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THE MIOCENE RADIOLARIA FROM THE CARPATHIAN FOREDEEP

Abstract. — The Middle Badenian radiolarian horizon had been characterized. Life conditions of these organisms have been discussed. Thirty-eight radiolarian species have been described including seven new ones: *Cenosphaera micropora* sp.n., *Caryosphaera sphaerica* sp.n., *Hexacontium miocenicum* sp.n., *Cenellipsis minuta* sp.n., *Cromyocarpus ovalis* sp.n., *Cenodiscus discoides* sp.n., and *Dictyocoryne triangularis* sp.n.

INTRODUCTION

The materials described and discussed in the present paper come from twenty-three borings and one outcrop situated in the southern part of the Carpathian foredeep. These are the following sites: in Upper Silesia — Ziemowit and Szewczyk; in the environs of Cracow — Borek Fałęcki, Kozłówek 3 and Bogucice A; in the environs of Bochnia — Kłaj 2, Bochnia E, Łysokanie XXI, Chełm at the Raba (outcrop), Sch-6, Staniątki B and Brzezowiec 1; in the area between Pilzno and Przemyśl — Pilzno 7, Korzeniów 8 and 12, Brzezówka 15, Podlipie 1, Rzeszów 4, Węgierka 4, Braciejowa 1, Przemyśl 127 and 140. The specimens described are housed at the Laboratory of Paleontology and Stratigraphy of the University of Mining and Metallurgy in Cracow (abbreviated as AGH). Fair copies of the sketches of the radiolarians have been drawn by Miss M. Kuśmierek and scanning electron microphotographs have been taken at the Institute of Metallurgy, Polish Academy of Sciences, Cracow.

New specific names have been proposed for the species described by Haeckel (1887) without illustrations (*nomina nuda*). In one case (*Druppula* sp.) the specific determination have been abandoned due to a poor state of the preservation of the material.

STRATIGRAPHIC POSITION OF THE HORIZON WITH THE RADIOLARIA

Radiolaria described in the present paper occur in the Middle Badenian deposits of the Carpathian foredeep within the *Velapertina indigena* Zone. The Radiolaria horizon contains many planktonic organisms such as

radiolarians, planktonic foraminifers, and pteropods of the genus *Spiratella*. This horizon occupies a stable stratigraphic position overlying chemical deposits (gypsum, anhydrite), displays an extensive geographical distribution and is relatively not very thick. Due to these characters, it plays an important role of a correlative horizon in the Carpathian foredeep. The clays, within which the Radiolaria horizon occurs, are distinguished as Chodenice Beds or the equivalents (Łuczkowska 1953; Alexandrowicz 1961a). In their lower part, these deposits are devoid of microfauna. The Chodenice Beds are overlain by clays, sandy clays and sands of the Grabowiec Beds marked by the occurrence of rich assemblages of the benthonic foraminifers.

The geographical distribution of Radiolaria horizon is connected with that of chemical deposits and, therefore, it occurs almost all over the Para-Tethys (that is, in all places where chemical deposits are developed) from Opawa in the west, through the Upper Silesian Coal District, the area of the Carpathian foredeep within Poland's borders, the Ukraine up to Pleven, Bulgaria (Alexandrowicz 1961b).

In Poland, the presence of the radiolarians within the limits of this horizon was recorded in many profiles (fig. 1). So far, these organisms

Fig. 1. The localization of profiles containing radiolarians: *1* Carpathian peripheral region; *2* the Carpathian flysch; *3* pre-Miocene deposits; *4* Miocene deposits; *5* state border; *6* profiles with the radiolarian fauna studied; *7* profiles with the radiolarian fauna known from literature.

have been described from Upper Silesian profiles and from the environs of Cracow and Bochnia (Barwicz-Piskorz 1969, 1970, 1972).

Outside Poland's borders, a horizon abounding in Radiolaria was observed in the Ukraine, where it occurs in the lower part of the Verbovetz Beds of the Kossov suite and overlies the roof of the Tyrazsa suite (chemical deposits), that is, in the same position as on the territory of Poland (Vjalov 1965; Runeva 1969; Pishvanova 1969). Likewise, a horizon containing radiolarians and other organisms having siliceous skeletons was observed in the Miocene of the Carpathian foredeep on the territory of Rumania, where it overlies chemical deposits and corresponds to the

horizon with radiolarians and to marls containing *Spirialis* know from Poland and the Ukraine (Dumitrica 1968; Saraiman 1970). In addition to the Middle Badenian, other localities are also known in which Radiolaria occur in the Miocene of the Carpathian foredeep, but they are less important. In Poland, few radiolarians were found in the Grabowiec Beds of the Upper Badenian (Łuczkowska 1967) in the environs of Staszów and Gliwice Stare (Śmigielska 1957) and they were locally recorded in the Sarmatian deposits of the environs of Tarnobrzeg (Łuczkowska 1964).

In the Lower Miocene beds of the Carpathian foredeep in the USSR, a horizon with Radiolaria was observed within the limits of the Upper Vorotyshcha suite (Aquitanian). It is conjectured, however, that this may be a microfauna on a secondary deposit (Subbotina 1960). Likewise, Radiolaria found in the Stebnik suite (Burdigalian) are also believed to lie on a secondary deposit. They come from the Eocene and Cretaceous washouts of the Carpathian Mountains (Runeva 1969). Few Radiolaria were also observed in the Balich suite of the Helvetian (Ney 1965). In the Vienna Basin, that is, outside the zone of the occurrence of chemical deposits in Para-Tethys, the presence of numerous radiolarians was recorded within the limits of the lower lagenid zone of the Lower Badenian (Bachmann *et al.* 1963).

As follows from the above considerations, the microfauna under study could occur in the Miocene deposits of Para-Tethys in various stratigraphic positions, but its abundant occurrence within the limits of a horizon with an extensive geographical range was a simultaneous phenomenon.

Horizons with many radiolarians, thin but extensive geographically, were also recorded in various series of the flysch Carpathians, in the Pieniny Klippen Belt and in the North-Sudeten Basin (Geroch and Nowak 1963; Kostecka and Węcławik 1967; Alexandrowicz 1966, 1971).

LIFE CONDITIONS OF THE RADIOLARIAN PLANKTON

The horizon with the radiolarians, described in the present paper, occurs among clayey-marly deposits overlying gypsum deposits which contain tuffite intercalations. The development of the organisms having siliceous skeletons is unquestionably connected with the presence of tuffite facies (Wieser 1963).

No microfauna has been found in lithologically similar deposits underlying the horizon with Radiolaria. On the other hand, many foraminifers, at first planktonic and then benthonic, occur above it. Thus, the radiolarians are the first organisms which might have developed in an environment marked by a high degree of salinity shortly after the termination of chemical sedimentation, that is, under conditions unfavorable to the organic life, at least in the first stage, which is confirmed by the initial lack of other fauna. Together with an improvement of the living

conditions in the basin, there took place a rich development of the foraminifers, which, with the lapse of time, probably became a competition to the radiolarians.

During the deposition of evaporites, the territory of Poland was marked by a predominantly warm and rather dry climate, with more evaporation than precipitation, but not tropical (Kwiatkowski 1972). One may conjecture that similar climatic conditions predominated during the deposition of the Chodenice Beds, as indicated by the composition of the radiolarian assemblage, which included many representatives of species considered as warm-water ones (*Euchitonia furcata*, *Eucyrthidium calvertense*). The composition of radiolarian assemblages may, to a certain extent, be indicative of the depth of the Miocene basin. In the littoral parts of the basin (the environs of Skalbmierz, Chmielnik, Staszów and Tarnobrzeg), Radiolaria are absent at all or occur only sporadically, while they abound near Bochnia and Wieliczka, that is, in the axial part of the basin (Barwicz-Piskorz 1972). In the last-named region, the assemblage is most varied and includes representatives of the suborder Nassellina considered as deep-water forms.

Taking into account the data on the living conditions of the Recent Radiolaria, we may state that the abundant development of these organisms in the Miocene of Para-Tethys was affected by the following factors: the warm climate, high salinity, considerable influx of free silica, optimum concentration of nitrates and phosphates and, finally, a vertical circulation of the water. The occurrence of radiolarians in thin beds should be ascribed to the possibility of the adaptation of these forms to the environment with a high salinity, which was unfavorable to other organisms. It seems that the horizon with radiolarians may be related with the final stage of chemical sedimentation in Para-Tethys.

DESCRIPTIONS

Subclass **Radiolaria** Müller, 1858
Order **Polycystina** Ehrenberg, 1838, emend. Riedel, 1967
Suborder **Spumellina** Ehrenberg, 1875
Family **Liosphaeridae** Haeckel, 1882
Genus *Melitosphaera* Haeckel, 1882
Melitosphaera minima (Clark and Campbell, 1942)
(pl. 2: 1)

1942. *Carposphaera* (*Cerasosphaera*) *minima* Clark and Campbell: 21, pl. 4: 8, 9.
1969. *Melitosphaera* cf. *entactinia* Ehrenberg; Barwicz-Piskorz: 181, fig. 2: 1.

Material. — Fifty well preserved specimens.

Dimensions (in μm):

diameter of cortical shell	142—180
diameter of modullary shell	44—63
diameters of pores on cortical shell	8—13
spaces between pores	3—6

Remarks. — The specimens under study correspond to the first description of this species, except for slightly larger dimensions of shells and pores on the cortical shell and a somewhat larger number of the pores (14 to 18) distributed over a half of the circumference of the cortical shell. The genera *Melitosphaera* and *Carposphaera* are now considered as synonyms (Campbell and Moore 1954).

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, Upper Silesia and the environs of Wieliczka. N. America: Eocene of California.

Genus *Cenosphaera* Ehrenberg, 1854
Cenosphaera mariae Lipman, 1960
(pl. 2: 3)

1960. *Cenosphaera mariae* Lipman: 72, pl. 10: 4, 5; pl. 13: 2, 3.

Material. — More than 200 well preserved specimens.

Dimensions (in μm):

diameter of shell	152—186
diameter of round pores	10—15
longer diameter of oval pores	20—35
spaces between pores	about 5

Remarks. — The specimens under study are in conformity with the description and illustration of *C.mariae* Lipman (Lipman 1960: pl. 10: 4). Specimens presented in other drawings do not fully correspond to the description of this form given by the author of this species. Our specimens differ from them in the shape of larger pores, which are frequently oval, while in Lipman's specimens all pores are round, as well as in a slight flattening of the shell in some cases.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, the environs of Cracow, Bochnia, Pilzno and Przemyśl. The USSR: Upper Eocene of the region of Sverdlovsk and Omsk.

Cenosphaera micropora sp.n.
(pl. 2: 2)

Holotype: specimen AGH Rad I/2; pl. 2: 2.

Type horizon: Chodenice Beds, Middle Badenian.

Type locality: Bochnia E borehole, depth: 475 to 476 m.

Derivation of the name: after small pores.

Material. — About 50 specimens.

Dimensions (in μm):

diameter of shell	85—148, holotype — 138
diameter of pores	8—10.

Diagnosis. — Shell spherical, latticed, its surface fairly rough. Pores round, almost uniform in dimensions, spaced closely and regularly (alternately).

Remarks. — The specimens under study are in conformity with the description of *C.eridani* Haeckel (*nomen nudum*), except for their somewhat smaller dimensions.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, the environs of Cracow and Bochnia.

Genus *Thecosphaera* Haeckel, 1882
Thecosphaera saccoi Principi, 1909
(pl. 2: 4)

1909. *Thecosphaera saccoi* Principi: 4, pl. 1: 6.

1969. *Theocosphaera* cf. *saccoi* Principi; Barwicz-Piskorz: 181, fig. 2: 2.

Material. — About 50 specimens varying in the state of preservation (some damaged).

Dimensions (in μm):

diameter of cortical shell	136—160
diameter of outer medullary shell	63—79
diameter of inner medullary shell	23—26
diameter of pores on cortical shell	8—20
diameter of pores on outer medullary shell	8—10
diameter of pores on inner medullary shell	about 5

Remarks. — The specimens under study are in conformity with the description of *Th.saccoi* Principi from which they are, somewhat larger. They are also very similar to *Th.dodecactis* Haeckel 1887 (*nomen nudum*), from which they are somewhat smaller.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, Upper Silesia. Italy: Miocene.

Genus *Rhodosphaera* Haeckel, 1882
Rhodosphaera cf. *magnaporulosa* Nakaseko, 1964
(pl. 2: 5)

Material. — Twenty poorly preserved specimens, with outer shell mostly damaged.

Dimensions (in μm):

diameter of outer cortical shell	95—195
diameter of inner cortical shell	72—94
diameter of medullary shell	25—29
diameters of round pores on cortical shells	3—8
diameters of oval pores on cortical shells	to 12
diameters of pores on medullary shell	about 5

Description. — Shell spherical, composed of three smaller, spherical, latticed shells embedded concentrically in each other, two cortical and one medullary. Shells very thin, openwork in structure, connected with each other by many thin radial beams. Outer shell is frequently completely crumbled, with fragments of beams forming a sort of spines visible on the surface of inner cortical shell. Pores on cortical shell in general round, closely spaced, rarely oval. Cortical shell displays round pores, widely spaced (three to four) over a half of the circumference. Proportions of the diameters of cortical and medullary shells amounting 1:3:3.5 or 4.

Remarks. — Our specimens correspond to the description of *Rh.magnaporulosa* Nakasenko, but are so poorly preserved that it is impossible to identify them for certain.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, Upper Silesia.

Genus *Caryosphaera* Haeckel, 1887
Caryosphaera sphaerica sp.n.
(pl. 2: 6)

Holotype: specimen AGH Rad I/6; pl. 2: 6.
Type horizon: Chodenice Beds, Middle Badenian.
Type locality: Bochnia E borehole, depth: 475 to 476 m.
Derivation of the name: after its spherical shell.
Material. — About 300 well preserved specimens.

Dimensions (in μm):

diameter of shell I	129—186; holotype 160
diameter of shell II	84—130; holotype 126
diameter of shell III	54—94; holotype 93
diameter of shell IV	26—48; holotype 45
diameter of shell V	13—22; holotype 20
diameters of pores on shell I	3—8

Diagnosis. — Shell spherical, smooth, composed of five smaller spherical shells concentrically arranged in each other and connected by radial beams. Beams numerous, thin, closely spaced. Inner shells visible in thin sections of specimens, spaces between particular shells almost uniform in size. Pores on outer shell almost uniform in size, round or subround, closely spaced, irregularly distributed. About 16 to 20 pores occur over a half of the circumference of outer shell. Proportions of diameters of shells amount to 1:2:5:7:9.

Remarks. — The specimens under study are similar to *C.hexalepas* Haeckel except for their having five shells, while the specimen described by Haeckel is composed of six. Outer shell, sometimes damaged, does not completely enfold the next shell and, if such is the case, the shell is not quite round in outline.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, the area between Cracow and Przemyśl.

Genus *Spongoplegma* Haeckel, 1882
Spongoplegma sp.
(pl. 2: 7)

Material. — About 100 mostly poorly preserved specimens.

Dimensions (in μm):

diameter of cortical shell	129—180
diameter of medullary shell	63—70
diameter of pores on cortical shell	8—13
diameter of pores on medullary shell	8—10
species between pores	about 3

Description. — Shell spherical or ovate, composed of a spherical or ovate cortical shell and a spherical medullary shell concentrically embedded in it. Cortical shell spongy or, locally, latticed. Pores polygonal or subround, irregularly distributed. Pores of medullary shell round or subhexagonal in outline, distributed densely and alternately. Shells connected with each other by thin radial beams, which, bifurcated at their ends, form a spongy structure of the cortical shell. Surface of cortical shell uneven, rough.

Remarks. — The form described above is not similar to any of so far known species of the genus *Spongoplegma*. Due to the poor state of preservation of the specimens, it is impossible to erect a new species.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Bochnia.

Family **Staurosphaeridae** Haeckel, 1882
Genus *Staurolonche* Haeckel, 1882
Staurolonche rara Carnevale, 1908
(pl. 2: 8)

1908. *Staurolonche rara* Carnevale: 15, pl. 2: 8.

Material. — Five well preserved specimens and several scores with spines broken off.

Dimensions (in μm):

diameter of cortical shell	170—207
diameter of medullary shell	59—69
length of spines	120—130
diameter of pores on cortical shell	10—13
proportions of shell diameters	1:3

Remarks. — Our specimens correspond to the description of *S.rara* Carnevale, although some of them differ in a slight flattening of the shell. From *S.hexagona* Haeckel they differ in larger dimensions and shape of pores and from *S.aculeata* Campbell and Clark — in considerably larger dimensions and proportion of the diameters of cortical and medullary shells.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Cracow, Bochnia and Przemyśl. Italy: Middle Miocene.

Family **Cubosphaeridae** Haeckel, 1882
Genus *Hexacontium* Haeckel, 1882
Hexacontium miocenicum sp.n.
(pl. 3: 1a, 1b)

Holotype: specimen AGH Rad I/12; pl. 3: 1a, 1b.
Type horizon: Chodenice Beds, Middle Badenian.
Type locality: an outcrop at Chełm on the Raba.
Derivation of the name: described from the Miocene.

Material. — Ten well preserved and several scores damaged specimens.

Dimensions (in μm):

diameter of cortical shell	174—206,	holotype	177
diameter of outer medullary shell	52—60,	holotype	55
diameter of inner medullary shell	21—23,	holotype	23
diameter of round pores on cortical shell	7		
diameter of oval pores on cortical shell	10—15		

Diagnosis. — Shell spherical or slightly flattened, composed of three smaller, spherical, latticed shells arranged concentrically (visible in thin sections). Shells are connected by radial beams, perpendicular to each other, running along the main axis of shell and prolonged in the form of spines. Spines fairly thick, about 90 μm long, triangular in transverse section, smooth, transparent, tapering. Pores on cortical shell round or oval, closely and regularly spaced. About 14 to 16 pores occur over a half of the circumference of shell. Pores on outer medullary shell round, 3 to 5 μm in diameter; an inner shell also round and 3 μm in diameter. Proportions between shell diameters amount to 1:2:5:8 or 1:3:9.

Remarks. — *Hexacontium miocenicum* sp.n. is very similar to *H.triplosphaericum* Haeckel (*nomen nudum*), from which it differs in somewhat larger dimensions.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Bochnia and Przemyśl.

Family **Astrosphaeridae** Haeckel, 1882
Genus *Haliomma* Ehrenberg, 1838
Haliomma sp.
(pl. 2: 9)

Material. — About 50, mostly poorly preserved, specimens.

Dimensions (in μm):

diameter of cortical shell	88—111
diameter of medullary shell	21—31

Remarks. — The specimens under study display a considerable similarity to *H.duodecimum* Haeckel. The specific identification of our material was precluded by a poor state of preservation: all spines broken off.

Occurrence. — *Haliomma* sp. occurs in small numbers in the Miocene of Upper Silesia and environs of Bochnia, Poland.

Family **Ellipsidiidae** Haeckel, 1887
Genus *Cenellipsis* Haeckel, 1887
Cenellipsis minuta sp.n.
(pl. 2: 10)

Holotype: specimen AGH Rad I/10, pl. 2: 10.
Type horizon: Chodenice Beds, Middle Badenian.
Type locality: Łysokanie XXI borehole, depth: 200 m.
Derivation of the name: after its small shell.

Material. — About 50 well preserved specimens.

Dimensions (in μm):

lenght of shell	118—193,	holotype 190
width of shell	90—128,	holotype 120
diameter of pores	3—8	

Diagnosis. — Shell ellipsoidal, latticed, smooth. Pores round, closely spaced, alternating. Twelve to fourteen pores occur over a half of the equatorial circumference of shell. The width to length ratio of shell amounts to 1:1.5.

Remarks. — The specimens under study correspond to the description of *C.micropora* Haeckel (*nomen nudum*).

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Bochnia.

Genus *Ellipsostylus* Haeckel, 1887
Ellipsostylus permagnus Moksjakova, 1965
(pl. 2: 11)

1965. *Ellipsostylus permagnus* Moksjakova: 246, pl. 1: 1.

Material. — Five well preserved and several scores damaged specimens.

Dimensions (in μm):

length of shell minus spines	212—244
width of shell	173—194
length of spine I	76—84
length of spine II	62—72
diameter of pores	10—15
width to length ratio	1:1.2

Remarks. — Our specimens are in conformity with the description of *E.permagnus* Moksjakova, differing from it only in somewhat shorter spines and less closely spaced pores.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Bochnia. The USSR: Upper Eocene of Western Turkestan.

Family **Druppulidae** Haeckel, 1887
Genus *Druppula* Haeckel, 1887
Druppula sp.
(pl. 3: 2)

Material. — Five fairly well preserved specimens.

Dimensions (in μm):

length of shell	130—140
width of shell	96—110
diameter of medullary shell	36—40
diameter of pores	3—4

Description. — Shell ellipsoidal, smooth, composed of an ellipsoidal, latticed cortical shell and a spherical, latticed medullary shell concentrically embedded in it and connected by few thin, radial beams. Pores round, very closely spaced. Width to length ratio of shell amounts to 1:1.3.

Remarks. — The specimens under study correspond to the description of *D.areca* Haeckel (*nomen nudum*), from which they differ only in a somewhat smaller medullary shell. Due to the small number of specimens it was impossible to erect a new species.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Bochnia.

Genus *Cromyocarpus* Haeckel, 1887
Cromyocarpus ovalis sp.n.
(pl. 1:1; pl. 3:3)

Holotype: specimen AGH Rad I/14; pl. 3: 3.

Type horizon: Chodenice Beds, Middle Badenian.

Type locality: an outcrop at Chełm on the Raba, on the southern slope of Grodzisko Hill.

Derivation of the name: after an oval outline of shell.

Material. — About 30 well preserved specimens.

Dimensions (in μm):

length of shell	128—215,	holotype 210
width of shell	90—177,	holotype 175
diameter of inner medullary shell	15—28,	holotype 28
diameter of pores on outer shell	3—5	

Diagnosis. — Shell ellipsoidal, composed of four smaller, latticed shells arranged concentrically at equal distances from each other. Oval outer (cortical) and spherical inner (medullary) shells are connected with each other by thin (fairly widely spaced) radial beams. On the outer cortical shell, pores are round and irregularly distributed. Few conical, transparent, mostly broken spines, up to 25 μm long, are widely scattered over the entire surface of shell, most of them occurring usually near one of the poles. Width to length ratio of shell amounts to 1:1.2.

Remarks. — *C.ovalis* sp.n. is not similar to any species known in literature.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Bochnia.

Genus *Cromyodruppa* Haeckel, 1887
Cromyodruppa concentrica Lipman, 1952
(pl. 1: 2; pl. 3: 4*a*, 4*b*)

1962. *Cromyodruppa concentrica* Lipman: 285, pl. 1: 1a, 1b.
1969. *Cromyodruppa concentrica* Lipman; Barwicz-Piskorz: 182, 2:3.

Material. — More than 300 well preserved specimens.

Dimensions (in μm):

length of shell	155—194
width of shell	96—122
diameter of inner medullary shell	9—10
diameter of pores	5—8
number of shells	5—7

Remarks. — The specimens under study correspond to the description of *C.concentrica* Lipman, from which they differ in a smaller number of concentric shells (according to Lipman 7 to 8). In addition, our specimens are somewhat slimmer than those presented in Lipman's work (1962: pl. 1: 1*a*, 1*b*), in which the width to length ratio of shell amounts to 1:1.7. Characterizing the variability of this species, Lipman mentions that her collection includes both strongly and slightly elongate specimens.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, an area from Upper Silesia to the environs of Przemyśl. The USSR: Upper Cretaceous (Campanian and Maastrichtian) of the Russian Platform.

Genus *Prunopyle* Dreyer, 1888
Prunopyle occidentalis Clark and Campbell, 1942
(pl. 3: 5)

1942. *Prunopyle occidentalis* Clark and Campbell: 35, pl. 5: 27.

Material. — About 50 well preserved specimens.

Dimensions (in μm):

length of shell	124—146
width of shell	101—110
width of pylome	37—44
diameter of pores	about 5

width to length ratio of shell amounting to 1:1.2 or 1:1.4.

Remarks. — The specimens under study correspond to the description of *P.occidentalis* Clark and Campbell, but are considerably smaller than the type specimen of this species. Their dimensions are, on the other hand, equal to those of dwarf specimens occurring in the topotypical material.

Occurrence. — Poland: Middle Badanian, *Velapertina indigena* Zone, environs of Cracow. N. America: Eocene of California.

Prunopyle sp.
(pl. 3: 6*a*, 6*b*)

Material. — Fifteen well preserved specimens.

Dimensions (in μm) of a specimen of which thin sections were made:

length of shell	147
width of shell	106

diameter of inner medullary shell	23
diameter of outer medullary shell	49
length of inner cortical shell	85
width of inner cortical shell	95
width of pylome	36
diameter of pores on outer shell	3—5

Description. — Shell elliptical, latticed, composed of four smaller shells concentrically embedded in each other, visible in thin sections. Two inner (medullary) shells are round in outline, while two cortical ones are oval. The outermost shell displays a wide pylome occurring on the lower, extended pole of shell. Shells are connected by many thin, radial, closely spaced beams. On the outer cortical shell, pores are round and closely spaced. Fourteen to sixteen pores are distributed over a half of the equatorial circumference. Width to length ratio of shell amounts to 1:1:4.

Remarks. — The specimens described above are not similar to any species known in literature. The small number of specimens and difficulties in preparing their thin sections, precluded the possibility to erect a new species.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Cracow and Bochnia.

Family **Cyphantidae** Campbell, 1954 (= **Cyphynida** Haeckel, 1881)
Genus *Cypassis* Haeckel, 1887
?Cypassis irregularis Nigrini, 1968
(pl. 3: 7)

1969. *Cyphanta* sp.; Barwicz-Piskorz: 182, fig. 2: 4.

Material. — Fifteen mostly poorly preserved specimens.

Dimensions (in μm):

length of outer cortical shell	124—155
width of outer cortical shell	95—121
length of inner cortical shell	65—82
width of inner cortical shell	46—72
diameter of medullary shell	13—21
diameter of pores on outer cortical shell	3—13
diameter of pores on inner cortical shell	3—5

Description. — Shell elliptical, composed of two cortical shells and a double (?) medullary shell. Outer cortical shell elliptical in outline, with one or two slightly marked contractions visible in the plane perpendicular to the longer axis of shell. Inner cortical shell oval, without contractions. Medullary shell spherical; the poor state of preservation of the specimens precludes the possibility of finding for certain whether or not it is double. Shells are connected with each other by fairly numerous, thin, radial beams. All shells are clathrate. Pores on outer cortical shell, variable in size and shape, are fairly closely but irregularly spaced. The dimensions of pores increase towards the poles of shell, where they become very strongly elongate, oval and closely spaced. Near the middle of shell, they are smaller, round and rather scattered. On the inner cortical shell, pores are round and fairly closely and regularly spaced. The surface of shell is rough and with short, thin, irregularly distributed spines. The width to length ratio of shell amounts to 1:1.3 to 1:1.6.

Remarks. — Our specimens correspond to the description of *C.irregularis* Nigrini (Nigrini 1968: fig. 2c), while other specimens, described in by this author (Nigrini 1968: figs 2a, 2c) have a contraction. The poor state of preservation of the materials precludes any certainty of identification.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, Upper Silesia.

Genus *Cannartus* Haeckel, 1882
Cannartus violina Haeckel, 1887
(pl. 3: 8)

1887. *Cannartus violina* Haeckel: 358, pl. 39: 10.
1887. *Cannartidium bicinctum* Haeckel: 374, pl. 39: 18.
1959. *Cannartus violina* Haeckel; Riedel: 290, pl. 1: 3.
1969. *Cannartiscus* cf. *amphiconiscus* Haeckel; Barwicz-Piskorz: 183, fig. 2: 5.

Material. — About 300 well preserved specimens.
Dimensions (in μm):

length of shell minus tubes	156—212
width of shell	120—166
diameter of outer medullary shell	28—37
diameter of inner medullary shell	16—18
length of tubes	20—40
diameter of pores	4—8

The width to length ratio of shell amounts to between 1:1.3 and 1:1.7.

Remarks. — The specimens characterized above correspond to the description of *C.violina* Haeckel, but are somewhat larger.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; from the environs of Cracow to those of Przemyśl.

Genus *Ommatospyris* Ehrenberg, 1860
Ommatospyris virginea (Haeckel, 1887)
(pl. 1: 3; pl. 3: 9)

1887. *Cyphonium virgineum* Haeckel: 363, pl. 39: 12, 12a.

Material. — Twenty well preserved specimens.
Dimensions (in μm):

length of shell	145—193
largest width	105—138
diameter of outer medullary shell	23—35
diameter of inner medullary shell	19—23
diameter of pores	5—8

The width to length ratio of shell amounts to 1:1.5.

Remarks. — The specimens under study correspond to the description of *Cyphonium virgineum* Haeckel, but are somewhat larger. These forms have been assigned to the genus *Ommatospyris* (Campbell and Moore 1954).

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Cracow and Bochnia. The Pacific Ocean: Recent.

Family **Cenodiscidae** Haeckel, 1887
Genus *Cenodiscus* Haeckel, 1887
Cenodiscus discoides sp.n.
(pl. 4: 1a, 1b)

Holotype: specimen AGH Rad I/22; pl. 4: 1a, 1b.
Type horizon: Chodenice Beds, Middle Badenian.
Type locality: Kozłówek 3 borehole; depth: 33 m.
Derivation of the name: after a discoid shape of shell.

Material. — More than 100 well preserved specimens.
Dimensions (in μm):

diameter of shell	111—184, holotype 178
diameter of pores	10—15.

Diagnosis. — Shell discoid, round in outline, single, clathrate, rough on surface, but devoid of spines and processes. Margins obtuse, rounded. Pores round or subround, very closely but irregularly spaced. Ten to twelve pores occur over a half of the circumference of shell.

Remarks. — Our specimens correspond to the description of *C.rotula* Haeckel (*nomen nudum*), from which they differ in a smaller shell and larger, more closely spaced, pores.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Cracow.

Family **Phacodiscidae** Haeckel, 1882
Genus *Sethodiscus* Haeckel, 1882
Sethodiscus cf. *phacoides* Haeckel, 1887
(pl. 3: 10*a*, 10*b*)

Material. — Thirty poorly preserved specimens.
Dimensions (in μm):

diameter of cortical shell	88—119
diameter of medullary shell	31—38
diameter of pores on cortical shell	5—8
diameter of pores on medullary shell	5—8

Description. — Shell discoid, flattened, rather irregularly round in outline, composed of a discoid, clathrate cortical shell and a spherical, clathrate medullary shell concentrically embedded in it. Cortical shell very thin, mostly damaged and fragmentary. Pores on cortical shell round or subround, rather widely and irregularly distributed. Four to five of them occur over a half of the circumference of shell. Shells are connected by several thin, radial beams. The proportion between the diameters of medullary and cortical shell amounts to about 1:3.

Remarks. — The specimens described are similar to *S.phacoides* Haeckel (*nomen nudum*), being, however, half its size.

Occurrence. — Middle Badenian, *Velapertina indigena* Zone; environs of Cracow and Bochnia.

Family **Euchitoniidae** Haeckel, 1887
Genus *Euchitonia* Ehrenberg, 1860
Euchitonia furcata Ehrenberg, 1861
(pl. 1: 4; pl. 4: 2)

1862. *Euchitonia mülleri* Haeckel: 508, pl. 30: 5—10.
1887. *Euchitonia furcata* Ehrenberg; Haeckel: 532.
1887. *Euchitonia mülleri* Haeckel: 533.
1967. *Euchitonia furcata* Ehrenberg; Ling and Anikouchine: 1584, pl. 189, 190: 1, 2, 5—7 (complete synonymy).

Material. — Several hundred well preserved specimens.

Dimensions (in μm):

length of an unpaired arm	129—223
length of an paired arm	110—193
diameter of central disc	45—80
diameter of pores	about 3

Remarks. — A revision of this species was conducted by Ling and Anikouchine (1967), who acknowledged *E.furcata* Ehrenberg as the oldest synonym.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, the area from Upper Silesia to the environs of Przemyśl. Barbados: Tertiary. Sicily: Miocene. Pacific and Indian oceans: Recent deposits.

Genus *Dictyastrum* Ehrenberg, 1860
Dictyastrum cf. *angulatum* Ehrenberg, 1872
(pl. 4: 3)

Material. — 30 well preserved specimens and many fragments.

Dimensions (in μm):

length of arm	127—200
largest width of arm	64—80
diameter of central disc	55—90
diameter of pores	about 3

Remarks. — The specimens under study are in conformity with the description of *D.angulatum* Ehrenberg, from which they differ, however, in larger dimensions and, slightly, in the shape of arms, which, in our specimens, are slimmer and less widening towards ends. They also display considerable similarity to *D.trirhopalum* Haeckel (*nomen nudum*).

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; an area from Upper Silesia to the environs of Przemyśl.

Genus *Rhopalastrum* Ehrenberg, 1847
Rhopalastrum malagaense (Campbell and Clark, 1944)
(pl. 4: 5)

1944. *Rhopalodictyum* (*Rhopalodictya*) *malagaense* Campbell and Clark: 29, pl. 4: 5.

Material. — About 50 well preserved specimens and many fragments.

Dimensions (in μm):

length of an unpaired arm	100—187
length of an paired arm	100—180
largest width of arm	36—90
diameter of central disc	54—73
diameter of pores	3

Remarks. — The specimens under study correspond to the description of *Rhopalodictyum malagaense* Campbell and Clark. A distinctly concentric structure of the central disc and the presence of a clathrate plate covering the shell induces the present writer to assign the form described to the genus *Rhopalastrum* (see: Campbell and Moore 1954).

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; an area from Upper Silesia to the environs of Pilzno. North America: the Miocene of California.

Rhopalastrum irvinense (Campbell and Clark, 1944)
(pl. 4: 4)

1944. *Rhopalodictyum (Rhopalodictya) irvinense* Campbell and Clark: 29, pl. 4: 6, 7.

Material. — About 50 well preserved specimens and many fragments.
Dimensions (in μm):

length of arm	170—200
largest width of arm	85—105
diameter of central disc	65—80
diameter of pores	3

Remarks. — The specimens under study correspond to the description of *Rhopalodictyum irvinense* Campbell and Clark, but the concentric structure of their central disc and the presence of a clathrate plate covering the surface of shell induce the present writer to assign this species to the genus *Rhopalastrum* (see: Campbell and Moore 1954).

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; and area from Upper Silesia to the environs of Przemyśl. North America: the Miocene of California.

Genus *Hymeniastrum* Ehrenberg, 1847
Hymeniastrum euclidis Haeckel, 1887
(pl. 1: 5; pl. 4: 6)

1887. *Hymeniastrum (Hymeniastrella) euclidis* Haeckel: 531, pl. 43: 13.
1967. *Hymeniastrum euclidis* Haeckel; Ling and Anikouchine: 1488, pl. 191: 3, pl. 192: 3.
1969. *Hymeniastrum* cf. *euclidis* Haeckel; Barwicz-Piskorz: 184, fig. 2: 8.

Material. — About 100 well preserved specimens.
Dimensions (in μm):

length of arm	127—205
largest width of arm	108—140
diameter of central disc	65—85
diameter of pores	3

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; Upper Silesia, environs of Cracow and Brzesko. The Pacific: Recent deposits.

Genus *Flustrella* Ehrenberg, 1838
Flustrella concentrica Ehrenberg, 1838
(pl. 1: 6; pl. 5: 1a, 1b)

1875. *Flustrella concentrica* Ehrenberg: 160, pl. 22: 13.
1887. *Porodiscus concentricus* Haeckel: 492.

Material. — About 100 well preserved specimens.
Dimensions (in μm):

diameter of shell	190—304
diameter of central chamber	11—19
diameter of pores	4—8
number of rings	8—11

Remarks. — Our specimens are in conformity with the description of *Flustrella concentrica* Ehrenberg, but are somewhat larger.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone, environs of Cracow and Bochnia. Barbados: Tertiary; Sicily and Greece: Miocene.

Flustrella sp.
(pl. 6: 1*a*, 1*b*)

Material. — About 50 mostly poorly preserved specimens.
Dimensions (in μm):

diameter of shell	150—212
diameter of central chamber	54—67
number of rings	2—3
diameter of pores	3—10

Description. — Shell discoid, flat or somewhat convex, composed of a spherical central chamber surrounded by two or three concentric rings almost uniform in thickness which may fluctuate in various specimens within the limits of 13 and 26 μm. Radial beams, connecting the central chamber with rings and particular rings with each other are rather few (ten to twelve) and widely scattered. Shell fairly thick, with thin margins, slightly transparent. Outer ring mostly incomplete, partly crumbled. The surface of shell covered bilaterally with a clathrate plate with pores varying in size and closely spaced. Most pores round, only some of them irregular in outline.

Remarks. — The specimens described above are not similar to any species known in literature. The poor state of preservation precludes the possibility of erecting a new species.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Cracow and Bochnia.

Family **Spongodiscidae** Haeckel, 1882
Genus *Spongodiscus* Ehrenberg, 1854
Spongodiscus gigas Campbell and Clark, 1944
(pl. 5: 4*a*, 4*b*)

1944. *Spongodiscus* (*Spongodisculus*) *gigas* Campbell and Clark: 27, pl. 14: 1, 3.
1960. *Spongodiscus gigas* Campbell and Clark; Kozlova: 315, pl. 3: 2a, 2b.

Material. — Several hundred well preserved specimens.
Dimensions (in μm):

diameter of shell	158—389
diameter of pores	5—8

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; and area from Upper Silesia to the environs of Przemyśl; occurs abundantly. North America: The Miocene of Southern California. The USSR: the Middle and Upper Miocene of Sakhalin.

Spongodiscus enodatus Kozlova, 1960
(pl. 5: 2*a*, 2*b*)

1960. *Spongodiscus enodatus* Kozlova: 313, pl. 1: 4*a*, 4*b*.

Material. — More than 100 well preserved specimens.
Dimensions (in μm):

diameter of shell	270—390
diameter of pores	5—7

Remarks. — The specimens under study correspond to the description of *S.enodatus* Kozlova, from which they are somewhat smaller.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; an area from the environs of Cracow to those of Przemyśl. The USSR: the Miocene of Sakhalin.

Spongodiscus bulla Kozlova, 1960
(pl. 5: 3*a*, 3*b*)

1960. *Spongodiscus bulla* Kozlova: 312, pl. 2: 2*a*, 2*b*.

Material. — Twenty well preserved specimens.
Dimensions (in μm):

diameter of shell	181—262
diameter of the central (biconvex) part	36—63
diameter of pores	3—5

Remarks. — Our specimens are similar to *S.bulla* Kozlova, but differ from it slightly in a smaller size and, probably, also thickness of shell. Kozlova does not give this character in her description, but, as follows from her illustration (Kozlova 1960: pl. 2: 2b), her specimens are thicker.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Cracow and Bochnia. The USSR: the Miocene of Sakhalin.

Spongodiscus charybdaeus (Haeckel, 1862)
(pl. 6: 2)

1862. *Spongocyclia charybdaea* Haeckel: 472, pl. 28: 5, 6.

Material. — About 50 well preserved specimens.
Dimensions (in μm):

length of shell	208 to 380
largest width	162 to 289

Remarks. — Our specimens correspond to Haeckel's original description. According to a current definition of this genus (Campbell and Moore 1954), this species was assigned to the genus *Spongodiscus*. The shape of its shell displays considerable variability.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; Upper Silesia, environs of Cracow and Bochnia. The Mediterranean Sea: Recent species. Similar specimens were described by Bachman and Papp (1963) from Lower Badenian clays of the Vienna Basin as *Euchitonia mülleri* Haeckel.

Genus *Dictyocoryne* Ehrenberg, 1860
Dictyocoryne triangularis sp.n.
(pl. 1: 7; pl. 6: 3)

Holotype: specimen AGH Rad I/34; pl. 6: 3.
Type horizon: Chodenice Beds, Middle Badenian.
Type locality: Łysokanie XXI borehole, depth 80 to 81 m.
Derivation of the name: after a triangular shape of shell.

Material. — About 100 well preserved specimens.

Dimensions (in μm):

lenght of shell	235—334,	holotype 276
largest width	199—289,	holotype 240
diameter of central disc	51—88,	holotype 69
diameter of central chamber	10—18,	holotype 17

Diagnosis. — Shell flat, transparent, clathrate, triangular, bilaterally symmetrical, composed of a round central disc, containing a spherical central chamber surrounded by three or four concentric rings and three arms connected by a patagium. Arms equal in length, straight, arranged so that the unpaired one faces an angle between paired arms (90° to 100°). The angles between an unpaired arm and each of the paired ones qual each other (130° to 135° each). Patagium usually complete. Arms slightly lobately extended towards their ends. Arms and patagium have a spongy, irregular structure.

Remarks. — Our specimens are not similar to any species described so far.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Cracow and Bochnia.

Family **Laracariidae** Haeckel, 1887
Genus *Cenolarcus* Haeckel, 1887
Cenolarcus usitatus Kozlova, 1960
(pl. 6: 4*a*, 4*b*)

1960. *Cenolarcus usitatus* Kozlova: 314, pl. 4: 2.

Material. — About 300 well preserved specimens.

Dimensions (in μm):

length of shell	156—193
width of shell	138—166
diameter of pores	10—20

The width to length ratio of shell amounts to 1:1.2.

Remarks. — The specimens under study correspond to the description of *C.usitatus* Kozlova, but are somewhat smaller.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Bochnia. The USSR: Middle Miocene of Sakhalin.

Suborder **Nassellina** Ehrenberg, 1875
Family **Sethopiliidae** Haeckel, 1882
Genus *Lithopera* Ehrenberg, 1847
Lithopera renzae Sanfilippo and Riedel, 1970
(pl. 6: 5)

1970. *Lithopera* (*Lithopera*) *renzae* Sanfilippo and Riedel: 454, pl. 1: 21—23, 27.
1973. *Lithopera renzae* Sanfilippo and Riedel; Sanfilippo *et al.*: 221, pl. 5: 17, 18.

Material. — Twenty well preserved specimens.

Dimensions (in μm):

total length of shell	96—144
length of joint I	21—26
length of joint II	57—103
length of joint III	18—26
largest width of shell	75—90
diameter of pores	3—5

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Bochnia. The Pacific: Middle Miocene. According to Johnson and Parker (1972), the species *L.renzae* Sanfilippo and Riedel has a narrow age range and occurs in *Calocycletta costata* and *Dorcadospyris alata* Zones (at the turn of the Lower to Middle Miocene) in the bottom deposits of the Pacific Ocean.

Family **Lophophenidae** Haeckel, 1882 (= **Sethocyrtida** Haeckel, 1887)
Genus *Sethocyrtis* Haeckel, 1887
Sethocyrtis sp.
(pl. 6: 6)

Material. — Five well preserved specimens.
Dimensions (in μm):

total length of shell	72—96
length of joint I	20—26
length of joint II	62—72
largest width of shell	36—42
diameter of pores	3—5

Remarks. — The specimens under study are not similar to any species of the genus *Sethocyrtis* known in literature. Due to a small number of specimens, it is impossible to erect a new species.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Bochnia.

Family **Stichocorythidae** Haeckel, 1882
Genus *Eucyrthidium* Ehrenberg, 1847
Eucyrthidium calvertense Martin, 1904
(pl. 1: 8; pl. 6: 7)

1963. *Eucyrthidium calvertense* Martin; Nakaseko: 120, pl. 3: 7, 8 (here synonymy).

Material. — About 100 well preserved specimens.
Dimensions (in μm):

total length of shell	186—286
length of joint I	16—28
length of joint II	22—39
length of joint III	116—126
diameter of pores	4—6

The width to length ratio of shell amounts to 1:1.5 to 1:1.2.

Remarks. — Our specimens correspond to the description of *E.calvertense* Martin, but are somewhat larger.

Occurrence. — Poland: Middle Badenian, *Velapertina indigena* Zone; environs of Cracow and Bochnia. North America: Miocene of Maryland. Japan: Upper Miocene.

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WANDA BARWICZ-PISKORZ

RADIOLARIA Z MIOCENU ZAPADLISKA PRZEDKARPACKIEGO

Streszczenie

Radiolaria opisane w niniejszej pracy występują w osadach środkowego badenu zapadliska przedkarpackiego w obrębie poziomu z *Velapertina indigena*. Poziom ten odznacza się masowym występowaniem promienic, otwornic planktonicznych i pteropodów z rodzaju *Spiratella*. Zajmuje on stałą pozycję stratygraficzną ponad osadami chemicznymi, wykazuje szerokie rozprzestrzenienie geograficzne oraz niewielką miąższość. Dzięki wymienionym cechom stanowi on ważny poziom korelacyjny. Iły, w obrębie których notowana była obecność poziomu z Radiolaria są wydzielane jako warstwy chodenickie lub ich odpowiedniki (Alexandrowicz 1961*a*). Leżą one na osadach chemicznych a przykryte są warstwami grabowieckimi.

Zasięg geograficzny poziomu z Radiolaria jest związany z rozprzestrzenieniem poziomów osadów chemicznych, występuje on prawie w całej Paratetydzie od Opawy na zachodzie przez obszar zapadliska przedkarpackiego do Pleven w Bułgarii (Alexandrowicz 1961*b*). Należy zwrócić uwagę, że w osadach miocenu Paratetydy promienice pojawiały się w różnej pozycji stratygraficznej, lecz ich masowe nagromadzenie w wyraźnie wyodrębnionym poziomie o szerokim zasięgu geograficznym i w stałej pozycji stratygraficznej było zjawiskiem jednoczasowym. Masowy rozwój promienic w mioceńskim zbiorniku morskim był prawdopodobnie spowodowany przez następujący zespół czynników: ciepły klimat, silne zasolenie wody (wkrótce po zakończeniu sedymentacji chemicznej), duży dopływ wolnej krzemionki (pochodzącej z rozkładu tufitów), optymalna koncentracja azotanów i fosforanów oraz pionowa cyrkulacja wód.

W pracy opisano 38 gatunków promienic, w tym 7 nowych.

ВАНДА БАРВИЧ-ПИСКОЖ

РАДИОЛЯРИИ ИЗ МИОЦЕНА ПРЕДКАРПАТСКОГО ПРОГИБА

Резюме

Радиолярии представленные в настоящей работе находятся в отложениях среднего бадения предкарпатского прогиба в зоне *Velapertina indigena*. Зона эта характеризуется массовым количеством остатков радиолярий, планктонических фораминифер и птероподов из рода *Spiratella*. Занимает она постоянное страти-

графическое положение над химическими отложениями, характеризуется широким географическим распространением, а также небольшой мощностью. Благодаря вышеуказанным признакам является она важным кореляционным горизонтом. Глины, в которых отмечалось присутствие зоны из радиоляриями, выделяются как ходэницкие слои или их видоподобные варианты (Александрович, 1961 *а*) которых прикривают грабовецкие слои.

Радиоляриевый горизонт выступает почти во всем Паратетисе от местности Опава на западе, через предкарпатский прогиб до Плевен в Болгарии (Александрович, 1961б). В миоценовых осадках Паратетиса радиолярии выступают в разных стратиграфических положениях. Их массовое нагромождение, в резко выделенной зоне широкого географического распространения и постоянного стратиграфического положения принимается как одновременное явление. Сплошное развитие радиолярий в миоценовом бассейне, по всей вероятности вызвали нижеследующие факторы: субтропический климат, повышенная солёность воды (на окончании химической седиментации), большое присутствие свободного кремнезёма (из распада туфитов), оптимальная концентрация азотнокислых солей и фосфатов, а также вертикальная водная циркуляция.

В настоящей работе описаны 38 видов радиолярий, в том числе 7 новых.

EXPLANATION OF THE PLATES 1—6

Plate 1

1. *Cromyocarpus ovalis* sp.n. × 130. AGH Rad I/39; an outcrop at Chełm on the Raba.
2. *Cromyodruppa concentrica* Lipman × 180. AGH Rad I/40, Bochnia E borehole, depth 56.5 m.
3. *Ommatospyris virginea* Haeckel × 180. AGH Rad I/41, Łysokanie XXI borehole, depth 56 m.
4. *Euchitonia furcata* Ehrenberg × 130. AGH Rad I/42, an outcrop at Chełm on the Raba.
5. *Hymeniastrum euclidis* Haeckel × 130. AGH Rad I/43, Bogucice A borehole, depth 270 m.
6. *Flustrella concentrica* Ehrenberg × 150. AGH Rad I/44, an outcrop at Chełm on the Raba.
7. *Dictyocoryne triangularis* sp.n. × 150. AGH Rad I/45, Łysokanie XXI borehole, depth 80 m.
8. *Eucyrthidium calvertense* Martin × 150. AGH Rad I/46, Kozłówek 3 borehole, depth 33 m.

All SEM micrographs

Plate 2

1. *Melitosphaera minima* Clark and Campbell: AGH Rad I/1; Bogucice A borehole, depth 265 m.
2. *Cenosphaera micropora* sp.n.: holotype AGH Rad I/2; an outcrop at Chełm on the Raba.
3. *Cenosphaera mariae* Lipman: AGH Rad I/3; an outcrop at Chełm on the Raba.
4. *Thecosphaera saccoi* Principi: AGH Rad I/4; Ziemowit borehole, depth 31 m.
5. *Rhodosphaera* cf. *magnaporulosa* Nakaseko: AGH Rad I/5; Ziemowit borehole, depth 31 m.
6. *Caryosphaera sphaerica*: holotype AGH Rad I/6; Bochnia E borehole, depth 475 to 476 m.
7. *Spongoplegma* sp.: AGH Rad I/7; Łysokanie XXI borehole, depth 20 m.
8. *Staurolonche rara* Carnevale: AGH Rad I/8; an outcrop at Chełm on the Raba.
9. *Haliomma* sp.: AGH Rad I/9; an outcrop at Chełm on the Raba.
10. *Cenellipsis minuta* sp.n.; holotype AGH Rad I/10; Bochnia E borehole, depth 410 m.
11. *Ellipsostylus permagnus* Moksjakova: AGH Rad I/11; Kłaj 2 borehole, depth 400 m.

Plate 3

1. *Hexacontium miocenicum* sp.n.: *a* frontal view, *b* lateral view; holotype, AGH Rad I/12; an outcrop at Chełm on the Raba.
2. *Druppula* sp.: AGH Rad I/13; Bochnia E borehole, depth 410 m.
3. *Cromyocarpus ovalis* sp.n.: holotype, AGH Rad I/14; an outcrop at Chełm on the Raba.
4. *Cromyodruppa concentrica* sp.n.: *a* frontal view, *b* manner of connecting shells; holotype, AGH Rad I/15; Bochnia E borehole, depth 565 m.
5. *Prunopyle occidentalis* Clark and Campbell: AGH Rad I/16; Kozłówek 3 borehole, depth 30 m.
6. *Prunopyle* sp.: *a* frontal view, *b* manner of connecting shells; AGH Rad I/17; an outcrop at Chełm on the Raba.
7. ?*Cypassis irregularis* Nigrini: AGH Rad I/18; Ziemowit borehole, depth 20 m.
8. *Cannartus violina* Haeckel: AGH Rad I/19; Łysokanie XXI borehole, depth 56 m.
9. *Ommatospyris virginea* Haeckel: AGH Rad I/20; Łysokanie XXI borehole, depth 56 m.
10. *Sethodiscus* cf. *phacoides* Haeckel: *a* frontal view, *b* lateral view; AGH Rad I/21; an outcrop at Chełm on the Raba.

Plate 4

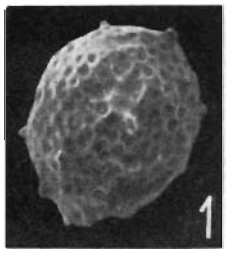
1. *Cenodiscus discoides* sp.n.: *a* frontal view, *b* lateral view; holotype, AGH Rad I/22; Szewczyk borehole, depth 16 m.
2. *Euchitonia furcata* Ehrenberg: AGH Rad I/23; an outcrop at Chełm on the Raba.
3. *Dictyastrum* cf. *angulatum* Ehrenberg: AGH Rad I/24; an outcrop at Chełm on the Raba.
4. *Rhopalastrum irvinense* (Clark and Campbell): AGH Rad I/25; Kłaj 2 borehole, depth 520 m.
5. *Rhopalastrum malagaense* (Clark and Campbell): AGH Rad I/26; Łysokanie XXI borehole, depth 30 m.
6. *Hymeniastrum euclidis* Haeckel: AGH Rad I/27; Bogucice A borehole, depth 270 m.

Plate 5

1. *Flustrella concentrica* Ehrenberg: *a* frontal view, *b* lateral view; AGH Rad I/28; an outcrop at Chełm on the Raba.
2. *Spongodiscus enodatus* Kozlova: *a* frontal view, *b* lateral view; AGH Rad I/29; Kłaj 2 borehole, depth 440 m.
3. *Spongodiscus bulla* Kozlova: *a* frontal view, *b* lateral view; AGH Rad I/30; an outcrop at Chełm on the Raba.
4. *Spongodiscus gigas* Campbell and Clark: *a* frontal view, *b* lateral view; AGH Rad I/31; Kłaj 2 borehole, depth 440 m.

Plate 6

1. *Flustrella* sp.: *a* frontal view, *b* lateral view; AGH Rad I/32; Kozłówek 3 borehole, depth 11 m.
2. *Spongodiscus charybdaeus* Haeckel: AGH Rad I/33; Borek Fałęcki borehole, depth 20 m.
3. *Dictyocoryne triangularis* sp.n.: holotype, AGH Rad I/34; Łysokanie XXI borehole, depth 80 to 81 m.
4. *Cenolarcus usitatus* Kozlova: *a* frontal view, *b* lateral view; AGH Rad I/35; Brzezowiec 1 borehole, depth 210 m.
5. *Lithopera renzae* Sanfilippo and Riedel: AGH Rad I/36; an outcrop at Chełm on the Raba.
6. *Sethocyrtis* sp.: AGH Rad I/37; an outcrop at Chełm on the Raba.
7. *Eucyrthidium calvertense* Martin: AGH Rad I/38; Kozłówek 3 borehole, depth 33 m.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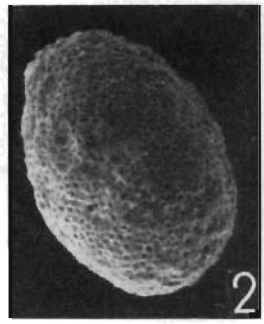
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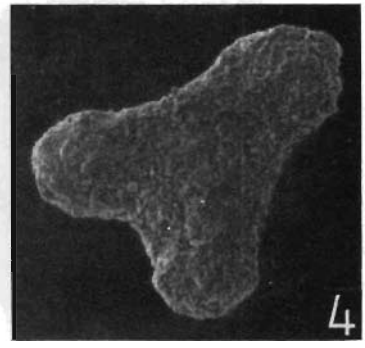
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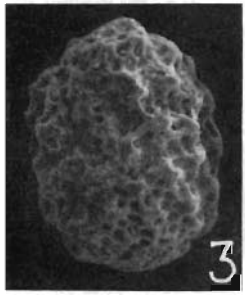
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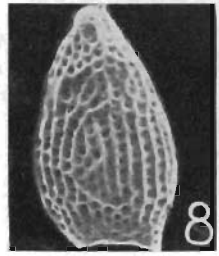
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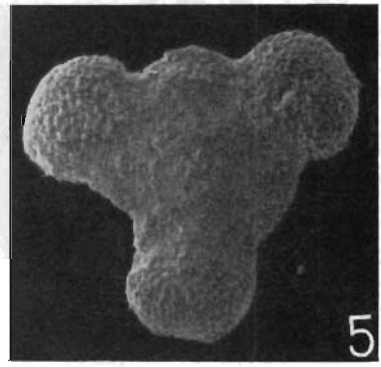
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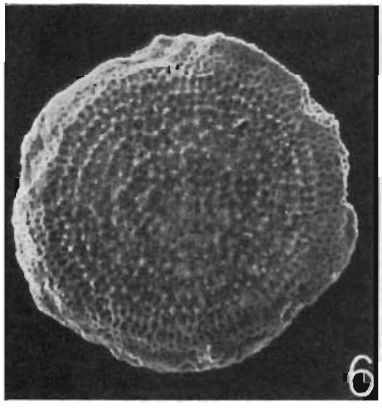
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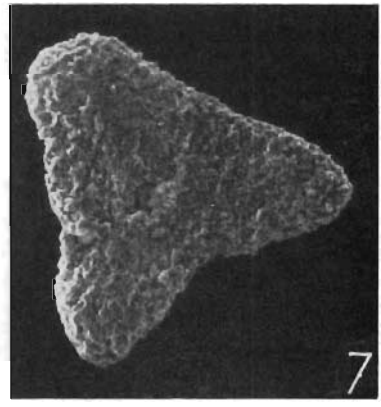
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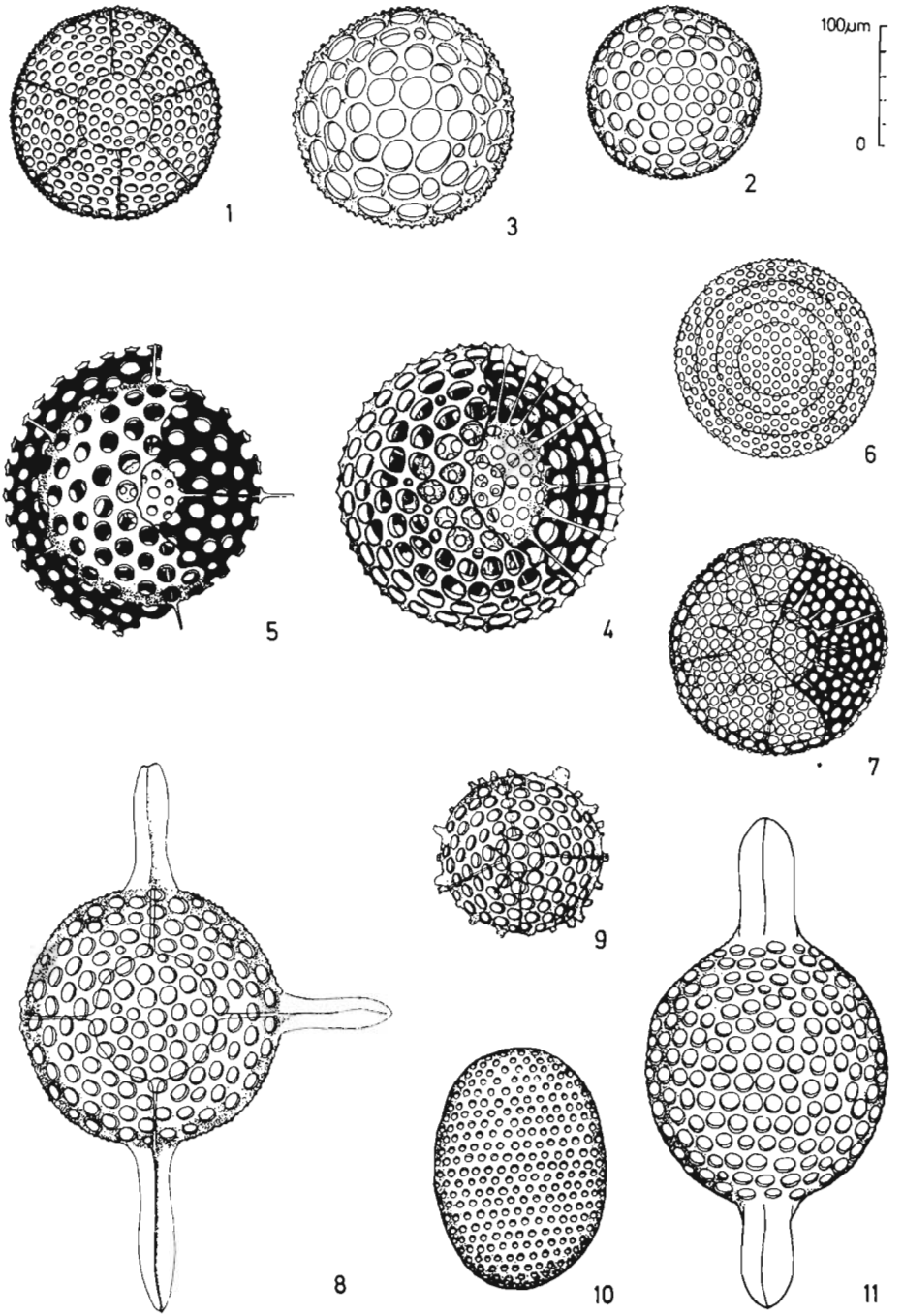
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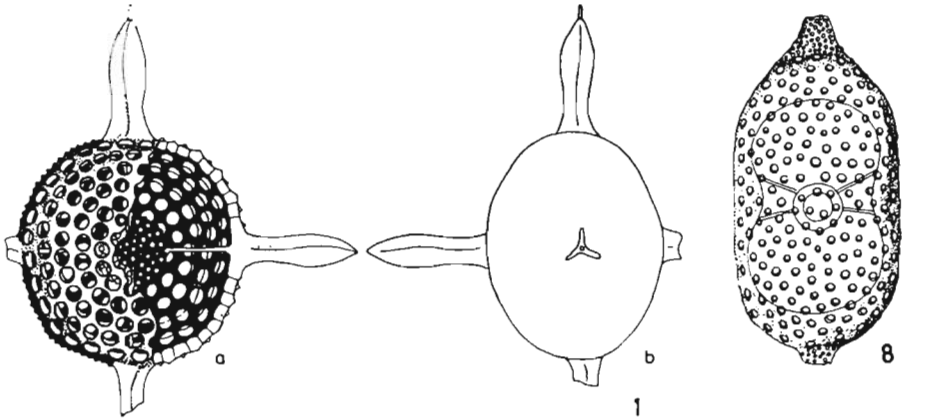
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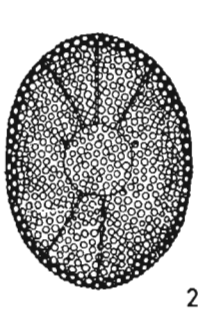
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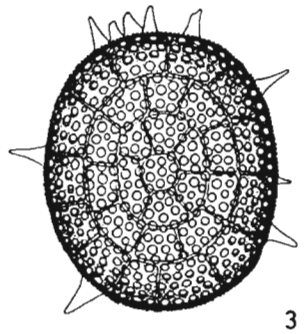
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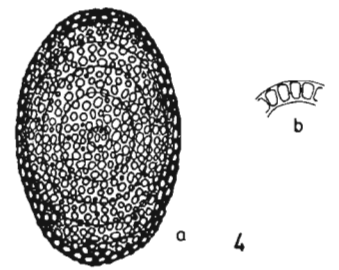
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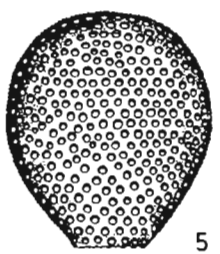
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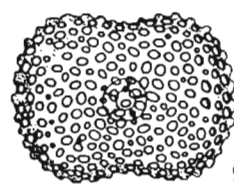
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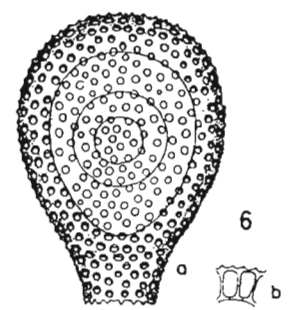
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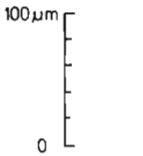
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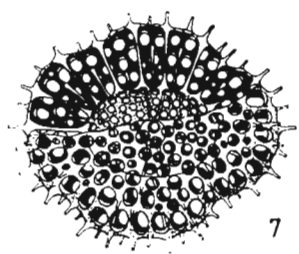
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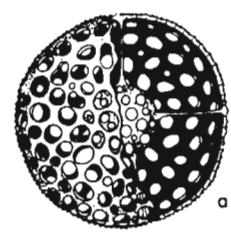
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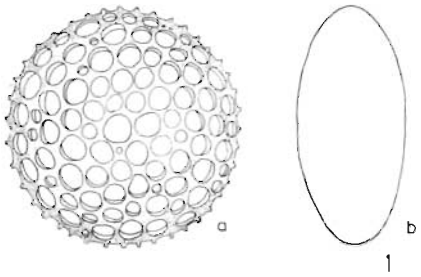

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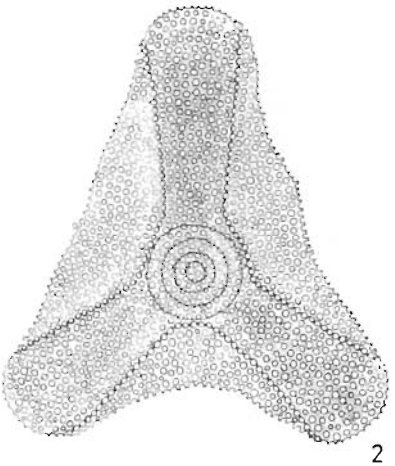

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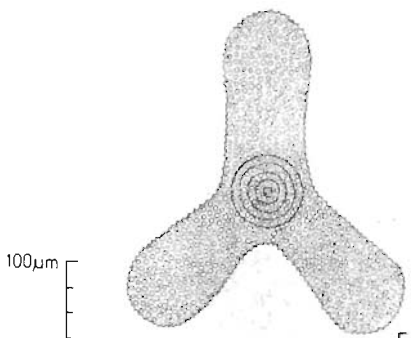

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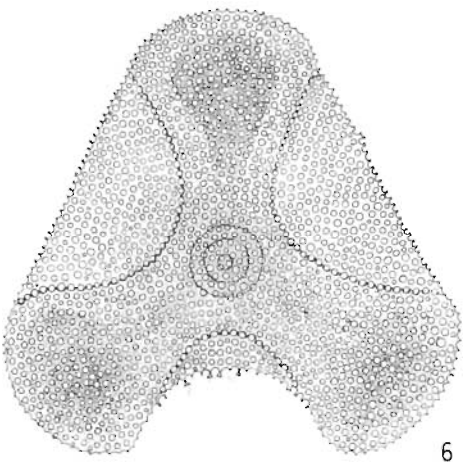

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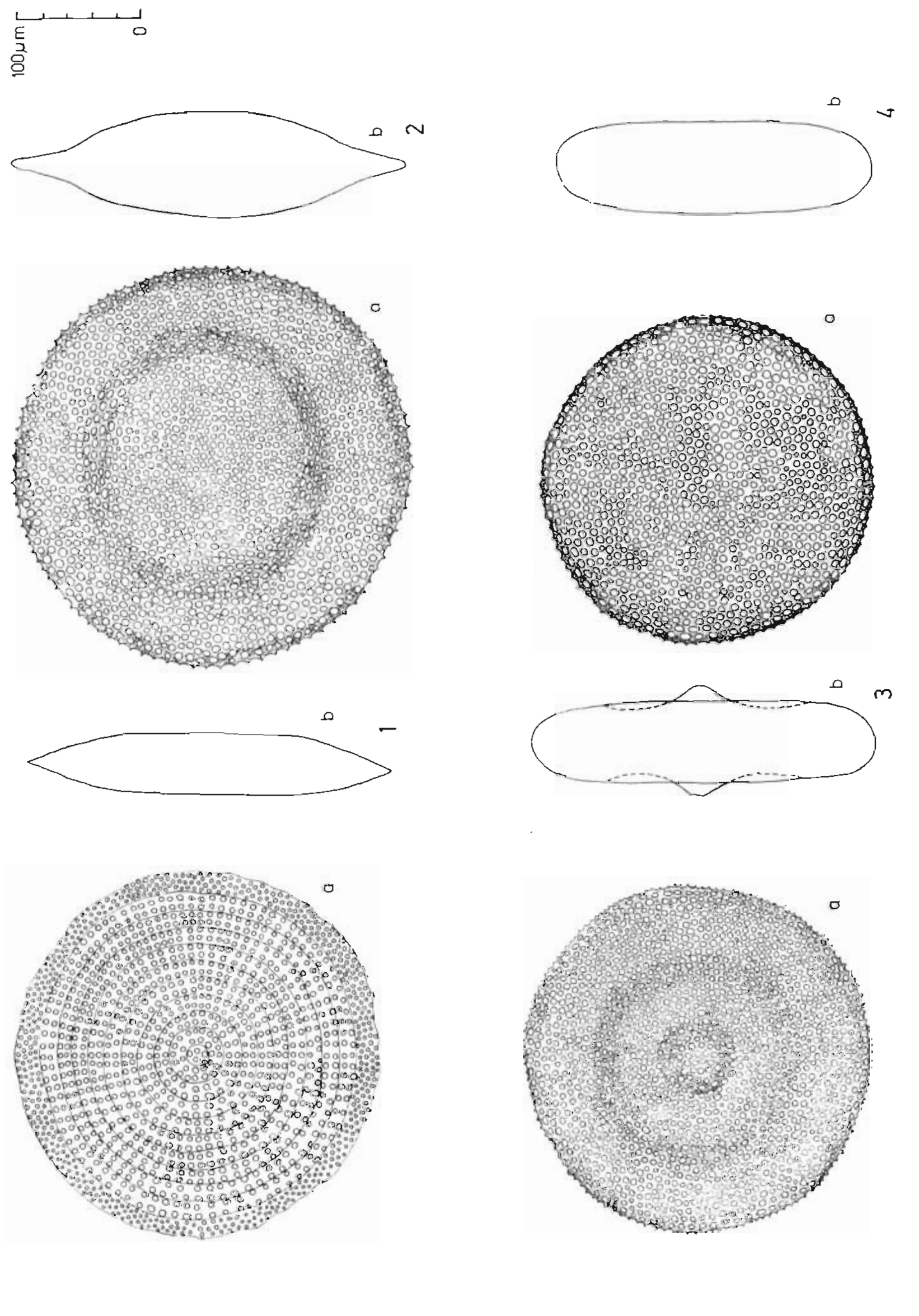
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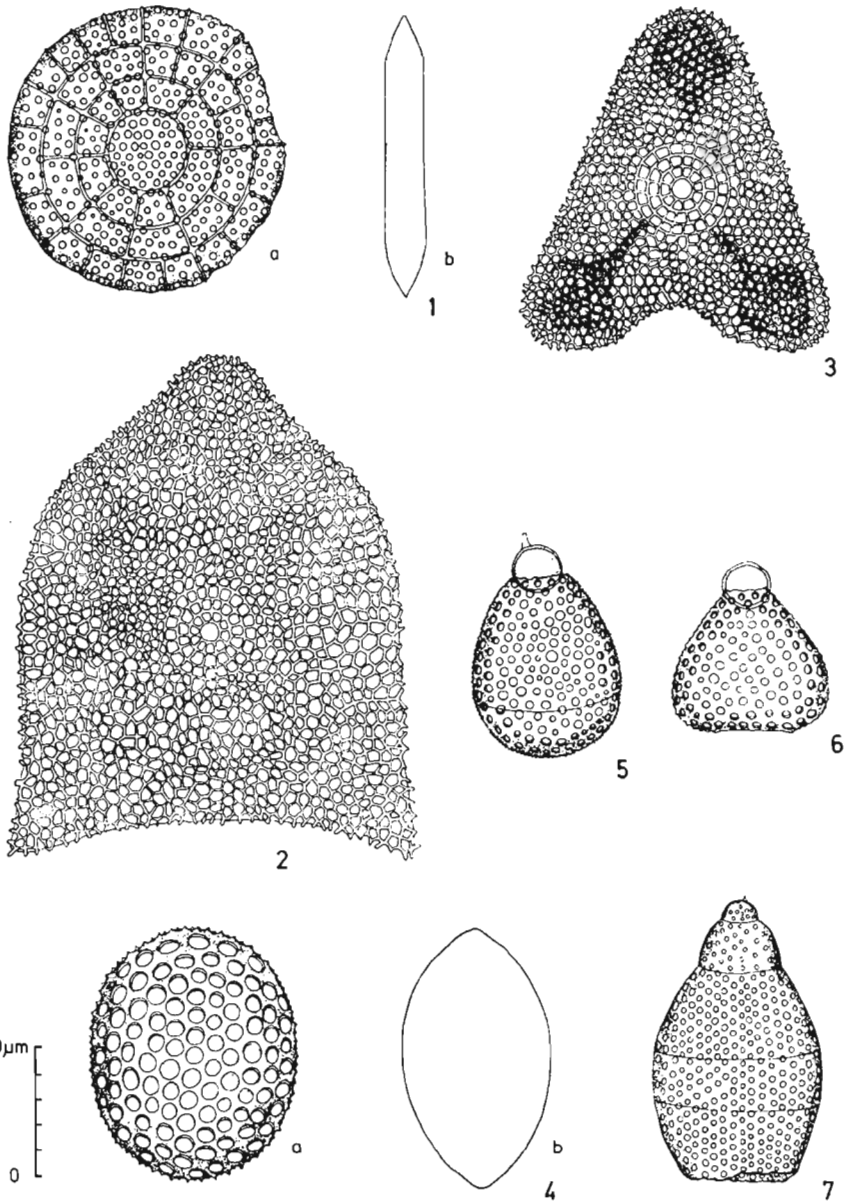
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