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Middle Miocene (Badenian) brachiopods from the Roztocze Hills, south-eastern Poland

ABSTRACT: The brachiopod assemblage from the Middle Miocene (Badenian) shallow water deposits of the Roztocze Hills (Lublin Upland, south-eastern Poland) comprises eight species belonging to six genera. Four of them, *i.e.* *Ancistrocrania abnormis* (DEFRANCE), *Cryptopora* sp. *A*, *Cryptopora* sp. *B*. and *Platidia* cf. *anomioides* (SCACCHI & PHILIPPI) are very rare, while the species *Megathiris detruncata* (GMELIN), *Argyrotheca cuneata* (RISSO), *A. cordata* (RISSO) and *Megerlia truncata* (LINNAEUS) are very abundant what allows the range of morphological variability of those species to be recognized. Three species: *Ancistrocrania abnormis*, *Platidia* cf. *anomioides* and *Argyrotheca cuneata* are reported for the first time from Poland. The brachiopod percentages in particular samples show considerable differences although the samples come from the shallow water deposits originating in similar conditions and during a narrow span of time. Thus, the brachiopod assemblage structure seems to be controlled not only by depth but by such factors as particular substrate and habitat availability as well. The brachiopod fauna from the Roztocze Hills displays the resemblance to the Miocene one from the Mediterranean region as well as to the Recent one living in the Mediterranean Sea.

INTRODUCTION

The brachiopods are very common fossils in the Badenian deposits of the Roztocze Hills (Lublin Upland, south-eastern Poland) (*see* Text-fig. 1). Their presence was earlier mentioned by several authors (KRACH 1950, 1962a; BIELECKA 1967; JAKUBOWSKI & MUSIAŁ 1977, 1979a, b; PISERA 1978, 1985) but they have never been paid a special attention, except the papers by POPIEL-BARCZYK (1977, 1980) who described the genus *Cryptopora* JEFFREYS from the south-eastern part of this region.

On the other hand, the Miocene brachiopods from other regions of Poland, notably from the western Ukraine (now Soviet Union; FRIEDBERG 1921) and from the Korytnica Basin (Barczyk & Popiel-Barczyk 1977, Radwańska & Radwański 1984) were the subject of separate elaborations.

The aim of the present paper is, however, broader than simply to describe a local fauna of brachiopods. A striking feature of most papers of the Miocene brachiopod taxonomy is a highly typologic approach resulting in over-splitting. This resulted from the fact that most brachiopod studies were based on a very limited material. In extreme cases new species were founded on single valves (*see* Sacco 1902, Friedberg 1921). In this context the investigated material, very rich in specimens which are excellently preserved, permitted to establish the variability range of such species as *Megathiris detruncata* (Gmelin), *Argyrotheca cuneata* (Risso), *A. cordata* (Risso) and *Megerlia truncata* (Linnaeus). The present author has undertaken the attempt to resolve the taxonomical problems and to critically evaluate the status of earlier established species basing on the recognized variability range of the particular species. The paleoecological and paleogeographical significance of brachiopods is also discussed.

PALEOGEOGRAPHICAL SITUATION AND THE AGE OF THE BRACHIOPOD-BEARING DEPOSITS

The Roztocze region from which the investigated brachiopods have been collected represents the northern zone of the Badenian sea, which during this time spread over the Fore-Carpathian Depression, and was a part of the Paratethys system of marine basins. It contains shallow-water deposits (red-algal limestones, marls, sands and clays) which are usually extremely fossiliferous and occur as facies mosaic. This last fact, and the Quaternary cover preclude the precise correlations. All the samples containing brachiopods are of the Badenian age, most probably the Upper Badenian, as it is indicated by the investigations of planktic foraminifera (*see* Szczechura 1982, Szczechura & Pisera 1986). Calcareous nannoplakton indicates the presence of zones NN5 and NN6 of Martini's standard nannoplankton zonation (Peryt 1987). Pisera (1985) postulated warm but not tropical climate of the Badenian during Roztocze reef growth, very similar to the climate of the modern eastern part of the Mediterranean Sea. For more detailed description of geological situation, lithologies, and the interpretation of sedimentary environments see Krach (1962a, b, 1981), Bielecka (1967), Pisera (1985) and Szczechura & Pisera (1986).

MATERIAL AND METHODS

All the investigated brachiopod material comes from the bulk samples (several kg each) collected in the field and then washed in the laboratory (mesh size 0.5 mm). Fourty eight samples were taken, mostly at Węglinek and Węglin, but the brachiopod frequency in the samples is highly variable (from 4 to 2948 specimens per sample). The total number of collected and identified specimens is 13 869, but there are additional specimens, the smallest ones, which cannot be identified, and few hundreds fragments of various size.

Several sections at Węglinek, Węglin, Łychów, Radwanówka, Zdziechowice and Modliborzyce (Text-fig. 1*A*) have been sampled and yielded numerous brachiopods.

Węglinek

At Węglinek (Text-fig. 1*B*) the brachiopods were mostly collected from internal sediments (extremely fossiliferous) filling various cavities and depressions in the red-algal vermetid reefs (they are the part of the reef assemblage of PISERA 1985) (samples *W6—1* to *W6—19, W6—22, W6—23*). Also red-algal marls rich in bryozoan fragments, surrounding and partly covering the algal-vermetid reefs towards the south, yielded numerous brachiopods (samples *W6—20, W6—21*).

Węglin

In the vicinity of Węglin (Text-fig. 1*B*) several sections with various lithologies yielded brachiopods. The richest and most diversified brachiopod fauna comes from the calcareous marls rich in red-algal and bryozoan fragments (section *5*, layer *2* of BIELECKA 1967; *see also* SZCZECHURA & PISERA 1986) (sample *W—1*). Less numerous and diversified fauna of brachiopods has been found in the strongly calcareous clay rich in molluscs (the outcrop described by MACIOSZCZYK 1988) (sample *W—2*) and in the calcareous marls with red-algae and molluscs (samples *W—3* to *W—6*), and in extremely fossiliferous marls (rich in molluscs) containing reef rock fragments (?forereef deposits) (samples *W3—1* to *W3—3*).

Łychów

At Łychów (Text-fig. 1*B*) the brachiopods were collected from three different sites and lithologies, *i.e.* from quartz sands with glauconite and poor fauna of bivalves and red-algal detritus (sample *Ł—3*), strongly fossiliferous marls interpreted as the kelp assemblage (for more detailed analysis *see* HOFFMAN & *al.* 1978) (samples *Ł—1, Ł—2*) and marly red-algal limestones (samples *Ł—4, Ł—5*).

Radwanówka

At Radwanówka (Text-fig. 1*C*) the brachiopods were collected from the very fossiliferous (rich molluscan fauna) marls covering the reef body and filling depressions in it. They represent the epi-reef assemblage of PISERA (1985) (samples *R—1* to *R—6*).

Zdziechowice

At Zdziechowice (Text-fig. 1*B*) the brachiopods were collected both from the deposits infilling cavities and depressions in the oyster bioherm (*see* BIELECKA 1967) (samples *Z—1, Z—2*) and from the calcareous marls (reef talus) surrounding the bioherm (sample *Z—3*).

Modliborzyce

At Modliborzyce (Text-fig. 1*A*) one sample from the marly red-algal limestones has been taken and yielded brachiopods.

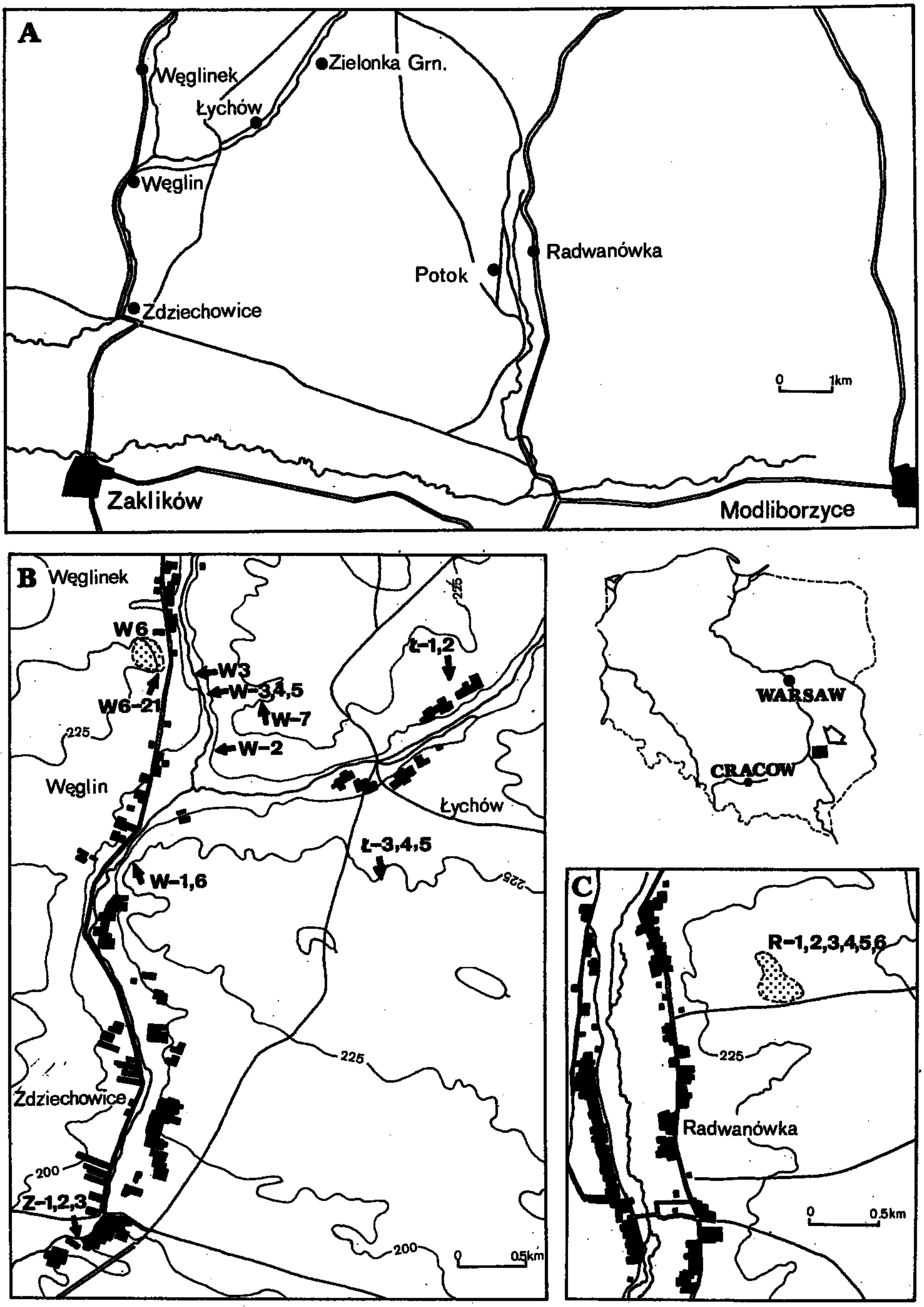


Fig. 1. Location of the Middle Miocene (Badenian) brachiopod-bearing sites in the Roztocze Hills, south-eastern Poland

A — Locality map of the studied area
B, C — Locality maps of the investigated sites with sample numbers indicated; stippled are algal-vermetid reefs

SYSTEMATIC ACCOUNT

Family **Craniidae** MENKE, 1828

Genus *Ancistrocrania* DALL, 1877

Ancistrocrania abnormis (DEFRANCE *in* HOENINGHAUS, 1828)

(Pl. 1, Figs 1—5)

1828. *Crania abnormis* DEFRANCE; F. W. HOENINGHAUS, pp. 13—14, Fig. 13.
1866. *Crania abnormis* DEFR.; G. SEGUENZA, p. 14.
1866. *Crania rugosa* SEG.; G. SEGUENZA, pp. 14—15, Pl. 2, Fig. 4.
1870. *Crania abnormis* (DEFRANCE); T. DAVIDSON, pp. 464—465, Pl. 21, Figs 22—27.
1902. *Crania* (*Ancistrocrania?*) *abnormis* DEFR. *in* HONING; F. SACCO. p. 4, Pl. 6, Figs 59—68.
1915. *Crania abnormis* (DEFRANCE) DESHAYES; J. deMORGAN, pp. 270—271, Text-fig. 12.
1940. *Crania abnormis* DEFRANCE; M. JULIEN, pp. 52—53, Pl. 4, Figs 23—24.
1943. *Crania abnormis* DEFRANCE *in* HOENINGHAUS; I. MEZNERICS, p. 20, Pl. 5, Figs 17—18.
1977. *Crania abnormis* (DEFR.); D. PAJAUD, pp. 61—62, Pl. 1, Fig. 1.

MATERIAL: 38 dorsal valves (8 badly preserved).
DIMENSIONS: Length 4.2 mm, width 4.9 mm (max),
4.1 mm, 4.0 mm,
3.7 mm, 3.9 mm,
3.5 mm, 3.7 mm.

DESCRIPTION: The shell is small, subcircular in outline, slightly wider than long (with one exception). Brachial valve relatively thin-shelled, ranges from distinctly conical, through subconical to nearly flat with the umbo only visible. Umbo situated slightly eccentrically, directed posteriorly. Shell surface rough with concentric, irregular growth lines. In the interior of the brachial valve a pair of large, subcircular posterior adductor muscle scars situated near the hinge line. The anterior adductor muscle scars form ovally elongated *V*-shaped ridges. In a median position there is a small ridge — the place of the attachement of brachial protractor muscles. A very low median septum .present in the middle.

REMARKS: This species is for the first time reported from Poland.

The revision of the genera belonging to the family Craniidae done by LEE & BRUNTON (1986) includes the species *Crania abnormis* (DEFRANCE) in the genus *Ancistrocrania* DALL. The investigated specimens show all the characters given as typical of the genus *Ancistrocrania*. Thus, the stratigraphical range of this genus should be extended from the Cretaceous to the Miocene (*compare* LEE & BRUNTON 1986).

The external and internal characters of the specimens under study are identical with those described and illustrated by SACCO (1902) and JULIEN (1940). They differ from the hitherto described specimens (HOENINGHAUS 1828, DAVIDSON 1870, SACCO 1902, JULIEN 1940, PAJAUD 1977) in much smaller dimensions.

The investigated specimens are very similar to the new species *Crania badensis* described from Czechoslovakia by MICHALIK & ZÁGORŠEK (1986), but their specimens are much larger. On the other hand, these authors did not present any comparisons with the earlier described Miocene species. Thus there is not clear what are the differences between their new species and those earlier established.

OCCURRENCE: Miocene of Poland: Węglinek (*W6—4, W6—11, W6—18, W6—21, W6—22, W6—23*), Węglin (*W3—2*), Radwanówka (*R—4, R—5*), Łychów (*Ł—4*); Miocene of France (deMORGAN 1915, JULIEN 1940), Italy (DAVIDSON 1870, SACCO 1902), Hungary (MEZNERICS 1943); Pliocene of Spain (PAJAUD 1977).

Family **Cryptoporidae** MUIR-WOOD, 1955
Genus *Cryptopora* JEFFREYS, 1869

Cryptopora sp. *A*
(Pl. 2, Fig. 2)

MATERIAL: 12 complete specimens and one brachial valve.
DIMENSIONS: Maximum length 2.5 mm,
length 2.1 mm, width 1.6 mm.
2.0 mm, 1.6 mm.

DESCRIPTION: The shell is very small (max. length 2.5 mm), thin, translucent and ovally elongate to subtriangular in outline with the greatest width in the middle or near the anterior margin, and displaying a smooth surface. The shell is slightly biconvex with more convex pedicle valve. The anterior commissure is rectimarginate. The foramen is large, oval-elongated to subtriangular, restricted posteriorly by an apical plate. The deltidial plates form triangular, wing-like structures. Crura of maniculifer type are slender and relatively long, with flattened endings. The median septum on the brachial valve is short but very high.

REMARKS: The low in number, badly preserved material does not allow for identification to the specific level. The specimens under discussion are very often damaged and crushed, what is a very common feature in the fossil record of this genus caused by the fragility of this very thin-shelled brachiopod.

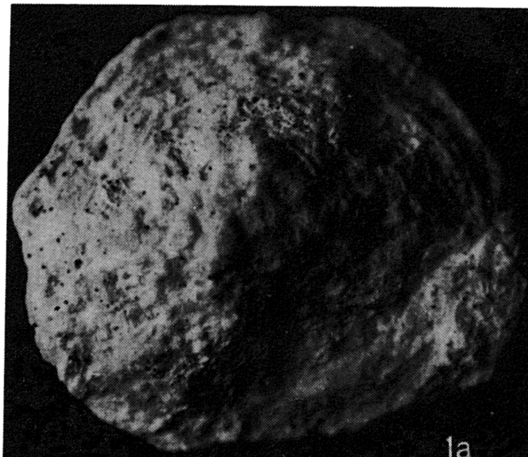
In the shell outline the investigated specimens resemble the Miocene species *Cryptopora nysti* (DAVIDSON) described and illustrated by COOPER (1959, Pl. 1, Figs 1—14) and POPIEL-BARCZYK (1977; 1980, Pl. 1, Figs 1—8) but the deltidial plates in *C. nysti* attain their maximum width close to the cardinal margin, while in the present author's specimens their maximum width is located in the middle. The discussed specimens differ from *C. lovisati* (DREGER), another Miocene species, in the shell outline (*see* DREGER 1911, Figs 3—5; *and* POPIEL-BARCZYK 1977; 1980, Pl. 2, Figs 1—12).

OCCURRENCE: Miocene of Poland: Węglin (*W—1*), Łychów (*Ł—3*).

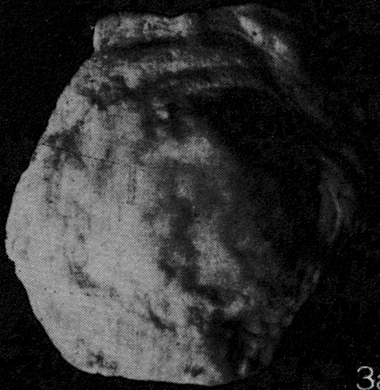
PLATE 1

Ancistrocrania abnormis (DEFRANCE *in* HOENINGHAUS)

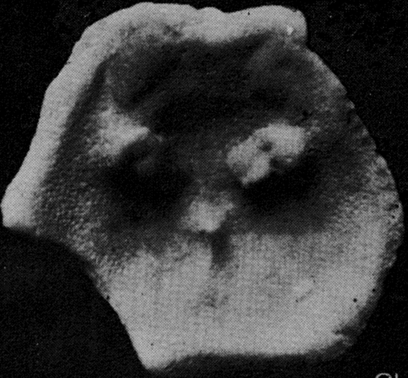
1 — Brachial valve (*1a* outer, *1b* inner view), × 14; Węglinek (sample *W6—22*)
2 — Outer view of brachial valve; visible are irregular growth lines, × 14; Węglinek (*W6—21*)
3 — Brachial valve, slightly damaged (*3a* outer, *3b* inner view), × 14; Radwanówka (*R—4*)
4 — Inner view of brachial valve, SEM × 30; Węglinek (*W6—21*)
5 — Outer view of brachial valve, SEM × 24; Węglinek (*W6—22*)

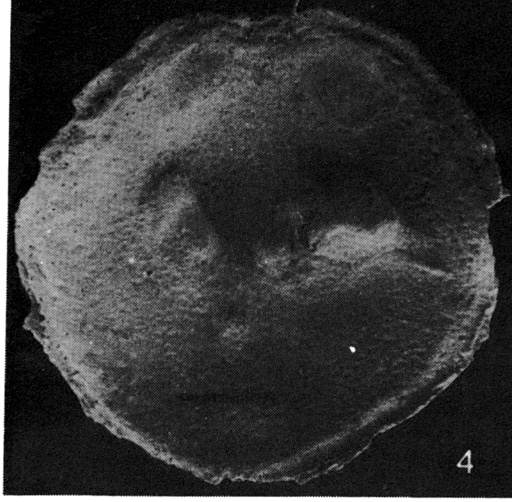

1a


2

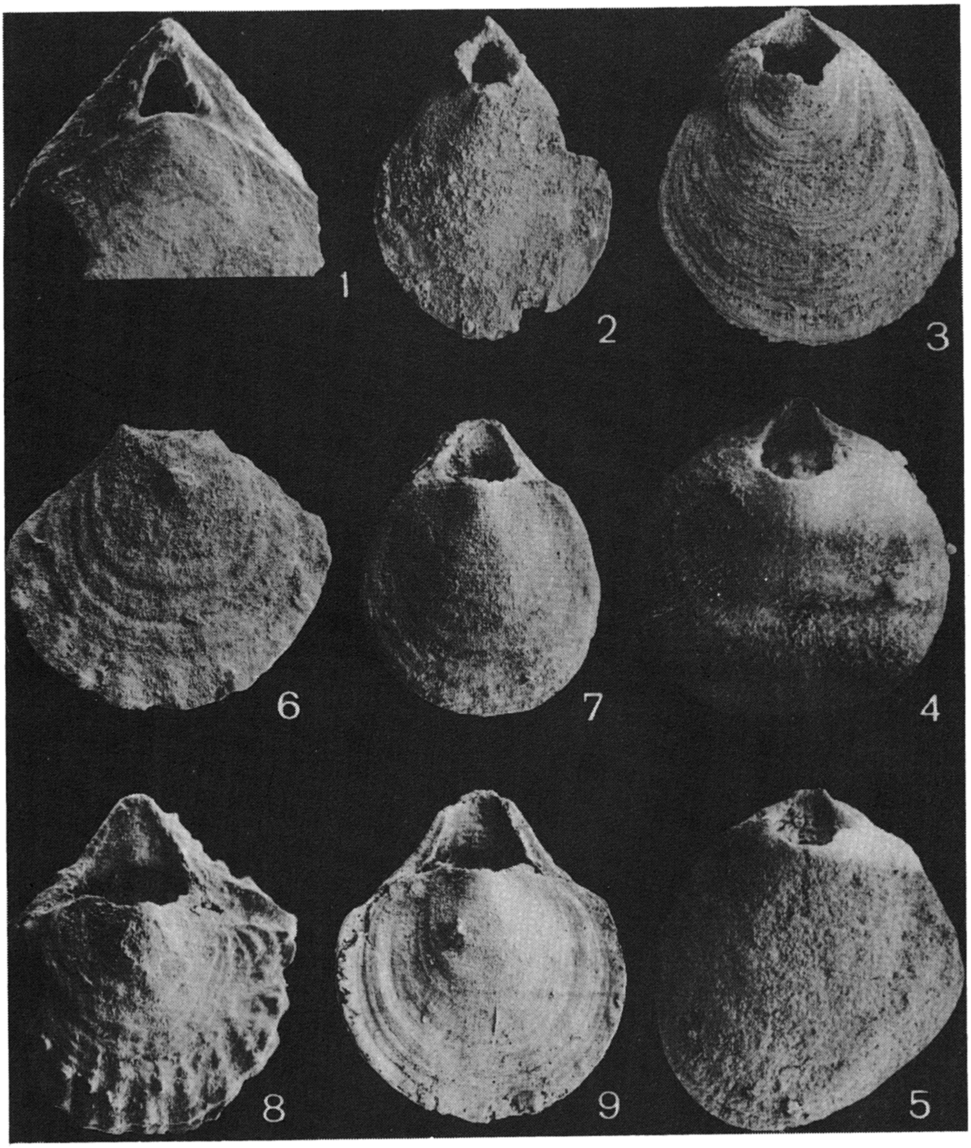

3a


1b


3b


4


5



1 — *Cryptopora* sp. *B:* fragment of complete specimen, dorsal view, SEM × 18.5; Łychów (sample *Ł—3*)

2 — *Cryptopora* sp. *A:* dorsal view of complete specimen; visible are wing-shaped deltidial plates, SEM × 18.5; Węglin (*W—1*)

3-5 — *Platidia* cf. *anomioides* (SCACCHI & PHILIPPI), dorsal views of complete specimens; *3* SEM × 28; Węglinek (*W6—13*); *4—5* SEM × 31; Węglinek (*W6—21*)

6-9 — *Megerlia truncata* (LINNAEUS); 6 — ventral view of complete specimen, SEM × 37; Węglin (*W3—2*); 7 — dorsal view of complete specimen, SEM × 31; Węglin (*W3—3*); 8 — dorsal view of complete specimen, SEM × 18.5; Węglin (*W3—3*); 9 — dorsal view of complete specimen, SEM × 28; Węglin (*W—1*)

Cryptopora sp. *B*
(Text-fig. 2; Pl. 2, Fig. 1)

MATERIAL: 41 complete specimens.
DIMENSIONS: Maximum length 3.2 mm, width 2.7 mm (*see also* Text-fig. 2).

DESCRIPTION: The shell is small, thin and translucent, and oval in outline with a smooth shell surface. The beak is sharp and slightly curved, with the large-sized foramen which is triangular and restricted by the deltidial plates forming narrow ridges.

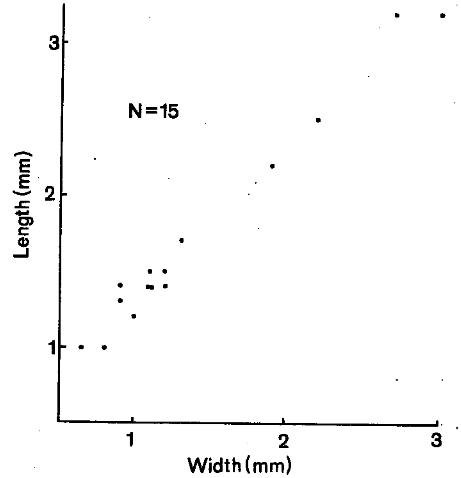


Fig. 2

Scattergram of length-width relationships for specimens of *Cryptopora* sp. *B*

REMARKS: The specimens of *Cryptopora* sp. *B* are even worse preserved than those of *Cryptopora* sp. *A*. They clearly differ, however, from the hitherto described Miocene species of the genus *Cryptopora* Jeffreys (*see* Dreger 1889, 1911; Popiel-Barczyk 1977, 1980). The absence of the wing-like deltidial plates makes them sharply different from the species *Cryptopora nysti* Davidson and *C. lovisati* (Dreger). They also differ from *C. discites* (Dreger) and *C.* cf. *discites* in the shell outline which is very characteristic for those species (*see* Dreger 1889, Pl. 5, Fig. 15; *and* Popiel-Barczyk 1980, Text-fig. 2C, Pl. 1, Figs 9—10).

OCCURRENCE: Miocene of Poland: Węglin (*W—1*, *W—4*), Łychów (*Ł—3*).

Family **Megathyrididae** Dall, 1870
Genus *Megathiris* d'Orbigny, 1847

Megathiris detruncata (Gmelin, 1790)
(Text-figs 3—4; Pl. 3, Figs 1—8; Pl. 6, Figs 1—7)

1865. *Argiope decollata* Chemn.; G. Seguenza, pp. 69—71.
1866. *Argiope decollata* Lin. sp.; G. Seguenza, p. 11, No. 10.
1870. *Argiope decollata* (Chemnitz Sp.); T. Davidson, pp. 405—406, Pl. 21, Figs 5, 6—8.
1883. *Megathyris decollatus* Chemnitz; J. deMorgan, p. 383.
1887. *Argiope decollata*, Chemnitz, sp.; T. Davidson, pp. 128—131, Pl. 21, Figs 30—35.
1889. *Argiope decollata* Chemnitz; J. Dreger, pp. 183—185, Pl. 1, Figs 1—5.
1891. *Megathyris decollata*, Chemnitz, sp.; P. Fischer & D. P. Oehlert, pp. 102—108, Pl. 8, Figs 16a—g.
1902. *Megathyris decollata*, (Chemnitz); F. Sacco, p. 30, Pl. 6, Figs 4—12.
1902. *M. decollata* var. *minima* Sacc.; F. Sacco, Pl. 6, Fig. 13.
1902. *M. decollata* var. *pertransversa* Sacc.; F. Sacco, p. 30, Pl. 6, Figs 14—15.

1902. *M. decollata* var. *longostricta* SACC.; F. SACCO, p. 30, Pl. 6, Fig. 16.
1902. *M. decollata* var. *semilaevis* SACC.; F. SACCO, pp. 30—31, Pl. 6, Figs 17—19.
1902. *M. decollata* var. *taurobifida* SACC.; F. SACCO, p. 31, Pl. 6, Fig. 21.
1902. *M. decollata* var. *raricostata* SACC.; F. SACCO, p. 31, Pl. 6, Fig. 22.
1902. *M. decollata* var. *magnicostata* SACC.; F. SACCO, p. 31, Pl. 6, Figs 23—26.
1902. *M. decollata* var. *eoinflata* SACC.; F. SACCO, p. 31, Pl. 6, Figs 27—28.
1920. *Megathyris detruncata* GMELIN; W. H. DALL, p. 330.
1921. *Megathyris decollata*, CHEMN.; W. FRIEDBERG, pp. 12—14. Pl. 2, Fig. 11, Pl. 3, Figs 1—5.
1921. *Megathyris decollata*, CHEMN. var. *austriaca* DREGER; W. FRIEDBERG, p. 14, Pl. 3, Fig. 7.
1921. *Megathyris decollata* CHEMN. var. *pertransversa* SACCO; W. FRIEDBERG, p. 14, Pl. 3, Fig. 6.
1921. *Cistella squamata* EICHW.; W. FRIEDBERG, pp. 15—16, Pl. 3, Figs 8—10.
1927. *Megathyris detruncata;* I. A. THOMSON, p. 213, Text-Fig. 63.
1934. *Megathyris praecursor* BOETTGER; A. ZILCH, p. 198, Pl. 1, Fig. 11.
1940. *Megathyris decollata* CHEMNITZ; M. JULIEN, pp. 48—49, Pl. 4, Figs 9—13.
1943. *Megathiris decollata* (CHEMNITZ); I. MEZNERICS, pp. 38—39, Pl. 2, Figs 1, 5, 8.
1943. *Megathiris decollata* CHEMN. var. *praecursor* BOETTGER; I. MEZNERICS, p. 39.
1943. *M. decollata* CHEMNITZ var. *semilaevis* SACCO; I. MEZNERICS, p. 39.
1950. *Megathyris decollata* CHEMN.; W. KRACH, Pl. 1, Fig. 25.
1960. *Megathyris detruncata* (GMELIN); D. ATKINS, pp. 463, 473—477, Text-Figs 3—4, 6—8, 9B—E, 10—11.
1977. *Megathiris detruncata* (GMELIN); W. BARCZYK & E. POPIEL-BARCZYK, pp. 164—165, Pl. 1, Figs 4—5.
1977. *Megathiris detruncata* (GMELIN); G. A. COOPER, pp. 121—122, Pl. 23, Figs 8—19.
1977. *Megathiris detruncata* (GMELIN); D. PAJAUD, p. 5, Pl. 1, Fig. C.
1978. *Argiope decollata* (CHEMNITZ); S. CALZADA, p. 356, Figs 5—6.
1979. *Megathyris decollata* (CHEMNITZ); A. d'ALESSANDRO & *al.*, Pl. 2, Figs 6—7.
1979. *Megathiris detruncata* (GMELIN); C. H. C. BRUNTON & G. B. CURRY, p. 43, Text-fig. 20.
1979a. *Megathiris detruncata* (GMELIN); G. JAKUBOWSKI & T. MUSIAŁ, p. 50, Pl. 1, Figs 6—9.
1979b. *Megathiris detruncata* (GMELIN); G. JAKUBOWSKI & T. MUSIAŁ, p. 85, Pl. 2, Figs 8—10.
1979. *Megathiris detruncata* (GMELIN); A. LOGAN, pp. 55—59, Text-Figs 15—16, Pl. 6, Figs 1—13.
1982. *Megathiris detruncata* (GMELIN); C. LLOMPART & S. CALZADA, pp. 195—196, Pl. 1, Figs 5—9.
1983. *Megathiris detruncata* GMELIN; M. GAETANI & D. SACCA, pp. 17—18, Pl. 9, Figs 10—12, Pl. 10 Figs 11—14.
1988. *Megathiris detruncata* (GMELIN); C. LLOMPART, p. 116, Pl. 1, Fig. 5.

MATERIAL: 2597 complete specimens, 711 pedicle valves, 780 brachial valves.
DIMENSIONS: Maximum length 6.5 mm, width 7.1 mm, thickness 3.2 mm (*see also* Text-fig. 3).

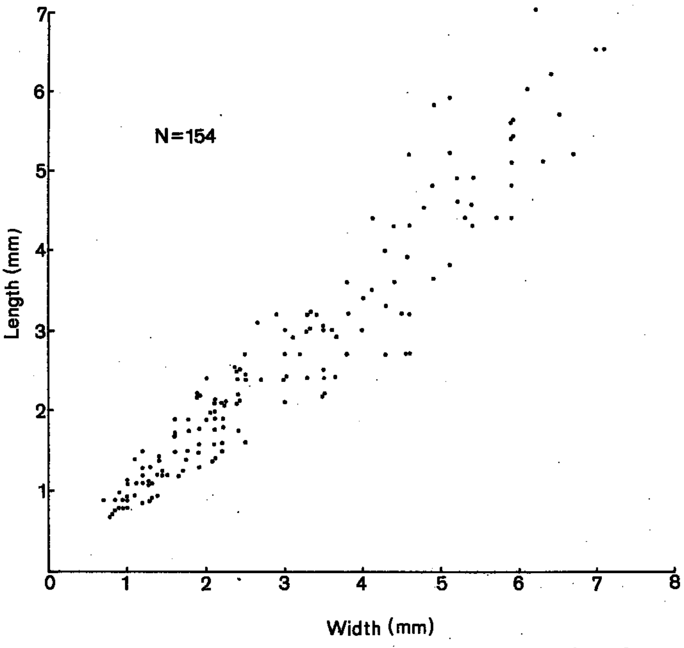


Fig. 3. Scattergram of length-width relationships for specimens of *Megathiris detruncata* (GMELIN)

REMARKS: The species *Megathiris detruncata* (GMELIN) is the most common one (more than 4000 specimens) in the investigated material. It has been widely described in the literature and is very well-known from the Eocene to Recent. This species shows a great variability already recognized by many authors (DAVIDSON 1870, 1887; SACCO 1902; THOMSON 1927; and others), some of them (*cf.* SACCO 1902, FRIEDBERG 1921, MEZNERICS 1943) have given, however, variable names for some of those forms. In the investigated material a high variation in shape (Text-fig. 4) and ornamentation is also observed. The specimens can be broadly transverse with the long, straight hinge line or subtriangular thus becoming longer than wide (*see* Text-fig. 4). Perhaps, the differences in shape result from the different growth rates as described by THAYER (1977) who has distinguished among the Recent *Terebratalia transversa* (SOWERBY) alate and globose morphological forms in the same populations. An alate individual grows faster in width than in length, while a globose one does it in opposite way. Not seeing any dependence in occurrence of those two forms on the environmental condition and finding both of them in the same samples he considers that this variation may be genetically controlled. One can note that the transverse and subtriangular forms appear independently of the size (*see* Text-fig. 4). There are also asymmetrical specimens in the studied material but not so common as in *Megerlia truncata* (LINNAEUS). The investigated specimens of *Megathiris detruncata* (GMELIN) are generally more elongate than the Recent ones from the Mediterranean Sea (*compare* Text-fig. 3 and Text-fig. 15 *in* LOGAN 1979). The smallest specimens have only a deep sulcus on both valves as an ornamentation, then 4—10 ribs appear what is less than in the specimens described by DAVIDSON (1887), THOMSON (1927) and LOGAN (1979), although the specimens from the Roztocze region attain slightly greater dimensions than those hitherto described. The ribs are usually distinct, rounded with narrower and deep grooves between them but there are also specimens with poorly marked ribs, less numerous and sometimes vanishing in the proximity of the anterior margin. The internal characters of the brachial valve, such as lateral septa, make this species easily distinguishable from the genus *Argyrotheca* DALL. In the specimens about 2 mm wide, two rudimentary, lateral septa appear (Pl. 6, Fig. 5). The largest specimens have also a small, rudimentary fourth and fifth septum (*see* Pl. 3, Fig. 7). The large, triangular foramen can be situated either on the low and broad area or on the very high one (*compare* Figs 5 and 8 on Pl. 3).

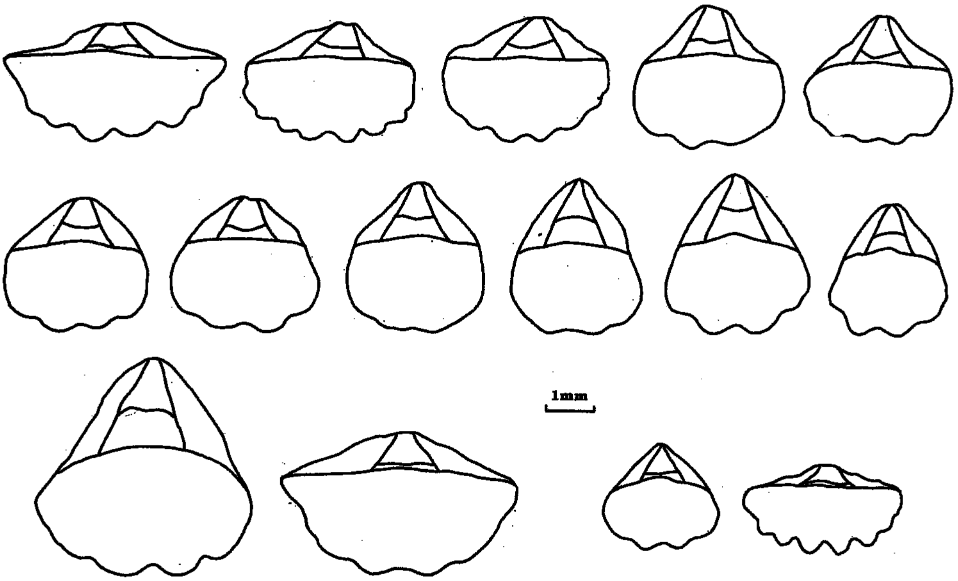


Fig. 4. Shape variability of *Megathiris detruncata* (GMELIN) from one sample (*W3—2*) from Węglin

OCCURRENCE: Eocene of Italy (DAVIDSON 1870); Miocene of Poland: Węglinek (*W6—1, W6—2, W6—4* to *W6—7, W6—9* to *W6—23*), Węglin (*W—1, W—4* to *W—7, W3—1* to *W3—3*), Łychów (*Ł—3, Ł—4, Ł—5*), Modliborzyce; JAKUBOWSKI & MUSIAŁ (1979a, b) and KRACH (1950) noted the presence of this species in other outcrops of the Roztocze region, BARCZYK & POPIEL-BARCZYK (1977) from the Korytnica Basin, and RADWAŃSKI (1969) and STUDENCKI (1988) from the Wójcza-Pińczów Range; Miocene of Italy (SEGUENZA 1865, 1866; DAVIDSON 1870; SACCO 1902), Austria (DREGER 1889), the western Ukraine (FRIEDBERG 1921), France (JULIEN 1940), Hungary (MEZNERICS 1943), Spain (CALZADA 1978, LLOMPART & CALZADA 1982); Pliocene of Italy (SEGUENZA 1865, DAVIDSON 1870), Spain (PAJAUD 1977); Pleistocene of Italy (GAETANI & SACCA 1983). Recent forms are known from the Mediterranean Sea (CAULET 1967, LOGAN 1979, LLOMPART 1988), from the Lusitanian and Mauritanian regions of the Atlantic Ocean (DAVIDSON 1887, BRUNTON & CURRY 1979), and from the Caribbean Sea (COOPER 1977).

Genus *Argyrotheca* DALL, 1900

Argyrotheca cuneata (RISSO, 1826)
(Text-figs 5—6; Pl. 4, Figs 1—9)

1865. *Argiope cuneata;* G. SEGUENZA, pp. 77—78.
1866. *Argiope costulata* SEG.; G. SEGUENZA, pp. 11—12, Pl. 2, Fig. 2.
1870. *Argiope costulata* (SEGUENZA); T. DAVIDSON, p. 406, Pl. 21, Fig. 9.
1870. *Argiope cuneata* (RISSO); T. DAVIDSON, p. 406.
1887. *Cistella cuneata,* RISSO, sp.; T. DAVIDSON, pp. 141—142, Pl. 22, Figs 30—34.
1902. *Cistella costulata* (SEGU.); F. SACCO, p. 32, Pl. 6, Fig. 34.
1920. *Argyrotheca cuneata* (RISSO); W. H. DALL, p. 326.
1920. *Argyrotheca cuneata,* var. *pera* MÜHLFELDT; W. H. DALL, p. 327.
1920. *Argyrotheca cuneata,* var. *pantellaria* JEFFREYS; W. H. DALL, p. 327.
1927. *Argyrotheca cuneata* (RISSO); J. A. THOMSON, p. 209, Text-fig. 62.
1960. *Argyrotheca cuneata* (RISSO); D. ATKINS, pp. 460, 468.
1979. *Argyrotheca cuneata* (RISSO); C. H. C. BRUNTON & G. B. CURRY, p. 44, Text-fig. 22.
1979. *Argyrotheca cuneata* (RISSO); A. LOGAN, pp. 45—49, Text-figs 11—12, Pl. 4, Figs 1—12.

MATERIAL: 2819 complete specimens, 347 pedicle valves, 515 brachial valves.

DIMENSIONS: Maximum length 3.0 mm, width 2.7 mm, thickness 1.3 mm, length 2.4 mm, width 2.6 mm, thickness 1.3 mm (*see also* Text-fig. 5).

DESCRIPTION: It is a very small species, with the shell variable in shape, usually wider than long (Text-fig. 5), ranging from subsquare to transversely subrectangular, with the maximum width at the hinge margin (Text-fig. 6). Very few specimens are asymmetrical. The shell surface of both

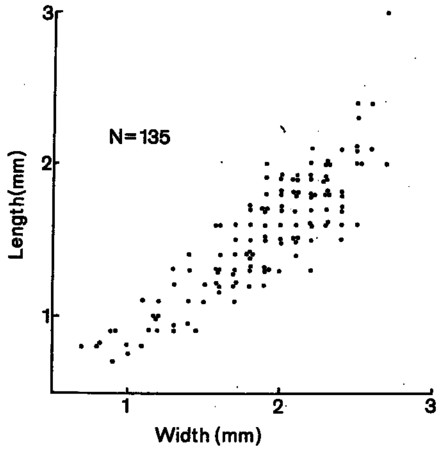
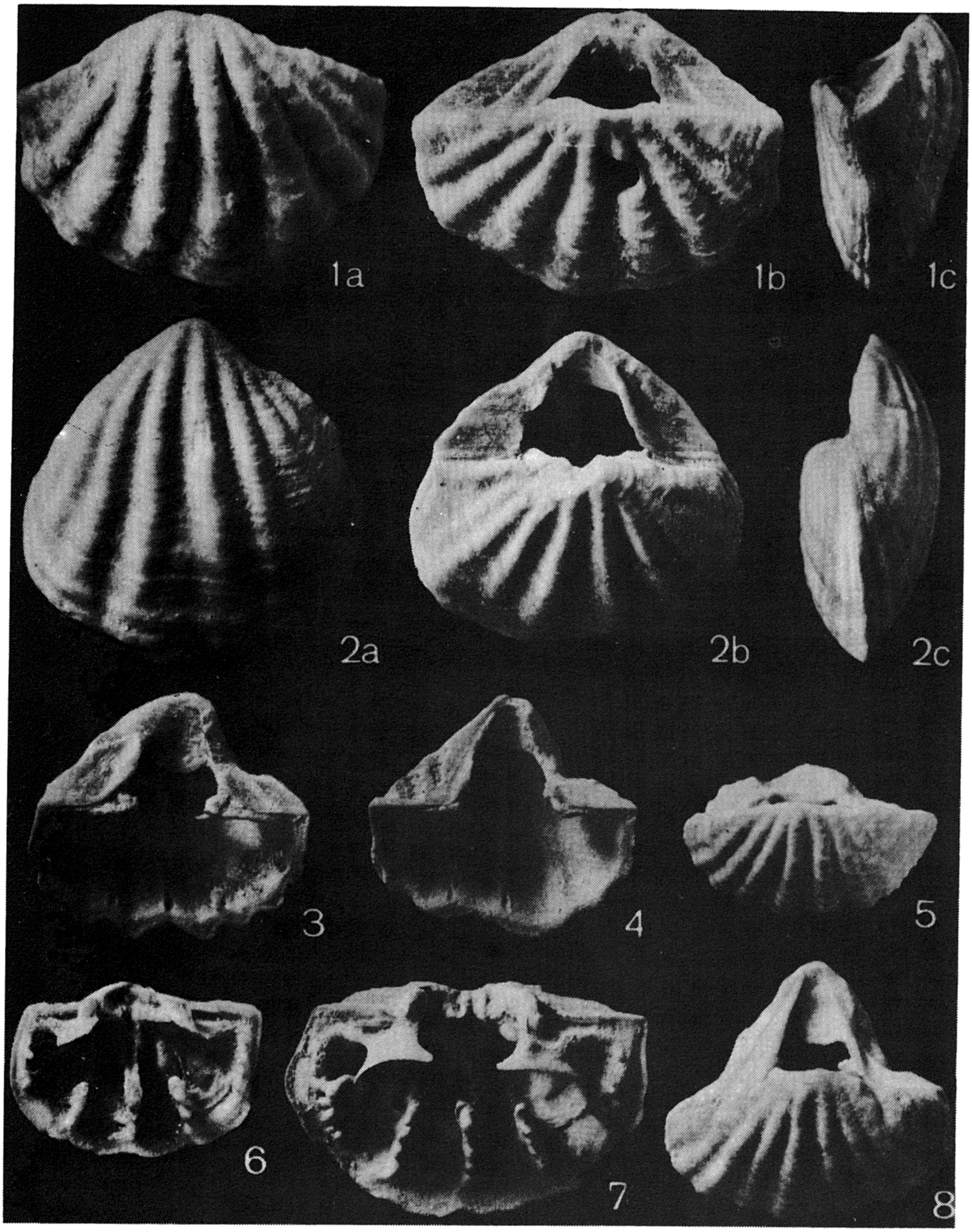


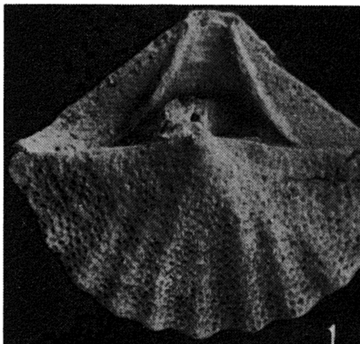
Fig. 5

Scattergram of length-width relationships for specimens of *Argyrotheca cuneata* (RISSO)



Megathiris detruncata (GMELIN) from Węglin (sample *W3—1*)

1 — Complete specimen (*1a* ventral, *1b* dorsal, *1c* lateral view), × 8.5
2 — Complete specimen (*2a* ventral, *2b* dorsal, *2c* lateral view), × 8.5
3-4 — Inner views of pedicle valves, × 7.5
5 — Dorsal view of complete specimen, × 7
6-7 — Inner views of brachial valves; visible are loop, median septum and two lateral septa, and on Fig. 7 also rudimentary fourth and fifth septum, × 7
8 — Dorsal view of complete specimen, × 7.5



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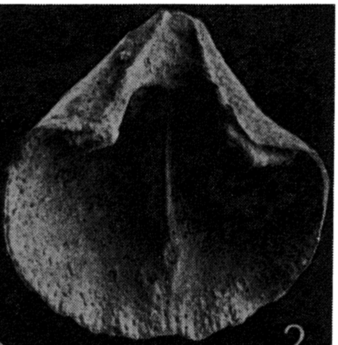

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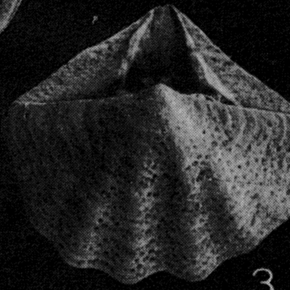

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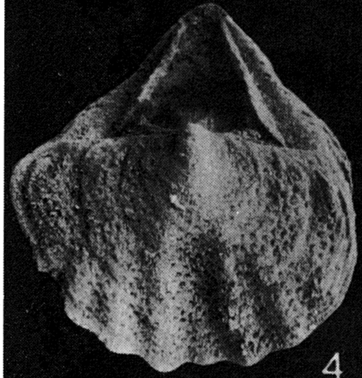

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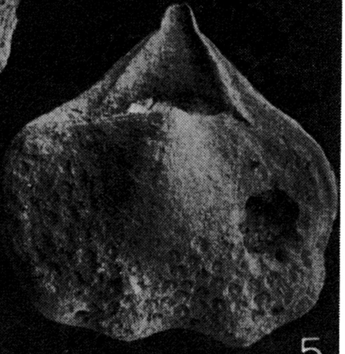

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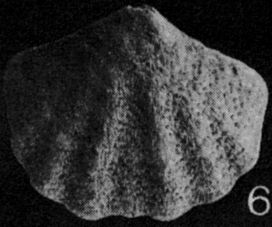

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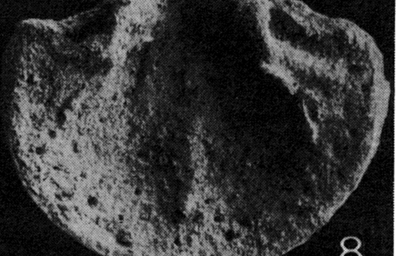

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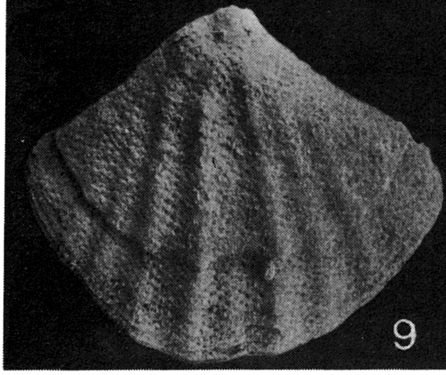

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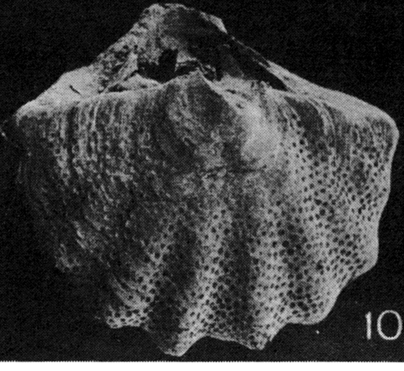

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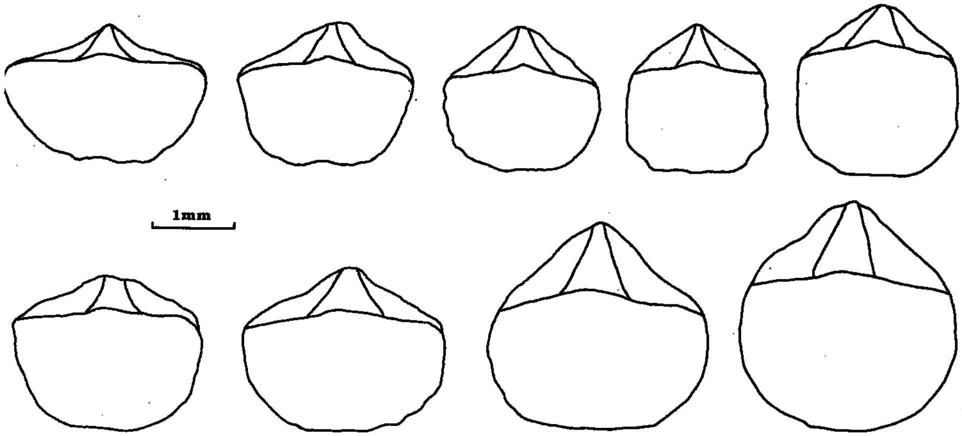

Fig. 6. Shape variability of *Argyrotheca cuneata* (Risso)

valves is covered with 2—7 flat, rounded ribs, often with a wider median groove where one short, intercalate rib may appear (*see* Pl. 4, Figs 1, 9). The shell is biconvex, with the pedicle valve more convex than the brachial one. The latter one is very often nearly flat. The beak is rather short, pointed, and a little incurved. On the broadly triangular area there is a very large, triangular in shape, hypothyridid foramen restricted by two disjunct, narrow deltidial plates. The wide pedicle collar supported by the median septum reaching the middle of the shell length. The teeth are wide but short. On the internal surface of the brachial valve one may see the high, triangular median septum reaching the maximum height near the anterior margin, sloping anteriorly by way of two serrations to the edge of the valve. The cardinal process is distinct, transversely elongate with two concave hinge plates below. The brachidium forms a simple loop which attaches to the median septum. The inner socket ridges are long. The internal side of the anterior margin of both valves without tubercles.

REMARKS: The species *Argyrotheca cuneata* (Risso) is described from Poland for the first time. It resembles slightly the species *Megathiris detruncata* (Gmelin) in the ornamentation and shell outline but it differs in being much smaller than *M. detruncata,* having fewer and not so distinct ribs. Those two species are very easy to distinguish by comparing the internal features. The species *A. cuneata* has only one septum on the brachial valve, while *M. detruncata* three or five septa.

The species *A. cuneata* (Risso) can also be very easily distinguished from the second, in the investigated material, species of *Argyrotheca,* namely *A. cordata* (Risso). They differ in shell outline

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PLATE 4

Argyrotheca cuneata (RISSO)

1 — Dorsal view of complete specimen, SEM × 19; Węglin (sample *W—1*)
2 — Inner view of pedicle valve, SEM × 24; Węglin (*W—1*)
3 — Dorsal view of complete specimen, SEM × 19; Zdziechowice (*Z—1*)
4-5 — Dorsal views of complete specimens, Węglin (*W—1*); *4* SEM × 22.5, *5* SEM × 45
6 — Ventral view of complete specimen, SEM × 19; Zdziechowice (*Z—1*)
7-8 — Inner views of brachial valves, Węglin (*W—1*); *7* SEM × 29, *8* SEM × 48
9 — Ventral view of complete specimen, SEM × 19; Węglin (*W—1*)
10 — Recent specimen from the Mediterranean Sea; dorsal, slightly oblique view, SEM × 19

(*compare* Text-figs 6 and 8), in the surface ornamentation, and mainly in internal characters of both valves.

The investigated specimens correspond closely to the Recent specimens of this species from the Mediterranean Sea (LOGAN 1979; *see also* Pl. 5, Fig. 10) but they are slightly smaller. They also differ from LOGAN's specimens in lacking of two rudimentary ascending branches. DAVIDSON (1887) mentioned about crenulation on the shell margins but it is not visible on his illustrations (*see* DAVIDSON 1887, Pl. 22, Figs 32—34).

Earlier, the Tertiary specimens of this Recent species were described under the name *Argiope costulata* (SEGUENZA) and *Cistella costulata* (SEGUENZA). Of these, both, DAVIDSON (1870) and SACCO (1902) had only one valve but they stressed a great similarity to the Recent species *Argyrotheca cuneata* (RISSO). SACCO (1902) suggested that *C. costulata* could be the Miocene ancestor of the Recent *A. cuneata*. He also pointed out a strong similarity with *C. squamata* (EICHWALD), being even ready to consider those two species as synonyms. MEZNERICS (1943) described the species *Argyrotheca squamata* (EICHWALD) from Hungary but she had given neither details of internal structures nor illustrations, thus it is difficult to decide about the systematic position of those specimens. The description and illustrations of *Terebratula squamata* (= *A. squamata*) given by EICHWALD (1853, p. 54, Pl. 3, Fig. 12) say nothing about internal characters. The specimen illustrated by him is more similar to *M. detruncata* (GMELIN) than to any *Argyrotheca* species. However, on the page 414 EICHWALD (1853) mentioned that his *Terebratula squamata* is „très voisin du *Terebratula cuneata*", *i.e. Argyrotheca cuneata*. Unfortunately, only the reinvestigations of all those specimens could resolve the problem. At the same time the specimens described by FRIEDBERG (1921) as *Cistella squamata* must belong to *M. detruncata* as they have three septa on the brachial valve and morphology consistent with this species. The investigated specimens differ from those described as *C. squamata* by DREGER (1889) in having broader and less sharp ribs, however, the shape and internal characters are similar. The specimens of *Cistella interponens* DREGER, 1889, are larger than the investigated specimens having, however, very similar shell ornamentation; they differ in internal features of the brachial valve displaying much longer median septum and tubercles on the shell margin.

The specimens under study show also a great similarity to the Recent specimens of *Argyrotheca jacksoni* COOPER described and illustrated by COOPER (1973a, Pl. 3, Figs 9—13) from the Red Sea. The difference consists in number of ribs.

OCCURRENCE: Miocene of Poland: Węglinek (*W6—2* to *W6—23*), Węglin (*W—1* to *W—7*, *W3—2*, *W3—3*), Radwanówka (*R—1* to *R—6*), Zdziechowice (*Z—1* to *Z—3*), Łychów (*Ł—1*, *Ł—2*, *Ł—4*, *Ł—5*), Modliborzyce; Miocene of Italy (SEGUENZA 1866, DAVIDSON 1870, SACCO 1902). This species is living today in the Mediterranean Sea (DAVIDSON 1887, LOGAN 1979), as well as in the Lusitanian and Mauritanian regions of the Atlantic Ocean (DAVIDSON 1887, BRUNTON & CURRY 1979).

Argyrotheca cordata (RISSO, 1826)
(Text-figs 7—8; Pl. 5, Figs 1—14; Pl. 7, Fig. 1)

1865. *Argiope neapolitana;* G. SEGUENZA, pp. 78—79.
1870. *Argiope Neapolitana* (SCACCHI, Sp.); T. DAVIDSON, p. 406, Pl. 21, Fig. 10.
1887. *Cistella neapolitana*, SCACCHI, sp.; T. DAVIDSON, pp. 131—139, Text-figs 10—13, Pl. 22, Figs 8—24.
1889. *Cistella Neapolitana* SCACC.; J. DREGER, pp. 185—186, Pl. 1, Fig. 10.
1915. *Cistella laevigata* sp. n.; J. deMORGAN, pp. 261—263, Text-fig. 5.
1915. *Cistella Marie* n. sp.; J. deMORGAN, pp. 263—264, Text-fig. 6.
1920. *Argyrotheca cordata* (RISSO); W. H. DALL, p. 327.
1920. *Argyrotheca cordata*, n. var. *exopleura;* W. H. DALL, p. 328.
1921. *Cistella neapolitana* SCACCHI; W. FRIEDBERG, p. 16—17, Pl. 3, Fig. 13.
1921. *Cistella dertomutinensis* SACCO (?); W. FRIEDBERG, p. 17, Pl. 3, Fig. 12.
1921. *Cistella zboroviensis* FRIEDB.; W. FRIEDBERG, pp. 17—18, Pl. 3, Fig. 11.
1934. *Cistella subcordata* BOETTGER; A. ZILCH, p. 198, Pl. 1, Fig. 12.
1934. *Cistella subcuneata* BOETTGER; A. ZILCH, p. 198, Pl. 1, Fig. 13.
1940. *Cistella neapolitana* SACHI; M. JULIEN, pp. 49—50, Pl. 4, Figs 14—18.

1943. *Argyrotheca neapolitana* (SCACCHI); I. MEZNERICS, p. 36, Pl. 2, Figs 4, 7.
1943. *Argyrotheca subcordata* (BOETTGER); I. MEZNERICS, p. 37, Pl. 2, Figs 2—3.
1943. *Argyrotheca subcuneata* (BOETTGER); I. MEZNERICS, pp. 37—38.
1960. *Argyrotheca cordata* (RISSO); D. ATKINS, pp. 460—462, 466, 472, Text-Figs 1—2, 5, 9A.
1977. *Argyrotheca subcordata* (BOETTGER); W. BARCZYK & E. POPIEL-BARCZYK, pp. 162—163, Pl. 2, Figs 2—9.
1979. *Argyrotheca cordata* (RISSO); A. LOGAN, pp. 50—54, Text-figs 13—14, Pl. 5, Figs 1—12.

MATERIAL: 2090 complete specimens, 742 pedicle valves, 519 brachial valves.
DIMENSIONS: Maximum length 3.2 mm, width 2.8 mm, thickness 1.5 mm (*see also* Text-fig. 7).

REMARKS: This species, very common in the investigated area, was earlier reported from the Tertiary deposits under the names either *Argyrotheca neapolitana* (SCACCHI) or *A. subcordata* (BOETTGER). As it has been recently shown by LOGAN (1977b) the name *cordata* has priority over the name *neapolitana*. Examining the illustrations given by ZILCH (1934, Pl. 1, Figs 12—13) there is no doubt that the species *A. subcordata* (BOETTGER) as well as *A. subcuneata* (BOETTGER) are conspecific with *A. cordata* (RISSO), fitting well within the variability range of this species. The species *A. subcordata* and *A. subcuneata* differ only in shell outline and in having more or less visible ribs on the brachial valve. The species *A. cordata* has typically elongate, heart-shaped outline but it shows great shape variability range — from subtriangular to broadly transverse (*cf.* Text-fig. 8). Other differences between the discussed species fit also well within the intraspecific variability range.

The investigated specimens agree well with the Recent ones described and illustrated by LOGAN (1979). The species *Argyrotheca cordata* (RISSO) varies not only in shape but in a shell ornamentation as well. The shell can be quite smooth or covered with rounded, shallow, almost imperceptible ribs differently defined in different specimens, and varying from 2 to 8 in number, always better visible on the pedicle valve. The anterior commissure is rectimarginate to slightly sulcate with a shallow, median sulcus being present in both valves. The shell is very thin, slightly translucent. This species is easily distinguishable from *A. cuneata* (RISSO) by its destinctive internal features. The internal side of the anterior margin of both valves is covered with more or less visible tubercles which number increases with size. The smallest specimens have hardly four tubercles (*see* Pl. 5, Fig. 1), while in adults one can observe about 20 tubercles. On the brachial valve there is a high, triangular median septum having 3—4 serrations. LOGAN (1979) observed in his specimens 5—6 serrations. Most probably the smaller number of serrations in the investigated specimens is caused by their smaller size.

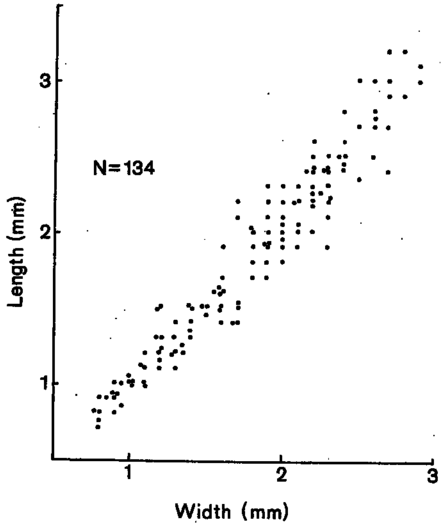


Fig. 7

Scattergram of length-width relationships for specimens of *Argyrotheca cordata* (RISSO)

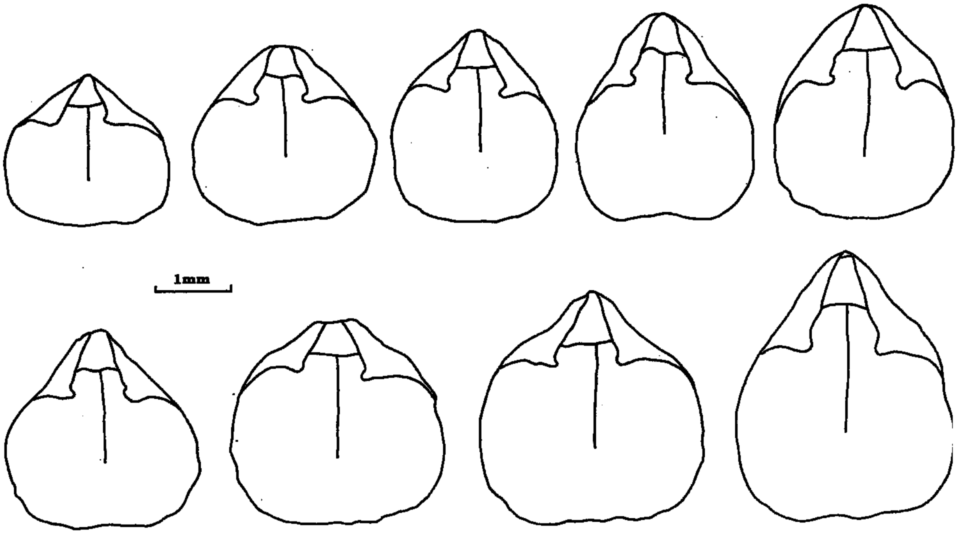


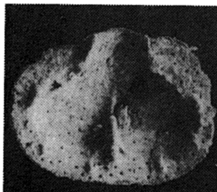
Fig. 8. Shape variability of the pedicle valve of *Argyrotheca cordata* (Risso) from one sample (*W—2*) from Węglin

The specimens described by deMorgan (1915) as new species *"Cistella laevigata"* and *"C. Marie"* have the external and internal features consistent with those of *A. cordata* (Risso). In such a situation the present author is of the opinion that those two species should be included in the synonymy of *A. cordata*. Also two species described by Friedberg (1921) under the name of *Cistella dertomutinensis* Sacco(?) and *C. zboroviensis* Friedberg are to be included in the synonymy of *Argyrotheca cordata* (Risso). Friedberg (1921) had only one specimen of the pedicle valve of each species but descriptions and illustrations given by him allow to be sure of their identity with *A. cordata*. Two species *Cistella dertotaurinensis* and *C. dertomutinensis* which were described by Sacco (1902, p. 34, Pl. 6, Figs 43—44) are very similar to the specimens under discussion but they are much larger, especially the first one which attains 7 mm of length. Also Sacco (1902) had only one specimen of the pedicle valve. However, the illustrations are not good enough and without examining the original material it is not possible to decide of the systematic position of those species.

PLATE 5

Argyrotheca cordata (Risso)

1 — Inner view of brachial valve, juvenile specimen, SEM × 15; Węglin (sample *W—2*)
2 — Inner view of brachial valve, juvenile specimen, SEM × 15; Zdziechowice (*Z—1*)
3 — Inner view of brachial valve, SEM × 25; Węglin (*W—2*)
4 — Inner view of brachial valve, SEM × 25; Łychów (*Ł—1*)
5 — Inner view of brachial valve (*5a* dorsal view, *5b* oblique view 45°), SEM × 25; Węglin (*W—2*)
6 — Inner view of brachial valve (*6a* dorsal view, *6b* oblique view 45°), SEM × 15; Węglin (*W—2*)
7-9 — Dorsal views of complete specimens, Łychów (*Ł—1*); *7* SEM × 15, *8* SEM × 25, *9* SEM × 30
10 — Inner view of pedicle valve, juvenile specimen, SEM × 20; Łychów (*Ł—1*)
11-12 — Inner views of pedicle valves, SEM × 15; Węglin (*W—2*)
13 — Ventral view of complete specimen, SEM × 15; Węglin (*W—2*)
14 — Dorsal view of complete specimen, SEM × 15; Węglin (*W—2*)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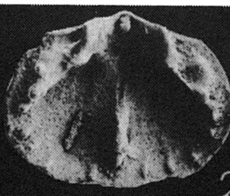
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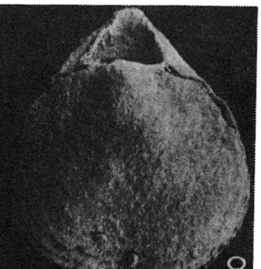
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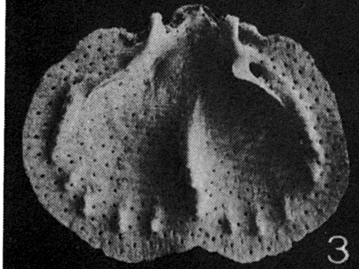
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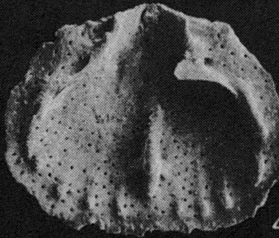
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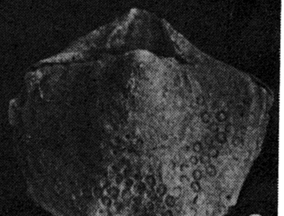
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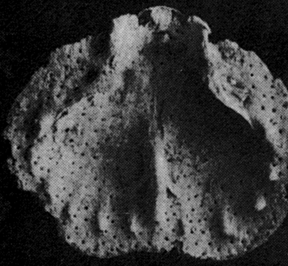
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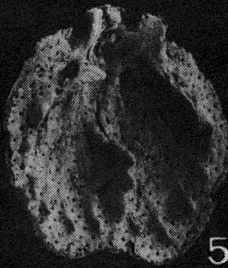
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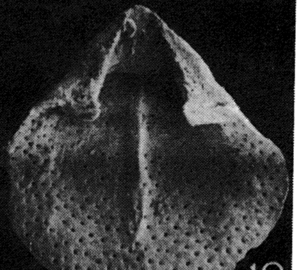
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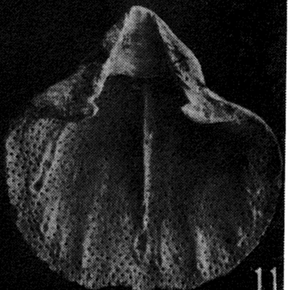
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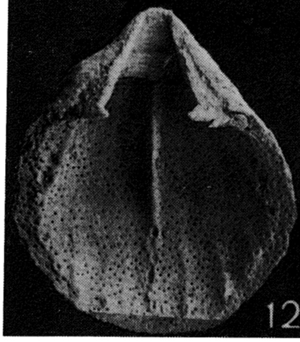
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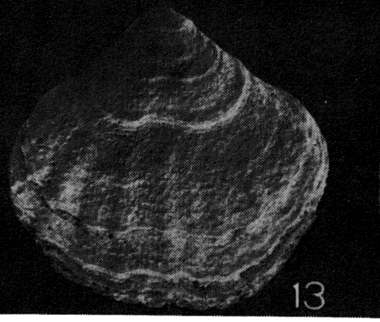
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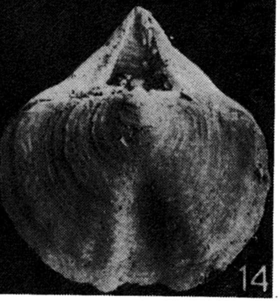
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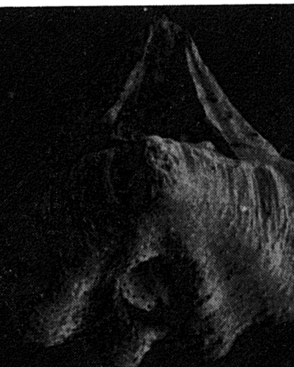
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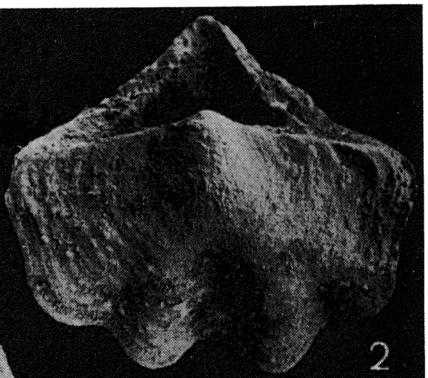
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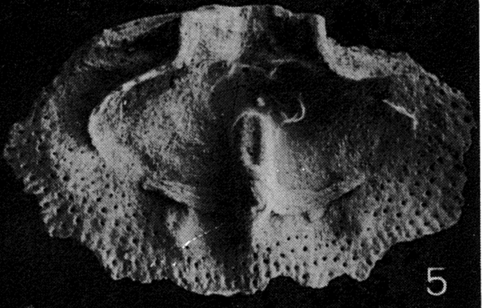
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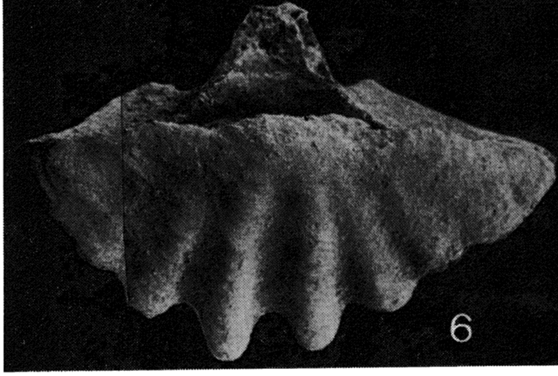
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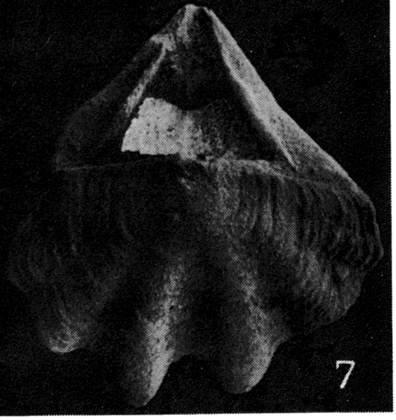
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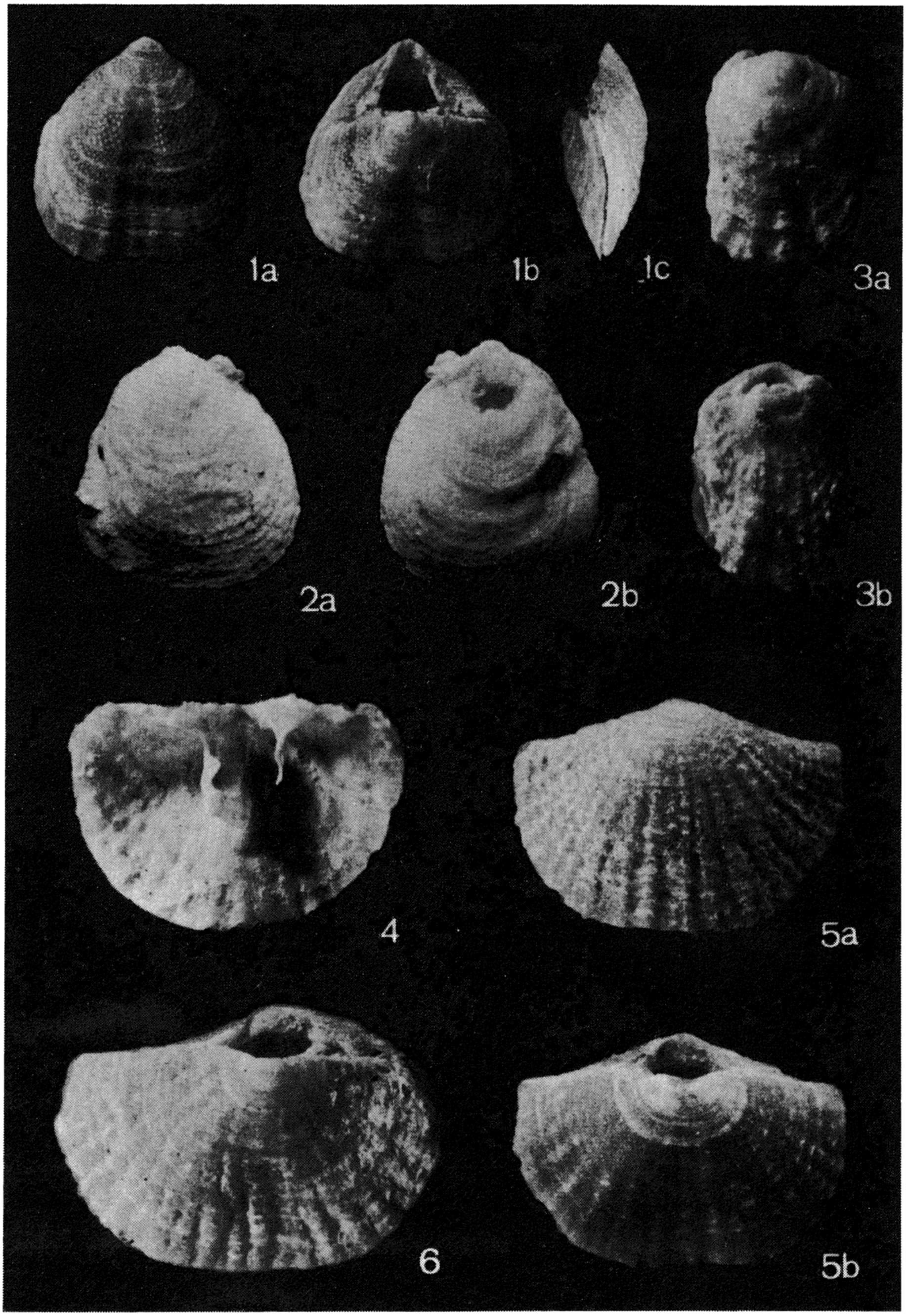
Megathiris detruncata (GMELIN)

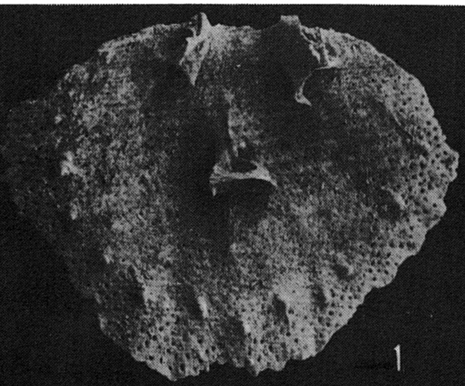
1 — Dorsal view of complete specimen, SEM × 23; Węglin (sample *W—1*)
2-3 — Dorsal views of complete specimens, SEM × 33; Węglin (*W3—2*)
4 — Dorsal view of complete specimen, SEM × 24; Węglin (*W—1*)
5 — Inner view of brachial valve; visible are rudimentary lateral septa of juvenile specimen, SEM × 25; Węglin (*W—1*)
6-7 — Dorsal views of complete specimens, SEM × 20; Węglin (*W3—2*)



1 — *Argyrotheca cordata* (Risso), complete specimen (*1a* ventral, *1b* dorsal, *1c* lateral view). × 10; Węglin (sample *W—2*)

2 — *Platidia* cf. *anomioides* (Scacchi & Philippi), complete specimen (*2a* ventral, *2b* dorsal view), × 20; Radwanówka (*R—5*)

3-6 — *Megerlia truncata* (Linnaeus); 3 — complete specimen (*3a* ventral, *3b* dorsal view) of untypical shell outline, × 10; Węglin (*W3—2*); 4 — inner view of brachial valve; visible is slightly damaged loop, × 10; Węglinek (*W6—10*); 5 — complete specimen (*5a* ventral, *5b* dorsal view), × 10; Węglin (*W3—1*); 6 — dorsal view of complete specimen, × 10; Węglinek (*W6—23*)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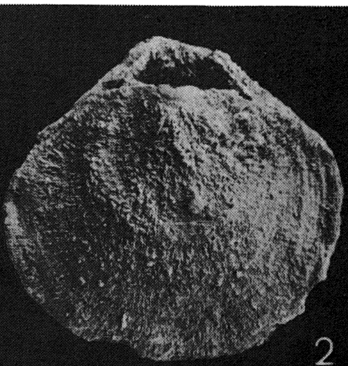
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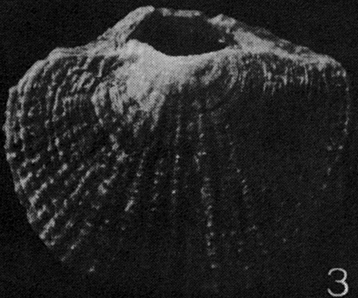
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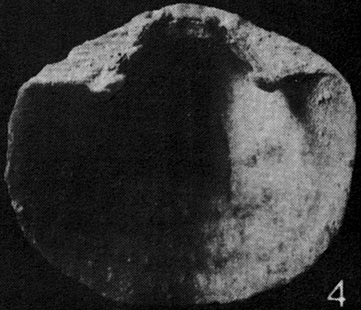
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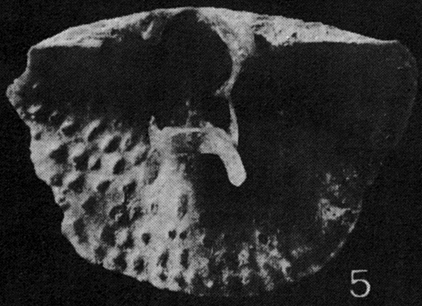
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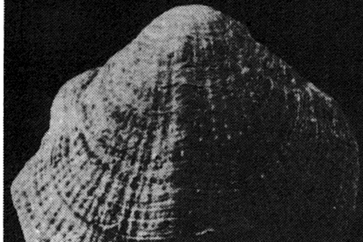
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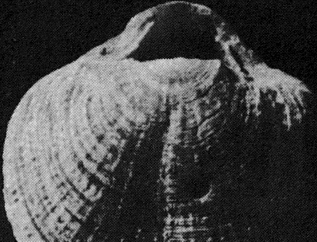
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7c

In the present author's opinion the specimens described by JULIEN (1940) as *Cistella cistellula* S. WOOD could represent the young specimens of *Argyrotheca cordata* (RISSO). The Recent *A. cistellula* (SEARLES-WOOD) is transversely subrectangular in outline and without any tubercles on the internal side of the anterior margin (*compare* Pl. 1, Figs 11—19 *in* LOGAN 1979). JULIEN's proposition to distinguish the species *"Cistella neapolitana"* and *"C. cistellula"* by their size — large shells should be included in *"C. neapolitana"* and small ones in *"C. cistellula"* — cannot be accepted because young specimens of *A. cordata* are also very small.

OCCURRENCE: Miocene of Poland: Węglinek (*W6—1* to *W6—23*), Węglin (*W—1* to *W—7*, *W3—2*, *W3—3*), Radwanówka (*R—1* to *R—6*), Zdziechowice (*Z—1* to *Z—3*), Łychów (*Ł—1* to *Ł—4*), Korytnica Basin (BARCZYK & POPIEL-BARCZYK 1977), Wójcza-Pińczów Range (STUDENCKI 1988); Miocene of Austria (DREGER 1889), the western Ukraine (FRIEDBERG 1921), France (deMORGAN 1915, JULIEN 1940), Hungary (MEZNERICS 1943); Pliocene of Italy (DAVIDSON 1870). The species *A. cordata* (RISSO) lives today in the Mediterranean Sea (DAVIDSON 1887, CAULET 1967, LOGAN 1979) and the Mauritanian region of the Atlantic Ocean (LOGAN 1979).

Family **Platidiidae** THOMSON, 1927

Genus *Platidia* COSTA, 1852

Platidia cf. *anomioides* (SCACCHI & PHILIPPI, 1844)
(Text-fig. 9; Pl. 2, Figs 3—5; Pl. 7, Fig. 2)

cf. 1865. *Morrisia anomioides* SCACC.; G. SEGUENZA, p. 66, Pl. 8, Fig. 6.
cf. 1870. *Platidia* (*Morrisia*) *anomioides* (SCACCHI Sp.); T. DAVIDSON, p. 405, Pl. 21, Fig. 15.
cf. 1887. *Platydia anomioides* (SCACCHI), PHILIPPI, sp; T. DAVIDSON, pp. 152—154, Pl. 21, Figs 15—19.
cf. 1889. *Platydia anomioides* SCACCHI; J. DREGER, p. 192, Pl. 2, Figs 10—11.
cf. 1891. *Platidia anomioides*, SCACCHI et PHILIPPI, sp.; P. FISCHER & D. P. OEHLERT, pp. 92—100, Text-fig. 9, Pl. 8, Figs 14a—14g.
cf. 1902. *Platydia anomioides* (SCACCHI); F. SACCO, p. 29.
cf. 1902. *Platydia anomioides* var. *rotundella* SACC.; F. SACCO, p. 29, Pl. 6, Figs 1—3.
cf. 1920. *Platidia seminula* PHILIPPI; W. H. DALL, p. 332.
cf. 1927. *Platidia anomioides* (SCACCHI & PHILIPPI); J. A. THOMSON, p. 218, Fig. 65.
cf. 1943. *Platidia anomioides* (SCACCHI et PHILIPPI); I. MEZNERICS, p. 42.
cf. 1959. *Platidia anomioides* (PHILIPPI); D. ATKINS, pp. 118—127, Text-figs 16—23.
cf. 1973b. *Platidia anomioides* (SCACCHI and PHILIPPI); G. A. COOPER, p. 21, Pl. 9, Figs 49—52.
cf. 1977. *Platidia anomioides* (SCACCHI and PHILIPPI); G. A. COOPER, pp. 122—123, Pl. 20, Figs 11—19; Pl. 33, Figs 15—17.
cf. 1979. *Platidia anomioides* (SCACCHI & PHILIPPI); C. H. C. BRUNTON & G. B. CURRY, p. 48, Fig. 24.
cf. 1979. *Platidia anomioides* (SCACCHI & PHILIPPI); A. LOGAN, pp. 60—63, Text-figs 17—18, Pl 7, Figs 1—11.
cf. 1981b. *Platidia anomioides* (SCACCHI & PHILIPPI); G. A. COOPER, p. 16, Pl. 2, Fig. 18.

MATERIAL: 49 complete specimens, 5 pedicle valves, 5 brachial valves.
DIMENSIONS: Maximum length 1.7 mm, width 1.6 mm, thickness 0.7 mm (*see also* Text-fig. 9).

DESCRIPTION: The shell is very small and thin, reaching a maximum length of 1.7 mm. In outline it is subcircular, oval to longitudinally oval, sometimes asymmetrical and irregular. The shell is slightly biconvex to plano-convex, often the brachial valve being posteriorly convex and

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PLATE 8

Megerlia truncata (LINNAEUS)

1 — Inner view of brachial valve of juvenile specimen, showing initial stage of development of the loop, SEM × 18.5; Węglin (sample *W3—2*)
2 — Dorsal view of complete juvenile specimen, SEM × 46.5; Węglin (*W—1*)
3-7 — Węglin (*W3—1*); 3 — dorsal view of complete specimen, × 6.5; 4 — inner view of pedicle valve, × 6.5; 5-6 — inner views of brachial valves, showing well developed brachial skeleton, × 6.5; 7 — complete specimen (*7a* ventral, *7b* dorsal, *7c* lateral view), × 4.2

anteriorly flat. The shell surface smooth, with numerous concentric growth lines. The area is small with short, straight hinge line and the large foramen of amphithyridid type, circular in shape. The deltidial plates are very narrow. The teeth are short with very feeble dental plates.

REMARKS: The species *Platidia anomioides* (Scacchi & Philippi) is well-known and reported from the Miocene to Recent. The present material is generally consistent in morphology with that reffered to in the synonymy. However, the small size and the preservation state of the investigated specimens preclude the study of internal characters of the brachial valve and therefore they are identified as *P.* cf. *anomioides.*

The specimens from the Roztocze region differ in shell outline from the Recent ones of *P. anomioides* (Scacchi & Philippi) which are more often transversely oval (*cf.* Fischer & Oehlert 1891; Thomson 1927; Cooper 1973b, 1977, 1981b; Brunton & Curry 1979; Logan 1979). They show the greatest similarity in shell outline to the fossil specimens illustrated by Seguenza (1865), Dreger (1889) and Sacco (1902). The specimens of the species *P.* cf. *anomioides* are much smaller from those hitherto described, both fossil as well as Recent ones, of the species *P. anomioides.* The studied specimens are very similar, both in size and outline, to the specimens of *Platidia* sp. from the Miocene of Cuba described and illustrated by Cooper (1979, Pl. 5, Figs 45—46) as well as to the Recent specimen of *Platidia* sp. from the Atlantic Ocean (near easternmost tip of South America) illustrated by Cooper (1982, Pl. 2, Fig. 1). Cooper (1979, 1982) suggests that all his specimens are immature. It seems probable that the investigated specimens are also immature, as they are more often longer than wide what is a typical feature of the young individuals of *P. anomioides* (Scacchi & Philippi) (*cf.* Atkins 1959). If that is the case the absence of the median septum and crura does not follow from a bad state of preservation but because the specimens under study are too small, *i.e.* immature; the beginning of the median septum is visible in individuals 1.8—2 mm wide (Atkins 1959, Cooper 1981b), while the full development of brachidium is reached at the length of about 4 mm.

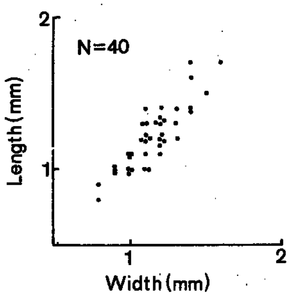

Fig. 9

Scattergram of length-width relationships for specimens of *Platidia* cf. *anomioides* (Scacchi & Philippi)

Logan (1979) noted the absence of deltidial plates in his specimens, other authors, however, (Davidson 1887, Fischer & Oehlert 1891, Thomson 1927, Brunton & Curry 1979) mentioned the presence of narrow deltidial plates. Although Cooper (1981a) included specimens of *P. anomioides* (Scacchi & Philippi) described by Davidson (1887) into a new species *P. marionensis* created by himself, in the present paper they are still considered as belonging to *P. anomioides,* as in the present author's opinion the differences given by Cooper (1981a) are not sufficient to create a new species.

OCCURRENCE: Miocene of Poland: Węglinek (*W6—9, W6—11, W6—12, W6—13, W6—15, W6—16, W6—18, W6—20, W6—21*), Radwanówka (*R—5*), Łychów (*Ł—4*).

The genus *Platidia* is reported from the Pińczów Limestone by Studencki (1988).

Family **Kraussinidae** DALL, 1870

Genus *Megerlia* KING, 1850

Megerlia truncata (LINNAEUS, 1767)

(Text-fig. 10; Pl. 2, Figs 6—9; Pl. 7, Figs 3—6; Pl. 8, Figs 1—7)

1865. *Megerlia truncata* LINNEO, var *M. monstruosa* (SCACCHI); G. SEGUENZA, p. 63, Pl. 8, Fig. 4
1866. *Megerlia truncata* LIN.; G. SEGUENZA, p. 11, no. 9.
1870. *Megerlia truncata* (LINNÉ); T. DAVIDSON, p. 404, Pl. 21, Figs 1—2.
1870. *Megerlia oblita* (MICHELOTTI); T. DAVIDSON, p. 405, Pl. 21, Fig. 3.
1887. *Megerlia truncata*, LINNÉ, sp.; T. DAVIDSON, pp. 103—108, Pl. 19, Figs 11—20.
1887. *Megerlia truncata*, var. *monstruosa*, SCACCHI; T. DAVIDSON, p. 108, Pl. 19, Figs 21—22.
1889. *Megerlea oblita* MICH.; J. DREGER, pp. 190—191, Pl. 2, Figs 6—9.
1891. *Mühlfeldtia truncata*, LINNÉ, sp.; P. FISCHER & D. P. OEHLERT, pp. 80—87, Pl. 7, Fig. 11.
1891. *Mühlfeldtia monstruosa*, SCACCHI, sp.; P. FISCHER & D. P. OEHLERT, pp. 87—90, Pl. 7, Figs 12a—12c.
1902. *Mühlfeldtia truncata* (L.); F. SACCO, p. 27, Pl. 5, Figs 38—43.
1902. *M. truncata* var. *rotundatula* SACC.; F. SACCO, p. 27, Pl. 5, Figs 44—45.
1902. *M. truncata* var. *sabatia* (ISS.); F. SACCO, pp. 27—28, Pl. 5, Figs 46—48.
1902. *M. truncata* var. *orbicularis* (MENEGH.); F. SACCO, p. 28, Pl. 5, Figs 49—50.
1902. *M. truncata* var. *serravallensis* SACC.; F. SACCO, p. 28, Pl. 5, Figs 52—53.
1902. *M. truncata* var. *parvula;* F. SACCO, Pl. 5, Fig. 51.
1902. *M. truncata* var. *oblita* (MICHT.); F. SACCO, p. 28, Pl. 5, Figs 54—60.
1920. *Mühlfeldtia disculus* PALLAS; W. H. DALL, pp. 333.
1920. *Pantellaria monstruosa* (SCACCHI); W. H. DALL, p. 335.
1921. *Mühlfeldtia truncata* L.; W. FRIEDBERG, pp. 10—12, Pl. 2, Figs 3—7, 10.
1921. *Mühlfeldtia truncata* L. var. *oblita* MICHT.; W. FRIEDBERG, p. 12, Pl. 2, Figs 8—9.
1927. *Mühlfeldtia truncata* (LINNÉ); I. A. THOMSON, p. 220, Text-fig. 66, pp. 226—228, Text-fig. 69.
1927. *Pantellaria monstruosa* (SCACCHI); I. A. THOMSON, p. 229, Text-fig. 70.
1943. *Mühlfeldtia oblita* (MICHELOTTI); I. MEZNERICS, p. 43, Pl. 2, Figs 6, 9.
1950. *Mühlfeldtia truncata* L.; W. KRACH, Pl. 1, Fig. 29.
1960. *Megerlea truncata* (LINNAEUS); E. KOJUMDGIEVA, p. 26, Pl. 9, Fig. 2.
1961b. *Megerlia truncata* (L.); D. ATKINS, pp. 95—104, Text-figs 1—9A.
1977. *Megerlia truncata* (LINNÉ); D. PAJAUD, p. 51, Pl. 1, Fig. D.
1979. *Megerlia truncata* (LINNAEUS); C. H. C. BRUNTON & G. B. CURRY, pp. 52—53, Fig. 26.
1979. *Megerlia truncata* (LINNAEUS); A. LOGAN, pp. 68—72, Text-fig. 21, Pl. 9, Figs 1—23.
1981b. *Megerlia truncata* (LINNÉ); G. A. COOPER, pp. 16—17, Pl. 3, Figs 5—11.
1981b. *Pantellaria monstruosa* (SCACCHI); G. A. COOPER, p. 17, Pl. 3, Figs 16—18.
1982. *Pantellaria monstruosa* (SCACCHI); G. A. COOPER, p. 15, Pl. 5, Figs 1—6.
1982. *Megerlia truncata* (LINNÉ); C. LLOMPART & S. CALZADA, p. 195, Pl. 1, Fig. 3.
1983. *Megerlia truncata* (LINNEO); M. GAETANI & D. SACCA, p. 16, Pl. 10, Fig. 10, Pl. 11, Figs 1—5.
1983. *Megerlia truncata* (LINNÉ); C. LLOMPART, p. 25, Fig. 2:6.
1988. *Megerlia truncata* (LINNÉ); C. LLOMPART, pp. 316—317, Pl. 1, Fig. 2a—c.
1988. *Pantellaria monstruosa* (SCACCHI); C. LLOMPART, p. 317, Pl. 1, Fig. 3a—c.

MATERIAL: 1411 complete specimens, 525 pedicle valves and 662 brachial valves.
DIMENSIONS: Maximum length 13 mm, width 15.3 mm and thickness 5.7 mm (*see also* Text-fig. 10).

REMARKS: The species *Megerlia truncata* (LINNAEUS) is one of the four commonest in the brachiopod assemblage from the Roztocze region. The very rich material (more than 2500 specimens) allows to observe a great variability of this species. Its variability concerns a shell outline, an ornamentation and a degree of convexity. Some authors (DAVIDSON 1887, SACCO 1902, FRIEDBERG 1921) have even given varietal names for each morphological form but all the differences between such forms are within the intraspecific variability range and continuous transitions have been noted in the material available for the present study. The investigated specimens are consistent in external and internal characters with the hitherto described specimens but they are slightly smaller than the Recent ones described by LOGAN (1979) and BRUNTON & CURRY (1979). The investigated material allows also to reevaluate the systematic position of the species *Pantellaria monstruosa* (SCACCHI) which is the subject of controversy. The genus *Pantellaria* was created by DALL for those species of *Megerlia* which have the pedicle opening of amphithyridid type. Basing on detailed studies of different growth stages of the living species *Megerlia echinata* (FISCHER & OEHLERT), ATKINS (1961a) has given convincing arguments in support of opinion that the genus *Pantellaria* DALL is synonymous with *Megerlia* KING, because the shape of shell and of pedicle opening depends on an angle of attachement to substrate and as such cannot be used as generic characters (*see also* THOMSON 1927, p. 229). Examining the material from the Mediterranean Sea LOGAN (1979) has confirmed ATKINS's opinion and included the species *P. monstruosa* (SCACCHI) into the synonymy of *M. truncata* (LINNAEUS). However, some authors (*cf.* COOPER 1981b, 1982; LLOMPART 1988) believe that such morphological differences are sufficient to erect a new genus and species. Although, they agree that the both species have the same brachial skeleton and that the ornamentation of the pedicle valve of *P. monstruosa* is very similar to *M. truncata*. In the studied material the present author has not found specimens which are identical with those illustrated by DAVIDSON (1887, Pl. 19, Figs 21—22), LOGAN (1979, Pl. 9, Figs 20—23) or LLOMPART (1988, Pl. 1, Fig. 3) but there are many intermediate forms, thus specimens having the irregular, non-costate, only with irregular growth lines as an ornamentation, flat or slightly concave brachial valve but with the foramen submesothyridid or slightly amphithyridid. Sometimes one may observe a patch with preserved ornamentation on the brachial valve. There are also specimens which are biconvex with normal ornamentation on the brachial valve but having an amphithyridid pedicle opening, or specimens having ventral umbo badly worn. Thus, the present author's observations also confirm that *P. monstruosa* and *M. truncata* are conspecific, and differences between them are caused only by ecological factors.

The investigated material, especially rich in very small specimens, gives the possibility to follow the changes of morphology during ontogenesis. The shell shape changes with age as *M. truncata* (LINNAEUS) being normally transversely oval and wider than long in adults, as a young is longer than wide (*cf.* Pl. 2, Figs 7—9), that not being the rule, however (*see* Pl. 2, Fig. 6 and Pl. 8, Fig. 2; *see also* very untypical mature specimen, much longer than wide, on Pl. 7, Fig. 3, this caused undoubtedly by accomodation to a limited space during growth). The young individuals are

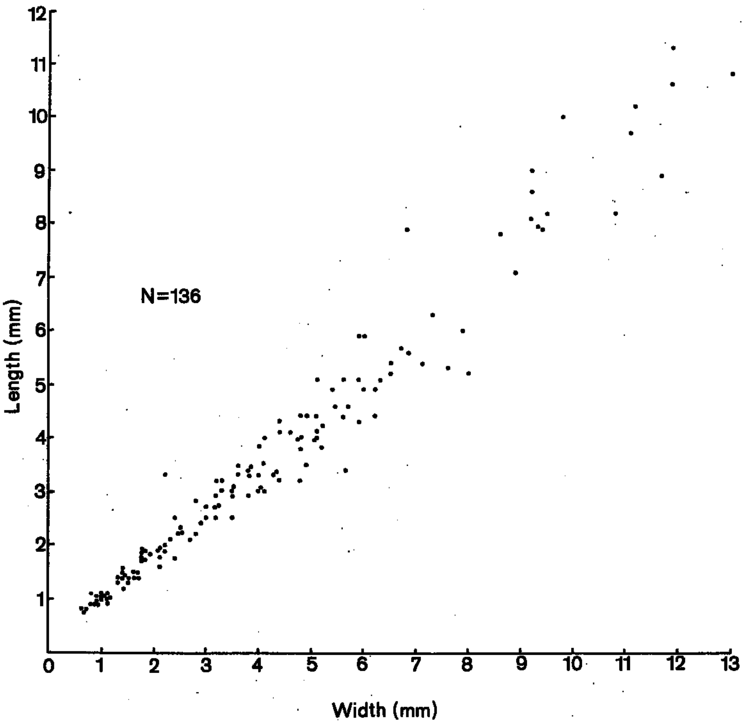

Fig. 10. Scattergram of length-width relationships for specimens of *Megerlia truncata* (LINNAEUS)

biconvex with the brachial valve even more convex than the pedicle one, especially posteriorly. The shells of adults are usually biconvex or plano-convex, always with the brachial valve less convex than the pedicle one. The individuals measuring about 1 mm in length have the smooth shell surface on both valves, sometimes only delicate wrinkles are visible on the anterior part of the pedicle valve (*see* Pl. 2, Fig. 6). Moreover, clear ribs appear on a pedicle valve, and only in larger specimens ribs appear on the anterior part of the brachial valve (*see* Pl. 2, Fig. 8). The ribs on both valves are numerous and very fine, the concentric growth lines are visible during all the growth stages. The investigated material is characterized by the presence of numerous, asymmetric specimens. The species *M. truncata* (LINNAEUS) shows a high degree of asymmetry, greater than other species in the investigated assemblage. The asymmetry as one of the elements of shape variation was investigated in the fossil (ASGAARD 1968) as well as Recent brachiopod populations (MCCAMMON 1970). According to MCCAMMON (1970) the environmental conditions are the main cause of shape variation but also the inherent characters of a species play an important role. Under the same conditions one species shows a greater variability than others. More asymmetrical forms are observed among smaller specimens. The same situation had been found by MCCAMMON (1970) investigating a dead population. Her explanation is that the survival ability is much greater when the specimens have the possibility to increase their size in all growth directions, *i. e.* when they have enough room for a free growth. This could explain an abnormally high proportion of asymmetric valves in fossil assemblages. It could be also an explanation of usually observed smaller size of "*P. monstruosa*" (which is asymmetrical) than the size of *M. truncata*. The anterior commissure being rectimarginate in the young individuals becomes sulcate when increasing in size but there are some adults with rectimarginate anterior commissure as well.

Among the studied specimens there are forms very similar to *Megerlia gigantea* (DESHAYES) as illustrated by COOPER (1981a, Pl. 6, Figs 1—26). Some authors (DAVIDSON 1887, JACKSON 1921) regard *M. gigantea* (DESHAYES) as only an ecological variant of *M. truncata* (LINNAEUS), but DALL (1920) saw its place in *M. echinata* (FISCHER & OEHLERT).

OCCURRENCE: Miocene of Poland: Węglinek (*W6—1* to *W6—3*, *W6—5* to *W6—7*, *W6—9* to *W6—18*, *W6—21* to *W6—23*), Węglin (*W—1*, *W—4* to *W—7*, *W3—1* to *W3—3*), Łychów (*Ł—4*, *Ł—5*), Modliborzyce, Lublin Upland (KRACH 1950), Wójcza-Pińczów Range (RADWAŃSKI 1969, STUDENCKI 1988); Miocene of Italy (SEGUENZA 1865, 1866, DAVIDSON 1870, SACCO 1902), Austria (DREGER 1889), the western Ukraine (FRIEDBERG 1921), Hungary (MEZNERICS 1943), Bulgaria (KOJUMDGIEVA 1960), Spain (LLOMPART & CALZADA 1982); Pliocene of Italy (SEGUENZA 1865, DAVIDSON 1870, GAETANI & SACCA 1983), Spain (PAJAUD 1977). Recently *M. truncata* (LINNAEUS) lives in the Mediterranean Sea (CAULET 1967, LOGAN 1979, LLOMPART 1988), in the Lusitatian, Mauritanian and Boreal regions of the Atlantic Ocean (DAVIDSON 1887, BRUNTON & CURRY 1979, LOGAN 1979, COOPER 1981b, 1982), and in the Indian Ocean (COOPER 1973a).

PALEOECOLOGY OF BRACHIOPOD ASSEMBLAGES

For a purpose of the ecological analysis, percentages of brachiopod species have been counted (Text-fig. 11) in particular samples representing various lithology and localities. Despite the fact that all the investigated samples were collected from the shallow water deposits representing similar sedimentary conditions and rather narrow span of time, brachiopod assemblages show considerable differences in composition. Basing on an ecology of the Recent brachiopods, and earlier paleoecological interpretations of other fauna from this area, as well as on data obtained from the character of the deposits, an attempt of the ecological interpretation of brachiopod assemblages is undertaken.

The brachiopod assemblage from the reef deposits at Węglinek (Text-fig. 11*A*) contains the following species: *Ancistrocrania abnormis* (Defrance), *Platidia* cf. *anomioides* (Scacchi & Philippi), *Megathiris detruncata* (Gmelin), *Argyrotheca cordata* (Risso), *A. cuneata* (Risso), and *Megerlia truncata* (Linnaeus). The last four species occur in similar quantities (over 20%). The species *Ancistrocrania abnormis* and *Platidia* cf. *anomioides* occur in negligible quantities (0.5% and 0.9% respectively). The brachiopods come from the cavities and reef depressions in the algal-vermetid reefs (*see* Pisera 1985). According to Pisera (1985) the reef originated in a shallow water environment where most of the fauna inhabited only caverns in the reef body, representing thus cryptic fauna. In Recent reef environments *Argyrotheca* and some *Platidia* species occupy similar ecological niche (Jackson & *al.* 1971; Logan 1975, 1977a). The data concerning the bathymetric distribution of Recent brachiopods are unequivocal. The Recent species *Neocrania anomala* (O. F. Müller) has a wide depth range (30—1478 m, Zezina 1976), similarly as *Platidia anomioides* (Scacchi & Philippi) (33—1179 m, Zezina 1976, Cooper 1977). Both species of *Argyrotheca* and *Megathiris detruncata* (Gmelin) are found today at the small depths (Pajaud 1977, Logan 1979) but they may also occur at the larger depths according to other authors (Zezina 1976, Brunton & Curry 1979). The species *Megerlia truncata* (Linnaeus) and the genus *Platidia* Costa belong, however, to eurybathic group (*cf.* Logan 1979). At the same time, an occurrence of *Megerlia truncata* at the depth of 12 m in the dark sea cave is also known (Logan 1979, p. 11; *see also* Zezina 1976 who gives the depth range of 16—555 m). On the other hand, Revert (1985) suggests that *M. truncata* preferred shallower water during the Miocene (optimum 50 meters) while today it prefers deeper environments (optimum between 95—150 m). This opinion agrees well with the present author's observations where *M. truncata* clearly constitutes an important element in very shallow water assemblages. The Recent brachiopods have very often wide depth ranges. According to Cooper (1977, p. 10) it should be a warning to paleontologists to be careful in using fossil brachiopod faunas as depth indicators. It is interesting that as early as in 1891 Fischer & Oehlert warned against using the Recent brachiopod depth requirement directly for the fossil record. In the Recent paper Emig (1988) points that the bathymetric distribution of Recent brachiopods depends mostly on the hydrodynamics, and thus related factors such as current, substrate, sedimentation rate, turbidity, nutrients and water

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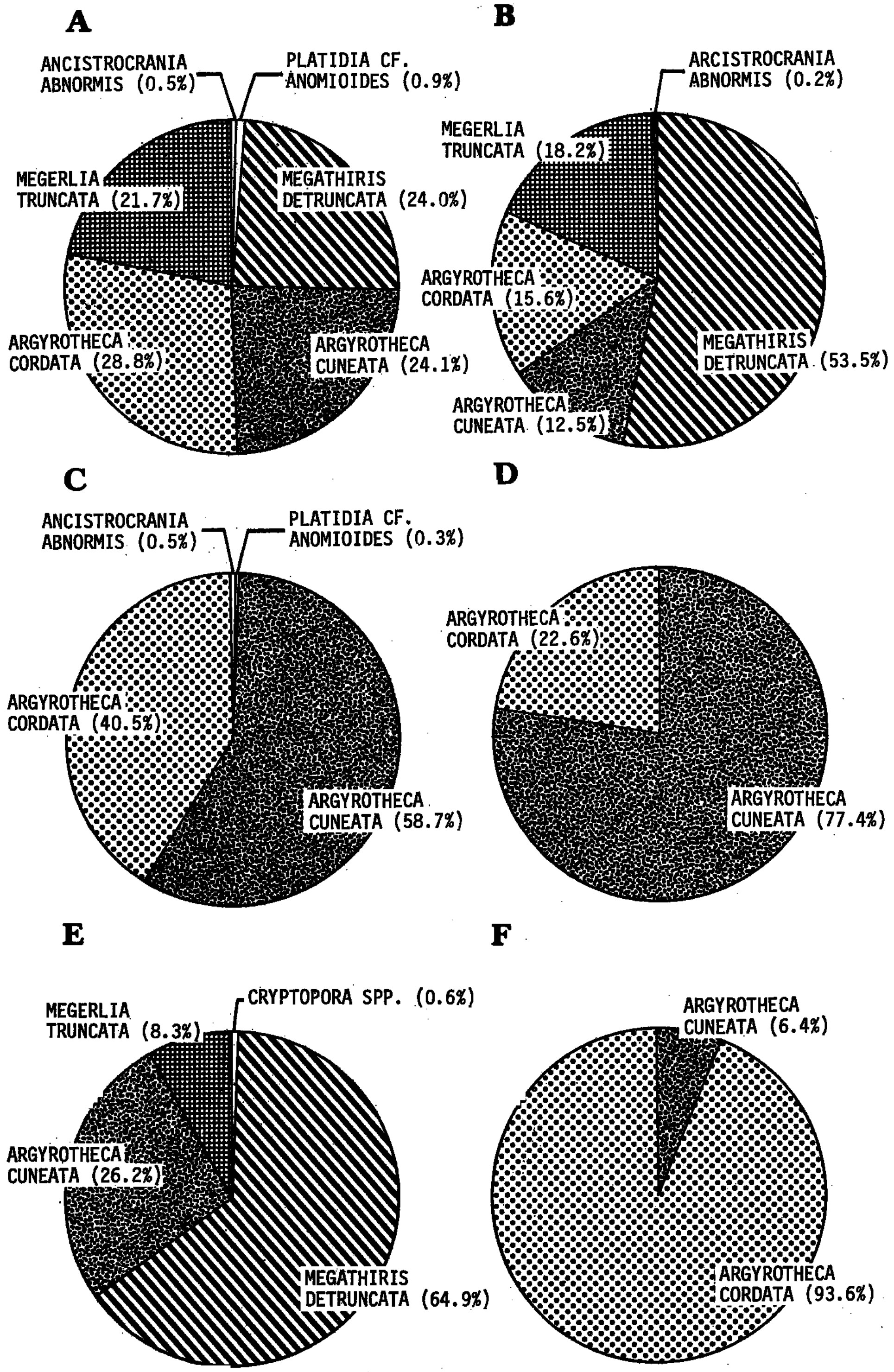
Fig. 11

Precentages of particular species in samples representing different deposits and localities

A — Red-algal vermetid reefs at Węglinek (samples *W6—1* to *W6—19, W6—22, W6—23*); **B** — forereef deposits (samples *W3—2, W3—3*) at Węglin; **C** — marls (samples *R—1* to *R—6*) at Radwanówka; **D** — marls (samples *Z—1* to *Z—3*) at Zdziechowice; **E** — marls (sample *W—1*) at Węglin; **F** — marls (samples *Ł—1, Ł—2*) at Łychów


A
ANCISTROCRANIA ABNORMIS (0.5%)
PLATIDIA CF. ANOMIOIDES (0.9%)
MEGERLIA TRUNCATA (21.7%)
MEGATHIRIS DETRUNCATA (24.0%)
ARGYROTHECA CORDATA (28.8%)
ARGYROTHECA CUNEATA (24.1%)
B
ARCISTROCRANIA ABNORMIS (0.2%)
MEGERLIA TRUNCATA (18.2%)
ARGYROTHECA CORDATA (15.6%)
MEGATHIRIS DETRUNCATA (53.5%)
ARGYROTHECA CUNEATA (12.5%)
C
ANCISTROCRANIA ABNORMIS (0.5%)
PLATIDIA CF. ANOMIOIDES (0.3%)
ARGYROTHECA CORDATA (40.5%)
ARGYROTHECA CUNEATA (58.7%)
D
ARGYROTHECA CORDATA (22.6%)
ARGYROTHECA CUNEATA (77.4%)
E
MEGERLIA TRUNCATA (8.3%)
CRYPTOPORA SPP. (0.6%)
ARGYROTHECA CUNEATA (26.2%)
MEGATHIRIS DETRUNCATA (64.9%)
F
ARGYROTHECA CUNEATA (6.4%)
ARGYROTHECA CORDATA (93.6%)

exchange. Thus, the occurrence in cryptic habitats and changes in depth requirement of *Megerlia truncata* (LINNAEUS) may explain the co-occurrence, in important quantities, the species of *Argyrotheca* (recently shallow water genus) and *M. truncata* (recently inhabiting deeper water) in a very shallow water reef assemblage from Węglinek.

The percentage of the particular brachiopods in the essemblage from the red-algal marls surrounding the reef limestones at Węglinek is very similar, thus suggesting their derivation from the reef.

The brachiopod assemblage occurring in the samples *W3– 2* and *W3– 3* representing marls (forereef deposits, originated in a deeper water) in Węglin (Text-fig. 11*B*) contains the same species as at Węglinek, except *Platidia* cf. *anomioides* (SCACCHI & PHILIPPI), their relative frequencies being, however, different. The species *Ancistrocrania abnormis* (DEFRANCE) also occurs in negligible amount (0.2%). Contrary to the Węglinek assemblage, where other species occur in similar proportions, *Megathiris detruncata* (GMELIN) dominates and amounts to over 50% in marls from Węglin. The species *Megerlia truncata* (LINNAEUS) (18.2%) and both of *Argyrotheca* species (12.5% and 15.6%) are much less numerous. This difference cannot be easily explained by depth differences and must be rather tied with substrate requirements.

A composition of the brachiopod assemblage occurring at Radwanówka (Text-fig. 11*C*) is sharply different from the assemblage of Węglinek and Węglin. The main difference is the total absence of *Megathiris detruncata* (GMELIN) and *Megerlia truncata* (LINNAEUS). The species *Ancistrocrania abnormis* (DEFRANCE) and *Platidia* cf. *anomioides* (SCACCHI & PHILIPPI) occur in small quantities (both less than 1%). The dominant species are *Argyrotheca cuneata* (RISSO) (58.7%) and *A. cordata* (RISSO) (40.5%). The fossil assemblage at Radwanówka corresponds to a shallow water, epi-reef assemblage structured by the presence of submarine flora (PISERA 1985). Thus, the dominance of *Argyrotheca* species (shallow water fauna) and the absence of *Megerlia truncata* and *Megathiris detruncata* (deeper water fauna) support this inference. This is one more case when the genus *Platidia* COSTA occurs in an apparently shallower water depth than it occurs today (ZEZINA 1976, LOGAN 1979 and others). Thus it seems that also *Platidia* has changed its depth range since the Miocene. One has to remember, however, that similar to *Megerlia*, also *Platidia* may occur in shallow water but cryptic habitats in Recent reefs (*see* LOGAN 1977a).

In the oyster bioherm at Zdziechowice (*see* BIELECKA 1967; *also* PISERA 1985, Text-fig. 3) the brachiopod assemblage consists only of two species: *Argyrotheca cuneata* (RISSO) and *A. cordata* (RISSO) (Text-fig. 11*D*). The species *A. cuneata* is dominating in this assemblage (77.4%), resembling in composition the assemblage from Radwanówka. The absence of *Megerlia truncata* (LINNAEUS) and *Megathiris detruncata* (GMELIN) in Radwanówka could be explained by an absence of cryptic environment; the oyster reef, however, had been a very porous structure, thus this explanation does not apply (one cannot exclude, however, that there were not enough large cavities as *Megathiris* and especially *Megerlia* are relatively large-sized brachiopods). The only other common factors controlling the brachiopod assemblage composition may be a very shallow water and the presence of submarine flora which thrived in the both discussed assemblages.

The brachiopod assemblage occurring in the sample *W- 1* from Węglin (Text-fig. 11*E*) shows a large difference in relation to all other assemblages. No *Ancistrocrania abnormis* (DEFRANCE), *Argyrotheca cordata* (RISSO) or *Platidia* cf. *anomioides* (SCACCHI & PHILIPPI) are present. Appear, however, other species: *Cryptopora* sp. *A* and *Cryptopora* sp. *B*, having small share in the assemblage (0.4% and 0.2% respectively), whereas *Megathiris detruncata* (GMELIN) dominates (64.9%). The species *Argyrotheca cuneata* (RISSO) (26.2%) and *Megerlia truncata* (LINNAEUS) (8.3%) are less numerous. The presence of the genus *Cryptopora* JEFFREYS, which is very rare in the investigated area, may indicate a larger depth of deposition (recently *Cryptopora* depth range is from 60 to 4000 m, CURRY 1983). One of the studied species has wing-like deltidial plates, another one narrow ridges. Recent species of the genus *Cryptopora* having wing-like deltidial plates inhabit shallow waters (COOPER 1959, 1973a), while the species with narrow deltidial plates live in deep waters (COOPER 1973b). However, ZEZINA (1976) reports for the species *C. brazieri* (CRANE), having narrow deltidial plates, the depth range from 31 to 183 m. CURRY (1983) suggests that "wings" of deltidial plates prevent only from sinking of a posterior margin in the sediment. Also POPIEL-BARCZYK (1980) thinks that the relationship between the morphology of deltidial plates and water depth cannot be applied to the geological past. General geological situation (*see* PISERA 1985) suggests that this assemblage represents the deepest environment in the investigated deposits. Thus, the presence of two *Cryptopora* species seems to support this conclusion. Basing on available geological and paleontological data (BIELECKA 1967, PISERA 1985) this depth still cannot be higher than several dozen meters, as already suggested by SZCZECHURA & PISERA (1986).

The assemblage of brachiopods from Łychów (Text-fig. 11*F*) has a similar composition as this from Zdziechowice. Only *Argyrotheca cuneata* (RISSO) and *A. cordata* (RISSO) are present, this last species dominating (93.6%). The fossil assemblage from Łychów has been interpreted by HOFFMAN & *al.* (1978) as a shallow water one and structured by kelp, what agrees well with interpretation of the similar assemblage from Radwanówka.

Other samples with investigated brachiopods show the structure more or less similar to those above discussed.

Summing up, all the investigated brachiopod assemblages characterize shallow water environments, but still some differentiation of depth is expressed in their composition. On the other hand, if compared with the Recent assemblages from the Mediterranean Sea (CAULET 1967, LOGAN 1979) no direct comparison seems possible. It is caused mainly by the fact of the presence, in important quantities, of *Megerlia truncata* (LINNAEUS) in a shallow water assemblage, while today this species characterizes rather deep environments. This fact may be explained by changes in ecological requirement of *M. truncata* as already suggested (REVERT 1985) and by its occurrence in cryptic habitats, environment commonly inhabited by a deep water species (not only brachiopods) in a shallow water. Differences in the occurrence of *Megathiris detruncata* (GMELIN) and *Argyrotheca* species are not easy to explain but perhaps may be caused by the presence of submarine flora (as it follows from the similarity in the brachiopod assemblage from Radwanówka and Łychów) and/or the presence of suitable substrate. Surprising is the absence, in the assemblage, of thecideid brachiopods, which are common today (DAVIDSON 1887, LOGAN 1979) as well as in the Miocene deposits (SEGUENZA 1866, DAVIDSON 1870, SACCO 1902, JULIEN 1940) from the Mediterranean region (PAJAUD 1970). The only explanation which seems to apply is the too low temperature in this part of Paratethys, as the fossil assemblage indicates normal marine conditions.

PALEOGEOGRAPHICAL REMARKS

The investigated assemblage of brachiopods contains 8 species and 6 genera which have a wide stratigraphical and geographical range. Four of them, *i.e.* *Megathiris detruncata* (GMELIN), *Argyrotheca cuneata* (RISSO), *A. cordata* (RISSO) and *Megerlia truncata* (LINNAEUS), occur also in the Mediterranean Sea, and the so-called Lusitanian and Mauritanian Provinces of the Atlantic (ZEZINA 1976, BRUNTON & CURRY 1979, LOGAN 1979). One species of *Platidia*, resembling closely *P. anomioides* (SCACCHI & PHILIPPI) which is also known from those regions occurs also in the studied material. All forms determined to the species level were also occurring in the Mediterranean region and Paratethys during the Miocene (DAVIDSON 1870, SACCO 1902, deMORGAN 1915, JULIEN 1940). Similar brachiopod assemblage is known from the Middle Miocene red-algal deposits of the Wójcza-Pińczów Range (STUDENCKI 1988).

During the Lower Badenian (*see* RÖGL & STEININGER 1984, Text-fig. 10.8) the Mediterranean, Indo-Pacific and Paratethys formed a system of well connected basins with fauna easily migrating between them. In effect the marine biotas were uniform, thus the Mediterranean affinities of the Lower Badenian brachiopod fauna known from Poland (BARCZYK & POPIEL-BARCZYK 1977, STUDENCKI 1988) are easy to understand. If the Miocene brachiopod fauna from the Roztocze region described in this paper is of the same age as the latter, then its Mediterranean affinities are also comprehensible. On the other hand, if the Miocene brachiopod-bearing deposits of the Roztocze region are of the Upper Badenian age, as suggested by SZCZECHURA (1982) and SZCZECHURA

& PISERA (1986), the situation is different. The Middle Miocene Paratethys salinity crisis interrupted the normal-marine sedimentation (*see* RÖGL & STEININGER 1984, Text-fig. 10.9) in this area and thick evaporatic sediments originated in the Carpathian Foredeep with no refuges of marine elements known. In the Upper Badenian the Central Paratethys was again flooded by the transgression coming from the Indo-Pacific province. No connection with the Mediterranean region existed during this time (RÖGL & STEININGER 1984, Text-fig. 10.10). Thus the Upper Badenian fauna had to be an immigrant one from the Indo-Pacific. It makes clearly Mediterranean affinities of the brachiopod fauna from the Roztocze region explanable only if one can regard such type of a brachiopod assemblage as a descendant of an earlier brachiopod fauna typical of the entire area, *i.e.* Mediterranean, Paratethys and Indo-Pacific bioprovinces. This opinion is supported by the today's relationship between the fauna of the Indian and Atlantic Oceans exhibited by brachiopods and other groups of animals (JACKSON 1921, COOPER 1973a). Both authors have noted the occurrence of such brachiopod species as *Terebratulina retusa* (LINNAEUS), *Platidia anomioides* (SCACCHI & PHILIPPI), *Megerlia truncata* (LINNAEUS) in the Indian Ocean. COOPER (1973a) has also emphasized the close resemblance of the species of *Argyrotheca*, *Gryphus* and *Lacazella* in the both regions.

Thus the first step to solve this problem is to determine the exact age of the investigated deposits of the Roztocze region; if their Upper Badenian age is proved, then only a recognition of the brachiopod fauna history during the Tertiary in the Mediterranean, Paratethys and Indo-Pacific regions may clarify the situation.

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BADEŃSKIE RAMIENIONOGI ZACHODNIEGO ROZTOCZA

(Streszczenie)

Przedmiotem pracy jest charakterystyka ramienionogów występujących w płytkowodnych osadach badeńskich Zachodniego Roztocza (*patrz* fig. 1). Zespół ten (*patrz* fig. 2—11 oraz pl. 1—8) obejmuje osiem gatunków należących do sześciu rodzajów. Cztery z nich, tj. *Ancistrocrania* *abnormis* (DEFRANCE), *Cryptopora* sp. *A*, *Cryptopora* sp. *B* oraz *Platidia* cf. *anomioides* (SCACCHI & PHILIPPI) należą do nadzwyczaj rzadkich; natomiast *Megathiris detruncata* (GMELIN), *Argyrotheca cuneata* (RISSO), *A. cordata* (RISSO) i *Megerlia truncata* (LINNAEUS) są bardzo licznie reprezentowane, co pozwoliło na rozpoznanie zakresu ich zmienności morfologicznej. Trzy gatunki, tj. *Ancistrocrania abnormis*, *Argyrotheca cuneata* i *Platidia* cf. *anomioides* stwierdzono po raz pierwszy w osadach badenu Polski.

Pomimo że wszystkie utwory zawierające badane ramienionogi reprezentują osady płytkowodne, powstałe w podobnych warunkach i wąskim przedziale czasu, procentowy udział gatunków w poszczególnych stanowiskach wykazuje znaczne różnice. Analiza sytuacji geologicznej oraz dane na temat wymagań współczesnych ramienionogów wskazują, że struktura badanych zespołów kontrolowana była nie tylko głębokością, ale także przez takie czynniki jak dostępność podłoża preferowanego przez konkretny gatunek, obecność podmorskiej flory oraz warunki kryptyczne.

Badane zespoły ramienionogów wykazują podobieństwo zarówno do zespołów mioceńskich południowej Europy, jak i do zespołów żyjących współcześnie w Morzu Śródziemnym.