1815
Genus *Sphyraena* SCHNEIDER, 1801

Sphyraena aff. *afra* PETERS, 1884
(Text-fig. 129 and Pl. 31, Fig. 8)

1979. *Sphyraena hansfuchsi* SCHUBERT, 1906; T. ŚMIGIELSKA, p. 314, Text-fig. 17 and Pl. 4, Fig. 7.
1982. *Sphyraena* sp.; E. STEURBAUT & S. JONET, p. 207, Pl. 3, Fig. 14.
1984. *Sphyraena* sp. 2; E. STEURBAUT, p. 97, Pl. 30, Figs 1-3.
1984. *Sphyraena dentata* sp. n.; U. RADWAŃSKA, p. 316, Text-fig. 21 and Pl. 2, Figs 5-6.

MATERIAL: Korytnica — 14 specimens, in majority with their rostral part damaged.

Coll. number	L	H	T	Figured in: Text-fig. 129	Pl. 31
RaK-357	12.0	4.0	0.8	Fig. 129	Fig. 8

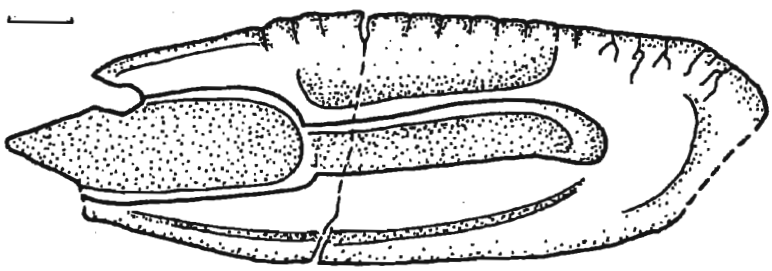


Fig. 129. *Sphyraena* aff. *afra* PETERS, 1884

Right sagitta, inner face; the same specimen as illustrated formerly (*see* RADWAŃSKA 1984, Fig. 21 item 1)

REMARKS: The studied specimens have formerly been described by the present author (RADWAŃSKA 1984) as "*Sphyraena dentata* sp. n.". A comparison with the otoliths of various present-day forms (NOLF's Collection) of the genus *Sphyraena* SCHNEIDER, 1801, shows a marked affinity of the Korytnica specimens to those of the species *Sphyraena afra* PETERS, 1884, living along the coasts of the Canary Islands and of western Africa (*see* Text-fig. 130). A great similarity of the collected specimens differing from those of the present-day species only in a shorter rostrum, indicates that the more reasonable should be to determine the investigated otoliths as "*Sphyraena* aff. *afra*".

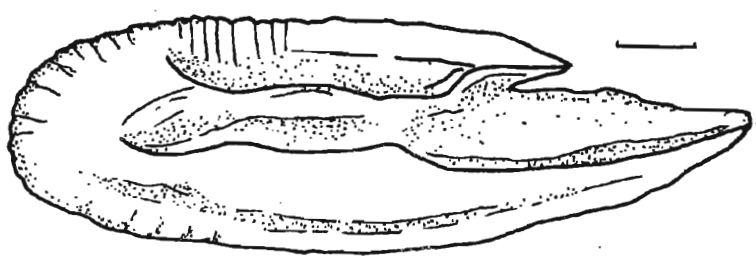


Fig. 130. *Sphyraena afra* PETERS, 1884

Present-day specimen: left sagitta, inner face; Canary Islands (NOLF's Collection)

Suborder **Polynemoidei** REGAN, 1909
Family **Polynemidae** CUVIER, 1828

"genus *Polynemidarum*" *huyghebaertae* STEURBAUT & JONET, 1982
(Text-fig. 131 and Pl. 31, Figs 3-4)

1979. "genus *Polynemidarum*" sp.; D. NOLF & E. STEURBAUT, p. 14, Pl. 5, Figs 5-6.
1982. "genus *Polynemidarum*" *huyghebaertae* n. sp.; E. STEURBAUT & S. JONET, p. 208, Pl. 6, Figs 7-10.
1984. "genus *Polynemidarum*" *huyghebaertae* STEURBAUT & JONET, 1982; E. STEURBAUT, p. 98, Pl. 30, Figs 12-15.

MATERIAL: Korytnica – 3 specimens, well preserved.

Coll.			Figured in:	
numbers	L	H	Text-fig. 131	Pl. 31
RaK-360	3.4	2.0	Fig. 131b	Fig. 3
RaK-358	3.3	2.0	Fig. 131a	Fig. 4a-4b

DESCRIPTION: Otoliths elongated, slightly rhomboidal in outline. All rims are crenulated. Posterior rim is strongly elongated and, in some specimens (*see* Pl. 31, Fig. 4), separated from the dorsal and ventral rims by distinct incisions. Ventral rim is asymmetrical. Inner face is convex. Sulcus acusticus is deeply incised. Ostium is funnel-shaped. Cauda is distinctly longer, bubble-like widened posteriorly. Area is well developed. Outer face is concave.

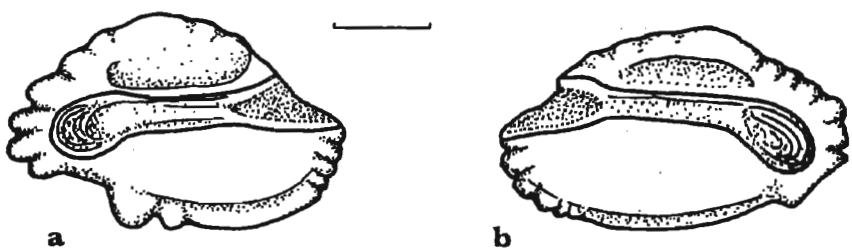


Fig. 131. "genus *Polynemidarum*" *huyghebaertae* STEURBAUT & JONET, 1982

a – Left sagitta, inner face; **b** – right sagitta, inner face

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* STEURBAUT & JONET 1982, Pl. 6, Fig. 9). Some of them differ, however, from these of the type series in their posterior rim being separated from the anterior one by a deep incision (*see* Text-fig. 131a and Pl. 31, Fig. 4). Such a distinction is herein regarded as falling into the intraspecific variability. The species has not hitherto been reported from Poland.

"genus *Polynemidarum*" sp.
(Text-fig. 132 and Pl. 31, Fig. 5)

1984. "genus *Polynemidarum*" sp.; E. STEURBAUT, p. 99, Pl. 30, Fig. 23.

MATERIAL: Korytnica – one specimen, badly preserved.

Coll. number	L	H	T	Figured in: Text-fig. 132	Pl. 31
RaK-361	2.8	1.4	0.6	Fig. 132a,a'	Fig. 5

DESCRIPTION: Otolith much elongated, relatively thick. Dorsal rim is almost flat and terminated by a heavily developed posterodorsal corner. Inner face is flat. Sulcus acusticus is deeply incised. Ostium is funnel-shaped. Cauda is much longer and slightly widened posteriorly. Outer face is convex.

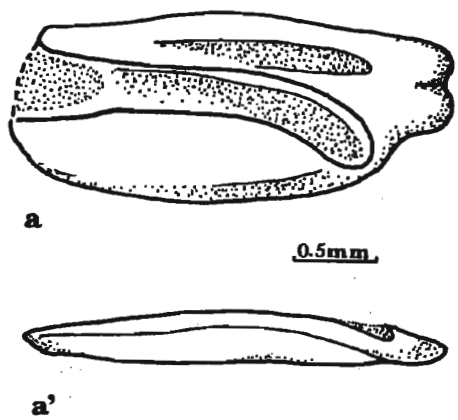


Fig. 132. "genus *Polynemidarum*" sp.
a – Right sagitta, inner face, a' – ventral view

REMARKS: The studied otolith, due to the structure of its sulcus acusticus, is herein assigned to the family Polynemidae CUVIER, 1828. An imperfect material does not allow to recognize its more precise taxonomic position. Anyway, it is almost identical with that one reported from the Aquitaine Basin by STEURBAUT (1984), and determined also to the family rank only (*see* synonymy).

Suborder **Labroidei** BLEEKER, 1859
Family **Scaridae** RAFINESQUE, 1810

"genus *Scaridarum*" sp.
(Text-fig. 133 and Pl. 8, Fig. 3)

MATERIAL: Korytnica – one juvenile specimen, well preserved.

Coll. number	L	H	T	Figured in: Text-fig. 133	Pl. 8
RaK-131	1.7	0.8	0.5	Fig. 133	Fig. 3

DESCRIPTION: Otolith elongated, rectangular in outline. Inner face is convex. Sulcus acusticus is divided. Collicula are oval in outline and deeply incised. Collum is narrow and shallow. Crista superior and crista inferior are well developed. Area is deep. Ventral furrow is placed very closely to the ventral rim. Outer face is slightly convex.

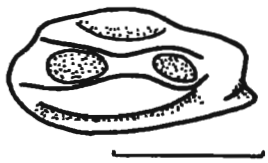


Fig. 133. "genus *Scaridarum*" sp.
Right sagitta, inner face

REMARKS: The studied otolith represents a juvenile form, of merely individualized generic and specific features. The structure of its sulcus acusticus allows to ascribe this specimen generally to the family Scaridae RAFINESQUE, 1810, in which, however, the otoliths are of a poor taxonomic significance (*compare* NOLF 1988, p. 94; BELLWOOD & SCHULTZ 1991, pp. 58-59). Such a form has not hitherto been reported from Poland.

Suborder **Trachinoidei** GREENWOOD & *al.*, 1966
Family **Trachinidae** RISSO, 1826
Genus *Trachinus* LINNAEUS, 1758

Trachinus biscissus KOKEN, 1884
(Text-fig. 134 and Pl. 32, Fig. 1)

1884. *Otolithus* (*Trachinus*) *biscissus*; E. KOKEN, p. 553, Pl. 11, Fig. 9.
1891. *Otolithus* (*Trachinus*) *mutabilis* KOKEN nov. nom.; E. KOKEN, p. 112.
1971. *Trachinus mutabilis* KOKEN, 1891; P. GAEMERS, p. 247, Pl. 3, Figs 15-16.
1977. *Trachinus biscissus* KOKEN, E., 1884; D. NOLF, p. 57, Pl. 16, Figs 15-16.
1985. *Trachinus biscissus* KOKEN, 1884; D. NOLF, p. 95.

MATERIAL: Korytnica – 4 specimens, well preserved; Węglinek – one specimen, badly preserved.

Coll. number	L	H	T	Figured in: Text-fig. 134	Pl. 32
RaK-362	4.8	2.5	0.9	Fig. 134a,a'	Fig. 1

DESCRIPTION: Otoliths oval, slightly elongated. Posterior rim is either straight or slightly convex. Inner face is convex. Sulcus acusticus is relatively narrow and shallow. Ostium is slightly

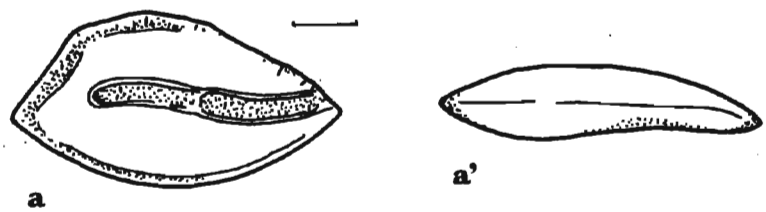


Fig. 134. *Trachinus biscissus* KOKEN, 1891

a – Left sagitta, inner face, a' – ventral view

longer than the cauda. Area is shallow. Outer face is asymmetrically convex, what realizes by the maximum convexity being displaced towards the posterior rim.

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* KOKEN 1884, Pl. 11, Fig. 9). This species has not hitherto been reported from Poland.

Trachinus aff. *draco* LINNAEUS, 1758
(Text-fig. 135 and Pl. 32, Figs 2-4)

1891. *Otolithus (Trachini) verus* KOKEN; E. KOKEN, p. 113, Pl. 10, Figs 13-14.
1942. *Trachinus verus* KOK.; W. WEILER, p. 68, Pl. 2, Figs 58- 59.
1971. *Trachinus verus* KOKEN, 1891; P. GAEMERS, p. 247, Pl. 3, Fig. 7 and Pl. 9, Fig. 3.
1977. *Trachinus verus* KOKEN, E., 1891; D. NOLF, p. 57, Pl. 16, Fig. 18.
1978. *Trachinus draco* LINNAEUS, 1758; D. NOLF, p. 330, Pl. 5, Figs 15-16.
1979. *Trachinus* aff. *draco* LINNAEUS, 1758; B. HUYGHEBAERT & D. NOLF, p. 79, Pl. 5, Fig. 8.
1979. *Trachinus verus* KOKEN, 1891; T. ŚMIGIELSKA, p. 324, Text-fig. 26 and Pl. 6, Fig. 8.
1982. *Trachinus* aff. *draco* LINNAEUS, 1758; E. STEURBAUT & S. JONET, p. 208, Pl. 3, Fig. 16.
1984. *Trachinus* aff. *draco* LINNAEUS, 1758; E. STEURBAUT, p. 100, Pl. 31, Figs 7-10.
1985. *Trachinus* aff. *draco* LINNAEUS, 1758; D. NOLF, p. 95.

MATERIAL: Rybnica – 9 specimens, in majority not very well preserved; Korytnica – one specimen, badly preserved; Nawodzice – one specimen, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 135	Pl. 32
RaR-363	6.3	3.3	0.8	Fig. 135c,c'	Fig. 2
RaR-364	5.4	2.8	0.9	Fig. 135a	Fig. 4
RaR-365	5.0	3.8	0.7	Fig. 135b	Fig. 3

DESCRIPTION: Otoliths much elongated, relatively flat. Dorsal rim is convex and sometimes crenulated. Posterior rim is straight and crenulated. Inner face is convex. Sulcus acusticus is relatively narrow and shallow. Ostium is slightly wider and longer than the cauda. Outer face is concave and, in some specimens, furnished with a small node centrally.

REMARKS: The studied otoliths are very close to those of the present-day species *Trachinus draco* LINNAEUS, 1758. Otoliths of the latter species display a distinct variability of their outline

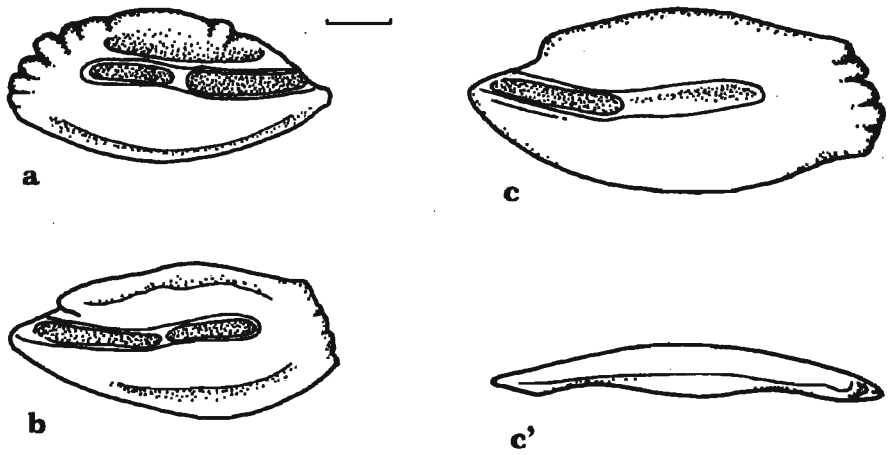


Fig. 135. *Trachinus* aff. *draco* LINNAEUS, 1758

a – Left sagitta, inner face; b, c – right sagitta, inner face, c' – ventral view

and thickness, the relations of which are changing with the ontogenic age of the fish. All collected specimens fall into this variability range but, nevertheless, they differ in having their dorsal rim more convex, and also more convex their inner face.

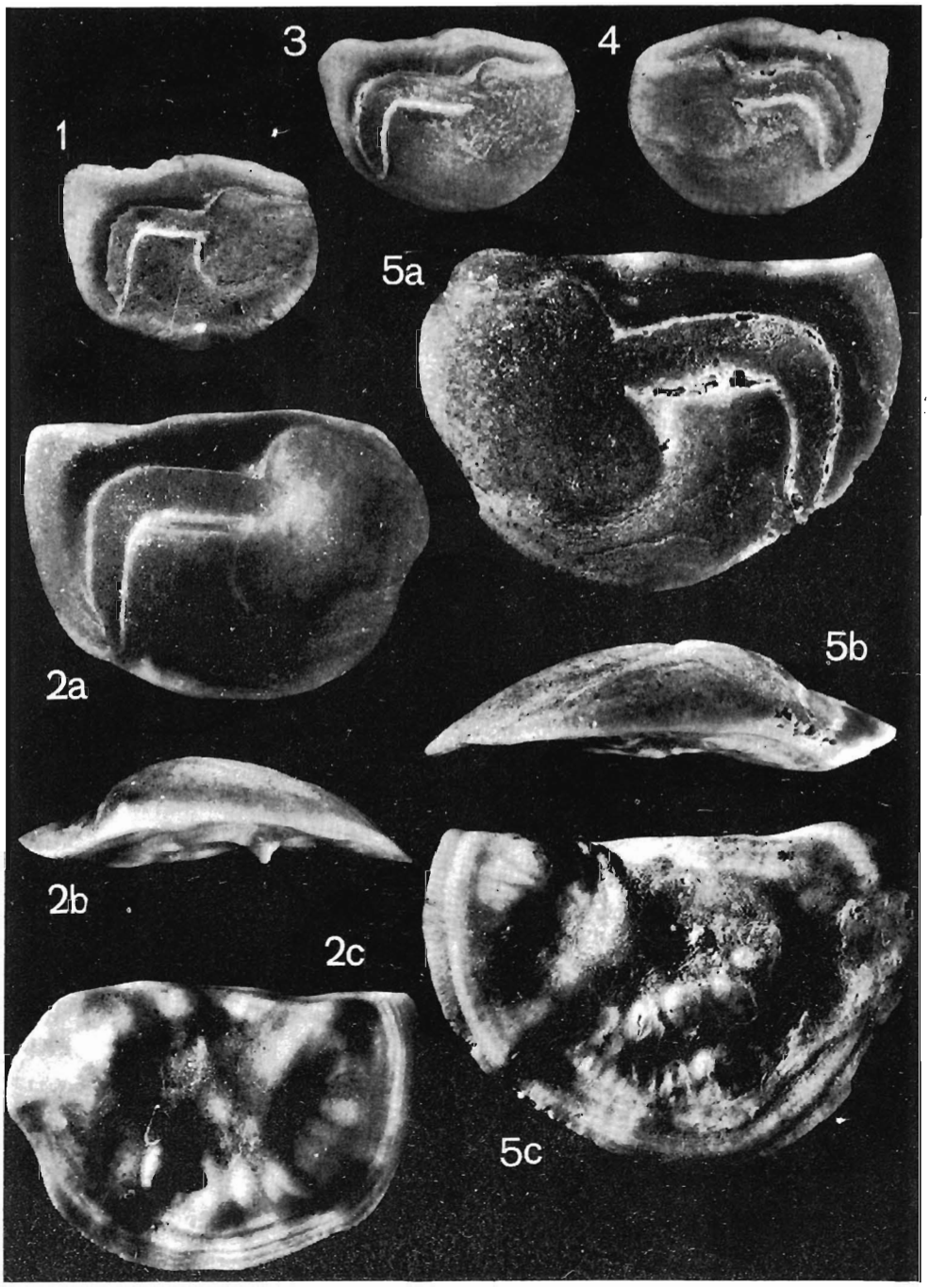
An otolith of this species has already been reported from the Korytnica Basin by ŚMIGIELSKA (1979) as "*Trachinus verus* KOKEN, 1891". The species *T. verus* KOKEN, 1891, is presently thought (HUYGHEBAERT & NOLF 1979) as conspecific with that labelled as "*Trachinus* aff. *draco* LINNAEUS, 1758".

Trachinus lineolatus FISCHER, 1884
(Text-fig. 136 and Pl. 32, Figs 7-8)

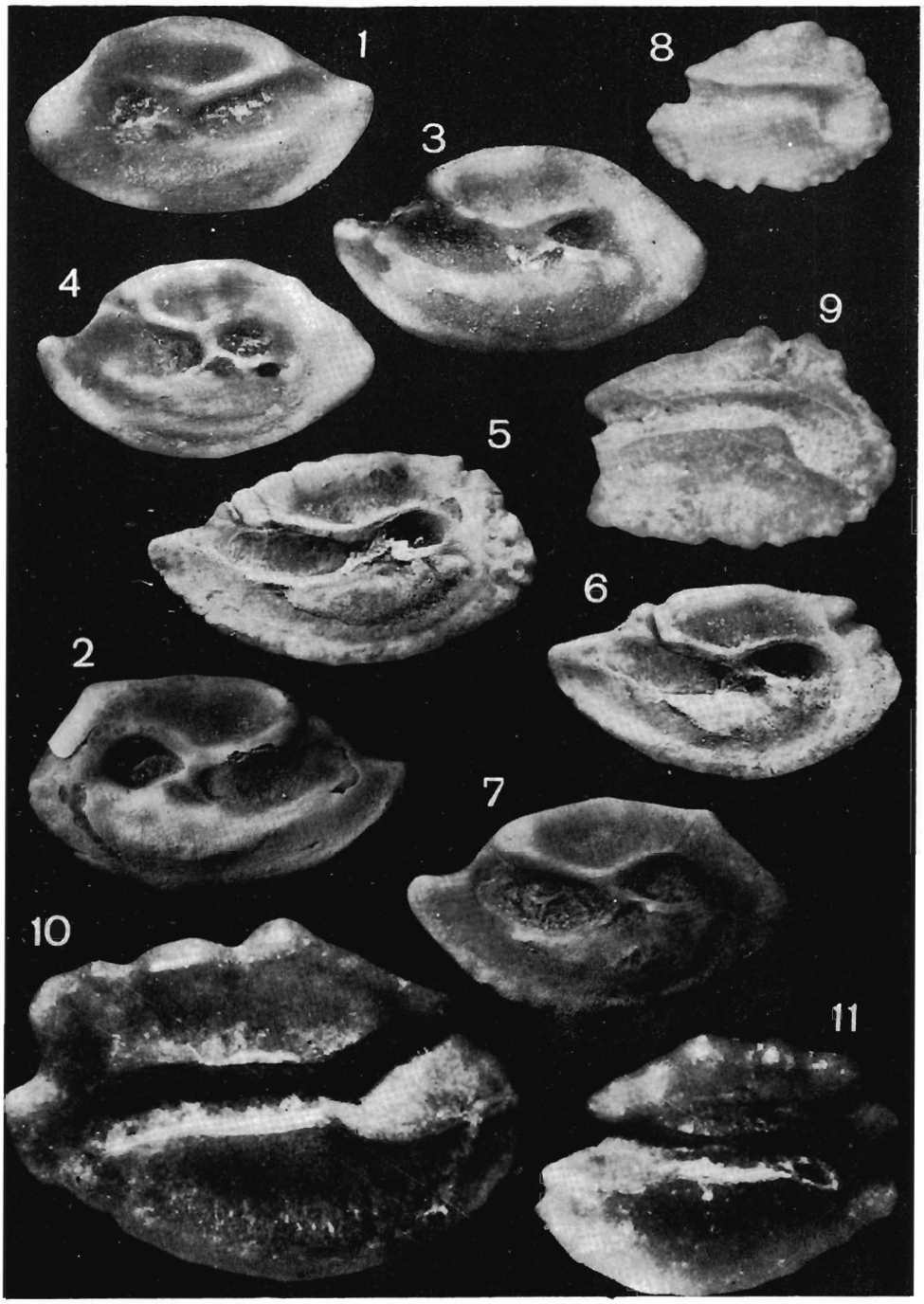
MATERIAL: Rybnica – 36 specimens, in majority well preserved, Nawodzice – 3 juvenile specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 136	Pl. 32
RaR-367	8.5	4.7	1.8	Fig. 136a,a'	Fig. 8
RaR-366	6.5	4.0	1.5	Fig. 136b	Fig. 7

DESCRIPTION: Otoliths massive, oval, of a slightly triangular outline. Dorsal rim may be undulant. On the anterior rim developed are: an antirostrum, a shallow excisura, and a bluntly-ended rostrum. Inner face is convex. Sulcus acusticus is wide and indistinctly divided. Outer face is asymmetrically convex, what realizes by the maximum thickness of the otoliths yielded near the ventral rim.



1-5 — *Sciaena rybnicensis* sp. n.; 2 — **holotype**, left sagitta, *2a* inner face, *2b* ventral view, *2c* outer face; 1 and 3-5 — **paratypes**, 1, 3 — left sagitta, inner face; 4-5 — right sagitta, *4*, *5a* inner face, *5b* ventral view, *5c* outer face; × 7.5

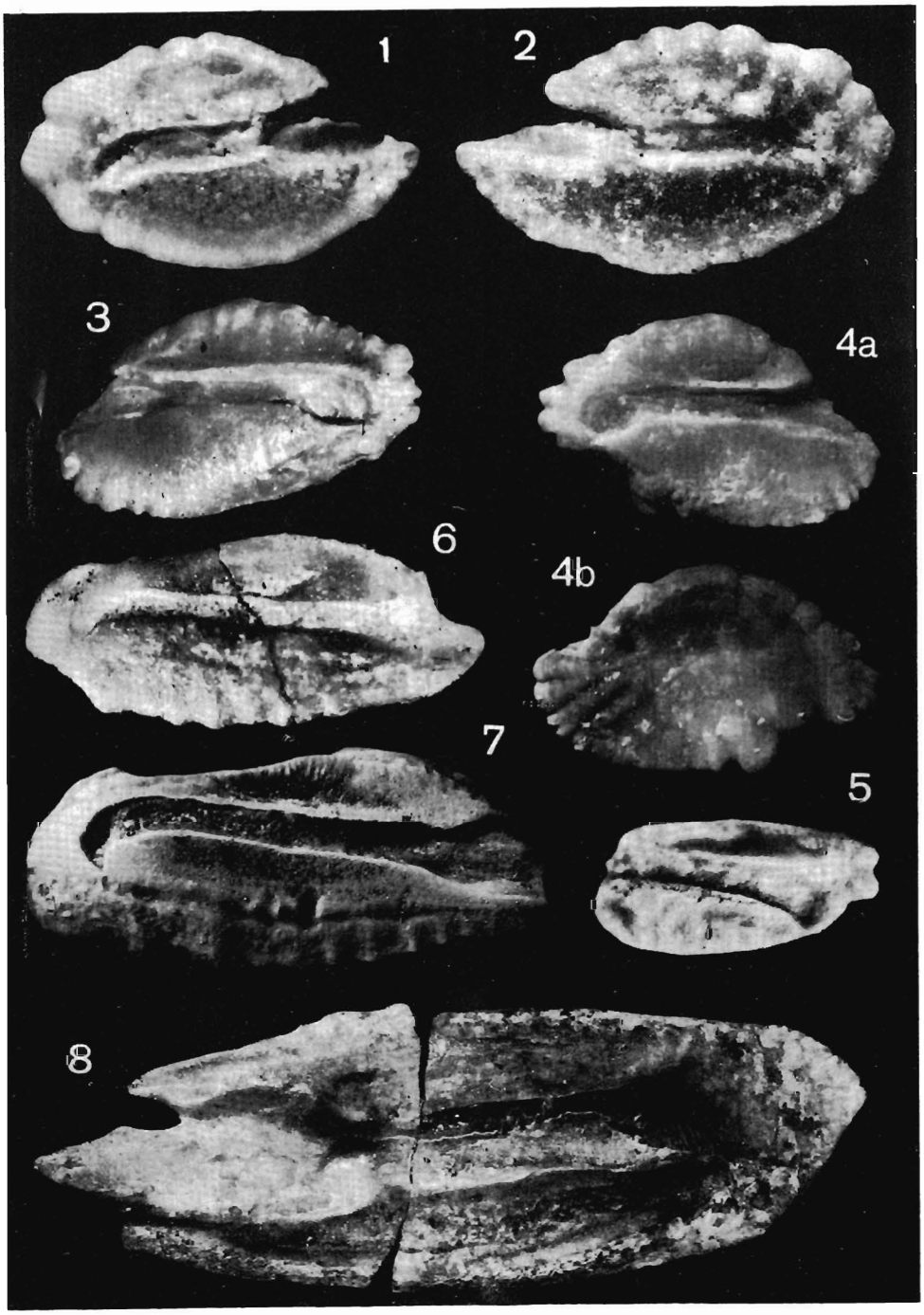


1-7 — *Cepola rubescens* LINNAEUS, 1766; 1-2 — left sagitta, inner face; 3-7 — right sagitta, inner face; × 10; the same specimens as illustrated formerly (*see* RADWAŃSKA 1984, Pl. 5, Figs 1-3, 6-8 and 10)

8 — *Mullus* sp.; right sagitta, inner face; × 20

9 — *Mullus elongatus* STEURBAUT, 1984; right sagitta, inner face; × 15

10-11 — "genus *Percoideorum*" *tietzei* (SCHUBERT, 1906); 10 — left sagitta, inner face; 11 — right sagitta, inner face; × 15



1-2 – "genus *Percoideorum*" *tietzei* (SCHUBERT, 1906); 1 – left sagitta, inner face; 2 – right sagitta, inner face; × 15

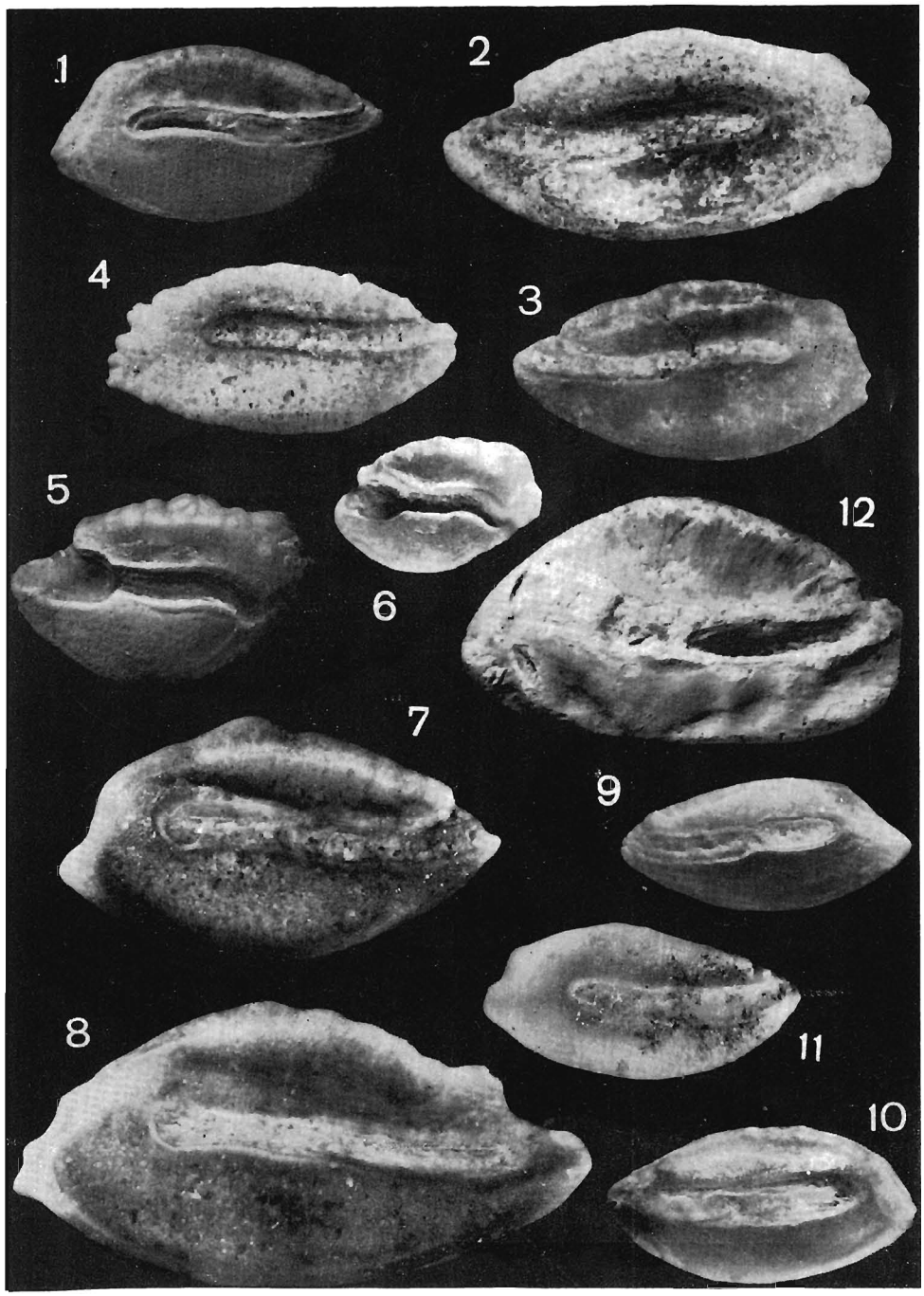
3-4 – "genus *Polynemidarum*" *huyghebaertae* STEURBAUT & JONET, 1982; 3 – right sagitta, inner face; 4 – left sagitta, *4a* inner face, *4b* outer face; × 15;

5 – "genus *Polynemidarum*" sp.; right sagitta, inner face; × 15

6 – "genus *Mugilidarum*" sp.; left sagitta, inner face; × 8.5

7 – *Liza steurbauti* RADWAŃSKA, 1984; holotype, left sagitta, inner face; × 10; the same specimen as illustrated formerly (*see* RADWAŃSKA 1984, Pl. 2, Fig. 4a-4b)

8 – *Sphyraena* aff. *afra* PETERS, 1884; right sagitta, inner face; × 10; the same specimen as illustrated formerly (*see* RADWAŃSKA 1984, Pl. 2, Fig. 5)



1 – *Trachinus biscissus* KOKEN, 1884; left sagitta, inner face; × 10

2-4 – *Trachinus* aff. *draco* LINNAEUS, 1758; 2-3 – right sagitta, inner face; 4 – left sagitta, inner face; × 10

5-6 – "genus *Chaetodontidarum*" sp.; right sagitta, inner face; × 10

7-8 – *Trachinus lineolatus* FISCHER, 1884; left sagitta, inner face; × 10

9-11 – *Trachinus vipera* CUVIER, 1829; 9-10 – right sagitta, inner face; 11 – left sagitta, inner face; × 10

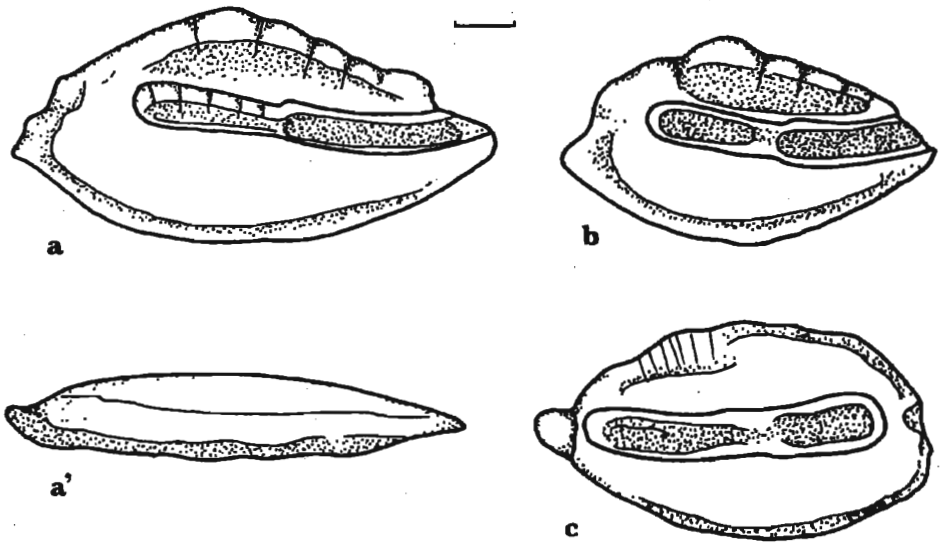


Fig. 136. *Trachinus lineolatus* FISCHER, 1884

a, b – Left sagitta, inner face, a' – ventral view; c – right sagitta, inner face

REMARKS: The studied otoliths are concordant with those of the present-day species *Trachinus lineolatus* FISCHER, 1884, known from the Atlantic shores of Europe and Africa, as well as from the Mediterranean (*see* HUYGHEBAERT & NOLF 1979, Pl. 5, Fig. 22). To the otoliths of this present-day species, very close are those of the fossil species *Trachinus acutus* WEILER, 1942, which differ by their height much longer in relation to their length.

Both the investigated ancient forms as well as those of the present-day fish are distinctly higher than those of *T. acutus* WEILER, 1942. The species *Trachinus lineolatus* FISCHER, 1884, has not hitherto been reported from Poland.

Trachinus vipera CUVIER, 1829
(Text-fig. 137 and Pl. 32, Figs 9-11)

1979. *Trachinus vipera* CUVIER, 1829; J. LANCKNEUS & D. NOLF, p. 94, Pl. 4, Fig. 9.

MATERIAL: Rybnica – 17 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 137	Pl. 32
RaR-369	4.7	2.3	1.0	Fig. 137a	Fig. 11
RaR-368	4.4	2.0	1.0	Fig. 137b	Fig. 9

DESCRIPTION: Otoliths relatively thick and slender. Dorsal and ventral rim are regularly convex. Posterior rim may be concave. Inner face is strongly convex. Sulcus acusticus is wide and

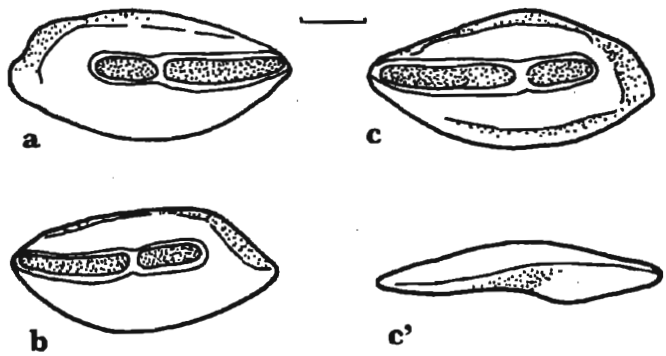


Fig. 137. *Trachinus vipera* CUVIER, 1829

a – Left sagitta, inner face; b, c – right sagitta, inner face, c' – ventral view

shallow. Ostium is slightly longer than the cauda. Collicula are well developed. Outer face is slightly concave centrally, alongwith elongation of the otolith.

REMARKS: The studied otoliths are concordant with those of the present-day species *Trachinus vipera* CUVIER, 1829, known from the Atlantic shores of Europe and Africa, as well as from the Mediterranean (*see* LANCKNEUS & NOLF 1979, Pl. 4, Figs 7-8). The species has not hitherto been reported from Poland.

Family **Uranoscopidae** BLEEKER, 1859
Genus *Uranoscopus* LINNAEUS, 1758

Uranoscopus aff. *scaber* LINNAEUS, 1758
(Text-fig. 138 and Pl. 32, Fig. 12)

1979. *Uranoscopus*? aff. *scaber* LINNAEUS, 1758; T. ŚMIGIELSKA, p. 324. Text-fig. 27 and Pl. 6, Fig. 10.
1979. gen. et sp. indet.; T. ŚMIGIELSKA, p. 333, Text-fig. 37 and Pl. 8, Fig. 9.

MATERIAL: Korytnica – 2 specimens, badly preserved.

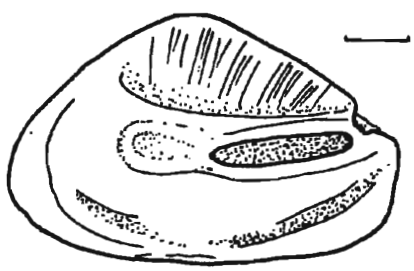


Fig. 138. *Uranoscopus* aff. *scaber* LINNAEUS, 1758

Left sagitta, inner face

Coll. number	L	H	T	Figured in: Text-fig. 138	Pl. 32
RaK-372	6.0	3.4	1.0	Fig. 138	Fig. 12

REMARKS: Otoliths of this species have already been reported from the Korytnica Basin by ŚMIGIELSKA (1979). To the synonymy of the species is herein included also an otolith described by ŚMIGIELSKA (1979) as "gen. et sp. indet.". According to the present author, this specimen represents a juvenile form of the discussed species *Uranoscopus* aff. *scaber* LINNAEUS, 1758.

Suborder **Gobioidei** JORDAN & EVERMANN, 1896
Family **Gobiidae** BONAPARTE, 1832

The otoliths of the fish belonging to the family Gobiidae BONAPARTE, 1832, are very commonly encountered within the Tertiary deposits, and this concern both the numbers of the specimens and of the species (*see* NOLF 1985). In the present-day marine fauna, the family Gobiidae BONAPARTE, 1832, is also very well represented by numerous species of about 200 genera.

Most of the fossil species have often been established upon the juvenile forms and/or badly preserved specimens what, combined with a poor state of knowlegde on the particular present-day species and their otoliths, involved a very chaotic systematics of the paleontological material. This makes quite serious troubles in recognition of many, particularly of new species.

In the present paper, the otoliths of the family Gobiidae BONAPARTE, 1832, are in majority determined to the genus or even to the family rank. To the species level assigned are only these forms which are well comparable either to the present-day species or to the unquestionable ancient taxa described from the Paratethys basins of Europe.

Genus *Deltenosteus* GILL, 1864

Deltenosteus telleri (SCHUBERT, 1906)
(Text-fig. 139 and Pl. 33, Figs 1-7)

1906. *Otolithus* (*Gobius*) *Telleri* SCHUB.; R. SCHUBERT, p. 648, Pl. 20, Figs 27-28.
1928. *Otolithus* (*Gobius*) *Telleri* SCHUB.; J. CHAINE & J. DUVERGIER, p. 201.
1966. *Gobius telleri* SCHUBERT; T. ŚMIGIELSKA, p. 263, Pl. 19, Fig. 1.
1973. *Gobius telleri* SCHUBERT; T. ŚMIGIELSKA, p. 26. Pl. 5, Figs 1-3.
1973. *Pomatoschistus telleri* (SCHUBERT, 1906); P. GAEMERS & W. SCHWARZHANS, p. 225, Pl. 3, Figs 16-21 and Pl. 9, Figs 3 and 5.

MATERIAL: Korytnica – 454 specimens, Rybnica – 272 specimens, Niskowa – 34 specimens, Nawodzice – 16 specimens, Bęczyn – 6 specimens, Węglinek – 3 specimens; in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 139	Pl. 33
RaK-375	2.3	2.0	Fig. 139b	Fig. 6
RaK-376	2.0	1.7	Fig. 139a	Fig. 1

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* SCHUBERT 1906, Pl. 20, Fig. 27). Within the material coming from Niskowa and Rybnica, there appear otoliths much deformed, both in regard with the course of their sulcus acusticus and with their thickness (*see* Pl. 33, Fig. 4). Such deformations could result from temporary fluctuations in salinity of the coastal waters, what already was suggested by ŚMIGIELSKA (1973).

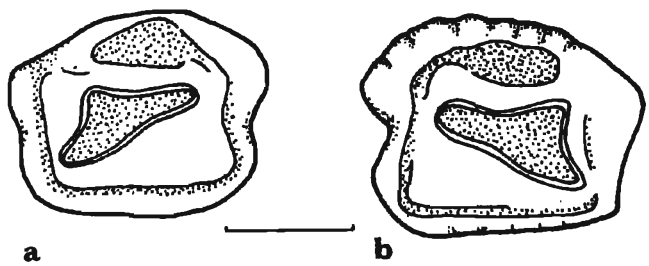


Fig. 139. *Deltenosteus* aff. *telleri* (SCHUBERT, 1906)

a — Right sagitta, inner face; **b** — left sagitta, inner face

A generic attribution of the discussed species has hitherto been interpreted variously (*see* synonymy). GAEMERS & SCHWARZHANS (1973) classified this species within the genus *Pomatoschistus* GILL, 1863, and indicated the two well comparable present-day species, *Pomatoschistus minutus* (PALLAS, 1770) and *P. microps* (KRØYER, 1838).

According to the present author, the investigated otoliths are much more evidently close, by their general outline and the structure of their sulcus acusticus, to those of the present-day species *Deltenosteus quadrimaculatus* (VALENCIENNES, 1837) living in the Mediterranean (*see* NOLF & CAPPETTA 1980, Pl. 4, Fig. 9). They differ from the latter only in their more pronounced posteroventral corner, whilst all other features are typical of the genus *Deltenosteus* GILL, 1864. The discussed species has already been reported from Poland by CHAINE & DUVERGIER (1928) and ŚMIGIELSKA (1966, 1973).

Genus *Gobius* LINNAEUS, 1758

Gobius vicinalis KOKEN, 1891
(Text-fig. 140; Pl. 33, Figs 8-11 and Pl. 34, Figs 3-6)

1891. *Otolithus* (*Gobius*) *vicinalis* KOKEN; E. KOKEN, p. 133, Text-fig. 21.
1906. *Otolithus* (*Gobius*) *vicinalis* KOKEN; R. SCHUBERT, p. 644, Pl. 20, Fig. 33 (*non* Figs 32, 34).
1950. *Gobius vicinalis* KOKEN, 1891; W. WEILER, p. 232, Pl. 4, Figs 24-26 and Pl. 8, Fig. 63.
1965. *Gobius vicinalis* KOKEN; A. ZILCH, p. 459, Pl. 37, Fig. 20.

1966. *Gobius vicinalis* KOKEN; T. ŚMIGIELSKA, p. 260, Pl. 18, Figs 8-11.
1973. *Gobius vicinalis* KOKEN; T. ŚMIGIELSKA, p. 22, Pl. 3, Figs 8-14 and Pl. 4, Figs 1-2.

MATERIAL: Korytnica – some 7000 specimens, Niskowa – some 600 specimens, Rybnica – 70 specimens, Bęczyn – 7 specimens; all well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 140	Pl. 33
RaR-382	2.3	2.5	Fig. 140d	Fig. 11
RaR-381	2.0	2.2	Fig. 140a	Fig. 9
				Pl. 34
RaK-383	2.0	2.0	Fig. 140c	Fig. 4

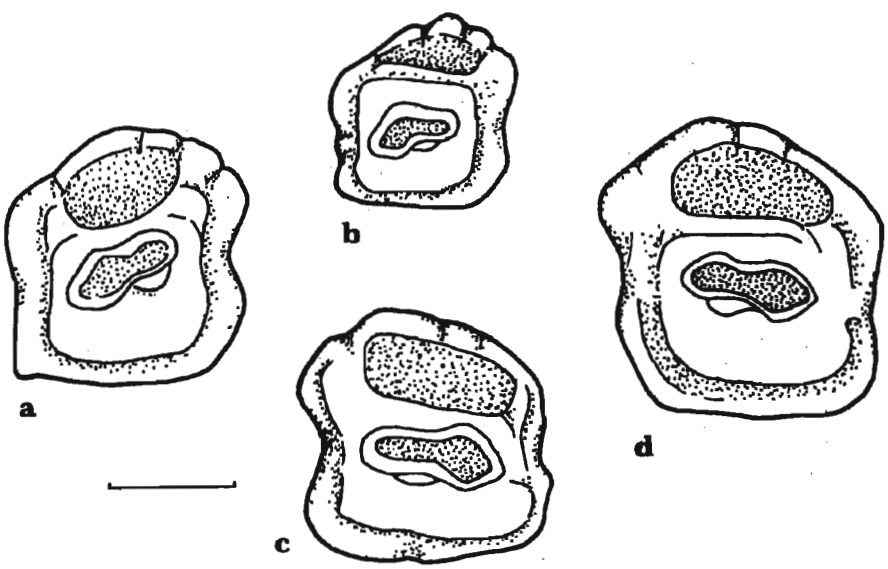


Fig. 140. *Gobius vicinalis* KOKEN, 1891

a, b – Right sagitta, inner face; c, d – left sagitta, inner face

REMARKS: The studied otoliths are consistent with the holotype of the species (*see* KOKEN 1891, Text-fig. 21; ZILCH 1965, Pl. 35, Fig. 20). The collected spcimens make up a relatively rich assemblage in which an individual variability is very slightly expressed and concerns only some details in the course of the ventral rim and the posteroventral corner.

According to the present author's knowledge, the species *Gobius vicinalis* KOKEN, 1891, is well established (*see* ZILCH 1965), and until a research upon otoliths of the present-day species of the genus *Gobius* LINNAEUS, 1758, does not object its reality, it should fully be accepted. This species has already been reported from Poland by ŚMIGIELSKA (1966, 1973).

Gobius aff. *geniporus* VALENCIENNES, 1837
(Text-fig. 141 and Pl. 34, Figs 1-2)

1906. *Gobius praetiosus* PROCH.; R. SCHUBERT, p. 646, Pl. 20, Figs 29-31.
1966. *Gobius multipinnatus* (H. von MEYER); T. ŚMIGIELSKA, p. 262, Pl. 18, Figs 13, 16 (*non* Figs 12 and 14-15).
1979. *Gobius* aff. *geniporus* VALENCIENNES, 1837; D. NOLF & E. STEURBAUT, p. 16, Pl. 5, Fig. 23.
1984. *Gobius* aff. *geniporus* VALENCIENNES, 1837; E. STEURBAUT, p. 104, Pl. 32, Figs 13-15.

MATERIAL: Korytnica – 69 specimens, Węglinek – 2 specimens; in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 141	Pl. 34
RaK-388	3.0	2.0	Fig. 141b	Fig. 2
RaK-387	2.6	1.8	Fig. 141a	Fig. 1

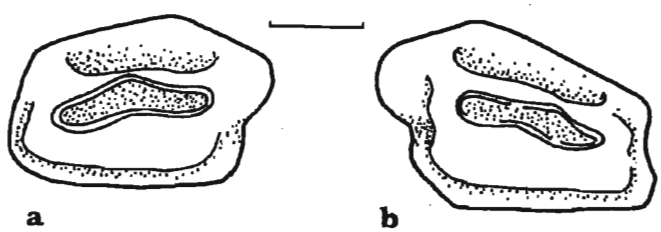


Fig. 141. *Gobius* aff. *geniporus* VALENCIENNES, 1837

a – Right sagitta, inner face; **b** – left sagitta, inner face

DESCRIPTION: Otoliths with much elongated posterodorsal corner. Dorsal rim is asymmetrically convex. Inner face is also convex. Sulcus acusticus is relatively narrow. Area and ventral furrow are well developed. Outer face is convex, lacking of any ornamentation.

REMARKS: The studied otoliths are very close to those of the present-day species *Gobius geniporus* VALENCIENNES, 1837, living in the Mediterranean (*see* NOLF & STEURBAUT 1979, Pl. 5, Fig. 22). Otoliths of this species have already been reported from Poland, by ŚMIGIELSKA (1966), under the name "*Gobius multipinnatus* (H. von MEYER)". However, to the synonymy of the discussed species of a marked affinity to *Gobius geniporus* VALENCIENNES, 1837, included are these otoliths described by ŚMIGIELSKA (1966) which by their general outline and the structure of the dorsal rim are the most similar to otoliths of this present-day species.

Gobius aff. *niger* LINNAEUS, 1758
(Text-fig. 142 and Pl. 35, Figs 12-15)

1966. *Gobius multipinnatus* (H. von MEYER); T. ŚMIGIELSKA, p. 262, Pl. 18, Figs 12, 14, 15 (*non* Figs 13, 16).
1973. *Gobius praetiosus* PROCHÁZKA; T. ŚMIGIELSKA, p. 23, Pl. 4, Figs 5-7 (? Figs 3-4).
1973. *Gobius* cf. *francofurtanus* KOKEN; T. ŚMIGIELSKA, p. 25, Pl. 4, Figs 8-9.

MATERIAL: Niskowa – some 750 specimens; Korytnica – some 300 specimens, in majority well preserved; Węglinek – 120 specimens, in majority juvenile; Rybnica – 20 juvenile specimens; Bęczyn – 4 specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 142	Pl. 35
RaK-396	3.2	2.5	Fig. 142d	Fig. 15
RaNi-395	3.2	2.6	Fig. 142b	Fig. 13

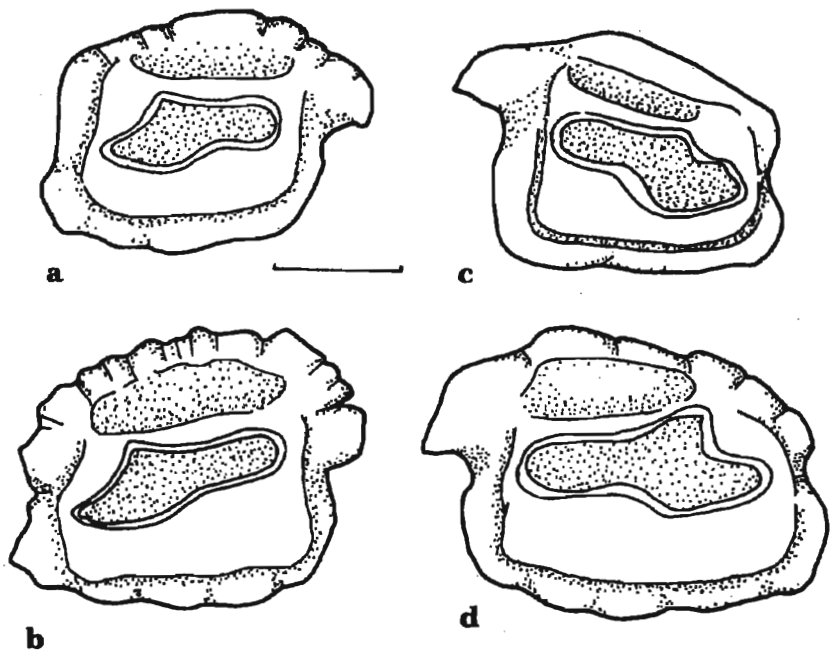


Fig. 142. *Gobius* aff. *niger* LINNAEUS, 1758

a, b – Right sagitta, inner face; c, d – left sagitta, inner face

DESCRIPTION: Otoliths with much elongated posterodorsal corner, which bends towards the outer face, and it is crenulated similarly as the whole dorsal rim. Posterior rim is concave, and it may also be crenulated. Inner face is slightly convex. Sulcus acusticus is distinctly divided. Ostium is wide and characteristically elongated towards the dorsal rim. Cauda is oval. Area and ventral furrow are well developed. Outer face is convex in its part near the ventral rim, and then passes into a depression continuing towards the dorsal rim.

REMARKS: The studied otoliths are very close to those of the present-day species *Gobius niger* LINNAEUS, 1758, known from the Mediterranean and the Atlantic coasts of Europe (*see*

Text-fig. 143); they differ only in their sulcus acusticus slightly wider. Such forms have already been reported from Poland by ŚMIGIELSKA (1966, 1973) uner different specific names (*see* synonymy). In 1973, ŚMIGIELSKA included the forms described earlier by herself (ŚMIGIELSKA 1966) as "*Gobius multipinnatus* (H. von MEYER)" into the synonymy of the species *praetiosus* of PROCHÁZKA (1893).

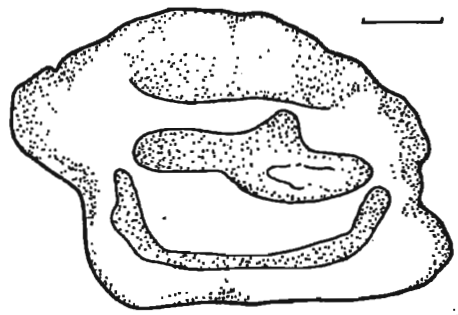


Fig. 143. *Gobius niger* LINNAEUS, 1758

Present-day specimen: left sagitta, inner face; Mediterranean Sea (NOLF's Collection)

According to the present author, the studied forms as well as all the other, indicated herein in the synonymy, represent evidently one morphotype, differing in their general outline and the structure of the sulcus acusticus, both from the species *Gobius praetiosus* PROCHÁZKA, 1893, and *G. francofurtanus* KOKEN, 1891. Otoliths labelled herein as *Gobius* aff. *niger* LINNAEUS, 1758, differ from those of *G.* aff. *geniporus* VALENCIENNES, 1837, in their greater height, their dorsal rim more crenulated, and their outer face more concave.

Gobius sp.
(Text-fig. 144 and Pl. 34, Figs 7-9)

MATERIAL: Korytnica – some 1300 specimens, in majority well preserved; Niskowa – 10 specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 144	Pl. 34
RaK-391	3.4	2.8	1.0	Fig. 144a	Fig. 9
RaK-393	3.2	2.6	1.0	--	Fig. 7

DESCRIPTION: Otoliths relatively large, rectangular in outline. Dorsal rim is of an irregular course. Ventral rim is slightly convex. Posterior and anterior rims are concave at their midheight. Inner face is slightly convex. Sulcus acusticus is relatively wide. Ostium is a bit longer and wider than the cauda. Area and ventral furrow are well developed. Outer face is generally convex, but it may be concave nearer the dorsal rim.

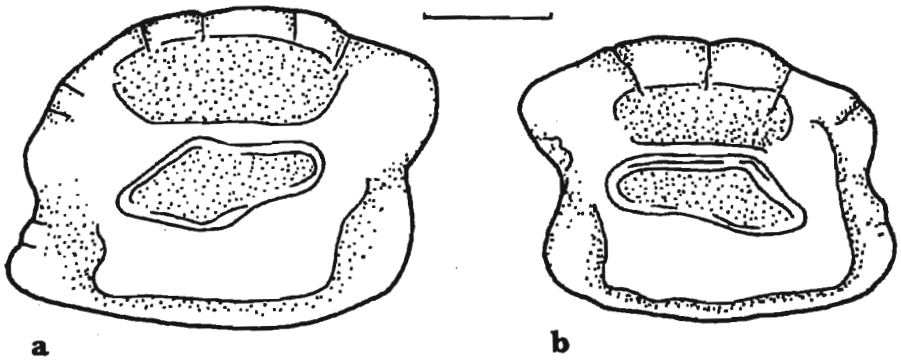


Fig. 144. *Gobius* sp.

a – Right sagitta, inner face; b – left sagitta, inner face

REMARKS: The studied otoliths are close to those of the present-day species *Gobius angolensis* NORMAN, 1935 (*see* Text-fig. 145), and thus they are assigned to he genus *Gobius* LINNAEUS, 1758. From the present-day forms they differ in their slightly wider ostium and the more undulant dorsal rim. Such forms have not hitherto been reported from Poland.

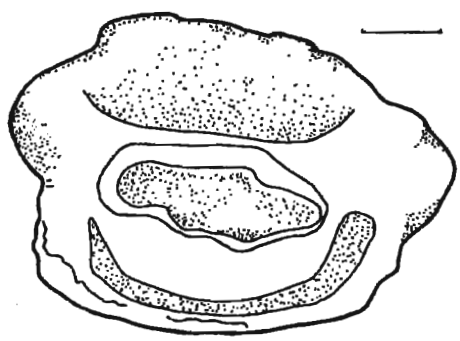


Fig. 145. *Gobius angolensis* NORMAN, 1935

Present-day specimen: left sagitta, inner face; Western Africa (NOLF's Collection)

"genus *Gobiidarum*" sp. 1
(Text-fig. 146 and Pl. 35, Figs 1-2)

MATERIAL: Niskowa – 30 juvenile specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 146	Pl. 35
RaNi-399a	1.4	1.3	Fig. 146b	Fig. 2
RaNi-399b	1.2	1.1	Fig. 146a	Fig. 1

DESCRIPTION: Otoliths pentagonal in outline. Dorsal rim is convex, hooked at its midlength. Anterior and posterior rims are slightly concave. Ventral rim is straight. Inner face is slightly convex. Sulcus acusticus is displaced towards the anterior rim. Cauda is very short, and narrow. Outer face is convex.

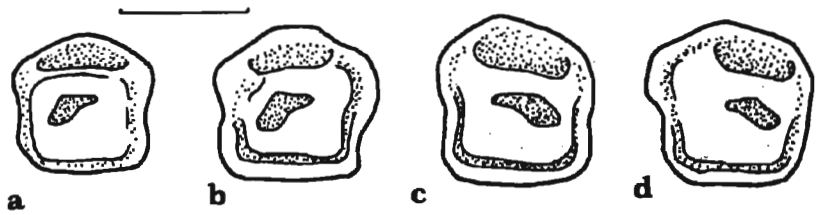


Fig. 146. "genus *Gobiidarum*" sp. 1

a, b – Right sagitta, inner face; c, d – left sagitta, inner face

REMARKS: The studied otoliths, assigned generally to the family Gobiidae BONAPARTE, 1832, are similar to those of the present-day species *Pomatoschistus pictus* (MALM, 1865), known from the Atlantic coasts of Europe *(see* HÄRKÖNEN 1986, Pl. 80), but their juvenile nature does not allow to make any more precise recognition. Such forms have not hitherto been reported from Poland.

"genus *Gobiidarum*" sp. 2
(Text-fig. 147 and Pl. 35, Figs 9-11)

MATERIAL: Niskowa – 28 specimens, Korytnica – 17 specimens; all well preserved.

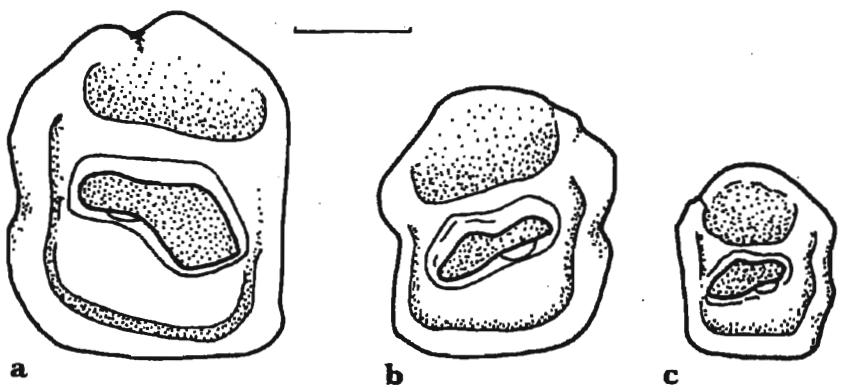


Fig. 147. "genus *Gobiidarum*" sp. 2

a – Left sagitta, inner face; b, c – right sagitta, inner face

Coll. numbers	L	H	T	Figured in: Text-fig. 147	Pl. 35
RaNi-402	2,5	3.0	0.7	Fig. 147a	Fig. 11
RaNi-400	2.2	2.8	0.7	Fig. 147b	Fig. 9

DESCRIPTION: Otoliths relatively thick and high. Dorsal rim is rounded. Anterior rim is straight or slightly concave. Posterior rim is also concave. Ventral rim is slightly convex, with a truncated posteroventral corner. Inner face is flat. Sulcus acusticus is deeply incised. Ostium is almost as long as the cauda. Area and ventral furrow are well developed. Outer face is convex, flattened centrally.

REMARKS: The studied otoliths are herein assigned to the family Gobiidae BONAPARTE, 1832. They are close to those of the genera *Gobius* LINNAEUS, 1758, and *Gobisculus* DUNCKER, 1928, but they differ from the former in their relatively greater height, and from the latter in their greater size and their sulcus acusticus wider. Such forms have not hitherto been reported from Poland.

"genus *Gobiidarum*" sp. 3
(Text-fig. 148 and Pl. 35, Figs 7-8)

MATERIAL: Korytnica – 24 specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 148	Pl. 35
RaK-404a	0.9	0.9	Fig. 148a	Fig. 7
RaK-404b	0.7	0.7	Fig. 148d,d'	Fig. 8

DESCRIPTION: Otoliths tiny in their size, almost circular in outline. Inner face is flat. Sulcus acusticus, rhomboidal in outline, is so displaced towards the anterior rim that its end is placed at the center of the otolith. Outer face is convex.

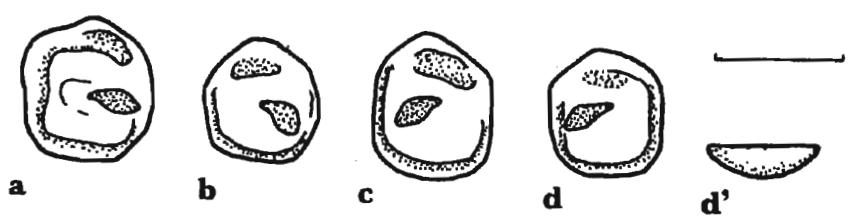


Fig. 148. "genus *Gobiidarum*" sp. 3

a, b – Left sagitta, inner face; **c, d** – right sagitta, inner face, **d'** – ventral view

REMARKS: The studied otoliths, assigned to the family Gobiidae BONAPARTE, 1832, are very close to those of such present-day species as *Aphia minuta* (RISSO, 1810) and *Crystallogobius linearis* (DEUVEN & KOREN, 1846). Otoliths of these two species of different genera are so similar to each other (*see* HÄRKÖNEN 1986, Pl. 83) that they cannot be distinguished unequivocally in the fossil state. Such forms have not hitherto been reported from Poland.

"genus *Gobiidarum*" sp. 4
(Text-fig. 149 and Pl. 35, Figs 5-6)

MATERIAL: Korytnica – 84 specimens, in majority well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 149	Pl. 35
RaK-406a	1.8	1.8	Fig. 149d	Fig. 6
RaK-406b	1.5	1.4	Fig. 149a	Fig. 5

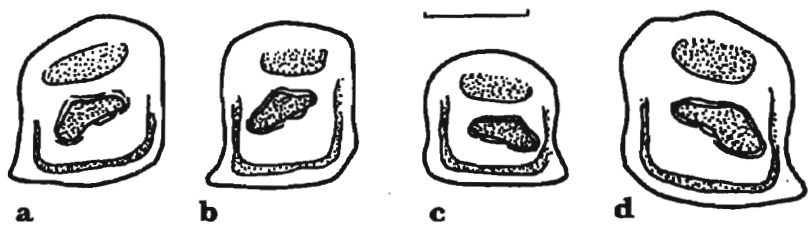


Fig. 149. "genus *Gobiidarum*" sp. 4

a, b – Right sagitta, inner face; c, d – left sagitta, inner face

DESCRIPTION: Otoliths relatively thin, rectangular in outline. Anteroventral corner is developed as a spur. Dorsal and ventral rims are slightly convex. Posterior rim is straight or slightly concave. Inner face is almost flat. Sulcus acusticus is deeply incised. Ostium is slightly wider and longer than the cauda. Ventral furrow is well developed. Outer face is slightly convex.

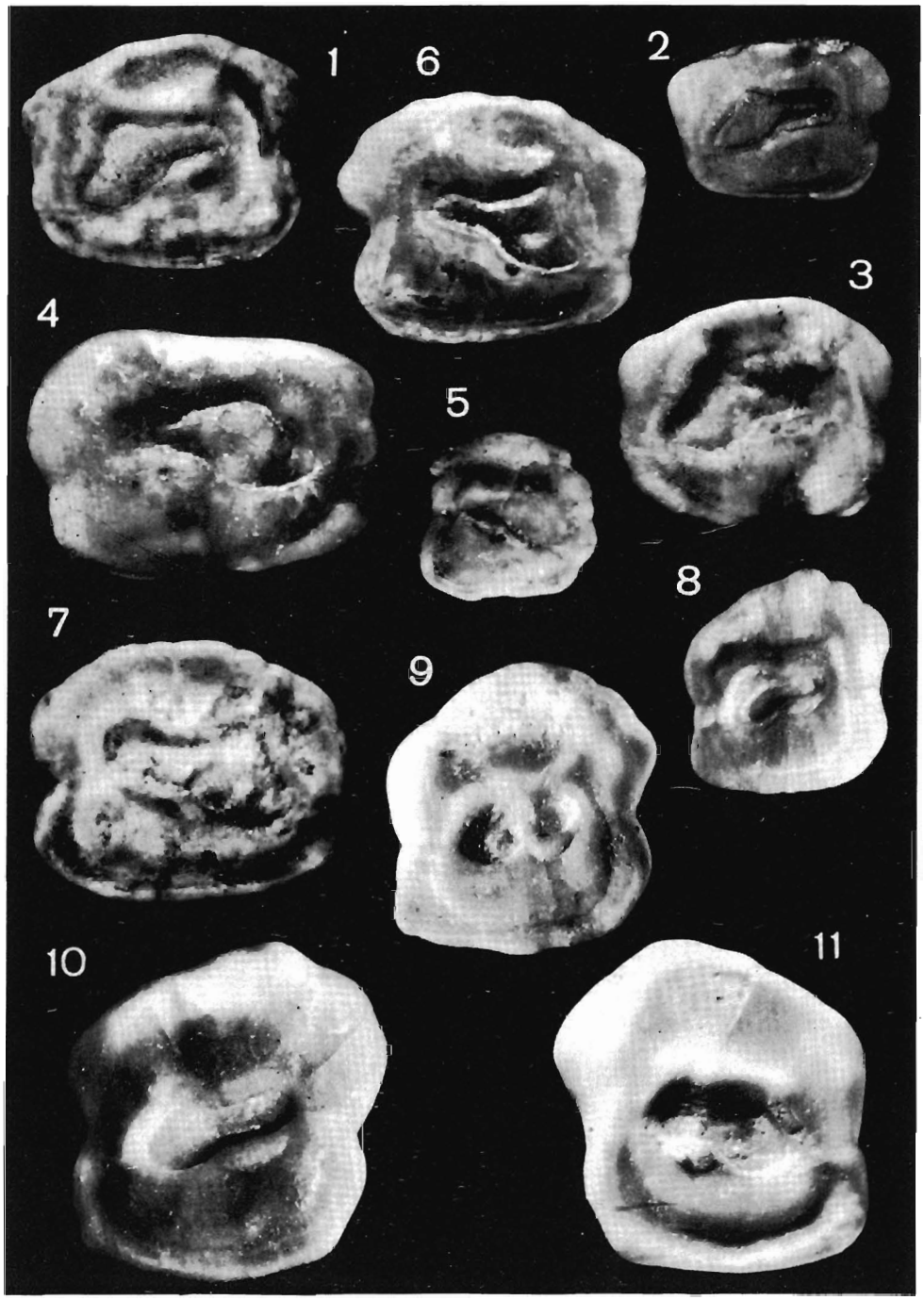
REMARKS: The studied otoliths, assigned generally to the family Gobiidae BONAPARTE, 1832, differ from all the heretofore discussed forms of this family in having a pronounced anteroventral corner developed as a spur. Such forms have not hitherto been reported from Poland.

"genus *Gobiidarum*" sp. 5
(Text-fig. 150 and Pl. 35, Figs 3-4)

MATERIAL: Korytnica – 5 specimens, well preserved.

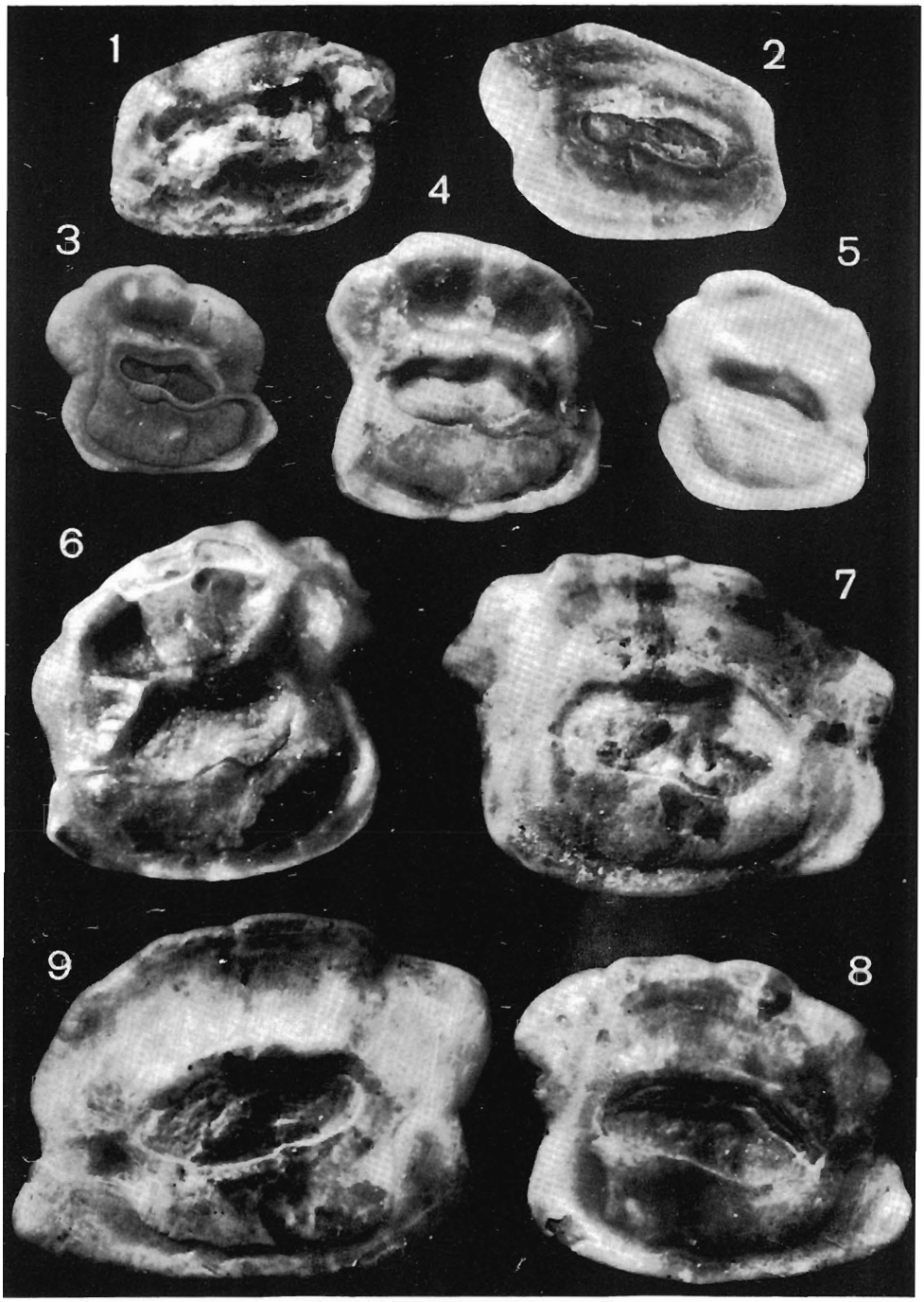
Coll. numbers	L	H	Figured in: Text-fig. 150	Pl. 35
RaK-407a	1.3	1.1	Fig. 150a	Fig. 4
RaK-407b	1.2	1.0	Fig. 150b	Fig. 3

DESCRIPTION: Otoliths almost rectangular in outline. Dorsal rim is convex and slightly undulant. Ventral rim is ideally straight. Inner face is flat. Sulcus acusticus is narrow, shaped like a flattened triangle. Outer face is convex, furnished with striae propagating from the dorsal rim.



1-7 — *Deltenosteus telleri* (SCHUBERT, 1906); 1-3 — right sagitta, inner face; 4-7 — left sagitta, inner face; × 20

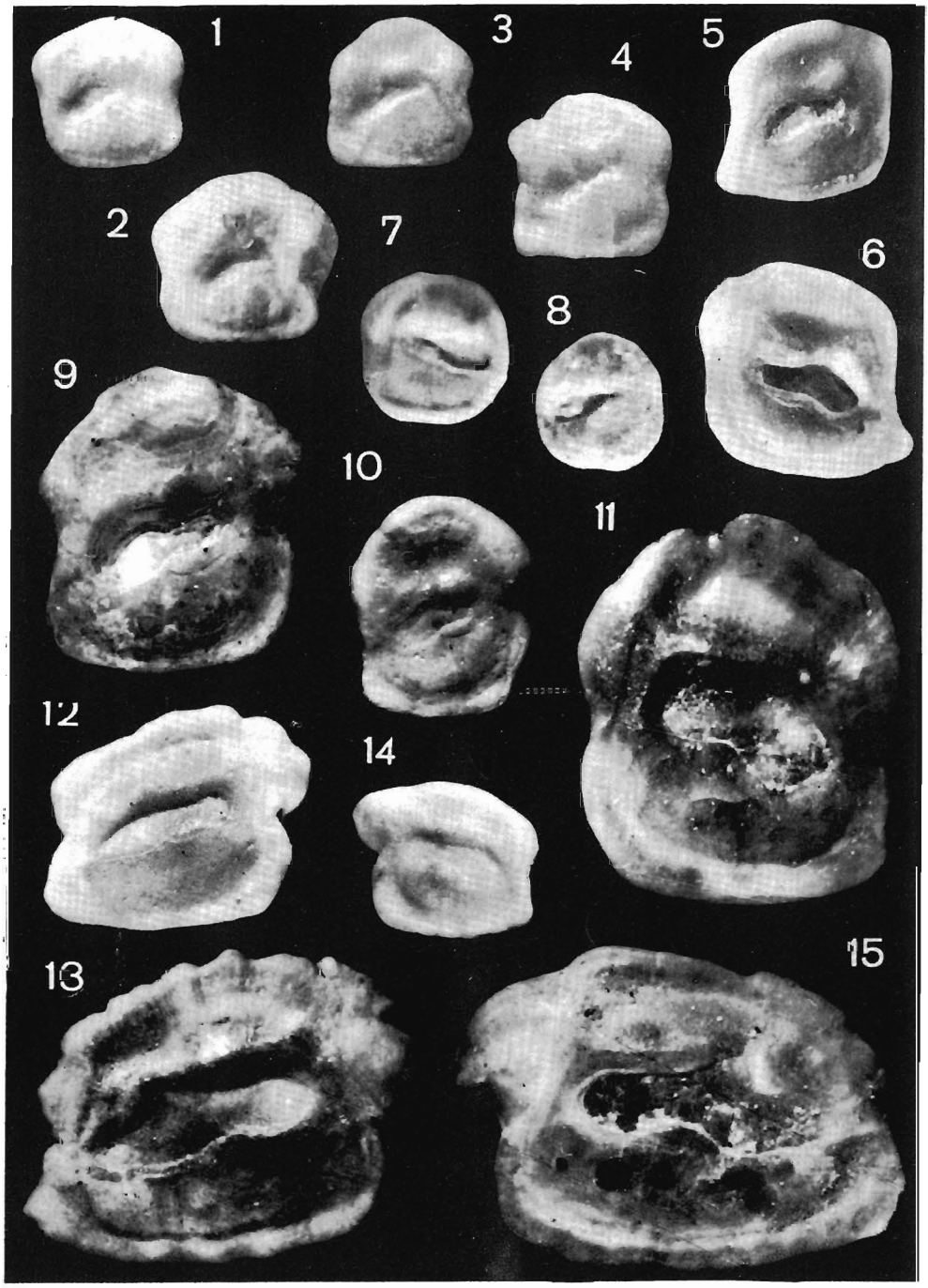
8-11 — *Gobius vicinalis* KOKEN, 1891; 8-10 — right sagitta, inner face; 11 — left sagitta, inner face; × 20



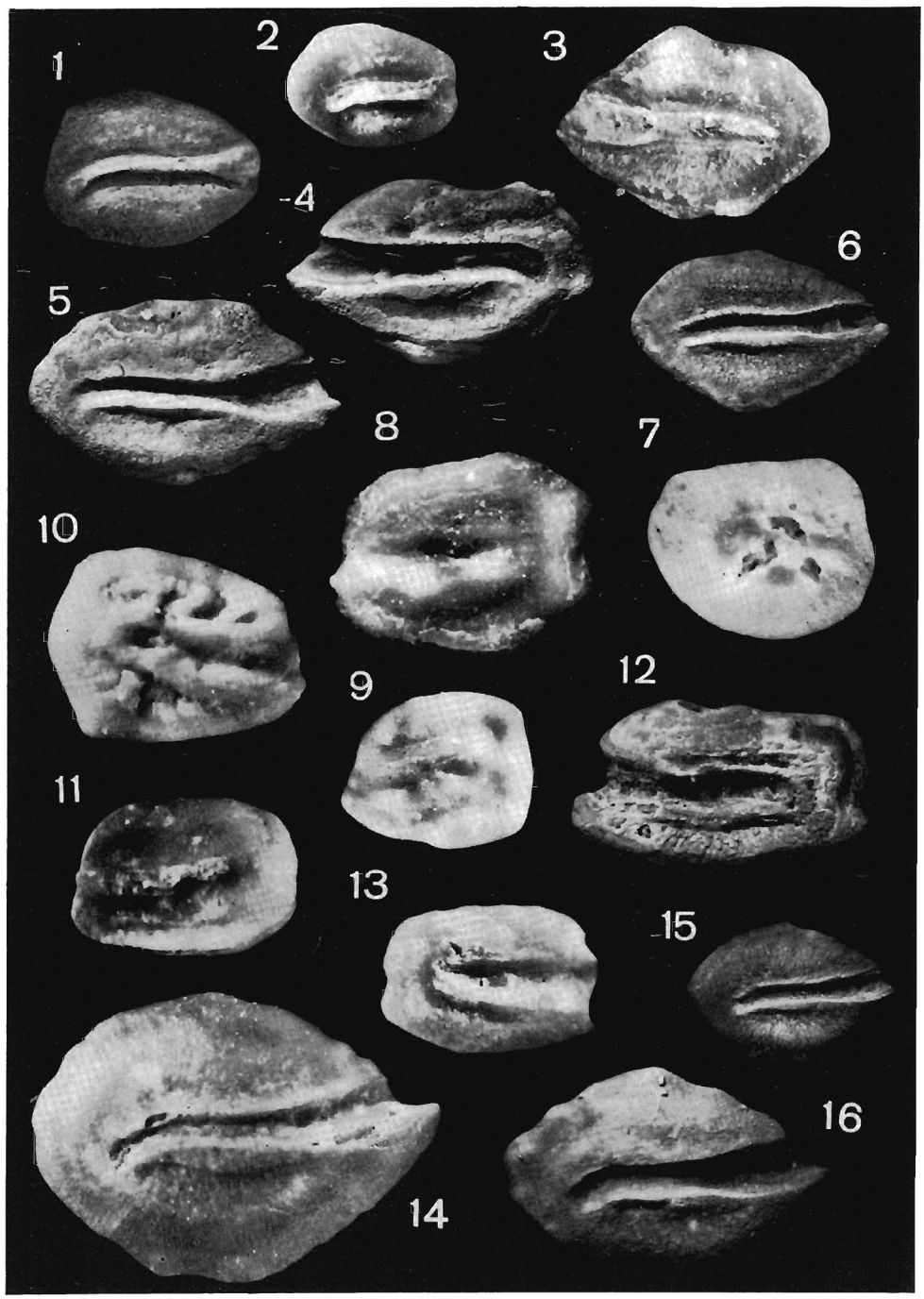
1-2 — *Gobius* aff. *geniporus* VALENCIENNES, 1837; 1 — right sagitta, inner face; 2 — left sagitta, inner face; × 15

3-6 — *Gobius vicinalis* KOKEN, 1891; 3-5 — left sagitta, inner face; 6 — right sagitta, inner face; 3 × 15; 4-6 × 20

7-9 — *Gobius* sp.; 7-8 — left sagitta, inner face; 9 — right sagitta, inner face; × 20



1-2 – "genus *Gobiidarum*" sp. 1; right sagitta, inner face; × 20
3-4 – "genus *Gobiidarum*" sp. 5; right sagitta, inner face; × 20
5-6 – "genus *Gobiidarum*" sp. 4; 5 – right sagitta, inner face; 6 – left sagitta, inner face; × 15
7-8 – "genus *Gobiidarum*" sp. 3; 7 – left sagitta, inner face; 8 – right sagitta, inner face; × 20
9-11 – "genus *Gobiidarum*" sp. 2; 9-10 – right sagitta, inner face; 11 – left sagitta, inner face; × 18
12-15 – *Gobius* aff. *niger* LINNAEUS, 1758; 12-13 – right sagitta, inner face; 14-15 – left sagitta, inner face; × 20



1-2 – *Citharus* sp. 2; left sagitta, inner face; × 10
3-6 – *Citharus lusitanicus* (JONET, 1973); 3-4 – right sagitta, inner face; 5-6 – left sagitta, inner face; × 10
7 – "genus *Soleidarum*" sp. 1; left sagitta, inner face; × 15
8-10 – *Arnoglossus* aff. *laterna* (WALBAUM, 1792); 8-9 – right sagitta, inner face; 10 – left sagitta, inner face; × 15
11 – *Arnoglossus* sp. 1; right sagitta, inner face; × 18
12-13 – "genus *Bothidarum*" sp.; 12 – right sagitta, inner face; 13 – left sagitta, inner face; × 10
14-16 – *Citharus* sp.; left sagitta, inner face; × 15

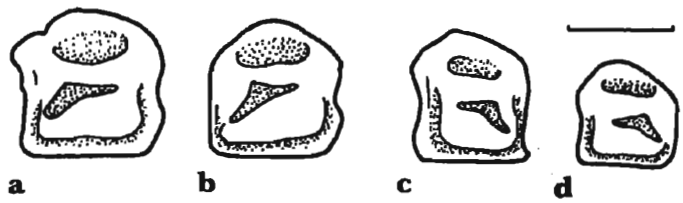


Fig. 150. "genus *Gobiidarum*" sp. 5

a, b — Right sagitta, inner face; c, d — left sagitta, inner face

REMARKS: The studied otoliths, assigned generally to the family Gobiidae BONAPARTE, 1832, differ from all the heretofore discussed forms of this family in having an ideally straight ventral rim, and the outline of their sulcus acusticus. Such forms have not hitherto been reported from Poland.

Order **Pleuronectiformes** BLEEKER, 1859
Suborder **Pleuronectoidei** BLEEKER, 1859
Family **Citharidae** HUBBS, 1945
Genus *Citharus* RÖSE, 1793

Citharus lusitanicus (JONET, 1973)
(Text-fig. 151 and Pl. 36, Figs 3-6)

1973. *Eucitharus lusitanicus* nov. sp.; S. JONET, p. 225, Text-fig. 12 (items 33-34) and Pl. 4, Figs 131-133.
1979. *Citharus lusitanicus* (JONET, 1973); T. ŚMIGIELSKA, p. 330, Text-figs 34-35 and Pl. 8, Figs 6-8.
1982. *Citharus lusitanicus* (JONET, 1973); E. STEURBAUT & S. JONET, p. 209, Pl. 4, Figs 14-16.
non 1984. *Citharus lusitanicus* (JONET, 1973); E. STEURBAUT, p. 108, Pl. 34, Figs 14-16.
1985. *Citharus lusitanicus* (JONET, 1973); D. NOLF, p. 102.

MATERIAL: Korytnica — 83 specimens, in majority well preserved.

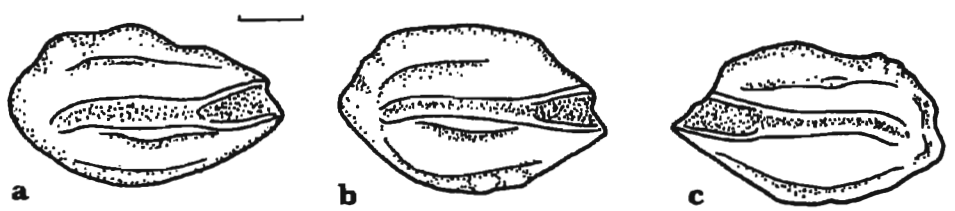


Fig. 151. *Citharus lusitanicus* (JONET, 1973)

a, b — Left sagitta, inner face; c — right sagitta, inner face

Coll. numbers	L	H	T	Figured in: Text-fig. 151	Pl. 36
RaK-409	4.0	2.6	0.9	Fig. 151b	Fig. 5
RaK-410	4.0	2.5	0.8	Fig. 151c	Fig. 4

REMARKS: The studied otoliths are concordant with those of the type series described from the Miocene of Portugal (*see* JONET 1973). This species has already been described from the Korytnica Basin by ŚMIGIELSKA (1979).

According to the present author, the otoliths from the Aquitaine Basin described by STEURBAUT (1984) as "*Citharus lusitanicus* (JONET, 1973)" represent another species. They differ in their thickness, sulcus acusticus narrower, all rims crenulated, and in different lateral profile as seen from their dorsal rim (*see* STEURBAUT 1984, Pl. 34, Fig. 11a).

Citharus sp. 1
(Text-fig. 152 and Pl. 36, Figs 14-16)

1979. *Citharus miocenicus* (WEILER, 1942); E. STEURBAUT, p. 78, Pl. 11, Fig. 16.
1984. *Citharus* sp.; E. STEURBAUT, p. 108, Pl. 34, Figs 3-9.

MATERIAL: Korytnica – 15 specimens, in majority well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 152	Pl. 36
RaK-413	3.9	2.8	0.7	Fig. 152a	Fig. 14
RaK-415	3.0	2.0	0.5	Fig. 152b	Fig. 16

DESCRIPTION: Otoliths oval in outline. On the anterior rim developed are: a relatively pronounced antirostrum, a deep excisura, and a sharply-ended rostrum. Inner face is convex. Sulcus acusticus is distinctly bent posteriorly. Outer face is convex in its posterior part, but it passes into a deep depression anteriorly.

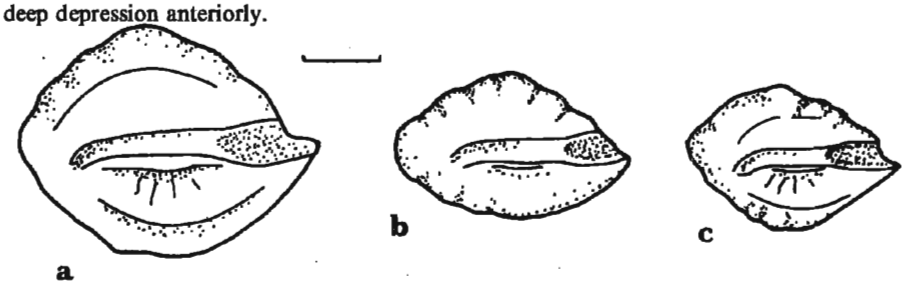


Fig. 152. *Citharus* sp. 1

a, b, c – Left sagitta, inner face

REMARKS: The studied otoliths, in regard with the structure of their sulcus acusticus, are herein assigned to the genus *Citharus* RÖSE, 1793. All collected specimens are concordant with those described by STEURBAUT (1984) from the Miocene of Aquitaine as "*Citharus* sp.". They are determined to the genus rank, since the recognition of the fossil species is rather very poor (*see* STEURBAUT 1984), and most of them have been established on the basis of juvenile forms.

The collected specimens differ from those of the species *Citharus lusitanicus* (JONET, 1973) in their outline more rounded and their sulcus acusticus more distinctly bent posteriorly. Such forms have not hitherto been reported from Poland.

Citharus sp. 2
(Text-fig. 153 and Pl. 36, Figs 1-2)

MATERIAL: Korytnica – 4 specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 153	Pl. 36
RaK-416	3.0	2.2	Fig. 153a	Fig. 1
RaK-417	2.4	1.5	Fig. 153b	Fig. 2

DESCRIPTION: Otoliths relatively thin, with posterodorsal corner well developed. Dorsal rim is asymmetrically convex, bent towards the ventral rim posteriorly. Inner face is flattened. Sulcus acusticus is relatively wide. Ostium is short. Cauda is much longer, and it distinctly turns towards the ventral rim. Outer face is flat, and ununiformly corrugated.

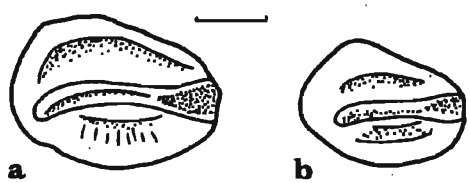


Fig. 153. *Citharus* sp. 2
a, b – Left sagitta, inner face

REMARKS: The studied otoliths, due the structure of their sulcus acusticus, are herein assigned to the genus *Citharus* RÖSE, 1793. The collected specimens are close to those of the fossil species *Citharus schuberti* (BASSOLI, 1906), from which they differ in their outline being more rounded. Such difference may presumably be interpreted as a case of the intraspecific variability, but a limited number of specimens does not allow to verify this assumption. Any similar forms have not hitherto been reported from Poland.

Family **Scophthalmidae** JORDAN, 1923
Genus *Lepidorhombus* GÜNTHER, 1862

Lepidorhombus angulosus NOLF, 1977
(Text-fig. 154 and Pl. 37, Figs 1-7)

1977. *Lepidorhombus angulosus* n. sp.; D. NOLF, p. 60, Pl. 17, Figs 15-16.
1979. *Lepidorhombus angulosus* NOLF, 1977; B. HUYGHEBAERT & D. NOLF, p. 69, Pl. 6, Figs 17-18.
1985. *Lepidorhombus angulosus* NOLF, 1977; D. NOLF, p. 103.

MATERIAL: Rybnica – 12 specimens, well preserved; Nawodzice – one specimen, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 154	Pl. 37
RaR-423	3.5	2.3	0.7	Fig. 154c	Fig. 5
RaR-421	3.5	2.1	0.5	Fig. 154b	Fig. 3
RaR-418	3.0	1.9	0.5	Fig. 154a	Fig. 1

DESCRIPTION: Otoliths flat, with the posterodorsal and posteroventral corners well developed. On the anterior rim developed are: an antirostrum, a shallow excisura, and a pronounced, bluntly-ended rostrum. Inner face is flat, slightly concave around the whole sulcus acusticus which is relatively narrow and divided. Collicula are well developed only in some specimens. Outer face is concave centrally.

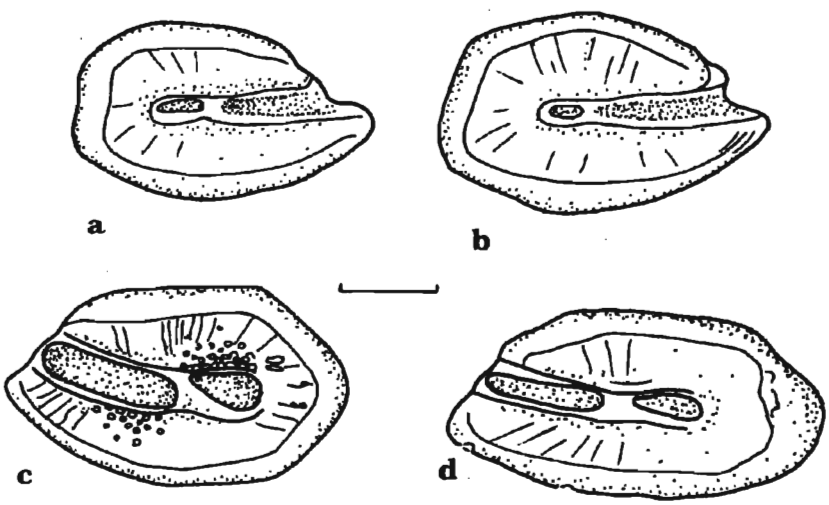


Fig. 154. *Lepidorhombus angulosus* NOLF, 1977

a, b – Left sagitta, inner face; **c, d** – right sagitta, inner face

REMARKS: The studied otoliths are concordant with those of the type series of the species (*see* NOLF 1977, Pl. 17, Figs 15-16).

Within the genus *Lepidorhombus* GÜNTHER, 1862, a typical feature is dissymmetry between left and right sagittas (*see* NOLF 1985). Such a dissymmetry is well visible in the material collected at Rybnica where the right sagittas are elongated more than the left ones (*see* Pl. 37, Figs 5-7). This species has not hitherto been reported from Poland.

Genus *Scophthalmus* RAFINESQUE, 1810

Scophthalmus sp.
(Text-fig. 155 and Pl. 37, Figs 8-10)

MATERIAL: Rybnica – 4 specimens, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 155	Pl. 37
RaR-429	6.0	4.8	1.4	Fig. 155b,b'	Fig. 10
RaR-428	4.4	3.0	0.8	Fig. 155a	Fig. 9

DESCRIPTION: Otoliths massive, slightly rectangular in outline. All rims are convex, except of the posterior one which may be concave. On the anterior rim developed are: a shallow excisura, and a long, bluntly-ended rostrum. Inner face is strongly convex and it may be ornamented with granules in adult specimens (*see* Pl. 37, Fig. 10). Sulcus acusticus is narrow and distinctly divided. Ostium is wider and slightly longer than the arcuated cauda. Outer face is flat.

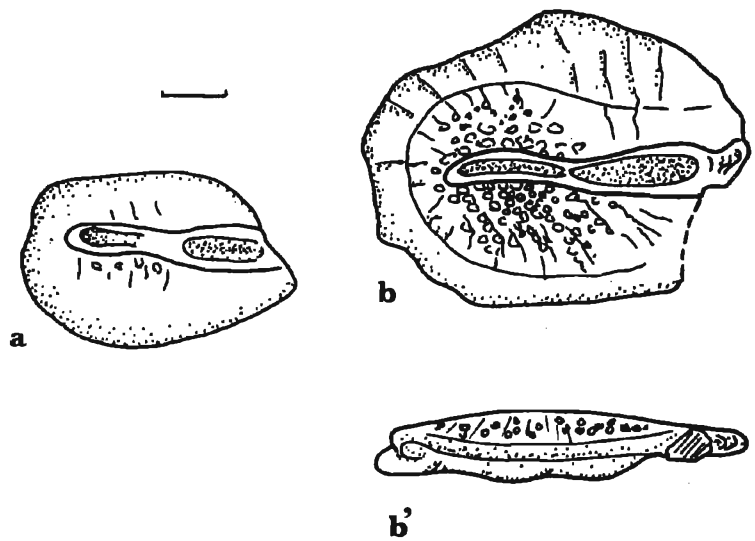


Fig. 155. *Scophthalmus* sp.

a, b — Left sagitta, inner face; **b'** — ventral view

REMARKS: The studied otoliths are very close to those of the present-day species *Scophthalmus rhombus* (LINNAEUS, 1758) known from the Mediterranean and the Atlantic coasts of Europe (*see* HÄRKÖNEN 1986, Pl. 86). The collected specimens differ in their overall outline, since they are higher and their ventral rim is more convex. A poor material does not allow to classify it more precisely. Such forms have not hitherto been reported from Poland.

Family **Bothidae** JORDAN, 1923
Genus *Arnoglossus* BLEEKER, 1862

Arnoglossus aff. *laterna* (WALBAUM, 1792)
(Text-fig. 156 and Pl. 36, Figs 8-10)

1973. *Arnoglossus inconspectus* n. sp.; T. ŚMIGIELSKA, p. 28, Text-fig. 5 and Pl. 5, Fig. 10.

MATERIAL: Niskowa – 7 specimens, some of which well preserved; Korytnica – 3 specimens, badly preserved.

Coll. numbers	L	H	Figured in: Text-fig. 156	Pl. 36
RaNi-430	2.4	1.8	Fig. 156a	Fig. 10
RaNi-432	1.5	1.4	Fig. 156c	Fig. 9

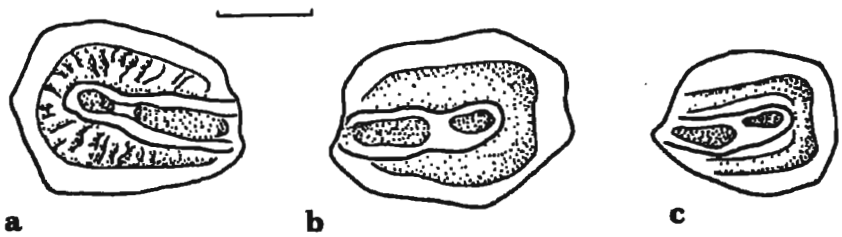


Fig. 156. *Arnoglossus* aff. *laterna* (WALBAUM, 1792)

a – Left sagitta, inner face; b, c – right sagitta, inner face

REMARKS: The studied otoliths are close to those of the present-day species *Arnoglossus laterna* (WALBAUM, 1792), known from the Mediterranean and the eastern Atlantic (*see* NOLF 1978, Pl. 7, Figs 1-3). The collected specimens differ in their sulcus acusticus located more obliquely.

Such a form has already been reporetd from Niskowa by ŚMIGIELSKA (1973) who treated it as a separate species, "*Arnoglossus inconspectus* n. sp.". The only specimen described by ŚMIGIELSKA (1973) differs from the otoliths of the above indicated present-day species in its lesser size what supposedly signifies its juvenile nature.

The newly collected material, obtained i. a. at Niskowa contains also the adult forms, what allows to study its variability (*see* Text-fig. 156). According to the present author, both the own material as well as the specimen described by ŚMIGIELSKA (1973), in regard with its sulcus acusticus more oblique, represent the species of a marked affinity to the present-day *Arnoglossus laterna* (WALBAUM, 1792).

Arnoglossus sp. 1
(Text-fig. 157 and Pl. 36, Fig. 11)

MATERIAL: Korytnica – 3 juvenile specimens, well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 157	Pl. 36
RaR-433	1.8	1.2	Fig. 157a	Fig. 11

DESCRIPTION: Otoliths rectangular in outline. Anterior rim is slightly oblique to the dorsal rim. Inner face is slightly convex. Ostium is long and narrow. Cauda is small, oval, and three times shorter than the ostium. Outer face is asymmetrically convex.

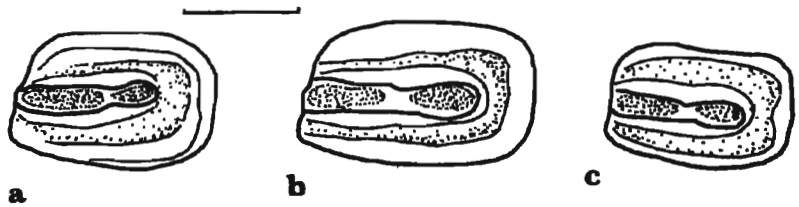


Fig. 157. *Arnoglossus* sp. 1

a, b, c — Right sagitta, inner face

REMARKS: The studied otoliths, due to the structure of their sulcus acusticus are herein assigned to the genus *Arnoglossus* BLEEKER, 1862. A juvenile nature of the specimens does not allow to precise their specific affinity. Such forms have not hitherto been reported from Poland.

Arnoglossus sp. 2
(Text-fig. 158 and Pl. 38, Figs 1-3)

1966. *Solea* aff. *laureri* WEINFURTER; T. ŚMIGIELSKA, p. 267, Pl. 19, Figs 10-11.

MATERIAL: Korytnica — 56 specimens, in majority well preserved; Rybnica — 6 specimens, well preserved; Niskowa — 3 specimens, well preserved; all of them juvenile.

Coll. numbers	L	H	Figured in: Text-fig. 158	Pl. 38
RaK-434	1.9	1.4	Fig. 158c	Fig. 3
RaK-436	1.5	1.3	Fig. 158a	Fig. 1

DESCRIPTION: Otoliths of an irregularly rectangular outline. Dorsal rim is either straight or centrally concave. Both antero- and posterodorsal corners are well developed. On the anterior rim developed are: a shallow excisura and a short rostrum. Ventral rim is asymmetrically convex.

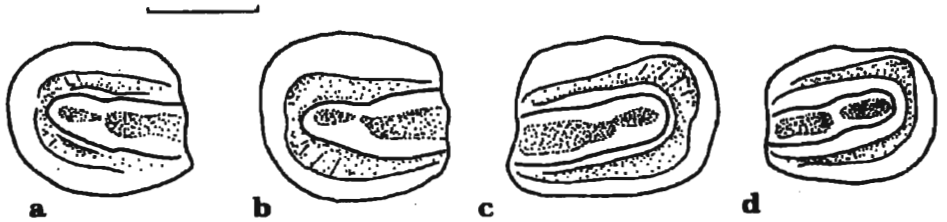


Fig. 158. *Arnoglossus* sp. 2

a, b — Left sagitta, inner face; c, d — right sagitta

Inner face is convex. Sulcus acusticus is distinctly divided. Ostium is twice longer than the cauda. Outer face is convex.

REMARKS: Within the genus *Arnoglossus* BLEEKER, 1862, there are several present-day species whose otoliths are very similar, and practically indistinguishable in juvenile specimens. The collected material is composed of specimens less than 2 mm in length, and thus evidently smaller than those of the adult present-day fish of this genus. They are thought to be the juvenile forms which are determinable to the genus rank only.

Such forms have formerly been described from the Miocene deposits of Poland by ŚMIGIELSKA (1966) as "*Solea* aff. *taureri* WEINFURTER". According to the present author, the specimens illustrated by ŚMIGIELSKA (1966) belong evidently to the genus *Arnoglossus* BLEEKER, 1862, and they represent the same morphology as that of the collected juvenile specimens.

"genus *Bothidarum*" sp.
(Text-fig. 159 and Pl. 36, Figs 12-13)

MATERIAL: Korytnica – 3 specimens, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 159	Pl. 36
RaK-441	4.9	2.6	0.7	Fig. 159b	Fig. 12
RaK-442	3.4	2.0	0.5	Fig. 159a	Fig. 13

DESCRIPTION: Otoliths elongated, rectangular in outline. Dorsal rim is straight. Posterior rim is concave at its midheight. On the anterior rim developed are: an antirostrum, an excisura, and a blunt rostrum. Inner face is strongly convex. Ostium is slightly wider than the cauda, which is twice shorter than the ostium. Outer face is flat, slightly concave anteriorly.

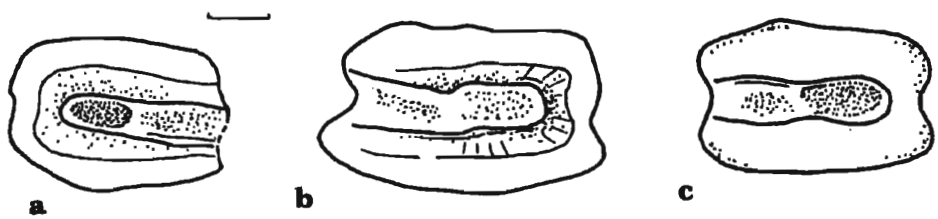


Fig. 159. "genus *Bothidarum*" sp.

a – Left sagitta, inner face; b, c – right sagitta, inner face

REMARKS: The studied otoliths are herein assigned generally to the family Bothidae JORDAN, 1923, whose present-day representatives are poorly recognized in regard to their otoliths. The collected specimens differ from those of the genus *Arnoglossus* BLEEKER, 1862, in their much longer size, and from the genus *Bothus* RAFINESQUE, 1810, in the structure of their sulcus acusticus. Such forms have not hithrto been reported from Poland.

Suborder **Soleoidei** NORMAN, 1931
Family **Soleidae** BONAPARTE, 1832
Genus *Dicologoglossa* CHABANAUD, 1930

Dicologoglossa aff. *cuneata* (MOREAU, 1881)
(Text-fig. 160 and Pl. 38, Figs 7-8)

MATERIAL: Korytnica – one specimen, Bęczyn – one specimen; the both well preserved.

Coll. numbers	L	H	Figured in: Text-fig. 160	Pl. 38
RaK-454	3.7	2.8	Fig. 160a,a'	Fig. 8
RaB-446	2.0	1.5	Fig. 160b,b'	Fig. 7

DESCRIPTION: Otoliths relatively thin with both antero- and posterodorsal corners well developed. Dorsal and anterior rims are almost straight. Ventral rim is asymmetrically convex. Inner face is convex. Sulcus acusticus is narrow and distinctly divided. Collicula are well developed. Outer face is concave.

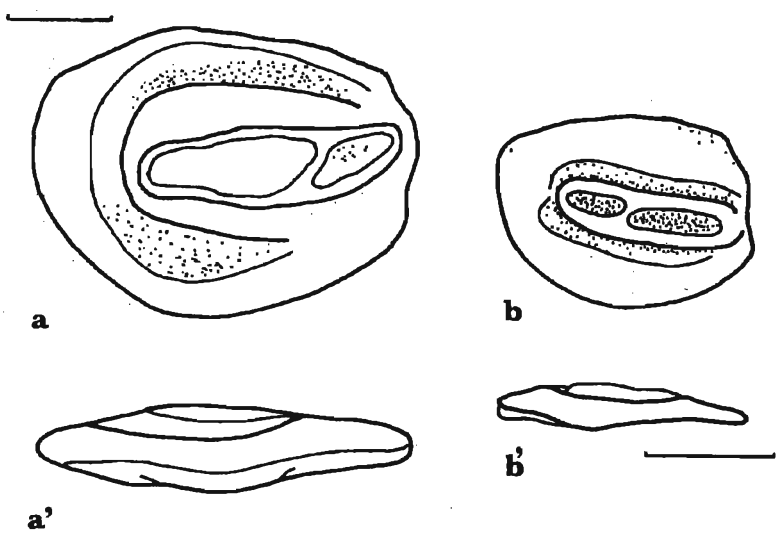


Fig. 160. *Dicologoglossa* aff. *cuneata* (MOREAU, 1881)

a, b – Left sagitta, inner face; a', b' – ventral view

REMARKS: The studied otoliths are close to those of the present-day species *Dicologoglossa cuneata* (MOREAU, 1881), known from the Mediterranean and the Atlantic coasts of northern Africa (*see* Text-fig. 161). A very limited number of specimens does not allow to recognize their

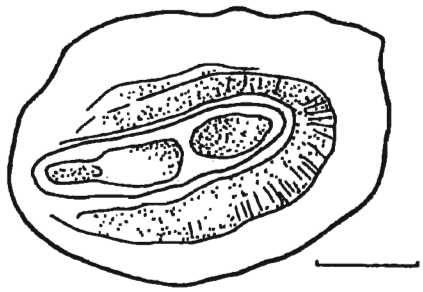


Fig. 161. *Dicologoglossa cuneata* (MOREAU, 1881)

Present-day specimen: right sagitta, inner face; Mediterranean Sea (NOLF's Collection)

range of variability and thus to define their relation to that present-day species. Such forms have not hitherto been reported from Poland.

Genus *Solea* QUENSEL, 1806

Solea solea (LINNAEUS, 1758)
(Text-figs 162-163 and Pl. 38, Figs 10-14)

MATERIAL: Korytnica – 7 specimens, not well preserved; Rybnica – one specimen, badly preserved; Niskowa – one specimen, well preserved.

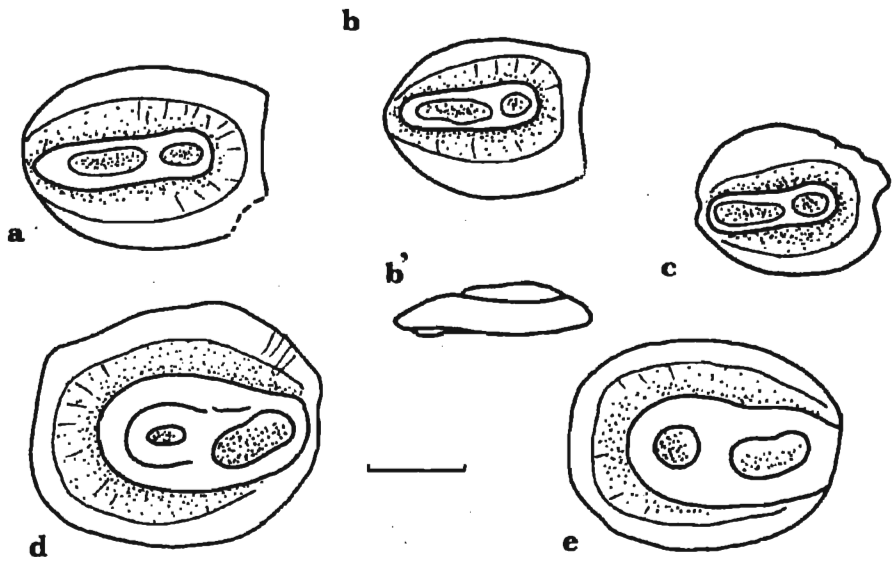


Fig. 162. *Solea solea* (LINNAEUS, 1758)

a, b, c – Right sagitta, inner face, b' – ventral view; d, e – left sagitta, inner face

Coll. numbers	L	H	T	Figured in: Text-fig. 162	Pl. 38
RaR-449	2.7	2.0	0.5	Fig. 162a	Fig. 10
RaR-450	2.2	1.8	0.5	Fig. 162b,b'	Fig. 11
RaR-451	1.9	1.5	0.4	Fig. 162c	Fig. 12

DESCRIPTION: Otoliths oval in outline. Posterior rim is either straight or concave. Inner face is strongly convex. Sulcus acusticus, typical of the genus *Solea* QUENSEL, 1806, is deeply incised and surrounded by dorsal and ventral areas. Collicula are well developed. Outer face is concave.

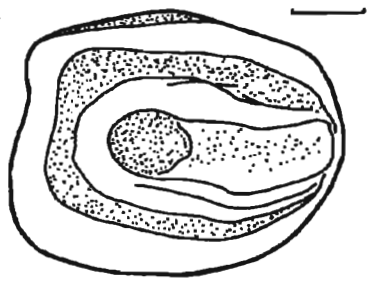


Fig. 163. *Solea solea* (LINNAEUS, 1758)

Present-day specimen: left sagitta, inner face; Mediterranean Sea (NOLF's Collection)

REMARKS: The studied otoliths are concordant with those of the present-day species *Solea solea* (LINNAEUS, 1758) known from the Mediterranean and the Atlantic coasts of Europe and northern Africa (*see* Text-fig. 163). The species has not hitherto been reported from Poland.

Genus *Microchirus* BONAPARTE, 1832

Microchirus aff. *variegatus* (DONOVAN, 1808) (Text-fig. 164 and Pl. 38, Fig. 9)

1906. *Otolithus* (*Solea*) *latior* n. sp.; R. SCHUBERT, p. 671, Pl. 6, Figs 12-14.
1981. *Microchirus* aff. *variegatus* (DONOVAN, 1808); D. NOLF, p. 167.

MATERIAL: Niskowa — one juvenile specimen, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 164	Pl. 38
RaNi-448	2.0	1.7	0.7	Fig. 164a,a'	Fig. 9

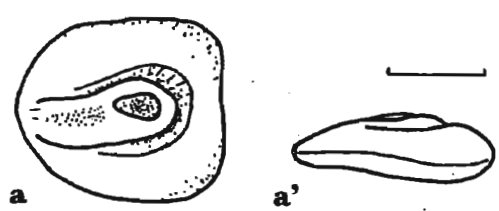


Fig. 164. *Microchirus* aff. *variegatus* (DONOVAN, 1808)

a — Right sagitta, inner face, a' — ventral view

DESCRIPTION: Otolith oval in outline, relatively thick. Posterior rim is straight. Ventral rim is rounded. Inner face is convex (*see* Text-fig. 164a'). Sulcus acusticus is featured with a well developed colliculum caudale. Outer face is asymmetrically convex.

REMARKS: The studied otolith is close to those of the present-day species *Microchirus variegatus* (DONOVAN, 1808) known from the Mediterranean and the Atlantic coasts of Europe and western Africa (*see* NOLF 1978, Pl. 7, Fig. 19). A juvenile nature of the collected specimen does not allow to include it unequivocally to that species. Such a form has not hitherto been reported from Poland.

"genus *Soleidarum*" sp. 1
(Text-fig. 165 and Pl. 36, Fig. 7)

MATERIAL: Rybnica — one specimen, badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 165	Pl. 36
RaR-455	2.1	1.8	0.5	Fig. 165a,a'	Fig. 7

DESCRIPTION: Otolith with dorsal rim straight, and the anterior rim perpendicular to the latter. Ventral rim is convex. Inner face is strongly convex (*see* Text-fig. 165a'). Sulcus acusticus is relatively shallow. Surface surrounding the sulcus is finely granulated. Outer face is convex.

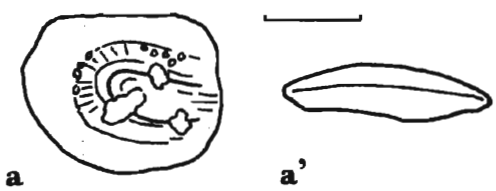


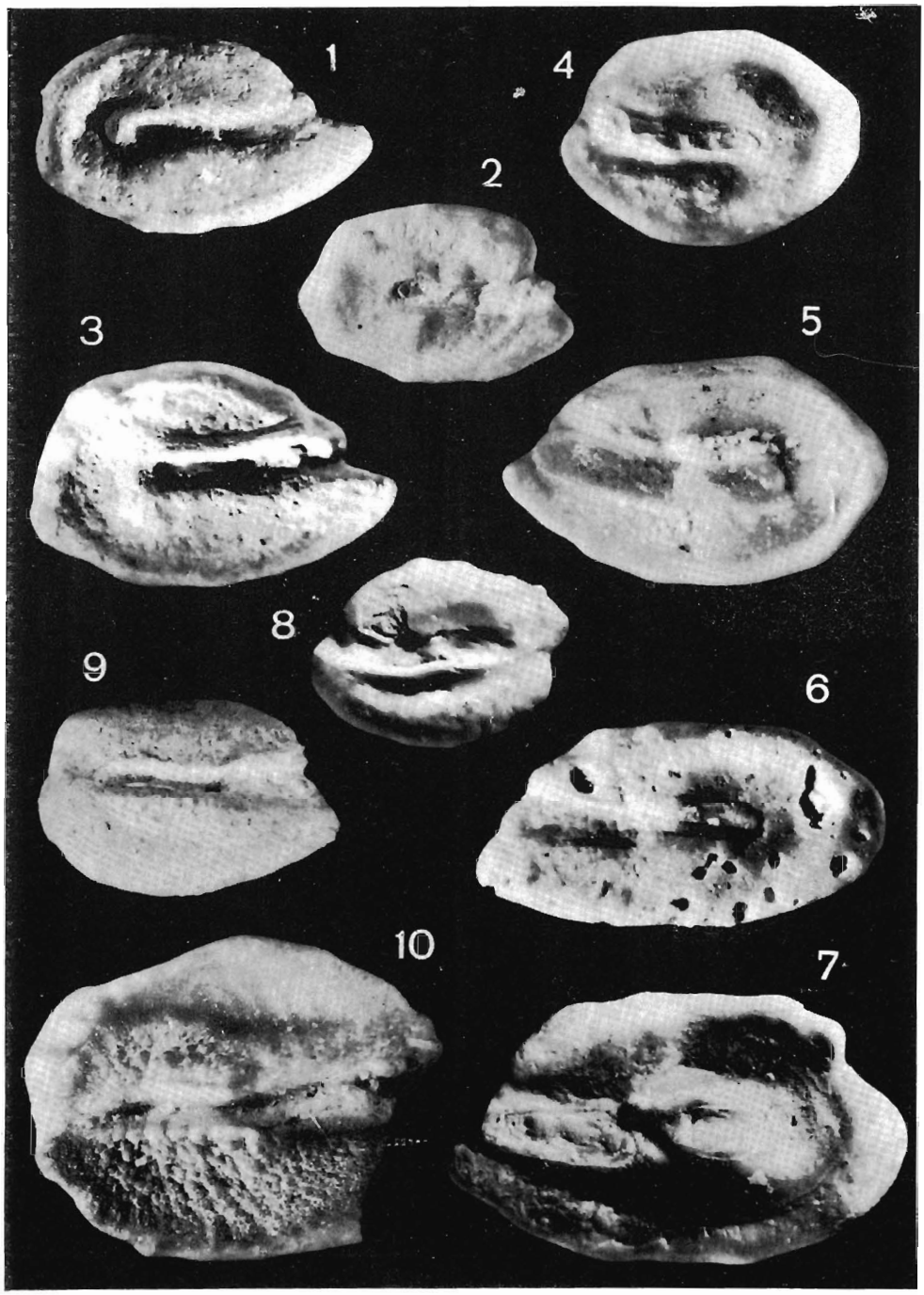
Fig. 165. "genus *Soleidarum*" sp. 1
a — Left sagitta, inner face, a' — ventral view

REMARKS: The studied otolith, due to the structure of its sulcus acusticus, is herein assigned to the family Soleidae BONAPARTE, 1832. Its poor state of preservation does not allow to precise its generic and specific attribution. Such a form has not hitherto been reported from Poland.

"genus *Soleidarum*" sp. 2
(Text-fig. 166 and Pl. 38, Figs 4-6)

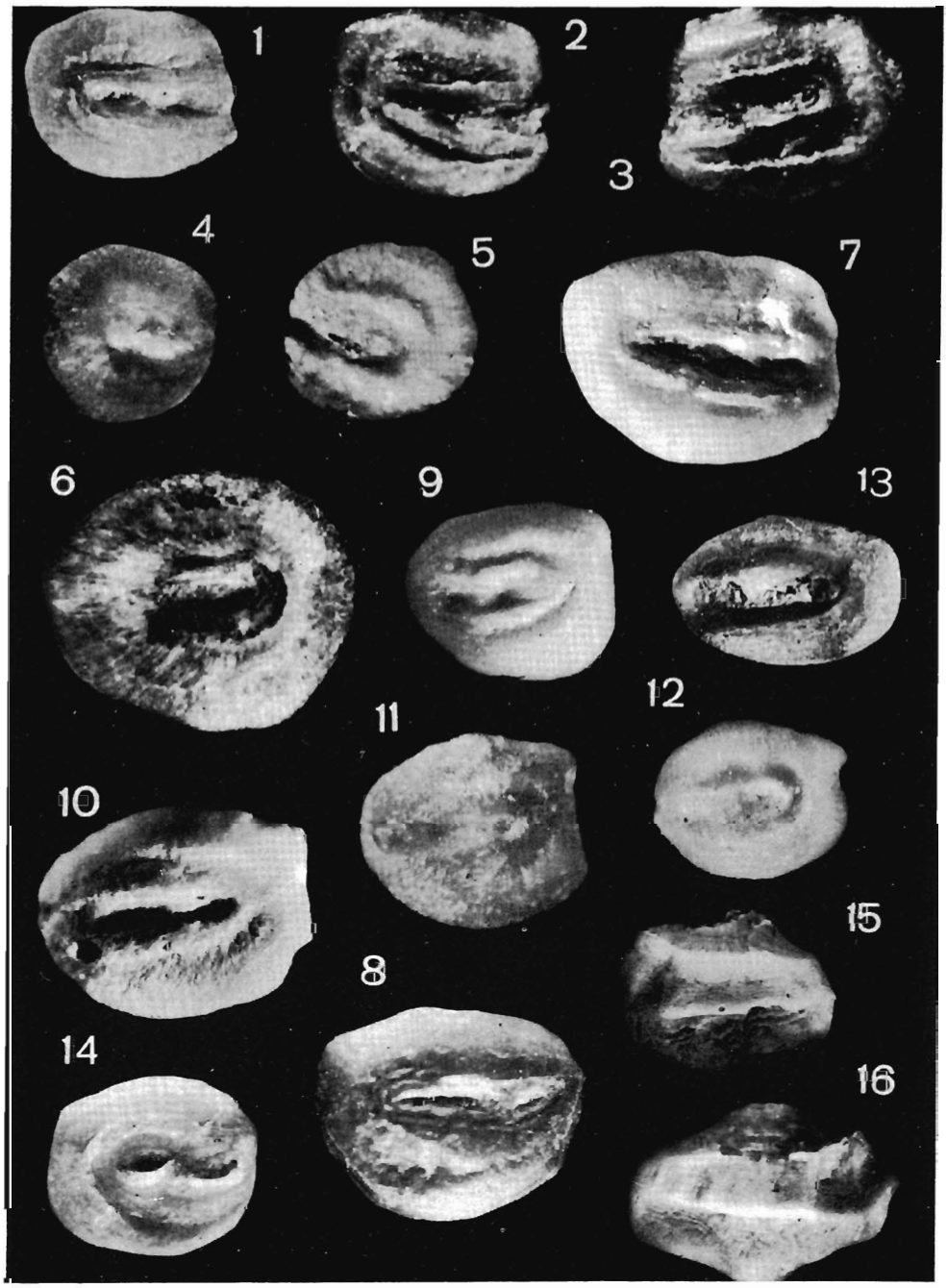
MATERIAL: Korytnica — 4 juvenile specimens, two of them badly preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 166	Pl. 38
RaK-445	2.3	2.0	0.7	Fig. 166c,c'	Fig. 6
RaK-444	1.5	1.3	0.4	Fig. 166b	Fig. 5
RaK-443	1.4	1.4	0.4	Fig. 166a	Fig. 4



1-7 – *Lepidorhombus angulosus* NOLF, 1977; 1-3 – left sagitta, inner face; 4-7 – right sagitta, inner face; × 15

8-10 – *Scophthalmus* sp.; 8 – right sagitta, inner face; 9-10 – left sagitta, inner face; × 10



1-3 — *Arnoglossus* sp. 2; 1-2 — left sagitta, inner face; 3 — right sagitta, inner face; × 20

4-6 — "genus *Soleidarum*" sp. 2; 4 — left sagitta, inner face; 5-6 — right sagitta, inner face; 4-5 × 20; 6 × 15

7-8 — *Dicologoglossa* aff. *cuneata* (MOREAU, 1881); left sagitta, inner face; 7 × 20; 8 × 15

9 — *Microchirus* aff. *variegatus* (DONOVAN, 1808); right sagitta, inner face; × 15

10-14 — *Solea solea* (LINNAEUS, 1758); 10-13 — right sagitta, inner face; 14 — left sagitta, inner face; × 15

15-16 — Teleostei, gen. et sp. indet.; 15 — right sagitta, inner face; 16 — left sagitta, inner face; × 15

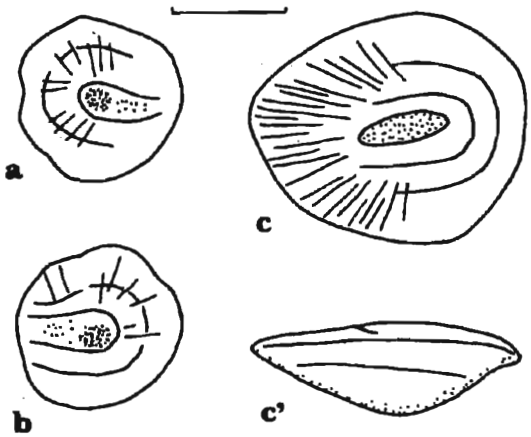


Fig. 166. "genus *Soleidarum*" sp. 2

a – Left sagitta, inner face; **b, c** – right sagitta, inner face, **c'** – ventral view

DESCRIPTION: Otoliths circular to oval in outline. Inner face is flat. Sulcus acusticus is shallow, indistinctly divided. Cauda is small, and the weakly developed colliculum caudale is circular. Outer face is asymmetrically convex.

REMARKS: The studied otoliths are herein assigned to the family Soleidae BONAPARTE, 1832. A juvenile nature of these otoliths hinders their more precise taxonomic attribution. From those designed as "genus *Soleidarum* sp. 1", they differ in their outline and lateral profile. Such forms have not hitherto been reported from Poland.

Teleostei, gen. et sp. indet.
(Text-fig. 167 and Pl. 38, Figs 15-16)

MATERIAL: Korytnica – 2 specimens, well preserved.

Coll. numbers	L	H	T	Figured in: Text-fig. 167	Pl. 38
RaK-457	2.5	1.9	0.8	Fig. 167a	Fig. 16
RaK-456	2.1	1.8	0.8	Fig. 167b	Fig. 15

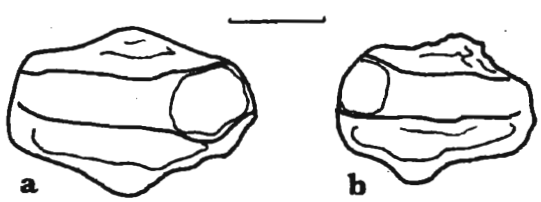


Fig. 167. Teleostei, gen. et sp. indet.

a – Left sagitta, inner face; **b** – right sagitta, inner face

DESCRIPTION: Otoliths irregular in outline, elongated alongwith their sulcus acusticus. Dorsal rim is irregularly tattered. Ventral rim is furnished with a projecting node at its midlength. Inner face is convex. Sulcus acusticus is wide and divided. Ostium is rounded. Cauda is straight, wide, and relatively shallow. Outer face is concave and ornamented with furrows radiating from the middle of the dorsal rim.

REMARKS: The studied otoliths deviate distinctly, by their outline and the structure of their sulcus acusticus, from any hitherto reported sagittae, both ancient and modern. A suggestion may only be coined up that they belong to the family Priacanthidae GILL, 1872, whose representatives are known to possess the otoliths much heavily modified (*see* NOLF 1985).

OTOLITH ASSEMBLAGES AND THEIR ENVIRONMENTAL INTERPRETATION

An environmental analysis of the otolith assemblages recognized in successive localities of the Middle Miocene (Badenian) deposits in southern Poland is herein presented to demonstrate which conclusions may be drawn from the otoliths themselves when the ecological requirements of modern fishes are used for comparison. In this actualistic method several premises are to be taken into account, as follows.

Firstly, the requirements of the extant species and/or genera may be used without hesitations. Secondly, the requirements of the families have generally not changed since the Miocene, although some exceptions are known (*see* NOLF 1985, p. 19), and these concern primarily the bathymetry, precisely the shallow marine habitats of Miocene and/or older Tertiary epochs which change into much deep-water habitats today, a phenomenon which is also known in other invertebrate groups (e.g. some bivalves*, articulate brachiopods). Thirdly, any fish-otolith assemblage in a deposit hardly corresponds to a fish community living upon and/or in that deposit, and this is due to numerous phenomena and processes of various kind, those biological ones (bi-environmental mode of life, spawning runs, daily vertical shifts, migration in search for food) including (*see* NOLF 1985, pp. 19-21).

One of the agents which changes composition of the potential accumulation of the otoliths from a community into a buried assemblage, is their transportation. Regardless physical transport, acting not only down the slope (currents, slumpings), but also upslope (stormy waving and surfing ashore, upwellings), the biogenic transport has recently been recognized as a significant agent. The matter is well evidenced by the content of stomachs of predatory animals (other fishes, birds, sea mammals) feeding upon fish. To exemplify,

* A good example is offered by the genus *Kelliella* M. SARS, whose representatives occur in the Nawodzice Sands (STUDENCKA 1987).

a record from the stomach of a dolphin (HÄRKÖNEN 1986, p. 25) speaks about over fifteen thousand otoliths (!). Should, thus, the whole investigated material (over 22,600 specimens) be a supply from stomachs of two starved dolphins?

Table 1

Distribution of the studied teleost-fish otoliths in particular sections of the Middle Miocene (Badenian) deposits in southern Poland

OTOLITH-BEARING LOCALITIES: **K** – Korytnica Basin, **N** – Nawodzice, **R** – Rybnica, **W** – Węglinek in the Łychów area, **B** – Bęczyn, **Ni** – Niskowa

Asterisked (*) are the species reported for the first time from Poland (*compare* CHAINE & DUVERGIER 1928; ŚMIGIELSKA 1966, 1973, 1979; RADWAŃSKA 1984)

Species	K	N	R	W	B	Ni
1. *Pterothrissus umbonatus* (KOKEN, 1884)	+					
2. * *Panturichthys subglaber* (SCHUBERT, 1906)	+					
3. *Ariosoma balearica* (DELAROCHE, 1809)	+					
4. *Conger* aff. *conger* (LINNAEUS, 1758)	+					
5. * *Gnathophis saubriguensis* (STEURBAUT, 1979)	+					
6. *Hildebrandia pantanellii* (BASSOLI & SCHUBERT, 1906)	+					
7. * *Pseudophichthys* sp.	+					
8. *Rhechias* sp. 1	+					
9. * *Rhechias* sp. 2					+	
10. * "genus *Congridarum*" sp.	+					
11. * "genus *Ophichthyidarum*" sp.			+			
12. *Etrumeus weileri* (ŚMIGIELSKA, 1966)	+					
13. "genus *Clupeidarum*" *pulcher* (ŚMIGIELSKA, 1966)	+		+			
14. * "genus *Ariidarum*" sp.	+					
15. * *Valenciennellus weinfurteri* (BRZOBOHATÝ & SCHULTZ, 1967)	+					
16. *Saurida germanica* (WEILER, 1942)	+					
17. * *Benthosema* aff. *suborbitale* (GILBERT, 1913)					+	
18. *Diaphus cahuzaci* STEURBAUT, 1979					+	
19. *Diaphus debilis* (KOKEN, 1891)	+	+	+		+	
20. * *Diaphus* sp. 1	+					
21. * *Diaphus* sp. 2	+				+	
22. * *Diaphus* sp. 3					+	
23. * *Diaphus* sp. 4					+	
24. * *Diaphus* sp. 5					+	
25. * *Diaphus* sp. 6					+	
26. * *Hygophum* sp.					+	
27. * *Lampadena* aff. *dea* (FRASER-BRUNNER, 1949)					+	
28. *Lampichthys schwarzhansi* BRZOBOHATÝ, 1989					+	
29. *Notoscopelus* sp.					+	
30. *Halobatrachus korytnicensis* (ŚMIGIELSKA, 1979)	+					
31. * *Chaunax* sp.	+					

Seriously, it is thought that the biogenic transport may greatly influence the composition of any otolith assemblage occurring in the deposits formed at the time of such transportation. It seems reasonable to accept a statement recently claimed by NOLF (1985, p. 19) that presumably most of the otoliths enter the sediment through predators. If so, it consequently becomes apparent that any

Species	K	N	R	W	B	Ni
32. * *Laemonema* sp.					+	
33. *Physiculus* aff. *huloti* POLL, 1953	+					
34. * *Bregmaceros* sp.	+					
35. *Merluccius merluccius* (LINNAEUS, 1758)	+		+			
36. * *Ciliata* sp.				+		
37. * *Gaidropsarus acuticaudatus* GAEMERS, 1973			+			
38. *Phycis tenuis* (KOKEN, 1891)	+		+	+		
39. *Gadiculus argenteus* GUICHENOT, 1810	+		+		+	
40. *Micromesistius arcuatus* sp. n.		+	+			
41. *Trisopterus sculptus* (KOKEN, 1891)		+	+			
42. * "genus *Bathygadinarum*" sp. 1				+		
43. * "genus *Bathygadinarum*" sp. 2					+	
44. *Carapus* aff. *acus* (BRÜNNICH, 1768)	+			+		
45. * *Carapus* cf. *caninus* (GÜNTHER, 1862)	+					
46. * *Echiodon heinzelini* HUYGHEBAERT & NOLF, 1979	+		+	+		
47. * *Echiodon nuntius* (KOKEN, 1891)	+					
48. *Echiodon* sp. 1						+
49. * *Echiodon* sp. 2				+		
50. *Hoplobrotula acutangula* (KOKEN, 1884)	+					
51. *Hoplobrotula gibba* (BASSOLI, 1906)	+					
52. * *Oligopus obliquus* (WEILER, 1942)	+					
53. * *Oligopus* sp.				+		
54. * "genus *Bythitinarum*" *wenglinensis* sp. n.				+		
55. * "genus *Bythitidarum*" sp.					+	
56. "genus *Hemiramphidarum*" *buluki* (ŚMIGIELSKA, 1979)	+					
57. * *Belone* sp.	+					
58. * "genus *Belonidarum*" sp.	+					
59. * *Atherina* sp.	+					+
60. *Atherinomorus aquitanicus* (PRIEM, 1911)	+					
61. *Centroberyx* sp.	+					
62. * *Adioryx* sp.	+					
63. *Myripristis verus* STEURBAUT, 1979	+	+	+	+	+	
64. "genus *Myripristinarum*" *banaticus* (WEILER, 1950)	+					
65. *Antigonia* sp.	+					
66. *Scorpaena edegemensis* GAEMERS, 1973						+
67. * *Scorpaena* sp.	+		+			
68. "genus *Scorpaenidarum*" sp.	+					
69. * *Trigla* cf. *asperoides* SCHUBERT, 1906			+			

fish-otolith assemblage in a given sediment may inform more about the structure of excreta of unrecognizable predators and their diet than about the fish community living upon that sediment.

The above premises concern all assemblages of fish otoliths of any time. Nevertheless, in ancient deposits the contained otoliths may often

Species	K	N	R	W	B	Ni
70. *Trigla* aff. *lyra* LINNAEUS, 1758	+					
71. * *Trigla* sp. 1	+					
72. * *Trigla* sp. 2	+					
73. * *Trigla* sp. 3	+					
74. *Platycephalus fusiculus* RADWAŃSKA, 1984	+					
75. * *Morone* aff. *labrax* (LINNAEUS, 1758)			+			
76. * *Morone* sp.	+					+
77. * "genus *Serranidarum*" sp. 1	+					
78. * "genus *Serranidarum*" sp. 2	+					
79. *Pristigenys rhombica* (SCHUBERT, 1906)	+		+	+		+
80. *Sillago schwarzhansi* STEURBAUT, 1984	+				+	
81. *Trachurus elegans* JONET, 1973	+		+			
82. * *Spicara smaris* LINNAEUS, 1758	+					
83. *Gerres* sp.	+					+
84. *Brachydeuterus latior* (SCHUBERT, 1906)	+			+	+	+
85. * *Brachydeuterus speronatus* (BASSOLI, 1906)	+					
86. * *Boops neogenicus* STEURBAUT & JONET, 1982	+					
87. * *Diplodus karrerae* NOLF & STEURBAUT, 1979	+					
88. * *Diplodus* sp. 1			+			+
89. * *Diplodus* sp. 2	+					
90. * *Pagellus acarne* (RISSO, 1826)			+			
91. * *Pagellus albuquerquae* STEURBAUT & JONET, 1982	+			+		+
92. * *Pagellus* aff. *erythrinus* (LINNAEUS, 1758)	+					
93. * *Pagellus* sp.	+				+	
94. *Pagrus distinctus* (KOKEN, 1891)	+	+	+	+		
95. * *Dentex gibbosus* (RISSO, 1810)	+					
96. *Dentex gregarius* (KOKEN, 1891)	+					
97. *Dentex* aff. *macrophthalmus* (BLOCH, 1791)	+					
98. * *Spondyliosoma* aff. *cantharus* (LINNAEUS, 1758)	+					
99. * "genus *Sparidarum*" sp.			+			
100. *Argyrosomus regius* (ASSO, 1801)	+					
101. *Sciaena polonica* (RADWAŃSKA, 1984)	+					
102. * *Sciaena rybnicensis* sp. n.			+			
103. * "genus *Sciaenidarum*" sp.	+					
104. * *Mullus elongatus* STEURBAUT, 1984	+					
105. *Mullus* sp.						+
106. * *Chaetodon* aff. *hoefleri* STEINDACHNER, 1882	+					
107. * "genus *Chaetodontidarum*" sp.	+					

Species	K	N	R	W	B	Ni
108. *Cepola rubescens* LINNAEUS, 1766	+				+	
109. "genus *Percoideorum*" *tietzei* (SCHUBERT, 1906)	+	+	+	+		
110. *Liza steurbauti* RADWAŃSKA, 1984	+					
111. "genus *Mugilidarum*" sp.						+
112. *Sphyraena* aff. *afra* PETERS, 1884	+					
113. * "genus *Polynemidarum*" *huyghebaertae* STEURBAUT & JONET, 1982	+					
114. * "genus *Polynemidarum*" sp.	+					
115. * "genus *Scaridarum*" sp.	+					
116. * *Trachinus biscissus* KOKEN, 1884	+			+		
117. *Trachinus* aff. *draco* LINNAEUS, 1758	+	+	+			
118. * *Trachinus lineolatus* FISCHER, 1884		+	+			
119. * *Trachinus vipera* CUVIER, 1829			+			
120. *Uranoscopus* aff. *scaber* LINNAEUS, 1758	+					
121. *Deltenosteus telleri* (SCHUBERT, 1906)	+	+	+	+	+	+
122. *Gobius vicinalis* KOKEN, 1891	+		+		+	+
123. *Gobius* aff. *geniporus* VALENCIENNES, 1837	+			+		
124. *Gobius* aff. *niger* LINNAEUS, 1758	+		+	+	+	+
125. * *Gobius* sp.	+					+
126. * "genus *Gobiidarum*" sp. 1						+
127. * "genus *Gobiidarum*" sp. 2	+					+
128. * "genus *Gobiidarum*" sp. 3	+					
129. * "genus *Gobiidarum*" sp. 4	+					
130. * "genus *Gobiidarum*" sp. 5	+					
131. *Citharus lusitanicus* (JONET, 1973)	+					
132. * *Citharus* sp. 1	+					
133. * *Citharus* sp. 2	+					
134. * *Lepidorhombus angulosus* NOLF, 1977		+	+			
135. * *Scophthalmus* sp.			+			
136. *Arnoglossus* aff. *laterna* (WALBAUM, 1792)	+					+
137. * *Arnoglossus* sp. 1	+					
138. *Arnoglossus* sp. 2	+		+			+
139. * "genus *Bothidarum*" sp.	+					
140. * *Dicologoglossa* aff. *cuneata* (MOREAU, 1881)	+				+	
141. * *Solea solea* (LINNAEUS, 1758)	+		+			+
142. * *Microchirus* aff. *variegatus* (DONOVAN, 1808)						+
143. * "genus *Soleidarum*" sp. 1			+			
144. * "genus *Soleidarum*" sp. 2	+					
145. * Teleostei gen. et sp. indet.	+					

deliver important information on the composition of the paleocommunity, environmental conditions, paleogeography, bioprovince affinities etc., all of which cannot be readable from other groups of fossils contained in these deposits.

It is to indicate that an environmental recognition of the Middle Miocene (Badenian) deposits of southern Poland, as based on the analysis of the otolith

assemblages, may easily be verified due to a reasonable amount of data apparent from analyses of invertebrate communities, sedimentary sequence and paleogeography of all the studied otolith-bearing localities (*see* review in description of localities). In the case of discrepant conclusions, otolith-based and non-otoliths based, and attempt of their interpretation will be presented.

THE KORYTNICA BASIN

The otolith assemblage from the Korytnica Basin is the richest, both in regard to its volume and taxonomic diversity, of all the localities of the Middle Miocene (Badenian) deposits in southern Poland. It thus well reflects the wealth of biotopes that offered optimum life conditions for very diversified invertebrates. The latter composed the majority of particular communities, to which various fishes were confined, and the predatory ones having been situated at the top of the tropic webs of these communities and of the whole basin (*cf.* HOFFMAN 1977).

The otoliths collected in the Korytnica Basin (over 16,300 specimens) are represented by 105 species belonging to 47 families (*see* Table 1).

The most common numerically are such families as: **Gobiidae** (56% of specimens), **Pomadasyidae** (21%), **Cepolidae** (3.7%), **Sparidae** (3.4%), and **Gadidae** (3.3%). The greatest diversity of recognized taxa is displayed by the **Sparidae** (11), the **Gobiidae** (9), the **Congridae** (7), as well as the **Carapidae**, **Bothidae** and the **Triglidae** (4 taxa each).

The commonest forms in the investigated assemblage (over 9000 specimens), these of the family **Gobiidae**, are recognizable to the family rank only. At present, this family includes numerous genera and species inhabiting a wide range of climatic and bathymetric zones, although the majority of its species is confined to the littoral zone. The occurrence of the two genera recognized in the Korytnica Basin, *Deltenosteus* and *Gobius*, is indicative of this very zone (*see* Table 2).

The second of the significant groups are otoliths of the family **Pomadasyidae**, and primarily of the species *Brachydeuterus latior* (SCHUBERT). This species, next to the Gobiidae, is the most numerous (over 3300 specimens) of all the taxa recognized in the studied assemblage. It may thus be thought that this species had its optimum life condition in the Korytnica Basin. This species is an important indicator of the environmental conditions, since at present all species of the genus *Brachydeuterus* inhabit tropical and subtropical littoral zones, having been tolerant also to nearshore freshened waters.

Another tropical element are quite common otoliths of fishes of the family **Holocentridae**, represented by the genera *Adioryx* and *Myripristis*. Of other families, also the genera *Pterothrissus*, *Hildebrandia*, *Valenciennellus*, *Saurida*, *Hoplobrotula*, *Atherinomorus*, *Antigonia*, *Platycephalus*, *Pristigenys*, and *Gerres*

Table 2

Ecological requirements of the present-day (extant) genera of teleost fishes recognized in the Middle Miocene (Badenian) deposits of southern Poland

GEOGRAPHIC DISTRIBUTION: **C** – cosmopolitic, **A** – Atlantic, **I** – Indo-Pacific;
CLIMATIC ZONES: **T** – tropical and/or subtropical, **W** – warm, **M** – moderate, **C** – cool;
BATHYMETRY and/or ENVIRONMENT: **Br** – brackish, **L** – littoral (depth 0 – 40-50m), **N** – neritic (50 – 200m), **B** – bathyal (200 – 2,000m), **O** – open oceanic waters;
MODE OF LIFE: **Bn** – benthic, **N** – nektic, **P** – pelagic

Based primarily on the data presented by STEURBAUT(1984), NOLF & CAPPETTA (1988), and "*Check-list of the fishes...*" (CLOFNAM, 1973)

GENERA	Geographic distribution			Climatic zones				Bathymetry					Mode of life		
	C	A	I	T	W	M	C	Br	L	N	B	O	Bn	N	P
1. Pterothrissus	C			T						N	B			N	
2. Panturichthys		A		T	W				L				Bn		
3. Ariosoma	C			T	W				L		B		Bn		
4. Conger	C			T	W	M			L	N	B		Bn		
5. Gnathophis	C			T	W				L		B		Bn		
6. Hildebrandia		A		T					L		B		Bn		
7. Pseudophichthys		A		T	W						B		Bn		
8. Rhechias	C			T					L		B		Bn		
9. Etrumeus	C			T	W	M	C		L	N					P
10. Valenciennellus	C			T								O			P
11. Saurida	C			T					L				Bn		
12. Benthosema	C			T	W	M	C					O			P
13. Diaphus	C			T	W	M						O			P
14. Hygophum	C			T	W	M						O			P
15. Lampadena	C			T	W	M						O			P
16. Lampichthys	C			T	W	M						O			P
17. Notoscopelus	C			T	W	M	C					O			P
18. Halobatrachus	C			T	W				L				Bn		
19. Chaunax	C			T	W						B		Bn		
20. Laemonema	C			T	W						B		Bn		
21. Physiculus	C			T	W				L		B		Bn		
22. Bregmaceros	C			T	W					N		O		N	P
23. Merluccius	C			T	W	M	C			N	B			N	
24. Ciliata		A			W	M	C		L				Bn		
25. Gaidropsarus		A			W	M			L	N				N	
26. Phycis		A			W	M	C			N	B			N	
27. Gadiculus		A			W	M	C			N	B	O		N	P
28. Micromesistius		A			W	M	C			N		O		N	P
29. Trisopterus		A			W	M	C		L	N				N	
30. Carapus	C			T	W				L	N			Bn		
31. Echiodon	C			T	W	M	C		L				Bn		
32. Hoplobrotula			I	T						N	B		Bn		
33. Oligopus	C			T	W				L		B		Bn		

GENERA	Geographic distribution			Climatic zones				Bathymetry					Mode of life		
	C	A	I	T	W	M	C	Br	L	N	B	O	Bn	N	P
34. Belone		A			W	M				N				N	P
35. Atherina		A			W	M		Br	L						P
36. Atherinomorus		(A)	I	T					L						P
37. Centroberyx			I	T						N	B			N	
38. Adioryx	C			T						N				N	
39. Myripristis	C			T					L	N				N	
40. Antigonia	C			T						N		O		N	
41. Scorpaena	C			T	W				L	N	B		Bn		
42. Trigla	C			T	W	M			L	N			Bn		
43. Platycephalus		(A)	I	T					L				Bn		
44. Morone	C				W	M		Br	L	N				N	
45. Pristigenys	C			T						N				N	
46. Sillago			I	T				Br	L	N				N	
47. Trachurus	C			T	W	M			L	N		O			P
48. Spicara		A		T	W	M			L	N				N	
49. Gerres	C			T				Br	L	N				N	
50. Brachydeuterus		A		T				Br	L	(N)				N	
51. Boops		A		T	W	M			L	N				N	
52. Diplodus		A		T	W			Br	L					N	
53. Pagellus	C			T	W	M			L	N				N	
54. Pagrus	C			T	W	M			L	N				N	
55. Dentex		A		T	W				L	N				N	
56. Spondyliosoma		A		T	W	M			L	N				N	
57. Argyrosomus	C			T	W			Br	L	N				N	
58. Sciaena	C			T	W			Br	L	N				N	
59. Mullus		A		T	W	M			L	N			Bn		
60. Chaetodon	C			T					L					N	
61. Cepola	C			T	W				L	N			Bn		
62. Liza	C			T	W	M		Br	L	N				N	
63. Sphyraena	C			T	W	M		Br	L	N				N	
64. Trachinus		A		T	W	M	C		L	N			Bn		
65. Uranoscopus		A		T	W				L				Bn		
66. Deltenosteus		A			W				L				Bn		
67. Gobius		A		T	W	M			L	(N)			Bn	N	
68. Citharus		A		T	W				L				Bn		
69. Lepidorhombus		A			W	M			L				Bn		
70. Scophthalmus		A			W	M			L				Bn		
71. Arnoglossus	C			T	W	M			L		B		Bn		
72. Dicologoglossa		A		T	W	M			L				Bn		
73. Solea	C			T	W	M	C		L				Bn		
74. Microchirus		A		T	W	M			L	N	B		Bn		

live in the tropical zone (*see* Table 2). The same concerns the families **Chaetodontidae** and **Scaridae**, the habitat of whose species is confined to the coral reefs.

Tolerant to a lesser salinity are, on the other hand, fishes of such genera present in the Korytnica Basin, as *Atherina*, *Morone*, *Sillago*, *Gerres*, *Diplodus*,

Argyrosomus, *Sciaena*, *Liza*, and *Sphyraena*. A quantitative share of representatives of these genera is rather small, and quite often it concerns single specimens which indicate, however, that along the shore zone of the Korytnica Basin there existed areas of lesser salinity, e.g. coastal lagoons or river mouths.

The remaining otoliths of the Korytnica assemblage represent stenohaline fishes, not tolerant to any oligohalinity, and thus well indicative of normal salinity of waters in the basin.

Relatively common in the studied assemblage are otoliths of fishes of the genus *Cepola* which at present inhabits littoral and neritic waters of tropical through moderate climatic zones (*see* Table 2). A comparable frequency is noted of otoliths of the family **Sparidae** which is represented by the greatest number of species. The fishes of various genera of this family display more or less similar life requirements (*see* Table 2), and they inhabit now waters of climatic zones ranging from tropical through warm moderate, primarily of the littoral zone. Many species of this family live, particularly during their spawning season, near coasts where they prefer plant-carpeted parts of the bottom, around or amongst rocky humps. The Korytnica Basin was an area which almost ideally fulfilled such life requirements; as it is apparent from a reconstruction of the shorescape (*see* BAŁUK & RADWAŃSKI 1977, Figs 5-6), the rocky humps (of the Jurassic substrate) projected here over the bottom which was either covered by seagrass beds or, in other places, by the kelp, and these two habitats were supplying very promising haunts for many species of fishes, and of their hunters as well. Of the latter, the cuttlefish *Sepia sanctacrucensis* BAŁUK may be indicated as an example (*see* BAŁUK 1977, p. 172).

The bare parts of the bottom provided habitats favorable for many mud-dwelling species. To such fishes belong all the flatfishes (suborder **Pleuronectoidei**), recognized in the studied assemblage and represented here by the genera *Citharus*, *Arnoglossus*, *Dicologoglossa*, and *Solea*.

A benthic mode of life, in fissures amongst submerged rocks, or a dwelling into the sediment, is also typical of modern fishes of the family **Congridae**. These predatory fishes are represented in the studied assemblage by species inhabiting today tropical and subtropical waters of the littoral zone, but being also present in the bathyal zone.

The clayey bottom of the Korytnica Basin probably favored also a settlement of fishes of the family **Ophidiidae**. At present, these fishes, i.a. of the genus *Hoplobrotula* inhabit (*see* Table 2) deeper parts of the neritic zone and the bathyal zone, but they may appear also in embayments and even in coastal lagoons. It is therefore to infer (NOLF 1980, 1985) about an evolutionary change of the behavior of that family since the Upper Tertiary (Miocene) through Recent.

Typically deep-water forms in the Korytnica assemblage are otoliths of the bathybenthic fishes of the genus *Chaunax*, which now inhabits continental

slopes (*see* Table 2). Live or dead specimens of this genus are, however, quite often stranded ashore during stormy waving.

Significantly common in the studied assemblage are otoliths of fishes of the family **Carapidae**. In majority, these fishes are commensals to the holothurians, in the intestines of which they live. The presence of these echinoderms in the Korytnica Basin has already been recognized earlier, and documented by isolated sclerites, especially rich in samples from the locality Karsy (WALKIEWICZ 1977).

A family next in succession in regard to the number of specimens and species is the family **Gadiidae**. These codfishes and their kin live usually in greater schools and they inhabit the neritic zone of subtropical through cool climates. Their presence in the Korytnica Basin should supposedly be attributed to their migration during the spawning season, and/or to the carrying their otoliths in stomachs of various predators.

Finally, a special attention is paid to the occurrence of otoliths of the genera typical of the Indo-Pacific bioprovince, such as *Hoplobrotula*, *Atherinomorus*, *Centroberyx*, *Platycephalus*, and *Sillago*. This recognition supplements well the formerly known data (*see* BAŁUK & RADWAŃSKI 1977, RADWAŃSKA & RADWAŃSKI 1984, RADWAŃSKA 1987) on the Indo-Pacific affinities of the invertebrate communities present in the Korytnica Basin.

An overall analysis of the whole assemblage of otoliths from the Korytnica Basin indicates an environment shallow marine, precisely of the littoral zone, normal salinity, and with a distinct share of fishes typical of tropical and/or subtropical zones.

NAWODZICE

The otolith assemblage from Nawodzice is relatively poor, both in regard to its quantity and taxonomic diversity, what evidently results from the environmental conditions under which the otolith-bearing fishes have lived. The structure of the sands exposed at Nawodzice indicates that they have been deposited under extremely shallow-marine conditions, close to the shallow subtidal or even intertidal zone. The depth may be estimated as ranging from almost nil to a few meters. It was, therefore, the area too shallow to be a permanent habitat of any fishes. The otoliths contained in the sands belonged, thus, either to the individuals sporadically invading that area, or to the dead specimens stranded ashore.

The composition of the otolith assemblage from Nawodzice (merely 131 specimens) is almost identical to that of Rybnica, described hereafter.

In the Nawodzice assemblage containing 10 species of 7 families (*see* Table 1), the commonest are representatives of the families **Gadidae** (79% of

specimens) and **Gobiidae** (12%), associated with the species "genus *Percoideorum*" *tietzei* (SCHUBERT) which is markedly subordinate (about 3%).

An ecological approach of this assemblage is presented below, in the description of the assemblage from Rybnica.

RYBNICA

The otolith assemblage from Rybnica is relatively rich in regard to its volume, but rather poor as concerns its diversity (*see* Table 1). In this assemblage (4106 specimens, belonging to 33 species of 18 families), the otoliths of fishes of the family **Gadidae** dominate (81% of specimens), and these are associated with those of the families **Gobiidae** (9%), **Sparidae** (3%), **Trachinidae** (1.5%), as well as of the species "genus *Percoideorum*" *tietzei* (SCHUBERT) figuring about 3% of the total. The number of the recognized taxa in the indicated families is as follows: **Gadidae** - 7, **Sparidae** - 4, and **Trachinidae** and **Gobiidae** - 3 taxa in each.

The family **Gadidae** is herein represented by the two common species, *Trisopterus sculptus* (KOKEN) and *Micromesistius arcuatus* sp. n. At present, the fishes of the genus *Trisopterus* live in small groups, at depths ranging from 30 to 300 meters, but being lesser at spawning time, under climatic conditions ranging from tropical to moderately cool (*see* Table 2). It is thought that fishes of this genus, especially when immature, have met their optimum life conditions in this very region. A great influence on their development was involved by the type of the bottom deposits, featured by sands with scattered pebbles. The latter were making up a habitat much favorable for diverse invertebrates being the basic food of these fishes.

The presence of representatives of the genus *Micromesistius*, that at present live at greater depths of the neritic zone and in the bathyal zone, may be interpreted as resulted from a significant adaptation ability of these fishes. They easily tolerate rapid changes both of the temperature and of the depth, spawning at shallow waters, and they often migrate to longer distances in their search for food. In the studied sequence of Rybnica, where the immature specimens predominate, supposedly the species *Trisopterus sculptus* (KOKEN) may be indicated as their commonest prey.

A sandy character of the bottom has its bearing also on the composition of the remaining part of the assemblage, in which a significant share is noted by the sand-dwelling fishes of the family **Trachinidae** and by numerous species of the flatfishes (suborder **Pleuronectoidei**). At present, these fishes inhabit littoral zones ranging from the tropical to those of a moderate cool climate.

Within the Rybnica assemblage, a distinct share is displayed also by fishes of the family **Sparidae**. The most common representatives of this family are documented by the otoliths of fishes of the genus *Pagrus* which live at present (*see* Table 2), especially during their spawning season, in coastal waters of tropical through warm-moderate climatic zones.

Of other forms of the family **Sparidae**, worth of an attention is the extant species *Pagellus acarne* (Risso) which lives in the Mediterranean and along the Atlantic coast of western Europe and northern Africa. This species nowhere occurs commonly and, at the northern limit of its range, it becomes quite sporadic. It does not gather into greater schools, and lives at depths ranging from 5 to almost 100 meters, primarily in areas of the sandy or other firm bottoms.

Within the Rybnica assemblage significant is the presence of quite numerous otoliths of fishes of the genera *Morone* and *Sciaena*, which tolerate oligohaline waters. This may indicate development of water areas with lesser salinity, for instance coastal lagoons somewhere nearby.

Ecological requirements of the whole assemblage from Rybnica indicate the dominance of otoliths which belonged to fishes that inhabited littoral waters of normal salinity. All the recognized taxa are, however, much tolerant to the thermic conditions, and thus they cannot inform precisely about the climate. Concerning the latter, it thus may be pointed at the occurrence of inarticulate brachiopods of the genus *Discinisca*, whose valves are commonly present in the otolith-bearing samples; this extant genus is a well recognized climatic indicator as all its species live in tropical waters exclusively and, on the other hand, in the shallow sublittoral, preferably shallow subtidal zone (*see* Radwańska & Radwański 1984, 1989).

WĘGLINEK – WĘGLIN – ŁYCHÓW

The otolith assemblage from the area of Węglinek – Węglin – Łychów is scarce (*see* Table 1). A limited number of specimens and their low taxonomic diversity allows only for a very preliminary conclusions on the environmental conditions.

The most numerous within the assemblage collected at Węglinek (166 specimens, representing 18 species of 10 families) are otoliths belonging to fishes of the families: **Gobiidae** (75% of specimens), **Gadidae** (8%), as well as of **Bythitidae** and **Pomadasyidae** (3% each), and of the species "genus *Percoideorum*" *tietzei* (Schubert) amounting about 5%.

All the otoliths of the family **Gobiidae** represent the species that occur commonly in the Korytnica Basin (*see* Table 1). This may indicate similar biotopes of the fishes of both regions, in which there also occur *Brachydeuterus latior* (Schubert) and *Myripristis verus* Steurbaut which are indicative of tropical and/or subtropical littoral zones. The littoral zone is at present also inhabited (*see* Table 2) by fishes of such genera as *Ciliata*, *Pagellus*, and *Pagrus*.

Relatively numerous are otoliths of fishes of the family **Carapidae**, represented by two species. These fishes are commensals to the holothurians, whose occurrence must thus be inferred in the discussed environment.

An overall analysis of the fishes recognized in the sections of Węglinek, Węglin, and Łychów is conclusive about a shallow offshore environment, featured by normal salinity, and climatic conditions of tropical and/or subtropical zones.

BĘCZYN

The otolith assemblage from Bęczyn is rather monotonous and relatively poor (269 specimens, belonging to 26 species of 13 families).

The assemblage is dominated (*see* Table 1) by the otoliths of fishes of the family **Myctophidae** which constitute over 86% of specimens. Of other families, more numerous are the **Gobiidae** (6%) and **Gadidae** (2.7%). The dominant family, the **Myctophidae**, contains the greatest number of species, namely twelve.

The more than significant share of the **Myctophidae** which now live primarily in warm, open oceanic waters, indicates an environment distinctly deeper than that of all other assemblages of the studied area. The deeper waters, ranging to the bathyal zone, become also apparent (*see* Table 2) from the occurrence of otoliths belonging to fishes of the genera *Laemonema* and *Gadiculus*, and of the subfamily **Bathygadinae**.

The shallow marine elements in the Bęczyn assemblage are the singly occurring otoliths of fishes of such families as the **Holocentridae**, the **Pomadasyidae**, the **Cepolidae**, and the **Gobiidae**. The presence of these otoliths in the discussed environment has certainly resulted from their carrying from shallow waters either by the predators of various kind, or by the hydrodynamic agents (*comp.* ALEXANDROWICZ 1975).

The majority of otoliths from the Bęczyn assemblage belongs to fishes which now prefer warm waters, ranging from tropical to those of the warm moderate zone.

NISKOWA

The otolith assemblage from Niskowa is not small in regard to its volume (1578 specimens, representing 21 species of 13 families), but it is rather poor as concerns the recognized taxa (*see* Table 1). This certainly results from their preservation potential which is low, and what is well visible in larger forms which usually are corroded and/or crushed. As an effect of this taphonomic loss, the collected assemblage is dominated by small otoliths of the family **Gobiidae** (92% of specimens). The families of a more pronounced share are: the **Priacanthidae** (2 %), the **Pomadasyidae** (1.6%), as well as the **Scorpaenidae**, the **Mugilidae**, and the **Bothidae** (1% each). The species diversity is the greatest just in the family **Gobiidae** (6 species), that is followed by the **Sparidae**

and the **Bothidae** (2 species each); of latter familes, the family **Sparidae** is represented by quite numerous juvenile specimens, taxonomically unrecognizable.

The above disopportunities do not allow to characterize environmental conditions under which the Niskowa sequence was formed but, nevertheless, some hints on that matter may be presented.

Otoliths of fishes of the family **Gobiidae** are mostly of these species which occur in other localities studied, primarily in the Korytnica Basin. It may thus be suggested that the environmental conditions were comparable in both regions. Such a suggestion is confirmed by the presence of the otoliths of fishes of the species *Brachydeuterus latior* (SCHUBERT) which, as given above, is a good indicator of tropical and/or subtropical littoral zones. Similar elements, indicative the same zone (*see* Table 2) are also otoliths of the genera *Myripristis*, *Pristigenys*, *Gerres*, and *Pomadasys* (the latter not presented in the systematic account because of their extremely bad state of preservation). The other otoliths of the Niskowa assemblage represent in their majority the genera which now inhabit littoral zones of tropical through warm moderate climates.

Within the Niskowa assemblage, remarkable is a share of the otoliths of fishes much tolerant to the oligohaline conditions. To such fishes belong representatives of the genera *Atherina*, *Morone* (particularly in layer *2*), *Gerres*, *Brachydeuterus*, *Pomadasys*, and of the family **Mugilidae** (*see* Table 2). A lowered salinity is thought to have been responsible for an abnormal growth of some otoliths of the genus *Deltenosteus*, as reported in the systematic account (*see* Pl. 33, Fig. 4).

The diversified fauna in the otolith-bearing parts of the sequence (*see* BAŁUK 1970, Fig. 3: layers *2*, *12-13*, *15*, *18*, *20*), particularly the common occurrences of echinoderms, indicates normal salinity of the basin at the time when the discussed deposits were formed. A significant share of fishes tolerant to oligohaline conditions certainly results from a nearby location of freshened lagoons and/or mouth parts of rivers, where these fishes have at least temporarily lived.

An analysis of the whole assemblage of otoliths from Niskowa allows to recognize the life environment as a shallow marine, of a tropical and/or subtropical zone, distinctly influenced by waters of a lesser salinity.

CONCLUDING REMARKS

The otoliths recognized in this study evidence the presence of a remarkable wealth of various teleost fishes — 145 taxa of 74 genera belonging to 50 families (*see* Table 1) — living more or less permanently in, and/or migrating into the Middle Miocene (Badenian) sea of southern Poland.

An attempt to recognize environmental conditions upon which the investigated otolith-bearing fishes had lived, was performed through an actualistic analysis (*see* Table 2) of the otolith assemblages. The obtained conclusions, presented in the preceding chapter, appear surprisingly compatible with those drawn from analyses of the structure of particular invertebrate communities, and of the sedimentary sequences and their regional paleogeography, as given by the above-referenced authors. This credibly indicates that a uniformitarianistic analysis of any ancient otolith assemblage may provide a good key for reconstruction of the paleoenvironmental conditions. On the other hand, such very analysis supplements well our knowledge on the studied otolith-yielding sequences, particularly on the climatic conditions under which these sequences were formed.

If we even take into account that almost all the fishes can migrate, the presence of tropical and/or subtropical forms in the investigated otolith-yielding sequences of southern Poland is significant because it indicates the presence of functional seaway connections at Middle Miocene (Badenian) time. This is also substantial to interpret the presence, in the studied otolith assemblages, of forms typical of the Indo-Pacific bioprovince.

Of the tropical and/or subtropical forms (*see* Table 2), the presence should be underlined of such genera as *Pterothrissus*, *Hildebrandia*, *Valenciennellus*, *Saurida*, *Hoplobrotula*, *Atherinomorus*, *Centroberyx*, *Adioryx*, *Myripristis*, *Antigonia*, *Platycephalus*, *Pristigenys*, *Sillago*, *Gerres*, *Brachydeuterus*, as well as those of the families Chaetodontidae and Scaridae, the two of which — genera *Valenciennellus* and *Adioryx* — have not hitherto been reported from Poland. Of these listed genera, the five — *Hoplobrotula*, *Atherinomorus*, *Centroberyx*, *Platycephalus*, and *Sillago* — are of a marked Indo-Pacific provenience (*see* Table 2).

On the other hand, of the forms of special environmental requirements, noteworthy is the presence of fishes tolerant to lesser salinity. Such forms, of the genera *Atherina*, *Morone*, *Sillago*, *Gerres*, *Brachydeuterus*, *Pomadasys*, *Diplodus*, *Argyrosomus*, *Sciaena*, *Sphyraena*, and of the whole family Mugilidae (*see* Table 2) are indicative of a freshwater influx and/or the presence of brackich basins along the nearby shore.

A special attention, as concerns the ecological requirements, should certainly be paid to rare representatives of the two families, the Chaetodontidae and the Scaridae, which are typical coral-reef dwellers in modern environments. The presence of these two families has been recognized only in the Korytnica Basin, where hermatypic corals are very subordinate componenets of some bottom communities (*see* BAŁUK & RADWAŃSKI 1977, RONIEWICZ & STOLARSKI 1991).

The family Chaetodontidae BONAPARTE, 1832, is recorded from the Tertiary of Europe by only one otolith-based genus and species in the Eocene deposits of the Paris Basin (*see* NOLF 1985, p. 90). The genus *Chaetodon* LINNAEUS, 1758, whose modern representatives feed on small invertebrates living in coral reefs, does not seem to have been recorded from any ancient otolith

material. It is, however, represented by two skeletons, discovered almost a century ago by GORJANOVIĆ-KRAMBERGER (1898) in the Oligocene deposits of Slovenia (*see also* ANDELKOVIĆ 1989, pp. 9, 17 and 91).

The family Scaridae RAFINESQUE, 1810, commonly known as the parrotfishes, contains the herbivorous forms adapted to graze upon the algae covering dead parts of reef corals (*see* BELLWOOD & CHOAT 1990). Its record from the Korytnica Basin is the second from the Tertiary of Europe, and it follows that one based on a single, fragmented skeleton from the Middle Miocene (Badenian) deposits of the Vienna Basin (BELLWOOD & SCHULTZ 1991). A thorough revision of all fossil records of the family, recently performed by the latter authors (BELLWOOD & SCHULTZ 1991) reveals that numerous former reports of this family must be objected and/or rejected.

When analyzing biotic conditions that prevailed in the Middle Miocene (Badenian) sea of southern Poland, one should remember that the studied otoliths are not the only fish remains known from that area. To the otolith-bearing modern species and/or otolith-based fossil species of the teleosts, reviewed in the systematic account, should thus be added those which are represented by teeth of various kind, and by the more or less complete skeletons.

The skeletal material of teleosts from the deposits coeval to those of the studied otolith-yielding localities, is extremely poor indeed, as it concerns only one, but well preserved juvenile specimen of *Scorpaena ensiger* (JORDAN & GILBERT), described from the Pińczów Limestones by JERZMAŃSKA (1958).

Another report on the skeletal material, by JERZMAŃSKA (1962), deals with specimens coming from the deposits younger than these discussed, namely those of the evaporitic sequence (Gypsum Member) of Upper Silesia; one of the poorly preserved skeletons, that of *Trisopterus macropterygius* (KRAMBERGER), has its right sagitta *in situ* (JERZMAŃSKA 1962, Fig. 2) which, however, does not show taxonomically useful features (NOLF 1985, p. 33; and p. 109 where the paper by JERZMAŃSKA is erroneously referenced as of 1977*).

The tooth material of teleosts, represented by the well known European species, is not uncommon in the Middle Miocene (Badenian) deposits of southern Poland, and it co-occurs with abundant teeth of various elasmobranchs (sharks and rays, the latter noted also by caudal thorns) which have been reported from several localities in Upper Silesia (ROEMER 1870), and from the southern slopes of the Holy Cross Mountains, both from the Korytnica Clays (KOWALEWSKI 1930; SCHULTZ 1977, 1979; RADWAŃSKA 1982) and the Pińczów Limestones (KOWALEWSKI 1930; PAWŁOWSKA 1960; RADWAŃSKI 1965, 1977a). It is worth to mention that the latter facies, the Pińczów Limestones, yields also teeth and/or other remains of marine vertebrates other than fishes, viz. the crocodile *Tomistoma*, dolphins and porpoises, baleen whales, and sea cows, the occurrence of which all has recently been discussed by CZYŻEWSKA & RADWAŃSKI (1991). Thus, it may be emphasized that these vertebrates, especially large mammals, although reported primarily from the facies lacking

* That paper (JERZMAŃSKA 1977) really concerns the fresh-water fishes, the otolith-bearing specimens of *Amia kehreri* ANDREAE including, from the famous Eocene locality Geiseltal in Germany (*see also* NOLF 1985, p. 33).

preservable otoliths, were evidently situated at the top of the Middle Miocene (Badenian) marine ecosystem to which all the investigated otolith-bearing teleost fishes belonged.

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