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Brachiopods from the Upper Cretaceous chalk of Mielnik (Eastern Poland)

ABSTRACT: The Upper Cretaceous chalk of Mielnik (Eastern Poland) yields a rich assemblage of brachiopods that contains 23 species, the two genera and three species of which are described new: *Cryptoporella antiqua* gen. et sp. n., *Leptothyrellopsis polonicus* gen. et sp. n., and *Dalligas mielnicensis* sp. n. Associated are diverse species of the genera *Lingula* Bruguière, *Terebratulina* d'Orbigny, *Rugia* Steinich, *Argyrotheca* Dall, and *Kingena* Davidson. The recognized assemblage is characterized by small-sized, minute forms. Stratigraphically, it indicates the presence of the brachiopod zones *2* and *3* of Surlyk, corresponding to the lowermost part of the Lower Maastrichtian.

INTRODUCTION

The brachiopods belong to the most common fossils obtained by washing methods from the Upper Cretaceous chalk deposits exposed at Mielnik on the Bug river (Eastern Poland). They were first noted by Data (1974) who reported *Lingula* sp., *Isocrania costata* (Sowerby), *Neoliothyrina obesa* Sahni, *N. fittoni* (Hagenow), *Chatwinothyris subcardinalis* Sahni, *Terebratulina faujasi* (Roemer), *T. longicollis* Steinich, and *Argyrotheca* sp.

The systematic sampling of the section exposed at the Mielnik chalk pit (*see* Text-fig. 1) resulted in collecting a rich assemblage of diverse brachiopods, most of which are represented by small-sized specimens. Some larger forms were obtained by searching directly in the pit, and their precise position in the sequence remains therefore unknown.

Most of the investigated specimens (*cf.* Text-fig. 2 and Pls 1—7) were collected at the Mielnik chalk pit. For comparison, however, a few samples from the same-aged chalk exposed at Kornica (18 km SSW to Mielnik) were also analysed. The sparse brachiopod fauna is there represented by *Cryptoporella antiqua* gen. et sp. n., *Terebratulina chrysalis* (Schlotheim), *T. longicollis* Steinich, *Rugia tenuicostata* Steinich, *R. acutirostris* Steinich, and *Kingena* sp. Some of these specimens are illustrat-

ed in the present paper and then, it is indicated that they come from Kornica (*see* Pl. 3, Figs 2 and 12—13; Pl. 4, Fig. 4).

The investigated brachiopod assemblage from the Mielnik chalk appears very close to the Maastrichtian assemblages from Rugen (*cf.* Steinich 1965) and from the Danish chalk (*cf.* Surlyk 1972). On the contrary, it comprises only a few species in common with the Polish Maastrichtian brachiopod fauna from diverse non-chalk facies (*cf.* Popiel-Barczyk 1968). The other brachiopod faunas from the Upper Cretaceous deposits of Poland (*cf.* Popiel-Barczyk 1972, 1977*b*; Marcinowski 1974) are much different in their taxonomic composition, due both to the differences in geological age and facies development of the associated deposits.

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GEOLOGICAL SETTING AND PREVIOUS WORK

At the Mielnik chalk pit exposed are some 16 meters of the chalk deposits, divided into two parts by a hardground horizon (*see* Text-fig. 1). In the lower part of the section, the chalk is white and it contains a zone of black cherts at the bottom of the chalk pit. Above the hardground, the chalk becomes grey. The Upper Cretaceous chalk deposits (*1—3* in Text-fig. 1) are covered by deeply green, glauconitic sands with phosphatic nodules of Oligocene age (*4* in Text-fig. 1), and Pleistocene glacifluvial sands and gravels (*5* in Text-fig. 1).

Basing upon the foraminifers, Bieda (1958) attributed the chalk deposits to the Upper Campanian to Lower Maastrichtian, with the limit between them established at the hardground horizon. The origin of the hardground was related by Pożaryski (1960) to submarine chemical corrosion caused by a shallowing of the basin at the Campanian/Maastrichtian boundary.

Until now, there is no monographical description of macro- and microfauna from Mielnik and other chalk deposits exposed in Eastern Poland. Two unpublished reports (Łysogórski 1960, Data 1974) are the graduate papers dealing with geology, paleoecology, and paleontology of certain macrofaunal groups. Pugaczewska (1965) described epi- and endobionts of the belemnite guards. The *Dendrina*-type borings in the belemnite guards, and their ecological and taphonomical implications were studied by Radwański (1972).

MATERIALS AND METHODS

Most investigated fossil remains derived from washing of the chalk samples (mesh size 0.5 mm); some samples had previously been treated with glaubersalt.

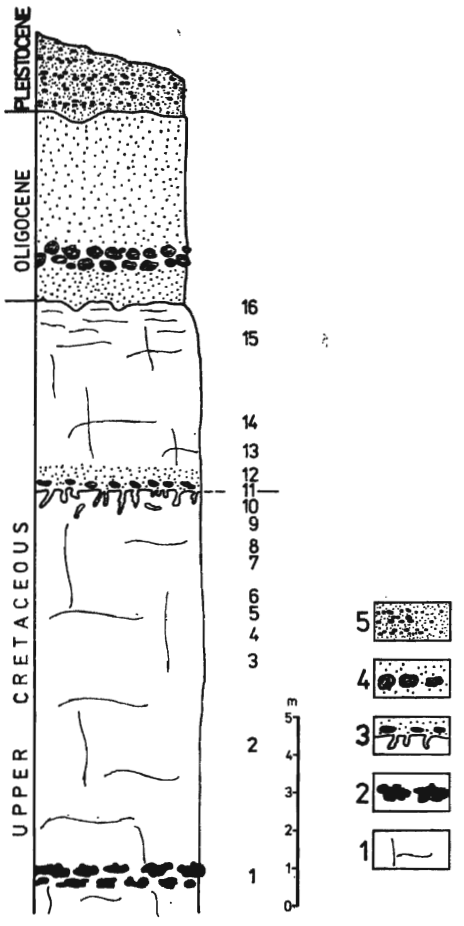


Fig. 1

Schematic profile of the chalk deposits exposed at Mielnik (*after* Data 1974; modified), and sampling sites (*1—16*) for the investigated brachiopods

1—3 Upper Cretaceous: *1* chalk, *2* cherts, *3* hardground horizon with phosphatic pieces

4 Oligocene glauconitic sands with phosphatic nodules; **5** Pleistocene gracifluvial sands and gravels

Totally, over 170 kg of the white chalk taken from various sections in the chalk pit were washed. The macrofaunal remains are very rare in the chalk; actually, attain at most 0.5% in weight. The brachiopod density is highly variable in the investigated samples, decreasing down to a single specimen per sample of a few kilograms in weight. The preservation state of the brachiopod shells is very good as a rule; only a few valves are broken, and the shell disarticulation resulted mostly from the washing procedure. Totally, over 700 brachiopod specimens have been recorded. This shows the low brachiopod frequency relative to the white chalk of Rugen (Steinich 1965, 1967, 1968*a*, *b*) and Denmark (Surlyk 1972).

The investigated brachiopod specimens are assigned to 23 species. Except of the new ones, all the species occur also in the Danish chalk where Surlyk (1972) recorded 43 brachiopod species. Steinich (1965, 1967, 1968*a*, *b*) reported 29 articulate brachiopod species from the Rugen chalk.

SYSTEMATIC DESCRIPTION

Family **Lingulidae** Menke, 1828
Genus *LINGULA* Bruguière, 1797
Lingula sp.
(Pl. 5, Figs 8—9)

Material: 67 damaged specimens (Coll. No. *B-1*).

Remarks. — The material is very poorly preserved. Because of the shell fragmentation, the investigated specimens can hardly be identified to the specific level. They differ from the most common Upper Cretaceous species *L. cretacea* Lundgren in their more rounded posterior margin.

Occurrence. — Samples *1, 3, 8, 10, 14—16* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Family **Craniidae** Menke, 1828
Genus *ISOCRANIA* Jaekel, 1902
Isocrania costata (Sowerby, 1823)
(Text-fig. 2)

1841. *Crania costata* Sowerby; F. A. Roemer, p. 37, No. 7.
1852. *Crania Egnabergensis* Retzius; T. Davidson *(partim)*, pp. 11—13, Pl. 1, Figs 10—11 (*non* Figs 8—9 and 12—14).
1894. *Crania costata* Sowerby; H. J. Posselt, pp. 15—17, Pl. 1, Figs 1—4.
1909. *Crania ignabergensis* Retzius; K. B. Nielsen *(partim)*, pp. 147—149.
1973. *Isocrania costata* (Sowerby); F. Surlyk, pp. 233—237, Pl. 1, Figs 1—11 and 16—19, Pls 3—5, and Pl. 6, Fig. 2.
1975. *Isocrania costata* (Sowerby); H. Nestler, p. 42, Text-fig. 52.

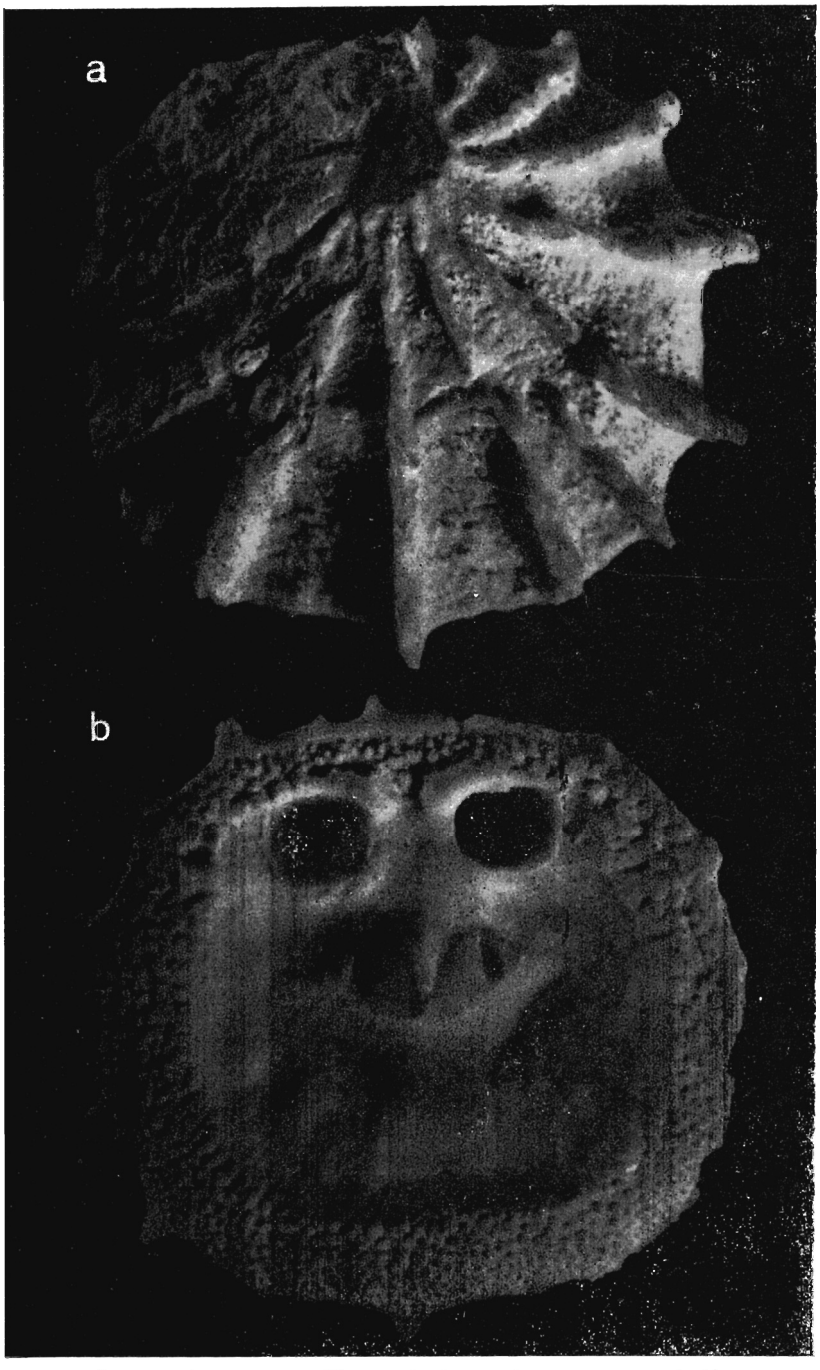
Material: 2 ventral valves (Coll. No. *B-2*).
Dimensions: Length 8.3 mm; width 9.2 mm (*cf.* Text-fig. 2).

Remarks. — The investigated specimens resemble closely in shell ornamentation and internal sculpture those illustrated by other authors (Posselt 1894, Surlyk 1973, Nestler 1975). The larger, illustrated specimen (Text-fig. 2) exceeds somewhat the range given by Surlyk (1972, 1973) and it appears relatively sparsely ribbed (15 primary and 2 intercalated ribs).

Occurrence. — Sample *6* (cf. Text-fig. 1) and a stratigraphically undetermined sample from the chalk pit.

Family **Wellerellidae** Likharev *in* Rzhonsnitskaya, 1956
Genus *ORBIRHYNCHIA* Pettitt, 1954
Orbirhynchia parkinsoni Owen, 1959
(Pl. 1, Fig. 2)

1854. *Rhynchonella sulcata* Parkinson, Sp.; T. Davidson *(partim)*, pp, 85—87, Pl. 10, Figs 18—20 (*non* Figs 21—36).
1959. *Orbirhynchia parkinsoni* sp. nov.; E. F. Owen, pp. 250—252, Text-fig. 1, Pl. 5, Fig. 2.
1969. *Orbirhynchia parkinsoni* Owen; G. Biernat & E. Popiel-Barczyk, pp. 567—569, Pl. 109, Figs 5—8.



Isocrania costata (Sowerby); ventral valve, × 10
a — outer view, *b* — inner view

1973. *Orbirhynchia parkinsoni* Owen; I. Dieni, F. A. Middlemiss & E. F. Owen, pp. 210—211, Pl. 38, Figs 10—11.
1974. *Orbirhynchia parkinsoni* Owen; R. Marcinkowski, Pl. 20, Fig. 7.
1977*b*. *Orbirhynchia parkinsoni* Owen; E. Popiel-Barczyk, pp. 32—35, Text-figs 5—8, Pl. 2, Figs 1—6.

Material: A single complete specimen (Coll. No. *B*-3).
Dimensions: Length 20.7 mm; width 24.4 mm; thickness 17.4 mm; brachial-valve length 18.3 mm; rib number 19.

Remarks. — The investigated specimen resembles in its dimensions and shape those illustrated by other authors (Owen 1959, Deni & *al.* 1973, Popiel-Barczyk 1977*b*). The shell is asymmetrical because of the position of the sulcus, which is indeed very common in this species. The shell is less densely ribbed than the hitherto described specimens. A single rib bifurcates very closely to the anterior commissure. The internal structures are inaccessible.

The species *O. parkinsoni* was reported exclusively from the Albian to Cenomanian.

Occurrence. — A stratigraphically undetermined sample from the chalk pit.

Orbirhynchia sp.
(Pl. 1, Fig. 3)

Material: A single complete, slightly damaged specimen (Coll. No. *B*-4).
Dimensions: Length 17.3 mm; width 22.4 mm; thickness 11.1 mm; rib number 26.

Remarks. — The investigated specimen agrees well with the generic diagnosis for *Orbirhynchia*. However, the internal structures are inaccessible and hence, any more precise identification is impossible. The shell is assymmetrical due to the position of the well marked sulcus.

Occurrence. — A stratigraphically undetermined sample from the chalk pit.

Family **Cryptoporidae** Muir-Wood, 1955
Genus *CRYPTOPORELLA* gen. n.

Derivatio nominis: After the affinity to the genus *Cryptopora* Jeffreys, 1869.
Diagnosis: Micromorphic rhynchonelloid with short crura and without median septum; triangular in outline; sharp beak with large foramen constricted by small, elongate deltidial plates.

Remarks. — Several specimens have been found at Mielnik attributable to the Rhynchonelloida because of the nature of their internal structures, and resembling with many respects the genus *Cryptopora* Jeffreys, 1869, reported insofar from the Eocene to Recent (Cooper 1959, 1973*a*, *b*; Popiel-Barczyk 1977*a*); their brachial valves lack, however, any median septum and the crura are shorter than in the latter genus. The investigated specimens appear sharply different from all the other rhynchonelloid families and hence, a new cryptoporid genus is here erected.

Cryptoporella antiqua sp. n.
(Pl. 1, Figs 4—9)

Holotypus: Pl. 1, Fig. 8.
Paratypi: Pl. 1, Figs 5—7.
Locus typicus: Mielnik, Eastern Poland.
Derivatio nominis: Latin *antiqua* — old; after being the oldest known representative of the family.

Diagnosis: Shell slightly biconvex; deltidial plates under the form of long and narrow ridges; teeth supported by dental plates, brachidium under the form of short crura; shell surface smooth.
Material: 9 complete specimens, 13 pedicle valves, 16 brachial valves, and several valve fragments (Coll. No. *B-5*).
Dimensions: Length 3.0 mm; width 2.8 mm; thickness 0.4 mm; brachial-valve length 2.5 mm.

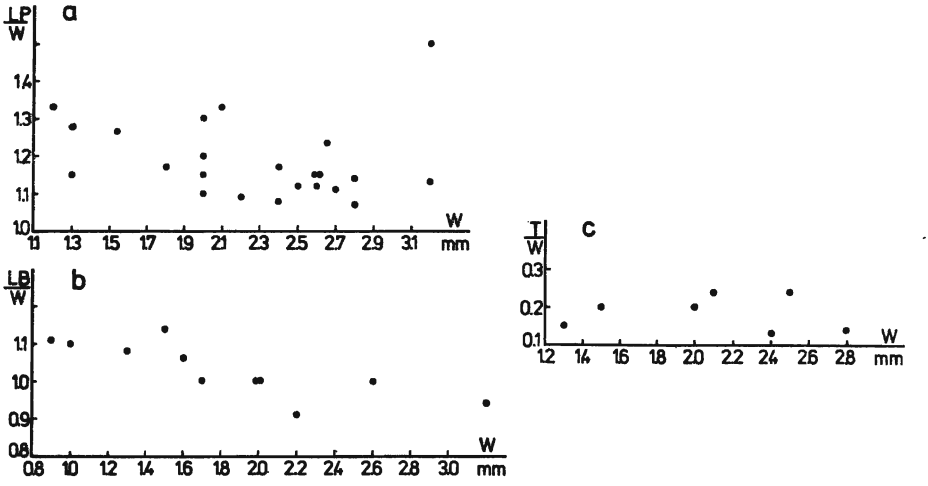


Fig. 3. Morphological ratios in *Cryptoporella antiqua* gen. et sp. n.
LP — length of pedicle valve, *LB* — length of brachial valve, *W* — width, *T* — thickness

Description. — The shell outline is subtriangular in ventral view and subtriangular to oval in dorsal view. The shell attains its maximum width in the anterior part. The hinge line is short and almost straight. The anterior commissure is rectimarginate. The shell elongation ranges from 1.07 up to 1.50 (Text-fig. 3*a*), while the brachial-valve elongation ranges from 0.91 to 1.14 (Text-fig. 3*b*). The shell is very slightly biconvex with the pedicle valve somewhat more convex than the brachial one. The shell thickness to width ratio ranges from 0.13 to 0.24 (Text-fig. 3*c*). The beak is sharp and fairly long. The foramen is large, triangular in outline, constricted posteriorily by a singular small-sized plate (apical plate?) as well as by the deltidial plates forming long and narrow ridges. The teeth are long and hooked, supported by the dental plates perpendicular to the shell surface. The dental sockets are relatively deep and the inner socket ridges are low. The cardinal processus is poorly developed. The crura are very short but at the same time wide. The shell surface is smooth; in the investigated specimens, it displays 1—2 growth lines. The shell is very thin and translucent.

Occurrence. — Samples *2*, *5*, *7* and *11—16*. (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Rhynchonelloid gen. et sp. indet.
(Pl. 1, Fig. 1)

Material: A single complete specimen (Coll. No. *B-6*).
Dimensions: Length 1.1 mm; width 0.8 mm; thickness 0.3 mm; brachial-valve length 0.8 mm; hinge-line length 0.6 mm.

Description. — The shell is elongate oval in outline, with its maximum width at the midlength. It is biconvex with the brachial valve less convex than the pedicle one. The hinge line is almost straight and the area is narrow triangular. The deltidial plates are disjunct and turned out inwards. The foramen is very large (it attains quarter the shell length) and triangular in outline. The shell surface is smooth with a single growth line close to the posterior margin.

Remarks. — The small size, large foramen relative to the shell length, and a single growth line indicate clearly that this is a juvenile specimen. The deltidial plates turned out inwards support its attribution to the Rhynchonelloida (*cf.* also Steinich 1963*c*, 1965).

Occurrence. — Sample *6* (cf. Text-fig. 1).

Family **Terebratulidae** Gray, 1840
Genus *CHATWINOTHYRIS* Sahni, 1925
Chatwinothyris subcardinalis Sahni, 1925
(Pl. 2, Figs 5—6)

1894. *Terebratula carnea* Sowerby; H. J. Posselt, p. 38, No. 29.
1909. *Terebratula carnea* Sowerby; K. B. Nielsen, pp. 163—164, Pl. 2, Figs 68—77.
1925. *Chatwinothyris subcardinalis* sp. n.; M. R. Sahni, p. 369, Pl. 26, Figs 4 and 4*a*.
1958. *Chatwinothyris subcardinalis* Sahni; M. R. Sahni, pp. 15—16, Pl. 5, Figs 1—4 and 4*x*.
1965. *Chatwinothyris subcardinalis* Sahni; G. Steinich, pp. 37—46, Text-figs 24—34; Pl. 5, Fig. 4, Pl. 6, Figs 1—4, Pl. 7, Figs 1—2, and Pl. 21, Figs 1—3.
1968. *Chatwinothyris subcardinalis* Sahni; E. Popiel-Barczyk, pp. 44—48, Text-figs 12—14, Pl. 8, Figs 1—7, and Pl. 9, Figs 1—7.
1975. *Chatwinothyris subcardinalis* Sahni; H. Nestler, p. 44, Text-fig. 55.

Material: A single complete, open and slightly damaged specimen (Coll. No. *B*-7).
Dimensions: Length ?29.7 mm; width 27.3 mm; brachial-valve length ?24.5 mm.

Remarks. — The investigated specimen appears identical in its external and internal morphologies to the conspecific specimens illustrated by Sahni (1925, 1958), Steinich (1965), and Popiel-Barczyk (1968). In its shell elongation, it resembles most closely those specimens studied by Popiel-Barczyk (1968).

Occurrence. — A stratigraphically undetermined sample from the chalk pit.

Family **Cancellothyrididae** Thomson, 1962
Genus *TEREBRATULINA* d'Orbigny, 1847
Terebratulina chrysalis (Schlotheim, 1813)
(Pl. 3, Figs 12—15)

1841. *T. striatula* Mantell.; F. A. Roemer, pp. 39—40, No. 20.
1841. *T. chrysalis* v. Schl.; F. A. Roemer, p. 40, No. 22.
1852. *Terebratulina striata* Wahlenberg, Sp.; T. Davidson *(partim)*, pp. 35—38, Pl. 2, Figs 18—20, 25, and 27—28 *(non* Figs 22—24 and 26).
1894. *Terebratulina striata* Wahlenberg; H. J. Posselt *(partim)*, pp. 32—33, No. 19.
1909. *Terebratulina striata* Wahlenberg; K. B. Nielsen, pp. 159—160, Pl. 1, Figs 28—32.
1965. *Terebratulina chrysalis* (Schlottheim); G. Steinich, pp. 53—66, Text-figs 53 and 56—57, Pl. 8, Fig. 1, and Pl. 9, Figs 1—5, 9—10.
1968. *Terebratulina chrysalis* (Schlottheim); E. Popiel-Barczyk, pp. 63—65, Text-fig. 25. Pl. 17, Figs 1—3.
1972. *Terebratulina chrysalis* (Schlottheim); E. Popiel-Barczyk, p. 136, Text-fig. 8, Pl. 1, Figs 7—8.
1972. *Terebratulina chrysalis* (Schlottheim); F. Surlyk, Pl. 4, Figs *b*—*c*, *h*.
1974. *Terebratulina chrysalis* (Schlotheim); R. Marcinowski, Pl. 19, Figs 4—5.

1974. *Terebratulina chrysalis* (Schlotheim); J. I. Katz, p. 256, Pl. 84, Fig. 8.
1977. *Bisulcina chrysalis* (Schlotheim); M. V. Titova, pp. 81—82, Text-fig. 6, Pl. 10, Fig. 1.
1977. *Bisulcina campaniensis* (Orbigny); M. V. Titova, pp. 82—83, Text-fig. 7, Pl. 10, Fig. 2.
1977. *Bisulcina tunicata* (Vančurov); M. V. Titova, pp. 83—84, Text-fig. 8, Pl. 10, Fig. 3.

Material: 2 complete specimens, 7 pedicle valves, 16 brachial valves, and several valve fragments (Coll. No. *B-8*).
Dimensions: Length 8.7 mm; width 6.0 mm; thickness 2.5 mm; rib number 15—40.

Remarks. — In general, the investigated specimens are smaller-sized than those described by Steinich (1965), Popiel-Barczyk (1968, 1972), and Surlyk (1972). Their shape resembles most closely those specimens illustrated by Popiel-Barczyk (1968), while the specimens investigated by Steinich (1965) appear less elongate. The adult specimens from Mielnik show less numerous and more sparsely distributed ribs than do the specimens recorded by other authors (Steinich 1965; Popiel-Barczyk 1968, 1972; Surlyk 1972); they show, however, 1—2 intercalated ribs between every two primary ones. It is noteworthy that the juvenile shell ornamentation of *T. chrysalis* from Mielnik does not differ from the ornamentation of the juveniles from the Rugen chalk (*cf.* Steinich 1965). In some investigated specimens, there are 1—4 distinct growth lines.

The internal structures are well preserved in the investigated material. The entirely developed brachidium has been recorded in three specimens (*cf.* Pl. 3, Figs 14—15); the loop forms a ring with a distinct elevation in its anterior part. The brachidium resembles very closely those illustrated by Steinich (1965) and Popiel-Barczyk (1968, 1972).

Recently, Titova (1977) reported the considered species from the Upper Cretaceous of Turkmenia, Soviet Union. She attributed it to the new genus *Bisulcina* including also two other related species, namely *T. campaniensis* d'Orbigny and *T. tunicata* Vančurov. Accordingly to the diagnosis, description, comparison, and illustrations given by Titova (1977), the genus *Bisulcina* differs from *Terebratulina* mainly in that the former shows two weakly developed sulci present exclusively in the adults; the difference consists also in shell convexity and some vague characteristics of the ribs. The present authors are, however, of the opinion that all these features are merely of a minor importance when compared to the apparent identity of the internal structures to those typical of the genus *Terebratulina*. Hence, the authors do not see any reason to erect the genus *Bisulcina*.

As described and illustrated by Titova (1977), the species *B. chrysalis*, *B. campaniensis*, and *B. tunicata* appear identical in rib characteristics, while slightly different in shell elongation and rib number. The present study shows that the latter features are highly variable; furthermore, the rib number and sulcus development do also strongly depend upon the individual age. All the three congeneric species reported by Titova (1977) resemble closely the specimens of *T. chrysalis* illustrated by Steinich (1965) or Surlyk (1972); actually, the specimen attributed by Titova (1977) to *B. chrysalis* appears the most different from all the others. The investigated material from Mielnik demonstrates clearly that all the considered specimens fall within the range of intraspecific variability and hence, they are here included in the synonymy of *T. chrysalis*.

Occurrence. — *Samples 1, 4, 8, 10, 12—13, 15* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Terebratulina faujasi (Roemer, 1841)
(Pl. 2, Figs 1—3)

1841. *Terebratula Faujasii* N.; F. A. Roemer, p. 40, No. 24, Pl. 7, Fig. 8.
1894. *Terebratulina striata* Wahlenberg; H. J. Posselt *(partim)*, pp. 32—33, No. 19.
1963*a*. *Terebratulina faujasii* (Roemer); G. Steinich, p. 607, Text-fig. 7.

1965. *Terebratulina faujasii* (Roemer); G. Steinich, pp. 72—81, Text-figs 76—94, Pl. 9, Figs 6—8 and Pl. 10, Figs 1—5.
1968. *Terebratulina faujasi* (Roemer); E. Popiel-Barczyk, pp. 66—67, Text-fig. 26, Pl. 17, Figs 4—5.
1972. *Terebratulina faujasii* (Roemer); R. Surlyk, Text-fig. 7, Pl. 2, Figs *c—g*.

Material: 41 complete specimens, 48 pedicle valves, and 102 brachial valves (Coll. No. *B-9*).
Dimensions: Length 5.4 mm; width 4.5 mm; thickness 2.5 mm; brachial-valve length 4.2 mm; rib number 8—14.

Remarks. — With respect to such external features as the shell ornamentation, rib granulation, and appearance of the foramen region (foramen, area, and deltidial plates), and such internal features as the brachidium structure and hinge elements, the investigated specimens resemble very closely those illustrated by other authors, and especially by Steinich (1965). They are oval to subsquare with their maximum width at the midlength. The shell elongation ranges from 1.08 to 1.46, and the brachial-valve elongation ranges from 0.88 to 1.21; the ears appear distinct. The thickness to width ratio ranges from 0.31 to 0.77, with the brachial valve being less convex than the pedicle one as a rule.

The ribs are usually singular, which is typical of the species and makes possible its distinction from the juveniles of *T. chrysalis* (Schlotheim). However, in both the valves of two investigated complete specimens, a single short intercalated rib appears very closely to the anterior commissure. Sporadically, 1—2 growth lines occur at the shell surface.

The poorly developed cardinal processus occurs exclusively in the larger-sized specimens. The brachidium has been investigated merely in two juveniles where it has still not formed any ring typical of the genus *Terebratulina*. The spicular skeleton of plectolophous lophophore appears clearly in a single damaged specimen; it resembles closely those shown by Steinich (1963*a*, Text-fig. 7) and Surlyk (1972, Pl. 2, Figs *d—f*).

The investigated specimens from Mielnik are larger-sized than those studied by Steinich (1965), Popiel-Barczyk (1968), and Surlyk (1972); nevertheless, their elongation falls entirely within the range of intraspecific variability as given by Steinich (1965). Steinich (1965) recorded somewhat less numerous ribs (7—12) in his collection of *T. faujasi*; in fact, the investigated specimens from Mielnik show the rib number intermediate between *T. faujasi* and *Gisilina jasmundi* Steinich. As noted by Steinich (1965), the two species are so close in their external morphologies that they are hardly distinguishable without recognition of the adult brachidium type. The present authors are, however, of the opinion that the investigated specimens fit the characteristics of *T. faujasi* in both the rib number (8—14) and shell convexity.

Occurrence. — Samples *1—2, 5, 8—12, 15—16* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Terebratulina longicollis Steinich, 1965
(Pl. 3, Figs 9—11)

1909. *Terebratulina locellus* Roemer; K. B. Nielsen, pp. 160—161, Pl. 1, Fig. 34.
1965. *Terebratulina longicollis* sp. n.; G. Steinich, pp. 66—72, Text-figs 62—75, Pl. 8, Fig. 2.
1972. *Terebratulina longicollis* Steinich; F. Surlyk, Pl. 2, Figs *a—b*.

Material: 3 complete specimens, 18 pedicle valves, and 6 brachial valves (Coll. No. *B-10*).
Dimensions: Maximum length 5.3 mm; average length 3.5 mm; maximum width 3.5 mm; average width 2.2 mm; thickness 1.5 mm; rib number 8—13.

Remarks. — A large intraspecific variability in shell elongation and convexity and an allometry in shell shape have been recorded in the investigated

specimens. The juveniles are usually more elongate and convex than the adults; they show also less numerous ribs. The adult brachial valves become commonly oval. In the investigated collection from Mielnik, the shell elongation ranges from 1.30 up to 2.0, the brachial-valve elongation ranges from 1.22 to 1.67, and the thickness to width ratio ranges from 0.56 to 0.68. The ears are always well developed. The range of the rib number appears larger than that given by Steinich (1965) for the type material.

The brachidium is well preserved merely in two specimens. Its loop forms a ring resembling very closely that illustrated by Steinich (1965).

Occurrence. — Samples *1, 6—7, 12—13, 15* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Terebratulina sp. *A*
(Pl. 1, Figs 10—11)

Material: **2 complete, slightly damaged specimens and 3 pedicle valves (Coll. No. *B-11*).**
Dimensions: **Maximum length 3.6 mm; average length 2.7 mm; maximum width 2.5 mm; average width 2.0 mm; thickness 1.0 mm.**

Description. — The shell is elongate to elongate oval, with its maximum width in the anterior part; the shell elongation ranges from 1.33 to 1.44. The thickness to width ratio is 0.50 and 0.33 in the specimens 2.0 and 0.9 mm wide, respectively. The brachial valve is much less convex than the pedicle one. The shell surface is covered with numerous tiny, delicately granulate ribs. There are also growth lines in two specimens. The area is small. The oval foramen is large, with a narrow pedicle collar. The small-sized teeth are very short. No brachidium has been preserved in the investigated specimens.

Remarks. — The investigated specimens resemble *T. chrysalis* but they are much smaller in size, more elongate in shape, more delicately and densely ribbed, and their pedicle collar is much less distinct. With respect to the ornamentation, they may remind the Recent species *T. retusa* (Linné) as illustrated by Surlyk (1972, Pl. 4, Figs *a* and *d—e*) and Pajaud (1977, Pl. 2, Fig. *b*).

Occurrence. — Samples *1, 11—12* (cf. Text-fig. 1) and a stratigraphically undetermined sample from the chalk pit.

Terebratulina sp. *B*
(Pl. 2, Fig. 4)

Material: **A single complete specimen (Coll. No. *B-12*).**
Dimensions: **Length 4.1 mm; width 3.7 mm; thickness 1.5 mm; brachial-valve length 3.2 mm; hinge-line length 2.0 mm; rib number 28.**

Description. — The shell is rounded in outline, with blunt ears, short and almost straight hinge line, and the maximum width attained at the midlength. An indistinct biconvexity of the shell decreases posteriorily where a shallow sulcus appears. The shell surface is covered with thick and chipped, radial ribs; 1—2 intercalated ribs occur at the midlength and in the anterior part of the shell. There is also a single growth line at the shell surface. The area is narrow. The oval foramen is large, with a wide and distinct pedicle collar; the deltidial plates are, in turn, under the form of small ridges.

Remarks. — The investigated specimen appears quite distinctive among the whole brachiopod collection from Mielnik in its shell shape and ornamentation. Its beak, foramen, and deltidial plates point to its relation to the genus *Tere-*

bratulina; however, any final identification is impossible because of the unknown nature of its brachidium. Actually, the specimen resembles the species *T. rudis* Koenen, 1894, as illustrated by Zelinskaya (1975, Pl. 12, Figs 4—7), but the poor illustration quality and vague description given by the latter author do not permit any precise comparison.

Occurrence. — Sample 7 (cf. Text-fig. 1).

Genus *RUGIA* Steinich, 1963

Rugia tenuicostata Steinich, 1963 (Pl. 4, Figs 3—6 and Pl. 5, Fig. 3)

1963*b*. *Rugia tenuicostata* sp. n.; G. Steinich, pp. 737—739, Text-figs 6—8.
1965. *Rugia tenuicostata* Steinich; G. Steinich, pp. 116—121, Text-figs 162—174, Pl. 11, Figs 3—4.

Material: 14 complete specimens, 48 pedicle valves, 76 brachial valves, and several valve fragments (Coll. No. *B-13*).
Dimensions: Length 3.0 mm; width 2.0 mm; thickness 1.0 mm; brachial-valve length 2.3 mm; rib number 12—25.

Remarks. — The investigated specimens resemble very closely in their external morphology those described by Steinich (1963*b*, 1965). Actually, the only two differences consist in their less variable rib number and more elongate shell shape. The shell elongation ranges from 1.20 to 1.80 in the collection from Mielnik, and the brachial-valve elongation ranges from 1.00 to 1.46; the thickness to width ratio ranges from 0.31 to 0.71. Indistinct growth lines appear in a few specimens. In a single damaged specimen, a brachidium can be observed. It is also damaged but nevertheless, resembles closely those presented by Steinich (1963*b*, 1965).

Occurrence. — Samples *1—2, 6—7, 11—15* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Rugia acutirostris Steinich, 1965 (Pl. 3, Figs 1—3)

1965. *Rugia acutirostris* sp. n.; G. Steinich, pp. 122—124, Text-figs 175—178, Pl. 14, Fig. 1.

Material: 6 complete specimens, 7 pedicle valves, and 26 brachial valves (Coll. No. *B-14*).
Dimensions: Maximum length 2.0 mm; average length 1.9 mm; maximum width 1.4 mm; average width 1.3 mm; thickness 0.8 mm; brachial-valve length 1.5 mm; rib number 27—40.

Supplementary description. — The investigated specimens differ somewhat in their external morphology from those studied by Steinich (1965) and hence, some supplementary data are to be added.

The shell is elongate oval to subtriangular in outline, with its maximum width attained close to the anterior margin. The shell elongation ranges from 1.30 to 1.50, whereas the brachial-valve elongation ranges from 1.00 to 1.25, respectively. There are always poorly developed, wide and blunt ears. The shell is biconvex with the brachial valve being less convex than the pedicle one; the shell thickness to width ratio ranges from 0.38 to 0.62. The shell surface is densely covered with finely granulate and flabellate ribs, several intercalated ribs including. The beak is sharply pointed.

In a single specimen (*cf.* Pl. 3, Fig. 2), its partly preserved brachidium can be observed, typical of the genus *Rugia*.

Remarks. — The investigated specimens agree well with the diagnosis given by Steinich (1965), differing from the type material merely in their shell outline, larger rib number, and more sharply ended beak.

Occurrence. — Samples *2, 11—18* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Rugia spinosa Surlyk, 1970
(Pl. 3, Figs 4—8)

1970a. *Rugia spinosa* sp. n.; F. Surlyk, pp. 157—159, Text-fig. 3*d—f*, Pl. 2, Fig. *a—d*.

Material: **2 complete specimens, 23 pedicle valves, 42 brachial valves, and several valve fragments (Coll. No. *B-15*).**
Dimensions: **Maximum length 1.8 mm; average length 1.5 mm; maximum width 1.5 mm; average width 1.3 mm; thickness 0.7 mm; rib number 10—17.**
Emended diagnosis: ***Rugia*** **with long and sharp spines deriving from the ribs.**

Supplementary description. — The shell is oval with the maximum width attained at the midlength. The shell elongation ranges from 1.07 to 1.36, whereas the brachial-valve elongation ranges from 0.90 to 1.21. The biconvex shell attains the thickness to width ratio of 0.54 in a specimen of 1.3 mm in width. The shell surface is covered with regularly spaced, distinct ribs, intercalated ribs including. The ribs give origin to long and sharp spines typical of the species. The area is fairly narrow and the foramen is very small. The inner socket ridges occur very closely to each other. There is usually a low ridge at the inner surface of every valve, separated by a furrow from the anterior margin of a brachial one.

Remarks. — Contrary to the original diagnosis given by Surlyk (1970*a*), the investigated specimens from Mielnik show very regular rib patterns; they are also larger-sized than the type material. Nevertheless, all the other characteristics point clearly to their identity with the species *R. spinosa* Surlyk. The diagnosis is therefore emended in the present paper and followed by the supplementary descriptive data.

Occurrence. — Samples *1—3, 5—7, 9* (cf. Text-fig 1) and stratigraphically undetermined sample from the chalk pit.

Family **Megathyrididae** Dall, 1870
Genus *ARGYROTHECA* Dall, 1900
Argyrotheca bronni (Roemer, 1841)
(Pl. 4, Figs 1—2)

1841. *T. Bronnii* v. Hag.; F. A. Roemer, p. 41, No. 31.
1854. *Argiope Bronnii* De Hagenow; T. Davidson, p. 102, Pl. 12, Figs 37, 37*a*.
1854. *Argiope Buchi* De Hagenow; T. Davidson, Pl. 12, Figs 38, 38*a*.
1894. *Argiope Bronnii* v. Hagenow; H. J. Posselt, p. 49, No. 38.
1909. *Argiope Bronnii* v. Hagenow; K. B. Nielsen, p. 171, Pl. 1, Figs 36—38.
1965. *Argyrotheca bronnii* (Roemer); G. Steinich, pp. 124—134, Text-figs 179—196, Pl. 17, Figs 1—2.
1968. *Argyrotheca bronnii* (Roemer); E. Popiel-Barczyk, pp. 67—69, Pl. 18, Figs 1—6.
1972. *Argyrotheca bronnii* (Roemer); F. Surlyk, Pl. 4, Fig. *g*.
1975. *Argyrotheca bronni* (Roemer); H. Nestler, pp. 44—45, Text-fig. 57.

Material: 5 complete specimens, 4 pedicle valves, and 11 brachial valves (Coll. No. *B-16*).
Dimensions: Length 5.3 mm; width 6.1 mm; thickness 1.8 mm; rib number 6—9.

Remarks. — The investigated specimens show less numerous and distinct ribs than those studied by Popiel-Barczyk (1968). In their shell elongation as well as in the rib number and appearance, they resemble, however, very closely the collection attributed by Steinich (1965) to the species *A. bronni*. In fact, the shell elongation ranges from 0.65 to 0.87 in the specimens from Mielnik, while the

brachial-valve elongation ranges from 0.57 to 0.83. The hinge line is straight and attains 3.3 mm in length in a specimen of 3.4 mm in width. The shell thickness to width ratio ranges from 0.30 to 0.53. The internal structures are poorly preserved in the investigated specimens but they seem to be consistent with the illustrations given by Steinich (1965) and Popiel-Barczyk (1968).

Occurrence. — Samples *15—16* (cf. Text-fig. 1) and a stratigraphically undetermined sample from the chalk pit.

Argyrotheca coniuncta Steinich, 1965
(Pl. 5, Figs 5—7)

1965. *Argyrotheca coniuncta* sp. n.; G. Steinich, pp. 138—144, Text-figs 200—216, Pl. 18, Fig. 2.

Material: 2 complete specimens, a single slightly damaged including, a single pedicle valve, and 6 brachial valves (Coll. No. *B-18*).
Dimensions: Maximum length 3.2 mm; average length 1.6 mm; maximum width ?7.0 mm; average width 3.3 mm; maximum thickness 2.5 mm; average thickness 1.1 mm; rib number 6—10.

Remarks. — The investigated specimens are more elongate in shell outline and less densely and distinctly (particularly at the brachial valves) ribbed than those described originally by Steinich (1965). The shells are close to plano-convex with the brachial valves being almost flat, which contrasts to the biconvex type material (*cf.* Steinich 1965, Pl. 18, Fig. 2*c*). The internal structures resemble very closely those illustrated by Steinich (1965, Text-fig. 214). In fact, the inner socket ridges are high; the brachidium forms a loop with its descending branches joining the inner shell surface and disappearing to re-appear close to the contact with the median septum; the latter structure is short but very high.

Occurrence. — Samples *1, 15—16* (cf. Text-fig. 1) and a stratigraphically undetermined sample from the chalk pit.

Argyrotheca hirundo (Hagenow, 1842)
(Pl. 4, Fig. 7)

1965. *Argyrotheca hirundo* (Hagenow); G. Steinich, pp. 152—159, Text-figs 232—249, Pl. 16, Fig. 3, and Pl. 17, Fig. 3.

Material: A single complete specimen (Coll. No. *B-17*).
Dimensions: Length 2.0 mm; width 2.1 mm; thickness 1.0 mm; brachial-valve length 1.5 mm; hinge-line length 1.7 mm; rib number 6.

Remarks. — The investigated specimen is triangular in outline but relatively lower-beaked and shorter than those studied by Steinich (1965). The pedicle valve is less convex than in the specimen illustrated by Steinich (1965, Pl. 17, Fig. 3*c*). The two lateralmost ribs are indistinct.

Occurrence. — Sample *15* (cf. Text-fig. 1).

Family **Platidiidae** Thomson, 1927
Genus *AEMULA* Steinich, 1968
Aemula inusitata Steinich, 1968
(Pl. 5, Fig. 4)

1968*a*. *Aemula inusitata* sp. n.; G. Steinich, pp. 193—199, Text-figs 1—5, Pl. 1, Fig. 1.
1972. *Aemula inusitata* Steinich; F. Surlyk, Pl. 3, Figs *e—f* and *h*.
1974. *Aemula inusitata* Steinich; F. Surlyk, Text-fig. 3, Pl. 2, Figs *A* and *C—F*.

Material: A single complete specimen, a single pedicle valve, and 2 brachial valves (Coll. No. *B-19*).
Dimensions: Length 1.7 mm; width 1.8 mm thickness 0.3 mm.

Remarks. — The investigated specimens are relatively small-sized but they fall within the range of variability given by Steinich (1968*a*). The internal structures are poorly preserved; one is, however, able to recognize the high inner socket ridges and the median septum at a brachial valve, typical of the species.

Occurrence. — Samples *9, 13, 15* (cf. Text-fig. 1) and a stratigraphically undetermined sample from the chalk pit.

Family **Dallinidae** Beecher, 1893
Genus *DALLIGAS* Steinich, 1968
Dalligas mielnicensis sp. n.
(Pl. 6, Figs 1—4)

Holotypus: Pl. 6, Fig. 3.
Paratypi: Pl. 6, Figs 1—2.
Locus typicus: Mielnik, Eastern Poland.
Derivatio nominis: After Mielnik, the type locality
Diagnosis: Shell wider than long; shell surface punctated; internal structures simple; median septum high triangular; inner socket ridges and hinge plates well developed.
Material: 3 complete, slightly damaged specimens, 5 pedicle valves, 9 brachial valves, and several valve fragments (Coll. No. *B-20*).
Dimensions: Maximum length 4.8 mm; average length 3.2 mm; maximum width 4.7 mm; average width ?3.4 mm; thickness 0.6 mm; maximum brachial-valve length 4.0 mm; maximum brachial-valve width 4.9 mm.

Description. — The shell is wider than long (except of a single specimen), rounded, with its maximum width attained at the midlength or in the posterior part. It ranges from 0.87 to 1.02 in elongation (Text-fig. 4*a*), and from 0.71 to 0.89 in brachial-valve elongation (Text-fig. 4*b*). The shell is plano-convex to slightly biconvex, with the brachial valve being flat. The thickness to width ratio attains 0.17 and 0.18 in the specimens of 2.3 mm and 3.4 mm in width, respectively. The hinge line is straight and the anterior commissure is rectimarginate. The shell

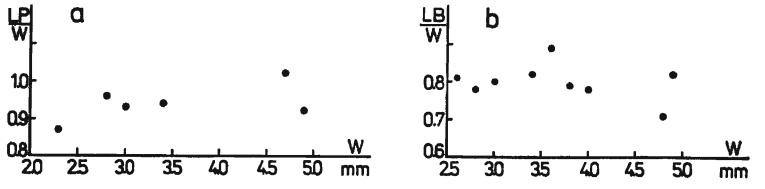


Fig. 4. Morphological ratios in *Dalligas mielnicensis* sp. n.
LP — length of pedicle valve, *LB* — length of brachial valve, *W* — width

surface is smooth; it displays merely punctae and several growth lines. The area is relatively narrow. The narrow and well separated deltidial plates border upon a large, triangular foramen with very wide pedicle collar. The dental sockets are small-sized but nevertheless deep. There are well developed (especially in the adults) inner socket ridges and hinge plates. The high triangular median septum reaches the midwidth or even further on.

Remarks. — The investigated specimens differ in their shell growth and ornamentation from their congeners recorded by Steinich (1968*b*) in the Rugen

chalk, eventhough they resemble very closely the species *D. nobilis* Steinich in their internal morphology. The shell elongation grows more or less isometrically in the investigated specimens, whereas it decreases with size in those illustrated by Steinich (1968*b*).

Occurrence. — Sample *15* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Family **Kingenidae** Elliott, 1948, nom. transl. Owen, 1970
Genus *KINGENA* Davidson, 1852
Kingena sp.
(Pl. 5, Figs 1—2)

Material: A single complete specimen, 2 pedicle valves, 4 brachial valves, and a lot of valve fragments (Coll. No. *B-21*).
Dimensions: Length 1.8 mm; width 1.7 mm; thickness 0.4 mm; maximum brachial-valve width 13.0 mm.

Remarks. — The investigated specimens are oval to pentagonal in shell outline, plano-convex to slightly biconvex. The shell surface is covered with tiny nodes variable in height. In a single specimen, poorly preserved internal structures appear consisting in a loop fragment and a long and thin median septum. The investigated specimens are therefore attributed to the genus *Kingena*. Their poor preservation state does, however, not permit their identification to the specific level. Actually, one may only claim that they are related (*cf.* Owen 1970) to either *K. pentangulata* (Woodward), or *K. blackmorei* Owen; these two species differ in some details of adult morphology (shell convexity, foramen size, deltidial-plate distinctness) unrecognizeable in the collection from Mielnik.

Occurrence. — Samples *8, 12—16* (cf. Text-fig. 1) and stratigraphically undetermined samples from the chalk pit.

Family **Terebratellidae** King, 1850
Genus *MAGAS* Sowerby, 1816
Magas chitoniformis (Schlotheim, 1813)
(Pl. 7, Figs 5—6)

1841. *Terebratula pumila* Sowerby; F. A. Roemer, p. 45, No. 53.
1852. *Magas pumilus* Sowerby; T. Davidson, pp. 19—24, Pl. 2, Figs 1—4 and 12.
1894. *Magas pumilus* Sowerby; H. J. Posselt, p. 48, No. 37, Pl. 1, Figs 10—11.
1909. *Magas pumilus* Sowerby; K. B. Nielsen, p. 170, Pl. 2, Fig. 106.
1965. *Magas chitoniformis* (Schlottheim); G. Steinich, pp. 183—193, Text-figs 280—294, Pl. 19, Fig. 2, and Pl. 20, Fig. 1.
1968. *Magas chitiniformis* (Schlottheim); E. Popiel-Barczyk, pp. 70—71, Text-figs 27—28, Pl. 20, Figs 1—5.
1972. *Magas chitoniformis* (Schlottheim); F. Surlyk, Text-fig. 11b.
1975. *Magas chitiniformis* (Schlottheim); H. Nestler, p. 44, Text-fig. 56.

Material: 3 pedicle valves and 4 brachial vales, all the specimens slightly damaged (Coll. No. *B-22*).
Dimensions: Pedicle-valve length 7.0 mm; pedicle-valve width 6.0 mm; brachial-valve length 7.2 mm; brachial-valve width 8.6 mm.

Remarks. — The investigated specimens resemble very closely in their external and internal morphologies those illustrated by Steinich (1965) and Popiel-Barczyk (1968). The only difference is in their elongation exceeding slightly the upper limit to the range of intraspecific variability as given by Steinich (1965). In a single specimen, a well preserved brachidium occurs (Pl. 7, Fig. 6*b*—*c*). It attains two

third of the brachial-valve length and forms a loop attached to the median septum at its maximum width. Two bended lamellae originate at the septum above the loop attachment.

Occurrence. — Samples *8, 11—12, 15* (cf. Text-fig. 1) and a stratigraphically undetermined sample from the chalk pit.

Family Uncertain
Genus *LEPTOTHYRELLOPSIS* gen. n.

Derivatio nominis: After the affinity to the Recent genus *Leptothyrella* Muir-Wood, 1965.
Diagnosis: Shell small-sized, elongate oval; foramen large; no pedicle collar; high, plate-like median septum at brachial valve; no loop.

Remarks. — This is a monotypic genus erected for specimens found at Mielnik and resembling very closely the genus *Leptothyrella* Muir-Wood, 1965, except that they lack any loop; the latter genus has insofar been recorded exclusively in the Recent. The specimens from Mielnik may also remind the genus *Pumilus* Atkins but they lack any pedicle collar and show a different median septum. Therefore, they are here considered as representatives of a new genus related closely to *Leptothyrella.*

Leptothyrellopsis polonicus sp. n.
(Pl. 7, Figs 1—4)

Holotypus: Pl. 7, Fig. 2.
Paratypi: Pl. 7, Figs 1 and 3—4.
Locus typicus: Mielnik, Eastern Poland.
Derivatio nominis: Lat. *polonicus* — Polish.
Diagnosis: As for the genus.
Material: 4 complete specimens, 7 pedicle valves, 15 brachial valves, and several valve fragments (Coll. No. *B-23*).
Dimensions: Length 3.2 mm; width 2.4 mm; thickness 0.9 mm; brachial-valve length 2.6 mm.

Description. — The shell is oval to elongate oval, with its maximum width at the midlength or displaced a little anteriorily; it ranges from 1.15 to 1.42 in elongation (Text-fig. 5*a*), and from 1.00 to 1.31 in brachial-valve elongation (Text-

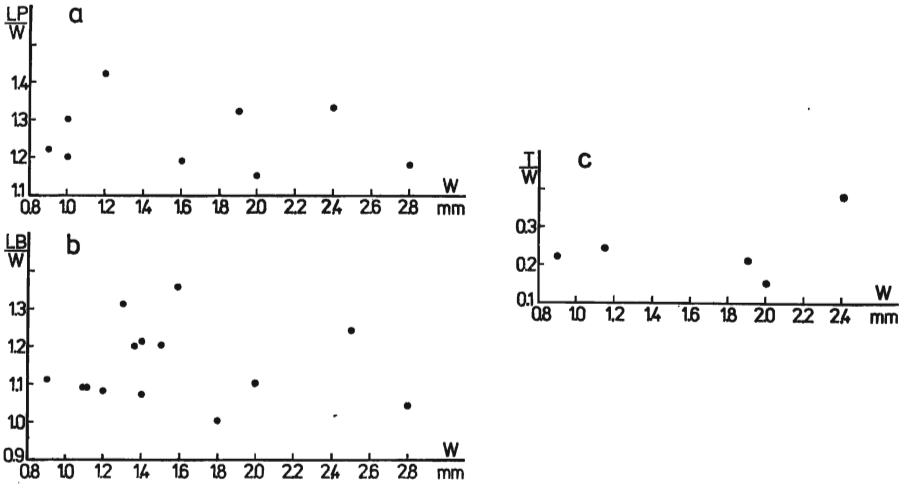


Fig. 5. Morhpological ratios in *Leptothyrellopsis polonicus* sp. n.
LP — length of pedicle valve, *LB* — length of brachial valve, *W* — width, *T* — thickness

-fig. 5*b*). The shell is slightly biconvex with its thickness to width ratio ranging from 0.15 to 0.38 (Text-fig. 5*c*). The anterior commissure is rectimarginate. The shell surface is smooth, except that it shows punctae and growth lines. The area is small. The large subtriangular foramen is bordered by two narrow deltidial plates; there is no pedicle collar. Only a prominent, plate-like median septum occurs at the brachial-valve inner surface. The dental sockets are deep, while the teeth themselves are sharp. There are also high inner socket ridges.

Occurrence. — Sample *1* (cf. Text-fig. 1) and a stratigraphically undetermined sample from the chalk pit.

ECOLOGICAL REMARKS

FOSSIL ASSEMBLAGE

In a decreasing order of abundance, the macrofauna is represented in the chalk deposits at Mielnik by belemnites, brachiopods, bryozoans, bivalves (mainly oysters and scallops), cirripedes, echinoids (mostly spines), serpulids, and fish remains; less abundant are corals (mainly octocorals), asteroids, and sponges. No gastropod body fossils have been found but their borings occur sporadically in brachiopod and mollusk shells. The benthic assemblage shows thus a high trophic uniformity, with most its components being filter feeders differing only in size and kind of the utilized food particles and level of food collecting. One may suppose that the food resources for filter feeders were highly diverse and/or superabundant.

There are no aragonite-shelled organisms in the fossil assemblage of Mielnik chalk, which might suggest that selective-solution processes could considerably change the original taxonomic composition. The very rarity of predatory-gastropod borings suggests, however, that the gastropods occurred indeed sporadically in the original benthic community. In fact, the original sparsity of aragonitic shells in the white chalk has also been demonstrated by some other authors (*cf.* Voigt 1929, Hancock 1963).

As indicated by the excellent preservation state of even very fragile skeletons of brachiopod brachidia and bryozoans as well as by the apparent homogeneity of the white chalk with no evidence for the presence of stronger currents, the fossils underwent probably an *in situ* burial.

BRACHIOPOD ECOLOGY

When treated in terms of brachiopod morphological adaptations to various bottom types and sedimentation rates (*cf.* Surlyk 1972), the investigated brachiopod assemblage of Mielnik appears quite different from that reported by Surlyk (1972) from the Danish chalk. Most of the species represent minute pedunculate forms able to attach to very small substrates; these are: *Cryptoporella antiqua* gen. et sp. n., *Terebratulina faujasi* (Roemer), *T. longicollis* Steinich, *Rugia tenuicostata* Steinich, *R.*

acutirostris Steinich, *R. spinosa* Surlyk, *Argyrotheca bronni* (Roemer), *A. coniuncta* Steinich, *A. hirundo* (Hagenow), *Dalligas mielnicensis* sp. n., *Aemula inusitata* Steinich, and *Leptothyrellopsis polonicus* gen. et sp. n. The most common species in the Mielnik chalk are very small-sized *Rugia tenuicostata* and a little larger-sized *Terebratulina faujasi*. Very abundant is also small-sized *Cryptoporella antiqua*, while very small--sized *Rugia spinosa* and *R. acutirostris* are moderately frequent.

It is noteworthy that *Terebratulina faujasi* occurs in various amounts in the investigated samples but dominates those derived from the top of the section which are also the richest in bryozoan remains; a similar pattern has also been recorded by Surlyk (1972) in the Danish chalk. The same is also the case of *Cryptoporella antiqua*. One may suppose that both the species were actually related in one way or another to the bryozoans.

Much less common are medium- to large-sized pedunculate brachiopods represented in the Mielnik chalk by *Terebratulina chrysalis* (Schlotheim) and *Kingena* sp. Free-living, burrowing, and cementing brachiopods occur rarely at Mielnik.

Recent small-sized brachiopod assemblages are considered by Zezina (1976) as stunted under conditions of strong bottom currents. The development of the small-sized species of *Argyrotheca* Dall and *Megathyris* d'Orbigny in the Miocene of Malta is regarded by Pedley (1976) as a neotenic effect in response to the unstable and unpredictable life environments of those brachiopods. The investigated fauna of the Mielnik chalk lived, however, under quiet-water conditions (this is also indicated by the vinculariform and cellariform bryozoans), in a rather predictable environment. Then, the apparent dominance of minute brachiopods in the Mielnik assemblage reflects probably merely a sparsity of large hard substrates adequate for settlement by larger-sized forms, a higher sedimentation rate and deeper water than in the Danish chalk (*cf.* Surlyk 1972). The latter conclusion is also supported by the rarity of juvenile belemnites which appears indicative, accordingly to Surlyk & Birkelund (1977), of the basinal part of the chalk sea.

STRATIGRAPHICAL IMPLICATIONS

The brachiopod fauna of Mielnik may be used to correlate the section with the brachiopod zones recognized by Surlyk (1970*a*, *b*, 1972) in the Danish chalk. The occurrence of *Rugia spinosa* Surlyk in the samples *1* to *9*, that is from the base of the section up to 1 m below the hardground (*cf.* Text-fig. 1), documents the brachiopod zone *2* corresponding to the lowermost Maastrichtian (*cf.* Surlyk 1970*a*, Tab. 1; 1970*b*, Text--fig. 3; 1972, Text-fig. 2). Higher in the section, the species *R. spinosa* disappears, while *R. tenuicostata* Steinich and *R. acutirostris* Steinich

persist documenting the brachiopod zone *3* of Surlyk. There are no species indicative of the successive brachiopod zones of Surlyk. One may thus conclude that the brachiopod fauna permits attribution of the Mielnik chalk to the lowermost part of the Lower Maastrichtian.

This conclusion disagrees with the foraminifer-based assignments of the Mielnik chalk to the Upper Campanian through Lower Maastrichtian, with the Campanian/Maastrichtian boundary at the hardground (Bieda 1958, Pożaryski 1960).

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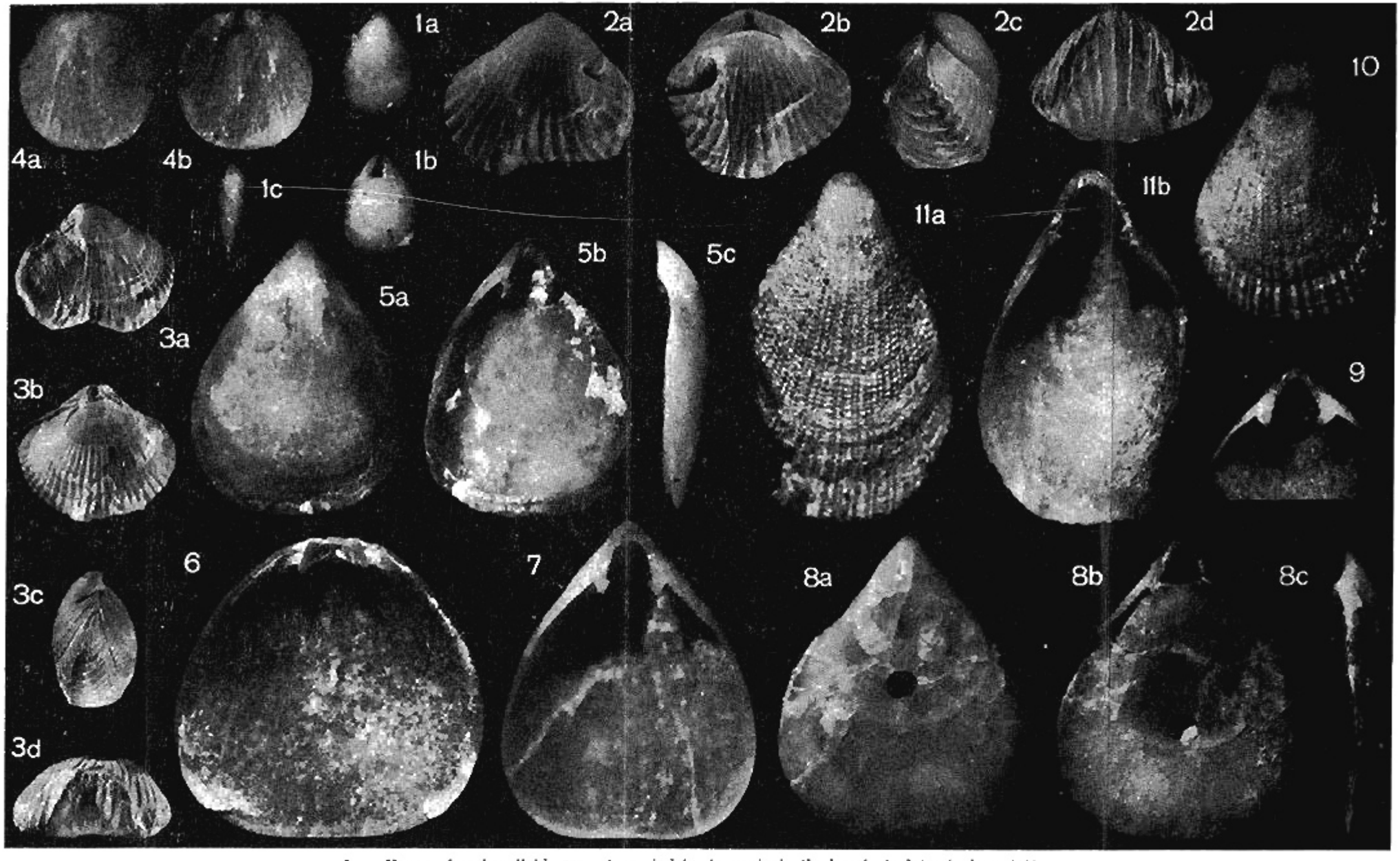
ZESPÓŁ BRACHIOPODÓW Z KREDY PISZĄCEJ MIELNIKA NAD BUGIEM

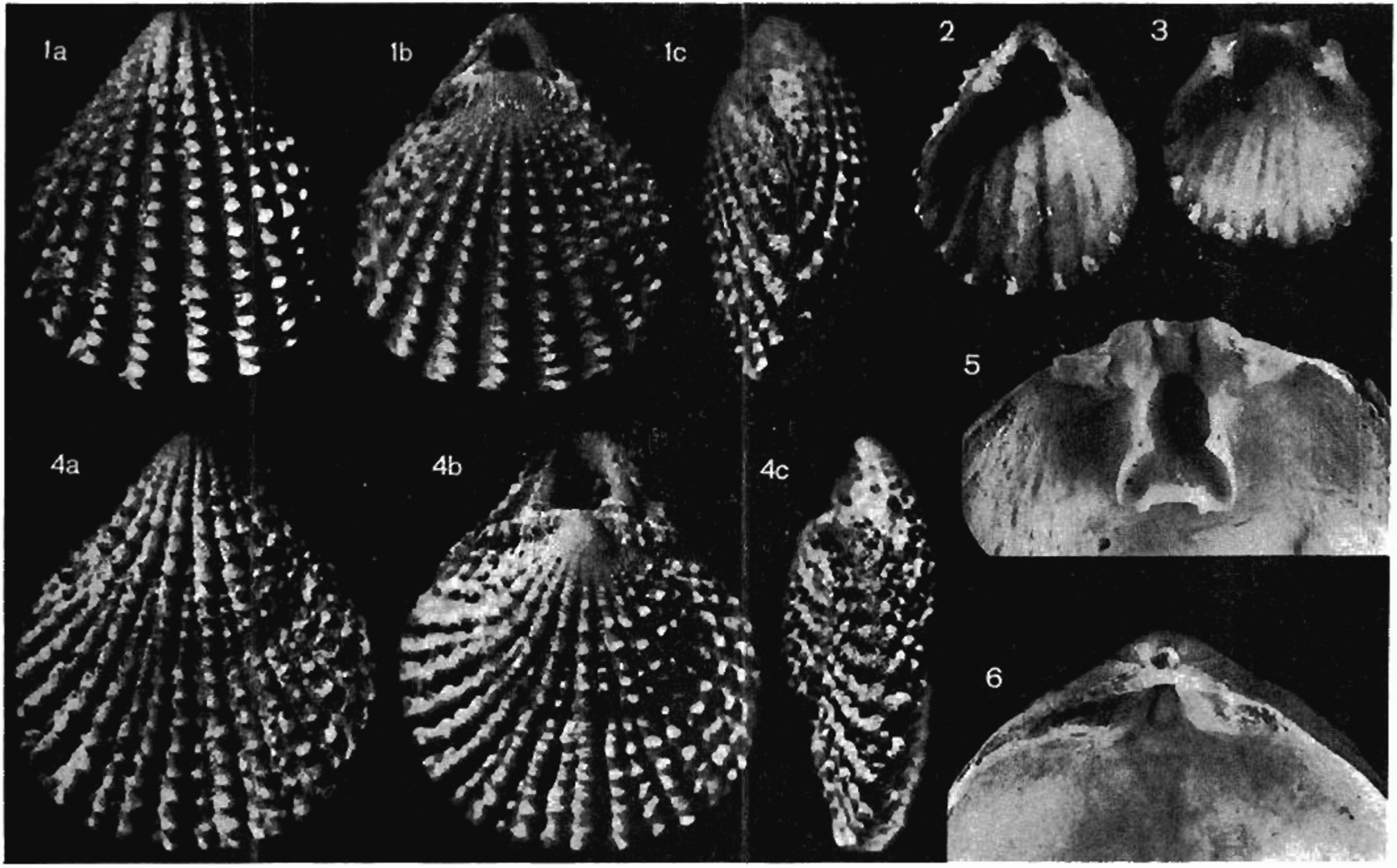
(Streszczenie)

Przedmiotem pracy jest charakterystyka bogatego i dobrze zachowanego zespołu brachiopodów z kredy piszącej Mielnika nad Bugiem. Zespół ten (*por.* fig. 1—5 oraz pl. 1—7) obejmuje 23 gatunki, wśród których 2 rodzaje i 3 gatunki opisano jako nowe: *Cryptoporella antiqua* gen. et sp. n., *Leptothyrellopsis polonicus* gen. et sp. n. oraz *Dalligas mielnicensis* sp. n. Ponadto w zespole tym stwierdzono obecność gatunków należących do rodzajów: *Lingula* Bruguière, *Isocrania* Jaekel, *Orbirhynchia* Pettitt, *Chatwinothyris* Sahni, *Terebratulina* d'Orbigny, *Rugia* Steinich, *Argyrotheca* Dall, *Aemula* Steinich, *Kingena* Davidson oraz *Magas* Sowerby. Zwrócono uwagę, że rozpatrywany zespół zdominowany jest przez gatunki o bardzo małych rozmiarach stadiów dorosłych.

Badany zespół brachiopodów wskazuje na obecność w osadach górnej kredy Mielnika zon *2* i *3* według podziału Surlyka (*por.* Surlyk 1970*a*, *b*, 1972), które odpowiadają najniższej części dolnego mastrychtu.



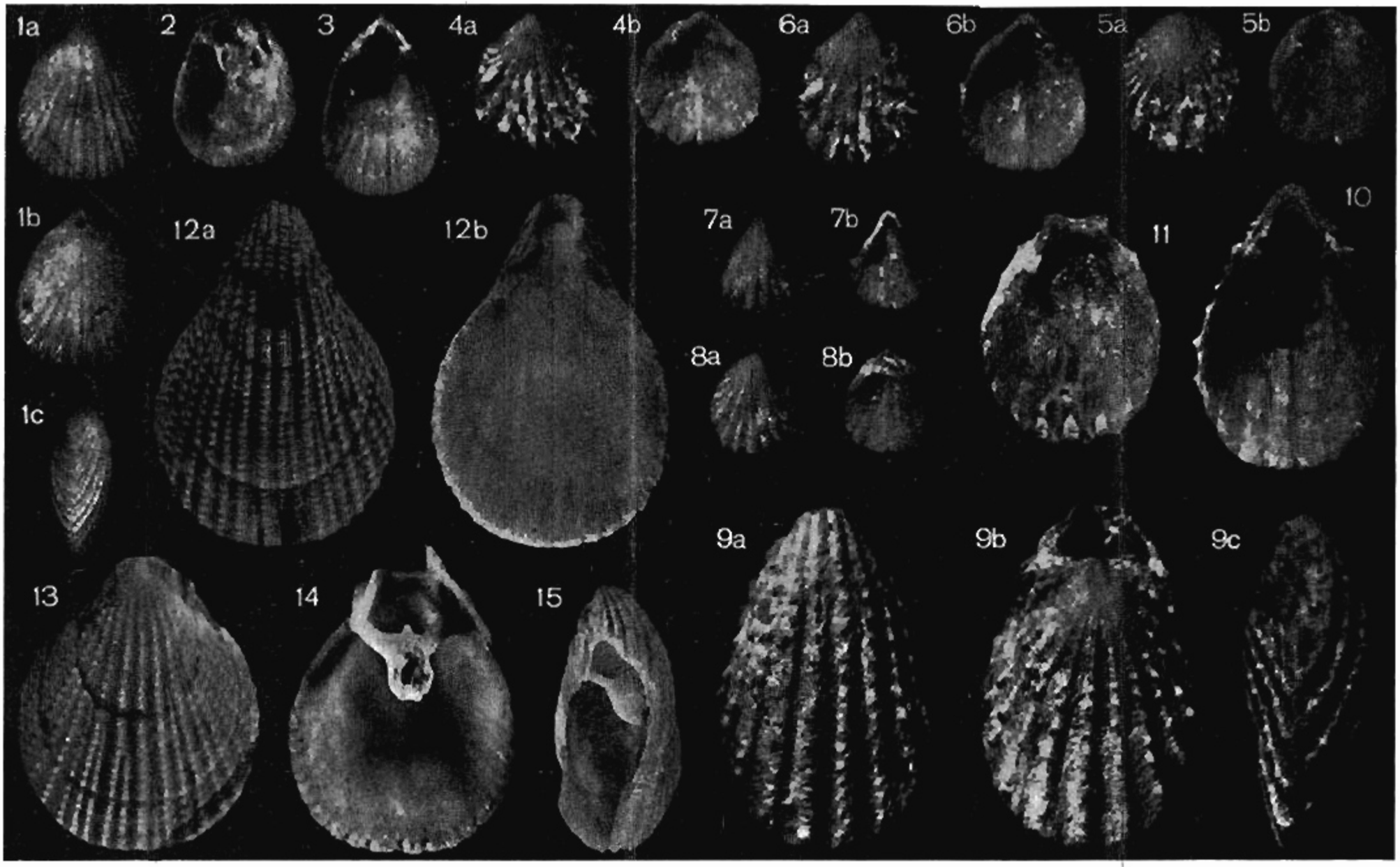
1 — Young rhynchonelloid, gen. et sp. indet.; *1a* ventral, *1b* dorsal, *1c* lateral view; ×20
2 — *Orbirhynchia parkinsoni* Owen; *2a* ventral, *2b* dorsal, *2c* lateral, *2d* anterior view; × 1.5
3 — *Orbirhynchia* sp.; *3a* ventral, *3b* dorsal, *3c* lateral, *3d* anterior view; ×1.5
4—9 — *Cryptoporella antiqua* gen. et sp. n. (*8* presents the holotype, *5—7* paratypes); *4* brachial valve of young specimen (*4a* outer; *4b* inner view, visible are short crura); *5* complete specimen (*5a* ventral, *5b* dorsal, *5c* lateral view); *6* brachial valve, inner view (visible are short crura and small cardinal process); *7* pedicle valve, inner view (visible are short and sharp teeth); *8* complete specimen (*8a* ventral, *8b* dorsal, *8c* lateral view); *9* fragment of pedicle valve, inner view (visible are teeth supported by dental plates); ×20
10—11 — *Terebratulina* sp. *A*; *10* ventral view of complete specimen; *11* pedicle valve (*11a* outer; *11b* inner view, visible are small teeth and weakly developed pedicle collar); ×20



1—3 — *Terebratulina faujasi* (Roemer): 1 complete specimen (*1a* ventral, *1b* dorsal, *1c* lateral view); *2* pedicle valve, inner view (visible are teeth and small deltidial plates); *3* brachial valve, inner view (visible are high inner socket ridges); × 20

4 — *Terebratulina* sp. B: complete specimen (*4a* ventral, *4b* dorsal, *4c* lateral view); × 20

5—6 — *Chattonothyris subcardinalis* Sahni: *5* fragment of brachial valve, inner view (visible are short loop of brachidium, and well developed cardinal process); *6* fragment of pedicle valve, inner view; × 5

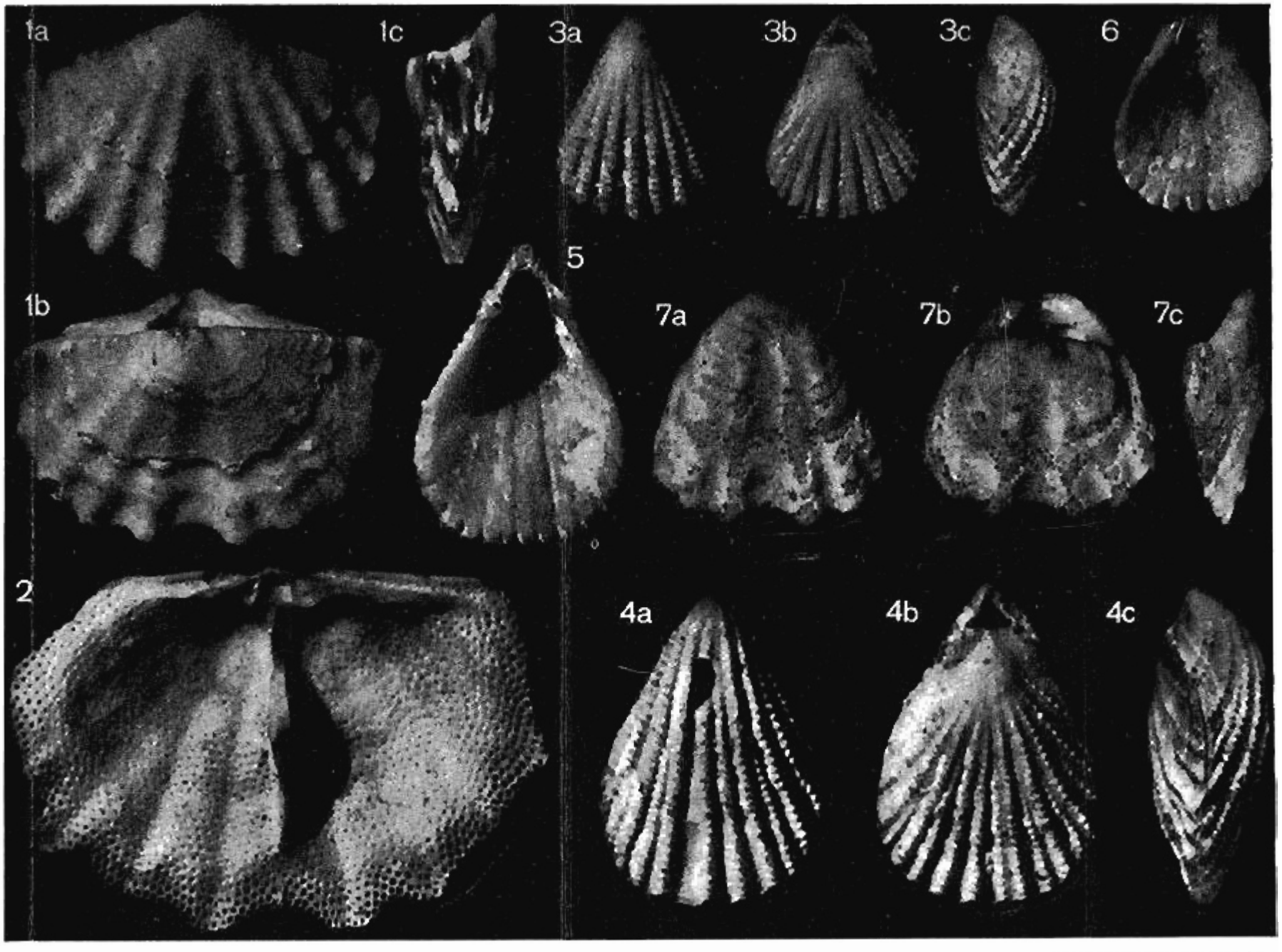


1–3 — *Rugia acutirostris* Steinich; *1* complete specimen (*1a* ventral, *1b* dorsal, *1c* lateral view), *2* brachial valve from Kornica, inner view (visible is partly destroyed brachidium); *3* pedicle valve, inner view; ×20

4–8 — *Rugia spinosa* Suzlyk; *4* brachial valve (*4a* outer, *4b* inner view, visible are inner socket ridges lying very close each other); *5* brachial valve (*5a* outer, *5b* inner view); *6* pedicle valve (*6a* outer, *6b* inner view); *7* pedicle valve of young specimen (*7a* outer, *7b* inner view); *8* brachial valve of young specimen (*8a* outer, *8b* inner view); ×20

9–11 — *Terebratulina longicollis* Steinich; *9* complete specimen (*9a* ventral, *9b* dorsal, *9c* lateral view), *10* pedicle valve, inner view; *11* brachial valve, inner view (visible are high inner socket ridges), ×20

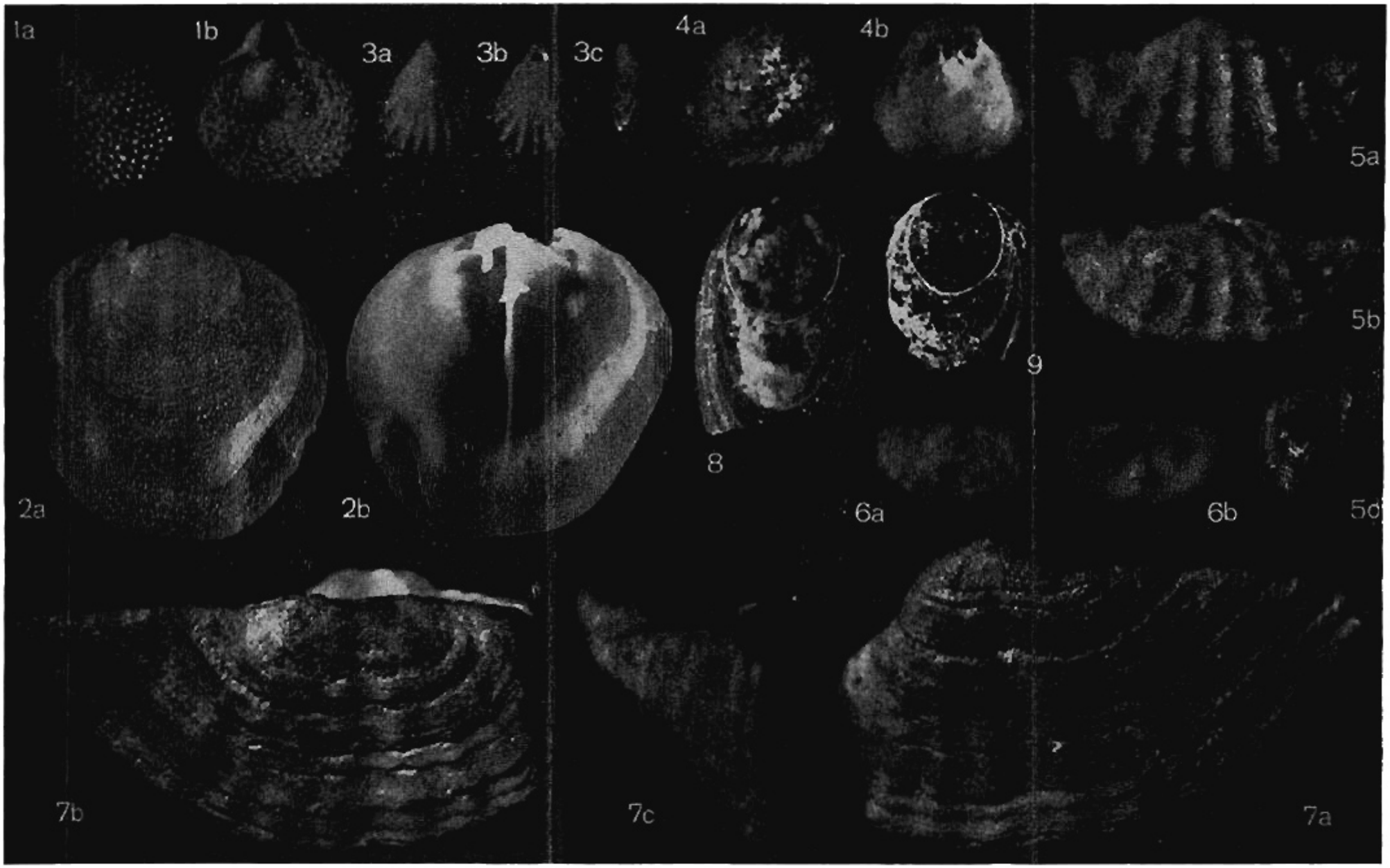
12–15 — *Terebratulina chrysalis* (Schlotheim); *12* pedicle valve from Kornica (*12a* outer; *12b* inner view, visible are short but wide teeth and small triangular deltidial plates); *13* brachial valve from Kornica, outer view; *14* brachial valve, inner view (visible are ring loop of brachidium and strong crura); *15* complete specimen with damaged pedicle valve, ventro-lateral view (visible is ring loop of brachidium); ×10



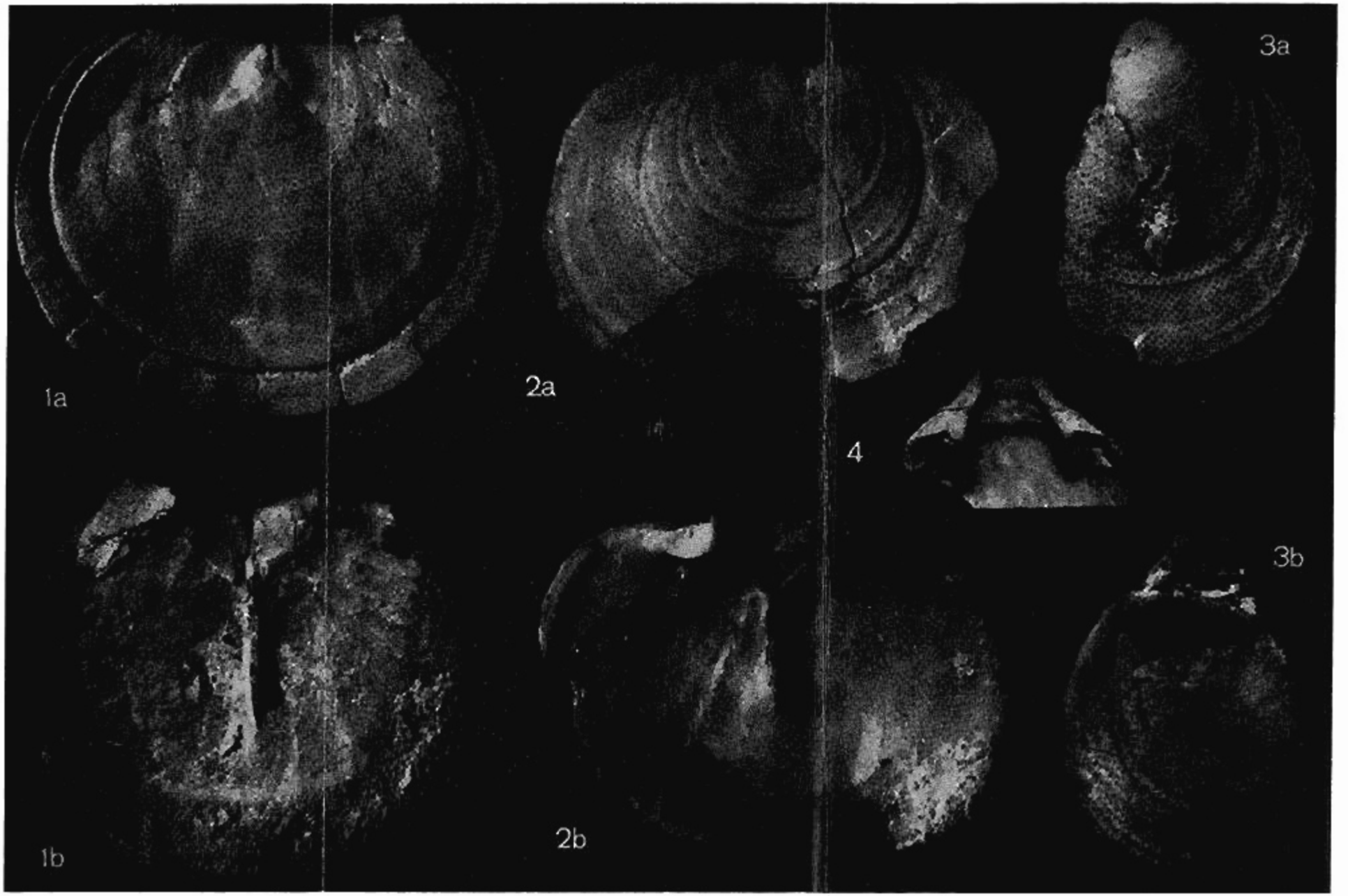
1—2 — *Argyrotheca bronni* (Roemer); *1* complete specimen (*1a* ventral, *1b* dorsal, *1c* lateral view); *2* brachial valve, inner view (visible are high median septum and punctae); ×20

3—6 — *Rugia tenuicostata* Steinich; *3* young complete specimen (*3a* ventral, *3b* dorsal, *3c* lateral view); *4* complete specimen from Kornica (*4a* ventral, *4b* dorsal, *4c* lateral view); *5* pedicle valve, inner view (visible teeth and long pedicle collar); *6* brachial valve, inner view; ×20

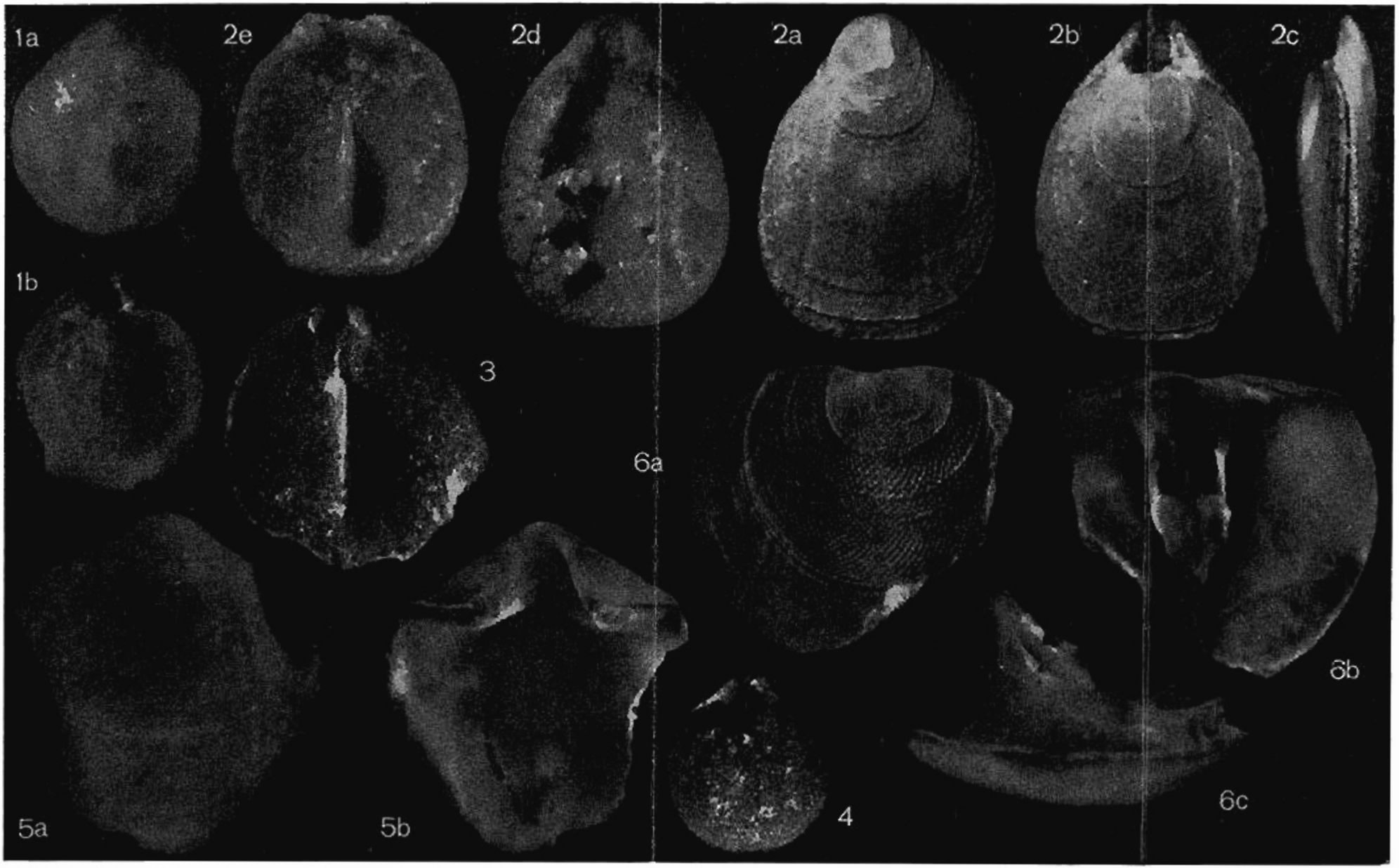
7 — *Argyrotheca hirundo* (Hagenow); *7a* ventral, *7b* dorsal, *7c* lateral view; ×20



1—2 — *Kingena* sp.; *1* young complete specimen (*1a* ventral, *1b* dorsal view); × 20. *2* brachial valve (*2a* outer; *2b* inner view, visible is long and thin median septum); ×5
3 — *Rugia tenuicostata* Steinich; young specimen (*3a* ventral, *3b* dorsal, *3c* lateral view); ×20
4 — *Aemula inusitata* Steinich; complete specimen (*4a* ventral, *4b* dorsal view); ×20
5—7 — *Argyrotheca contuncta* Steinich; *5* complete specimen (*5a* ventral, *5b* dorsal, *5c* lateral view); 6 brachial valve (*6a* outer, *6b* inner view, visible are inner socket ridges, high median septum and descending branches of loop); *7* complete specimen, slightly damaged (*7a* ventral, *7b* dorsal, *7c* lateral view); ×20
8—9 — *Lingula* sp.; dorsal view; ×20



1—4 — *Dalligas mielnicensis* sp. n. (3 presents the holotype, 1—2 paratypes): *1* brachial valve (*1a* outer; *1b* inner view, visible are well developed inner socket ridges and hinge plates, and broken median septum); *2* brachial valve (*2a* outer, *2b* inner view); *3* complete specimen (*3a* ventral, *3b* dorsal view); *4* fragment of pedicle valve, inner view (visible are narrow deltidial plates and very wide pedicle collar); ×20



1—4 — *Leptothyrellopsis polonicus* gen. et sp. n. (*2* presents the holotype, *1* and *3—4* paratypes); *1* complete specimen (*1a* ventral, *1b* dorsal view); *2* complete specimen (*2a* ventral, *2b* dorsal, *2c* lateral view, *2d* inner view of pedicle valve, *2e* inner view of brachial valve); *3* brachial valve, inner view (visible are well developed inner socket ridges and high median septum); *4* pedicle valve, inner view (visible are short teeth); ×20

5—6 — *Magas chitoniformis* (Schlotheim); *5* pedicle valve (*5a* outer, *5b* inner view); *6* brachial valve: *6a* outer view (visible are numerous growth lines and punctae), *6b* inner view (visible are well preserved brachidium), *6c* lateral view (visible is loop contacting with high median septum); ×10