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MIDDLE LIAS MILIOLIDS FROM WESTERN POMERANIA (POLAND)

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Six species of *Ophthalmidium* and *Cornuloculina*, including 3 new ones (*C. plana* sp.n., *C. polonica* sp.n., and *C. pazdroe* sp.n.) are described from the Middle Lias of NW Poland. The species were differentiated taking into account biometric data: length and width of test, length-to-width ratio, length and number of chambers, and size of proloculus. *Ophthalmidium concentricum* (Terquem and Berthelin) is considered to be more shallow-water in requirements than *Cornuloculina orbiculare* (Burbach).

K e y w o r d s: Foraminiferida, Miliolidae, Ophthalmidiinae, taxonomy, Middle Lias, Poland.

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INTRODUCTION

A very rich assemblage of miliolids has been found in the core material of Lias rocks from the Świnoujście-1 borehole (depth 752.5—760.1 m) in western Pomerania (Poland). The assemblage, dated at the Carixian-Domerian (Rek 1976), was found in rocks mainly represented by dark-gray, fine-laminated claystones and marly siltstones, sometimes with sandy admixture, except for the sample no. 8 which is represented by black silty clays rich in a shell detritus. Table 1 gives numbers of samples and the depths at which they were taken.

A quantitative analysis of the whole microfaunal assemblage, presented elsewhere (Rek 1976), indicated that the foraminifera lived in a shallow marine reservoir, characterized by bathymetric and shoreline oscillations. The curves of frequency of two most common species, *Ophthalmidium concentricum* and *Cornuloculina orbiculare*, showed that a share of the former increases at the expense of the latter and vice versa (table 1; fig. 1). The share of remaining species is sufficiently low to be neglected. The paleoecological reconstructions presented in the above paper suggest

that *O. concentricum* is typical of shallow-water environment, and *C. orbiculare* — of somewhat deeper environment so that the share of the latter increases along with increase in the depth of a reservoir.

Table 1

Frequency of miliolid species in the samples studied

Depth and number of sample	Total number of specimens	Species	Number of specimens	Percent
753,3 m		*O. concentricum*	304	93,5
		C. orbiculare	3	0,9
3	325	*C. plana*	10	3,1
		C. polonica	6	1,8
		C. pazdroe	2	0,7
754,7 m				
4	8	*O. concentricum*	8	100.0
756,5 m		*O. concentricum*	115	92,0
		O. sp.	2	1,6
5	125	*C. orbiculare*	3	2,4
		C. plana	1	0,8
		C. polonica	1	0,8
		C. pazdroe	3	2,4
6	105	*O. concentricum*	101	96,2
757,9 m		*C. pazdroe*	4	3,8
7		*O. concentricum*	575	67,2
		C. orbiculare	109	12,7
758,8 m	855	*C. plana*	100	11,7
		C. polonica	54	6,4
		C. pazdroe	17	2,0
759,6 m		*O. concentricum*	1316	66,9
		O. sp.	4	0,2
8	1968	*C. orbiculare*	337	317,1
		C. plana	137	7,0
		C. polonica	110	5,6
		C. pazdroe	64	3,2

The present paper has been prepared in Enterprise of Oil and Gas Research at Piła and Geological Institute, Warsaw. The collections studied are housed in Geological Institute (IG). Warm thanks are due to the Head of Enterprise of Oil and Gas Research at Piła for making the studies and the use of materials as well as their laboratory facilities possible.

SEM micrographs were taken by means of JSM 35 Jeol microscope in Enterprise of Oil and Gas Research at Wołomin. Photos in transmitted and reflected light were made in the Enterprise at Piła (using petrographic MIN-8 microscope) and the Photographic Laboratory of the Geological Institute, Warsaw.

Warm thanks are especially due to Professor Olga Pazdro for numerous fruitful discussions and valuable suggestions.

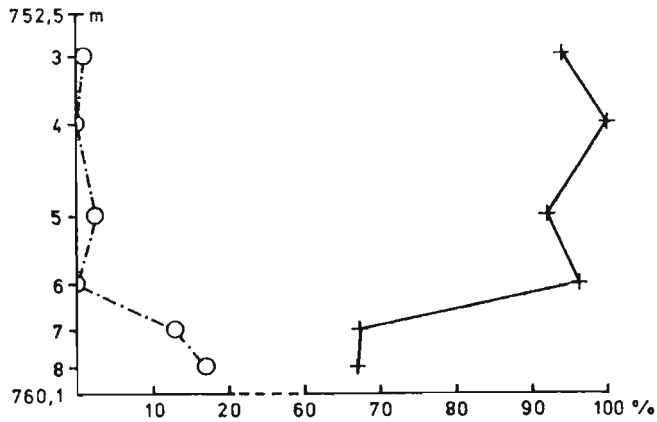


Fig. 1. Relative frequency of tests of *C. orbiculare* and *O. concentricum* in the borehole column Świnoujście-1; co-ordinate shows the depth at which a given sample has been taken.

TERMINOLOGY AND METHODS OF STUDIES

Figure 2 gives terminology and numeration of chambers as applied in this paper. The term "body chamber" is used after Pazdro (1958, 1972). In describing the genera *Ophthalmidium* and *Cornuloculina*, the majority of authors mention the existence of "plates" or "bridges" which separate individual "chambers" or whorls (Burbach 1886, Danitch 1971, Cushman 1927, 1948, Wood and Barnard 1946, Bogdanovitch 1952, Loeblich and Tappan 1964, and others). As it has been shown by Bykova (1948) and Pazdro (1958, 1972), chambers of representatives of these genera do not display any special plates or bridges which would separate individual whorls. Each chamber consists of a free space (body chamber) and surrounding wall which may either form "keels", "wing-like wall outergrowths" and "chamber floor" (Pazdro 1972: fig. 6), or it encloses the previous ones (in involute forms — see e.g. Pazdro 1972: fig. 5). In fossil state, body chamber is often infilled with deposit or pyrite. All of the elements of chambers mentioned above may be found in Lias material of the genera *Ophthalmidium* and *Cornuloculina* from the Świnoujście-1 borehole (see Pazdro 1972: fig. 6).

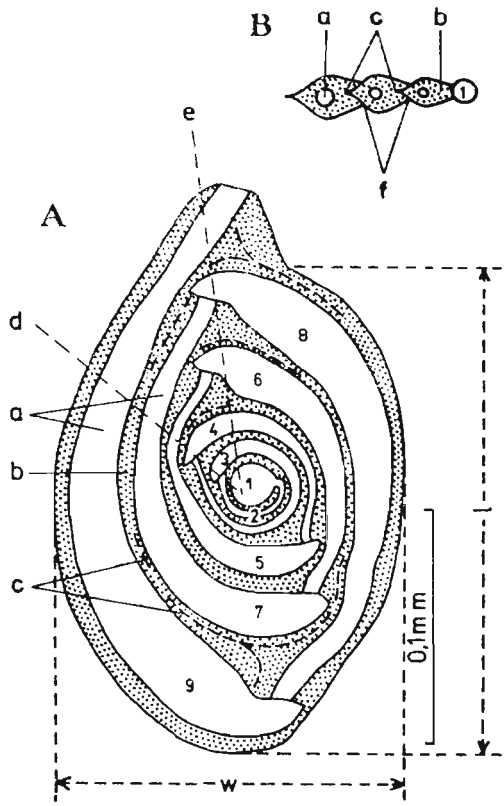


Fig. 2. *A* Internal structure as displayed by thick section (oriented in accordance with the coiling plane) of *Ophthalmidium concentricum* (specimen no. IG 10000/80/f) and *B* a generalized transverse section typical of *Cornuloculina pazdroe*. *1* proloculus (first chamber); *2* flexostyle (second chamber); *3—9* successive chambers; *a* body chamber; *b* space between body chambers, i.e. chamber wall (often called as plate or bridge); *c* internal suture; *d* line passing through joint points of middle body chambers; *e* line passing through joint points of outer body chambers; *f* outer suture; *l* length of test; *w* width of test.

Because of inhomogenous nature of the material studied, different methods were used in analysing individual groups of specimens. Translucent specimens were studied in transmitted light and the obtained data were analysed using methods discussed below. The studies covered representatives of 4 species: *Ophthalmidium concentricum* (Terquem and Berthelin), *Cornuloculina orbiculare* (Burbach), *C. plana* sp.n., and *C. pazdroe* sp.n. Opaque specimens were studied in relatively thick sections (because of highly fragile nature of the tests), oriented in accordance with the coiling plane. The studies showed that several tests resembling those of *Ophthalmidium concentricum* (Terquem and Berthelin) in outline and dimensions but differing in markedly thicker central part (which suggests coiling in various planes), do not display any significant differences in internal structure in relation to the latter (fig. 2). The differences appear merely related to a marked involuteness of the former (fig. 18: *J*, pl. 35: 4),

resulting in thickening of their central parts. The same method (of relatively thick sections oriented consistently with coiling plane) was applied in studies on internal structure of representatives of *C. polonica* sp.n.

INTERPRETATION OF BIOMETRIC DATA

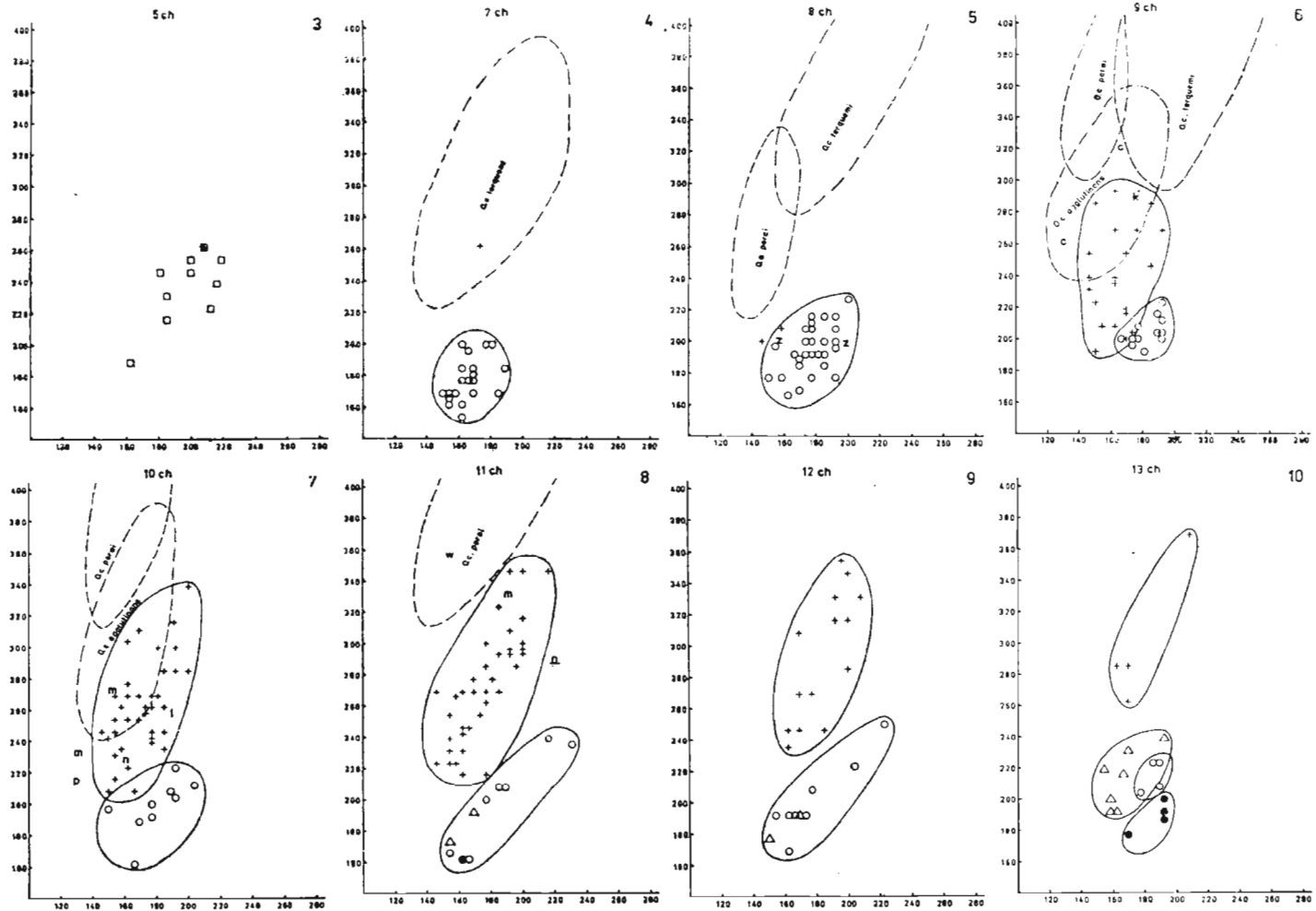
In the analysis of tests, the following features were taken into account: length and width, diameter of proloculus, number of chambers, length of flexostyle and the third chamber, length of the remaining chambers, shape of body chambers and nature of connections between them, tightness of coiling (measured as distance between neighbouring body chambers), and type of neck. The neck was omitted in measurements as it is usually broken off. Point diagrams and graphs show the obtained results and their interrelations. This method, previously used in the studies on miliolids by Pazdro (1958, 1972), makes more objective and accurate taxonomic identifications and estimations of the range on intraspecific variability possible.

Point diagrams show (figs. 3—10) the interrelationships between length and width of tests of different species at a given stage of growth (characterized by the same number of chambers). The analysis of diagrams made it possible to identify representatives of two genera, *Ophthalmidium* and *Cornuloculina*, in the studied population as they occupy different fields. The diagram drawn for 13-chambered individuals (fig. 10) enabled us to identify three species: *C. orbiculare* (Burbach), *C. plana* sp.n., and *C. polonica* sp.n., whereas the species *C. pazdroe* sp.n. is incomparable with the remaining ones because of much less numerous chambers (fig. 3).

The diagrams made it also possible to compare the species studied with those appropriately described or figured in the literature (figs. 4—8). Fields typical of some of these species largely overlap, giving the basis for their treatment as synonyms. This question is more fully discussed and comparisons are given in description of *Ophthalmidium concentricum* (p. 351).

Using the diagrams, the attempt was made to evaluate the variability of the following parameters characterizing individual species: changes in number of chambers (fig. 11), variability in the length-to-width ratio (fig. 12), and changes in length of flexostyle (fig. 16) and the third chamber (fig. 17). The graph from figure 11 shows that 5-chambered individuals are most common in *Cornuloculina pazdroe* sp.n., 8-chambered — in *C. orbiculare*, 13-chambered — in *C. plana* sp.n., and 10-chambered — in *Ophthalmidium concentricum*.

The curve of changes in the length-to-width ratio (fig. 12) displays a single peak in the case of all the species, except for *Ophthalmidium con-*



Figs. 3—10. Point diagrams of the ratio between length and width of specimens (vertical axis shows length and horizontal axis shows width); *ch* number of chambers; + ***Ophthalmidium concentricum***, ○ ***Cornuloculina orbiculare***, △ ***C. plana***, ● ***C. polonica***, □ ***C. pazdroe***. Data concerning other species after Pazdro (1972): *c* ***Ophthalmidium carinatum*** Kübler and Zwingli (after Wood 1947); *m* ***O. macfadyeni*** Wood and Barnard 1946; *n* ***O. northamptonensis*** Wood and Barnard 1946, megalospheric form; *n* as above, microspheric form; *p* ***O. obscurum*** (Ivanova) after Danitch 1971; *w* ***O. ivanova*** (Danitch); *z* ***O. cochlear*** Danitch; *k* ***O. kaptarenkoe*** (Danitch). Fields delineated with continuous line — species described here, and those delineated with broken line — subspecies proposed by Pazdro (1988).

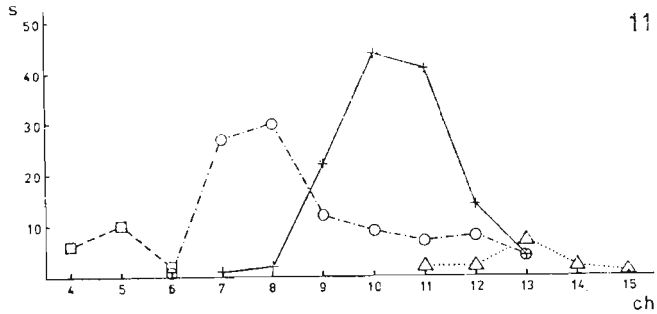


Fig. 11. Variability in number of chambers in the species *O. concentricum* (+), *C. orbiculare* (○), *C. plana sp.n.* (△), and *C. pazdroe sp.n.* (□), *s* number of specimens; ch number of chambers.

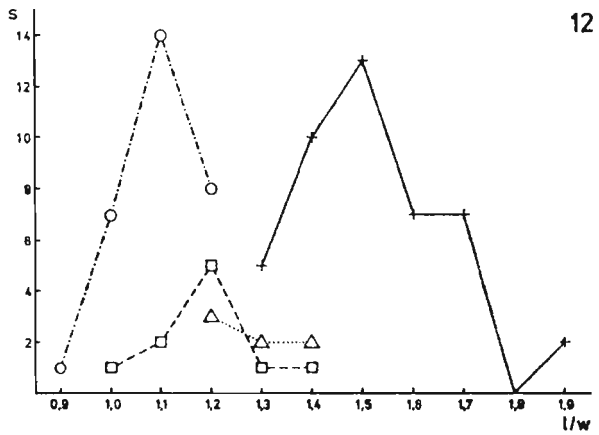


Fig. 12. Variability in the length-to-width ratio (l/w) for individuals with number of chambers typical for a given species: *Ophthalmidium concentricum*, 10 chambers (sample of 44 specimens), *Cornuloculina orbiculare*, 8 chambers (sample of 30 specimens), *C. plana* sp.n., 13 chambers (sample of 7 specimens), *C. pazdroe* sp.n., 5 chambers (sample of 10 specimens); other explanations as in fig. 11.

centricum (Terquem and Berthelin), characterized by a curve with 3 peaks. The search for the reasons of such shape of the latter curve resulted in differentiation of three morpho-type within that species, differing in length of test. The morpho-types are discussed in detail in characteristics of variability of *O. concentricum* (p. 351—353). The variability of the remaining features (lenth of flexostyle and the third chamber) may be found in descriptions of the species.

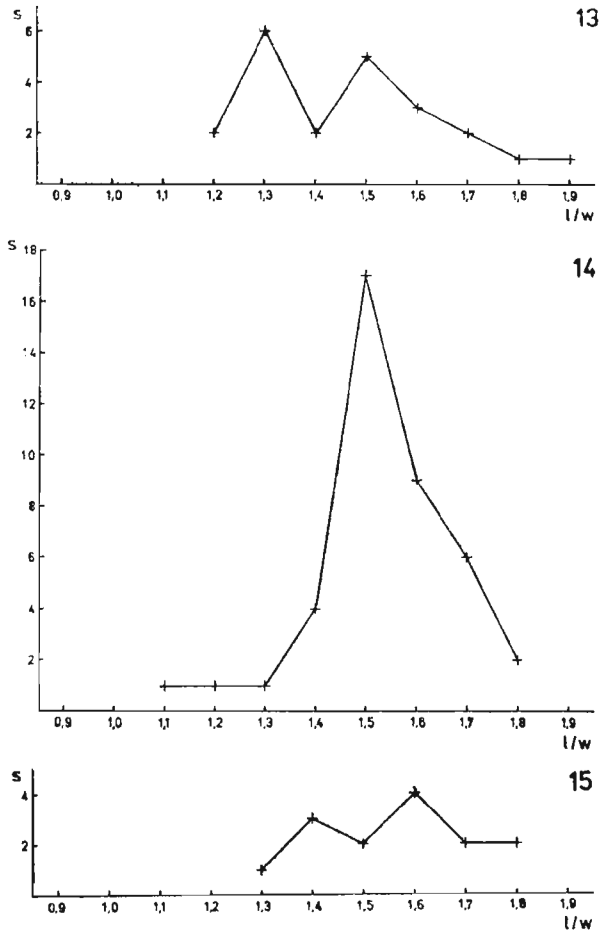
The data concerning the size of proloculus in the foraminifers studied (Table 2) gave further support to the point of view of Wood and Barnard (1946) and Pazdro (1958), according to whom the size of proloculus decreases along with the increase in number of chambers.

Table 2

Comparison of biometric data concerning the miliolids studied

N—number of specimens, L—length, W—width, D—diameter of proloculus

NUMBER of chambers		*Cornuloculina pazdroe*			*Cornuloculina orbiculare*			*Ophthalmidium concentricum*			*Cornuloculina plana*			*Cornuloculina polonica*		
		mean	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.
4	N	6														
	L	230	208	269												
	W	180	154	200												
	D	28	23	35												
5	N	10														
	L	236	189	262												
	W	197	162	219												
	D	24	19	31												
6	N	2			1											
	L	228	216	239	185											
	W	208	181	235	154											
	D	19	19	19	31											
7	N				27			1								
	L				177	154	200	262								
	W				166	150	189	173								
	D				26	23	31	23								
8	N				30			2								
	L				195	166	227	204	200	208						
	W				177	150	200	152	146	158						
	D				25	15	35	25	23	27						
9	N				12			22								
	L				204	192	223	242	192	293						
	W				183	166	192	164	146	192						
	D				22	12	27	21	15	31						
10	N				9			44								
	L				196	162	223	260	208	339						
	W				180	150	204	172	146	200						
	D				18	12	27	19	15	23						
11	N				7			41			2			1		
	L				203	162	239	272	216	346	182	173	192	162		
	W				188	154	231	175	146	216	162	154	169	162		
	D				14	8	19	18	12	27	17	15	19	15		
12	N				8			14			2					
	L				202	169	250	293	235	354	184	177	192			
	W				178	154	223	184	162	208	160	150	169			
	D				11	8	15	17	12	31	15	15	15			
13	N				4			4			7			4		
	L				214	204	223	300	262	369	213	192	239	189	177	200
	Wm				185	177	189	177	162	208	166	154	192	186	169	192
	D				12	12	12	14	12	15	13	12	15	19	15	23
14	N										2			1		
	L										184	177	192	216		
	W										176	162	189	177		
	D										12	12	12	15		



Figs. 13—15. *Ophthalmidium concentricum*. Curves of variability in the length-to--width ratio for individuals with 9, 11, and 12 chambers; s number of specimens, l/w length-to-width ratio.

REGENERATION

Anomalous forms were fairly often described and figured in the literature. Some authors explain their occurrence by anomalous ecological conditions (e.g. Trifonova 1970), whereas others only give their descriptions (e.g. Wood and Barnard 1946). It should be noted that new species or even genera were often proposed on the basis of such forms (see Bykova 1948, Bogdanovitch 1952, Azbel 1970, Terquem and Berthelin 1875 and others).

Untypical forms are also fairly common in the material studied. Disturbances in structure are easy to trace down in reflected light when they

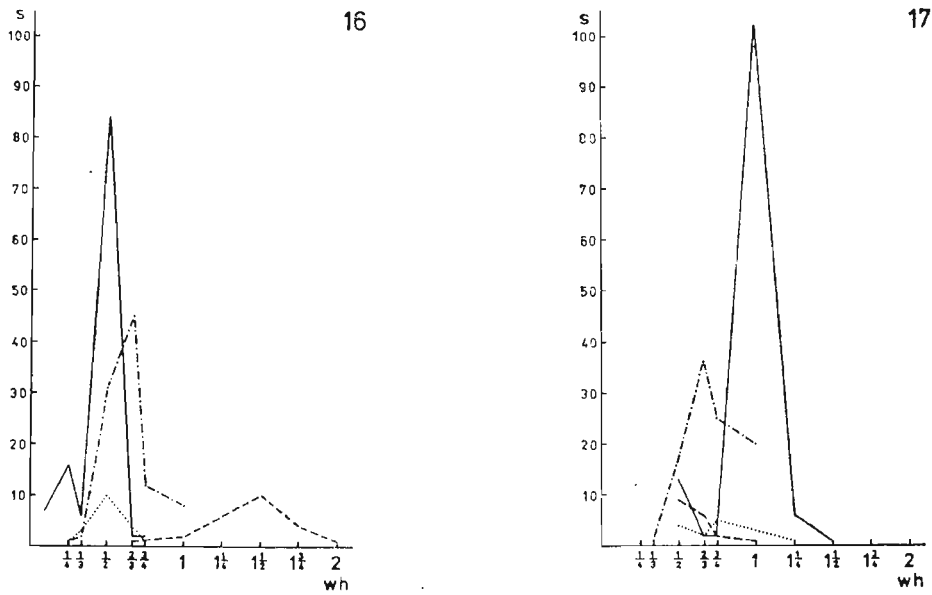


Fig. 16. Variability in the length of flexostyle: *s* number of specimens, *wh* length of flexostyle in relation to the length of one whorl; species marked as in fig. 11.

Fig. 17. Variability in the length of the third chamber: *s* number of specimens, *wh* length of the third chamber in relation to length of one whorl; species marked as in fig. 11.

are related to changes in coiling plane or appearance of supplementary chambers, otherwise further studies in transmitted light are necessary. The disturbances usually appear related to regeneration, similarly as in the case of *Ophthalmidium* from Bathonian clays of Częstochowa area, studied by Pazdro (1958).

The reasons of regeneration in the material studied are twofold: the entrance of a clastic grain to test interior or breakage of chamber wall. In the former case, the disturbances are connected with development of chambers around the grain (fig. 20: *E*; fig. 21: *F*) and in the latter they may be much greater as either successive chambers begin to surround the damaged part and they sometimes form additional necks (fig. 18: *M*, *N*; fig. 19: *K*; fig. 21: *E*) or there takes place a change in coiling plane, resulting in coiling of a part of test in varying planes (fig. 18: *O*; pl. 33: 6, 10). When the damage originated at a very early stage of growth, a form resembling the specimen IG 10011/80/f (fig. 18: *P*) may develop whereas a damage of almost adult individual may result in minor changes in shape of the ultimate chamber only (fig. 22: *F*; pl. 33: 11, 12) or its slight deviation and displacement of neck (fig. 22: *E*; pl. 32: 8, 10; pl. 33: 10).

In the Lias material studied, regeneration phenomena were found in representatives of all the identified species. The exception was here *Ophthalmidium* sp., presumably because of insufficiently numerous material.

REMARKS ON THE SUPERFAMILY MILIOLIDEA

For the Jurassic Miliolidea, several genera were proposed: *Ophthalmidium* Kübler and Zwingli, 1870, *Spirophthalmidium* Cushman, 1927, *Spiroloculina* d'Orbigny, 1826, *Cornuloculina* Burbach, 1886, *Praeophthalmidium* Knauff, 1966, *Eoophthalmidium* Langer, 1968, *Hauerinella* Schubert, 1921, and others. The views of various authors on these genera are summarized by Azbel (1971) and Pazdro (1972). The high number of the genera proposed may be explained by treatment of different features as diagnostic for a genus by individual authors. The majority of authors treat the length of chambers at early and (separately) late growth stages as the principal generic criterion (see Wood and Barnard 1946, Wood 1947, Azbel 1971, Pazdro 1972 and others). Nevertheless, some differences of opinions may be noted. For example, Loeblich and Tappan (1964) consider the genus *Cornuloculina* to be characterized by flexostyle up to 3 whorls long and successive chambers half a whorl long or shorter (2.5 to 3 chambers per whorl), and Azbel (1971) — by flexostyle 1/4 to 2/3 of a whorl long, the third (second as interpreted by that author) chamber one to one and half a whorl long, and the remaining chambers over half a whorl long (up to a whorl long in figures given in that paper).

Forms with very long flexostyle, even up to 4 whorls long, were often described (Franke 1936. Knauff 1966, Wood and Barnard 1946, Azbel 1971 and others). They were usually assigned to the genera: *Cornuloculina* Burbach, *Praeophthalmidium* Knauff, *Eoophthalmidium* Langer, and *Hauerinella* Schubert. No such forms were found in the material studied, in which the longest flexostyles (up to 2 whorls long at the most) are displayed by representatives of *Cornuloculina pazdroe* sp.n. (fig. 16). Specimens with extremely long flexostyles are also missing in the material from Vesulian and Bathonian clays of Częstochowa area (Pazdro, pers. inf.).

The analysis of early growth stage of a test is very tedious, especially in microspheric and multichambered forms. At that stage, chambers usually join one another at the angle of 180° and the joint is marked by a slight swelling only. It may be assumed that optic devices used by earlier authors were insufficiently precise and the obtainable magnifications too low for appropriate analysis of central parts of tests and, therefore, several chambers were treated as a single one.

Identification of species was somewhat impeded by the use of various techniques of illustrating and describing them by previous authors. In some papers no information on magnification of figured specimens is given (e.g. Paalzow 1922) or some biometric data concern holotype only (e.g. Fuchs 1970) which, along with rather laconic descriptions fall to give any indications with reference to intraspecific variability. Other papers (e.g.

Wood and Barnard 1946) fail to provide any information on the appearance of specimens in reflected light.

In modern subdivisions of the superfamily Miliolidae, most often differentiated families include Miliolidae and Ophthalmidiidae, which may be further subdivided into several subfamilies (Pokorny 1958, Bogdanovitch and Voloshinova 1959). Some authors reject the latter family, allocating the relevant species in Miliolidae (Schwager 1877, Brady 1884, Galloway 1933 and others). As it was shown by Pazdro (1972), genera assignable to the two families are characterized by identical wall structure and similar shape of body chambers and apertures, differing mainly in the mode of coiling: planispiral in Ophthalmidiidae and in varying planes in Miliolidae. However, transitional forms are fairly common which may make separation of the two families debatable and, therefore, gives further support to assignation of all the genera in a single family, Miliolidae and rejection of Ophthalmidiidae. That point of view is accepted here but it is proposed to retain the other taxon at the subfamily rank for accomodating two genera described in this paper: *Ophthalmidium* Kübler and Zwingli and *Cornuloculina* Burbach.

In the case of Lias material from Świnoujście-1 borehole, the recorded species are easy to allocate in the above mentioned genera taking into account the following features: test proportions (length-to-width ratio), nature of connections between body chambers and angle at which they are interconnected, as well as shape of body chambers and neck.

DESCRIPTIONS

Family **Miliolidae** Ehrenberg, 1839
Subfamily **Ophthalmidiinae** Wiesner, 1920
Genus *Ophthalmidium* Kübler and Zwingli, 1870

Type species: *Ophthalmidium carinatum* Kübler and Zwingli, 1870.

Supplemented diagnosis (see Pazdro 1972: 538). — Body chambers are usually connected at a right to low angle at late growth stages and at the angle close to 180° at the early stages. At the adult stage, diameter of body chamber is markedly varying along its length due to highly specific shape.

Remarks. — Kübler and Zwingli did not designate type species (Kübler and Zwingli 1870: 46) so some authors (Wood and Barnard 1946, Wood 1947, Bogdanovitch and Voloshinova 1959, Loeblich and Tappan 1964, Danitch 1971, Azbel 1971) chose *Ophthalmidium liasicum* (Kübler and Zwingli) as the type. However, as it was shown by Pazdro (1972: 531), the specific status of *O. liasicum* is debatable and *O. carinatum* Kübler and Zwingli appears much more appropriate as the type species. It should be noted that Kübler and Zwingli (1886: 11) based their species *O. liasicum* on a single, presumably damaged specimen.

Ophthalmidium concentricum (Terquem and Berthelin, 1875)

(pl. 32; pl. 33: 1, 2; pl. 35: 1—4; figs. 2, 18)

1875. *Spiroloculina concentrica* Terquem and Berthelin: 80, pl. 5: figs. 19—23.
1936. *Spirophthalmidium concentricum* (Terquem and Berthelin): Franke: 123, pl. 12: 15, 17.
1946. *Ophthalmidium macfadyeni* Wood and Barnard: 92, pl. 9.
1946. *Ophthalmidium northamptonensis* Wood and Barnard *partim*: 88, pls. 5, 6; *non* pl. 7: e, j, o.
1946. *Spiroloculina inopinata* Wood and Barnard: 93, pl. 10.
1956. *Spirophthalmidium concentricum* (Terquem and Berthelin): Mamontova: 37, pl. 1: 17a, b.
1958. *Spirophthalmidium concentricum* (Terquem and Berthelin): Antonova: 915, pl. 2.

Material. — About 2,000 well-preserved specimens (128 specimens prepared for studies in transmitted light). Point diagrams (figs. 4—10) and Table 2 present results of measurements of test length and width.

Description. — Tests smooth, ovate, egg-shaped, rounded or sharp-pointed, more or less elongate in outline in the coiling plane, flattened, sometimes convex, rarely somewhat concave in transverse section. Neck varying in length, short or long. Peripheral margin sharp or rounded. Coiling varying from evolute to semi-involute and involute. External sutures sometimes depressed (especially in evolute specimens) and, thus, well-marked, usually poorly visible. Coiling of chambers planispiral. The last two chambers of some specimens are very wide, flat, sometimes displaying very fine, hardly traceable longitudinal striae (pl. 32: 1, 3, 8). Aperture small, usually circular, sometimes ovate, situated at the end of neck. Neck rarely preserved, long, thin, sometimes with fine ridge-like lip (fig. 28: *C*, *D*, *M*; pl. 32: 6).

Transversal sections show that marginal chambers are usually more evolute and the test becomes more involute towards its center. The shape of body chambers of specimens with sharp peripheral margin changes from triangular in outer chambers to subcircular in the inner (pl. 35: 1, 2; fig. 18: *H*, *I*). In the case of specimens with rounded peripheral margin, the shape of body chamber of external chambers is semicircular to ovate (fig. 18: *K*, *L*; pl. 35: 3).

Arrangement of chambers is not visible unless the tests are studied in transmitted light. Proloculus is spherical and varying in size (Table 2). Flexostyle, i.e. the second chamber, usually extends from it at the right angle. Flexostyle is most often half a whorl long and then the third chamber reaches one whorl in length. Specimens with flexostyle a quarter of a whorl long are markedly scarcer. When this is the case, the third chamber is always half a whorl long (figs. 16, 17). Flexostyle is connected with the third chamber at the right angle or angle equal 180° and the remaining chambers are connected one with another at the angle close to 90° and they are about half a whorl long. Flexostyle represents a tube uniform in diameter and the remaining chambers display shape typical of that genus.

Inner suture is displayed by more translucent specimens only (fig. 2; fig. 18: *B*, *C*, *E*, *O*, *P*). Breakage takes place along the suture. The specimens are usually fairly tightly coiled.

The number of chambers noticeable in transmitted light is bigger than in reflected light, equalling 7—13. Individuals with 10 to 11 chambers are most common (fig. 11). Megalospheric forms have less chambers than the microspheric ones.

Variability. — Individual variability is fairly high. Point diagrams (figs. 4—10) show variability in length and width of tests. In order to find the feature responsible for the presence of additional peaks in graphs illustrating changes in the length-to-

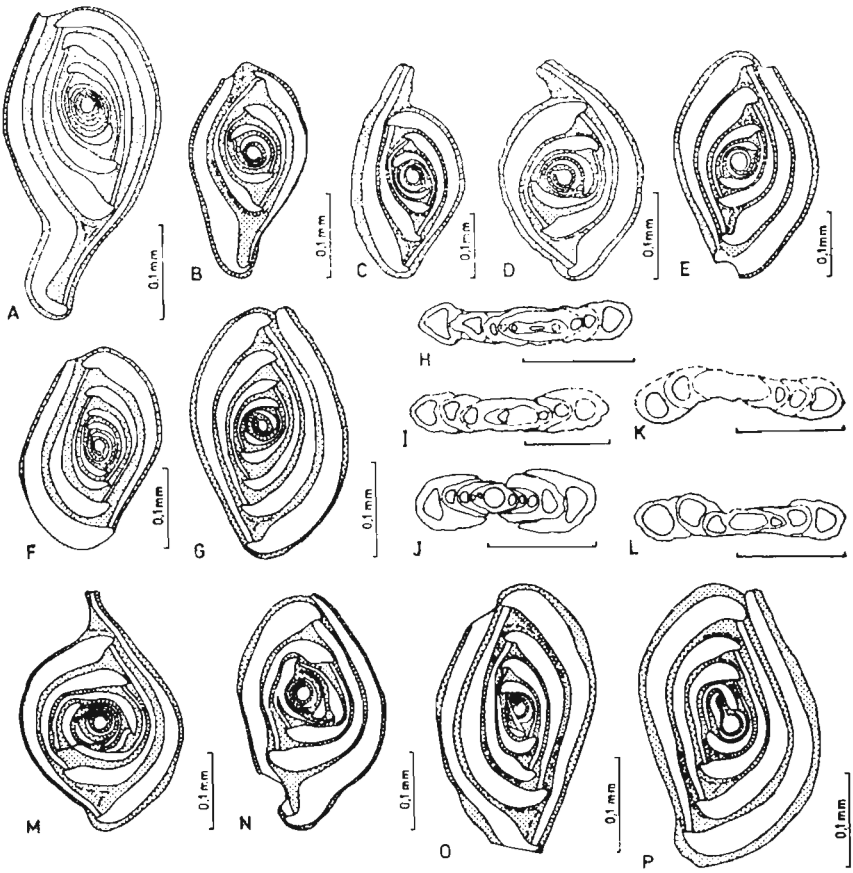


Fig. 18. *Ophthalmidium concentricum* (Terquem and Berthelin); drawings of specimens in transmitted light: *A* IG 10002/80/f, *B* IG 10001/80/f, *C* IG 10005/80/f, *D* IG 10003/80/f, *E* IG 10006/80/f, *F* IG 10004/80/f, *G* IG 10007/80/f, *H* IG 10064/80/f transverse section, in the plane passing by the proloculus; *I* IG 10065/80/f — transverse section, in the plane passing by the proloculus; *J* IG 10070/80/f — transverse section, in the plane passing through the proloculus; *K* IG 10067/80/f — transverse section, in the plane passing by the proloculus; *L* IG 10066/80/f — transverse section of regenerated specimen, in the plane passing by the proloculus; regenerated specimens: *M* IG 10008/80/f, *N* IG 10009/80/f, *O* IG 10010/80/f, *P* IG 10011/80/f.

-width ratio (figs. 12—15), several graphs were separately plotted for length and width values. The obtained graphs, not given here for the sake of clarity and brevity of the text, showed the length values to be responsible for the peaks. Three groups of specimens may be differentiated. Specimens of the first group are characterized by short-necked penultimate chamber, rounded ad-apertural end, the last two chambers connected at the angle close to 90°, and the length-to-width ratio ranging from 1.1 to 1.4 (fig. 18: E, F, G; pl. 32: 1, 2, 8; pl. 33: 1). Those of the second group are characterized by the penultimate chamber with very long neck and development of some kind of "tail" at ad-apertural end. The angle at which the last two chambers are connected in the "tail" is always very low and the specimens are characterized by the length-to-width ratio ranging from 1.7 to 1.9 (fig. 18: *A*, *B*; pl. 32: 4, 7). The third group comprises specimens with still underdeveloped "tail", neck of the penultimate chamber intermediate in length, the last two chambers con-

nected at the angle close to 60°, and the length-to-width ratio from 1.5 to 1.6 (fig. 18: *C*, *D*; pl. 32: 5; pl. 33: 2). The three groups differ in the above features only, displaying the same internal structure and appearance of tests. Therefore, they should not be treated as subspecies but rather morphological varieties (see p. 346).

The individual variability is also expressed in the degree of involuteness and — on a smaller scale — length of chambers and size of proloculus (and, therefore, number of chambers). Some specimens display slight deviations from the coiling plane. All the major differences in shape of tests, shape and length of chambers, and coiling plane presumably result from regeneration phenomena.

Comparisons. — Specimens originally identified as *Spirophthalmidium concentricum* (Terquem and Berthelin), and put here in the synonymy, differ from one another and those described here. For example, specimens described by Mamontova (1956) and Franke (1936) are formed of 5 to 15 chambers, and those of Antonova (1958) — 6 to 10 chambers. Those described by Antonova and Mamontova are longer than these described here but the length-to-width ratio (2 to 2.5 as reported by Antonova) suggests measurements of length of tests along with their necks. It should be also noted that flexostyle and the remaining chambers are half a whorl long in specimens described by Antonova (1959). Such individuals are also known in this species so Antonova's specimens may be treated as falling within its limits of individual variability.

Representatives of *Ophthalmidium concentricum* from the Lias of Świnoujście-1 borehole as seen in section appear very close in internal structure to those of *O. carinatum* (Kübler and Zwingli) as interpreted by both Macfadyen (1941) and Wood (1947) (compare the form with "tail" from fig. 18: B here and Wood 1947: pl. 30: 2; pl. 29: c). However, one can not be sure whether the specimens are also similar in their external appearance. From the Vesulian and Bathonian of Częstochowa area, Pazdro (1958) described *O. carinatum terquemi*, *O. carinatum porai*, and *O. carinatum agglutinans*. Of these, *O. carinatum terquemi* appears similar to *O. concentricum* as described here. The specimens of *O. concentricum* belonging to the group of markedly involute forms with rounded margin resemble representatives of that subspecies in the appearance of test, number of chambers (7—13 and 6—9, respectively), and dimensions at the 9-chamber stage (fig. 6: their fields partly overlap). The specimens studied differ from those of *O. carinatum porai* and *O. carinatum agglutinans* in outline of test and its appearance in reflected light as well as shape of body chamber. Considering *O. concentricum* and *O. carinatum* as synonyms is impeded by the fact that they come from different stratigraphic levels (the holotype of the former was derived from the Lias and of the latter — from the Dogger) and insufficient knowledge of their variability.

The 9-chambered forms of *O. concentricum* appear close to the representatives of *O. kaptarenkoae* (Danitch 1971) which differ from them in size, number of chambers (6—7), length of the third chamber (two-thirds of a whorl long) and rough, agglutinated-like wall structure.

Occurrence in Poland. — NW Pomerania: Carixian — Domerian.

Ophthalmidium sp.

(pl. 33: 3, 4, 5)

Material. — Eight slightly damaged specimens. The number of available specimens was too small for making transverse sections.

Dimensions (in mm):

	Length	Width	Length-to-width ratio
IG 10077/80/f	0.308	0.136	2.3
IG 10078/80/f	0.308	0.150	2.0

Description. — Calcareous test with rough wall (looking like covered with sticked up grains). The last two chambers sometimes smooth. Test outline markedly elongate in coiling plane (length-to-width ratio from 2.0 to 2.3). Test very thin and fragile. Transverse section uneven, curved. Peripheral margin rounded. Early chambers, as seen in reflected light, coiled in varying planes and the late — planispirally. Test evolute; sutures markedly depressed. Test fairly translucent in transmitted light (except for part coiled in varying planes, which precludes stating whether the specimens represent micro- or megalospheric forms); translucent part comprising no less than 6 chambers. Body chamber connected as a very low angle; shape typical of the genus *Ophthalmidium*. Test symmetrical, fairly tightly coiled; whorls consisting of two chambers at the late (translucent) stage. Neck broken off in all the available specimens, presumably long and thin as it may be judged on the basis of shape of the penultimate chamber.

Comparisons. — The specimens described seem most close to those of *Ophthalmidium carinatum agglutinans* Pazdro in somewhat agglutinated-like nature of test and markedly elongate shape, differing in first chambers coiled in varying planes (initial part of tests of *O. carinatum agglutinans* Pazdro displays typical planispiral coiling), smaller diameter of body chamber and low angle at which chambers are connected (close to 90° in *O. c. agglutinans* Pazdro). Small amount of available material makes specific identification hazardous.

Occurrence. — Poland (Świnoujście-1 borehole): Carixian — Domerian.

Genus *Cornuloculina* Burbach, 1886

Type species: Ophthalmidium orbiculare Burbach, 1886.

Redefinition of the genus. — Tests circular, rounded triangular, ovate or D-shaped in outline. Length-to-width ratio ranging from 0.9 to 1.4. Chambers planispirally coiled and usually connected at the angle of 180° at both early and late growth stages; connections of body chambers marked by a slight swelling at the beginning of a successive chamber only. Body chambers rounded or sharp-pointed at their thicker end; later they somewhat widen to undergo gradual narrowing afterwards. This results in rather minor changes in diameter of body chamber along its whole length at both early and late growth stages (figs. 19—21). Chambers display their own "chamber floors" (Pazdro 1972: fig. 6c). Necks usually short.

Remarks. — In discussing some species of the genus *Ophthalmidium* Kübler and Zwingli, Burbach (1886) put forward the question whether or not it is purposeful to establish a separate genus *Cornuloculina* to allocate such species as *Ophthalmidium orbiculare* Burbach and *O. ovale* Burbach. The genus *Cornuloculina* was originally defined as displaying features of both the genera *Cornuspira* and *Spiroloculina*. It should be noted that Burbach (*l.c.*) was paying much attention to the number of chambers per whorls (2 and 1 in *Ophthalmidium* and *Cornuloculina*, respectively). The reliability of that criterion may be doubted. In the assemblage studied, the species *Cornuloculina orbiculare* (Burbach) and *C. plana* sp.n. are characterized by 2-chambered last whorl and *C. polonica* sp.n. — by a 3-chambered one. The major difference between the genera is the angle at which chambers are connected: close to 90° or lower in *Ophthalmidium* and close to 180° in *Cornuloculina*.

Burbach did not designate any type species of the genus *Cornuloculina* and the type subsequently designated by Loeblich and Tappan (1964) is *Ophthalmidium inconstans* Brady. The selection was, however, rather infortunate as that species was mentioned by Burbach (*l.c.*) as an example of the genus *Ophthalmidium*. One is rather inclined to follow Azbel (1971) in treating the species *Ophthalmidium orbi-*

culare Burbach, the first of those given as examples of the genus *Cornuloculina* by Burbach (*l.c.*), as the type of that genus.

Cornuloculina orbiculare (Burbach, 1886)
(pl. 33: 6—12, fig. 19)

1886. *Ophthalmidium orbiculare* Burbach: 499, pl. 5: 3—6.
1961. *Ophthalmidium orbiculare* Burbach; Pietrzenuk: 55, pl. 9: 6.

Material. — About 450 well-preserved specimens (99 specimens prepared for studies in transmitted light). Point diagrams (figs. 4—10) and Table 2 show results of measurements of length and width of tests.

Description. — Tests smooth, circular to ovate in outline in the coiling plane, fairly thick, flattened, usually somewhat concave in transverse section (fig. 19: *F*, *G*; pl. 35: 6). Peripheral margin rounded; keel missing. Tests always evolute, with markedly depressed external sutures. Subdivision into chambers hardly visible in reflected light, resulting in marked similarity to representatives of the genus *Cornuspira*. The last two chambers of some specimens somewhat wider and laterally flattened. Aperture small, usually circular, located at the end of the last chamber. Neck very short, wide (especially at the base), usually without any additional elements (only occasionally with slight thickening at its end), rarely deviating from the rest of specimen.

Body chambers circular, ovate or semicrescent in transverse section (fig. 19: *F*, *G*; pl. 35: 6). Tests weakly translucent in transmitted light, especially close to outer margin on account of its thickness. Proloculus spherical, varying in size

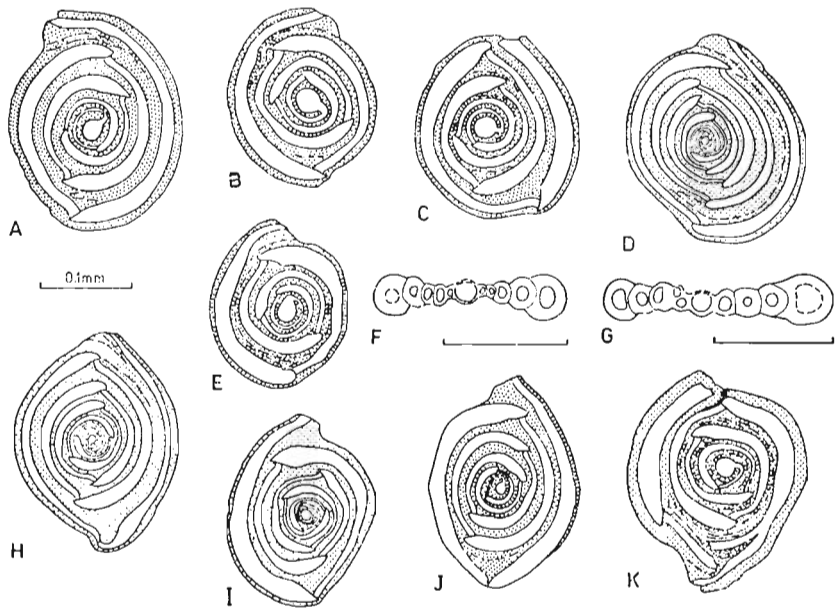


Fig. 19. *Cornuloculina orbiculare* (Burbach), drawings of specimens in transmitted light: *A* IG 10019/80/f, *B* IG 10017/80/f, *C* IG 10018/80/f, *D* IG 10014/80/f, *E* IG 10016/80/f; *F* IG 10062/80/f — transverse section, in the plane passing through the proloculus; *G* IG 10061/80/f — transverse section, in the plane passing through the proloculus; *H* IG 10013/80/f; *I* IG 10012/80/f; *J* IG 10015/80/f; *K* IG 10020/80/f — regenerated specimen.

(Table 2). Flexostyle (second chamber), connected with proloculus at the angle close to 90°, usually half to two-thirds of a whorl long (fig. 16). The third chamber is connected with it at the angle of 180° or somewhat lower (occasionally as low as 90°), usually two-thirds of a whorl long (fig. 17). The remaining chambers usually connected with one another at the angle close to 180°. Middle chambers usually about two-thirds of a whorl long and the last chamber — half a whorl long. Forms with the last chambers as long as the middle may be juvenile.

Flexostyle narrow, tubular, uniform in diameter. The remaining body chambers display shape typical of this genus. Some specimens are characterized by chamber bodies slightly widened at their thinner ends, close to the aperture of the next ones. However, that phenomenon is not typical for all the chamber bodies in a given specimen.

Inner suture, noticeable in highly transparent specimens (fig. 19: *A—E, H, K*), sometimes looks as double. The second line may represent external suture — see fig. 2. Tests are usually fairly tightly coiled.

The number of chambers visible in transmitted light ranges from 6 to 13. Eight-chambered individuals predominate here (fig. 11). Megalospheric specimens are characterized by less numerous chambers than the microspheric ones.

Individual variability is here primarily expressed in changes in dimension of tests (figs. 4—10) and proloculus (Table 2) and, on a smaller scale, length of chambers. Individuals wider than longer appear fairly common.

Comparisons. — The specimens studied differ from the representatives of *Ophthalmidium orbiculare* as described by Burbach (1886) in length of chambers. It is not excluded that the measurements made by Burbach were inaccurate because of the use of imprecise optic devices (see p. 00). However, test dimensions are similar (0.14—0.20 in Burbach) as well as the stratigraphic setting (Lias δ), so the specimens from Świnoujście-1 borehole are allocated in that species. The specimens studied also differ in length of chambers from the specimens described as *O. orbiculare* Burbach by Franke (1936). The latter are characterized by flexostyle 1—1.5 whorl long, the third chamber over a whorl long, and the next chamber (termed as the third by Franke) — two whorls long.

The specimens from Świnoujście-1 borehole also differ from those described as *O. orbiculare* Burbach by Antonova (1958) which are characterized by flexostyle 0.5 to 1.5 a whorl long, the length of three subsequent chambers decreasing from 1.3 to 1.0 whorl, chambers connected at the right angle, peripheral margin "sharp or uneven due to breaking off". The specimens vary in size from 0.22 to 0.25 mm, so they are larger than the Pomeranian ones (compare Table 2). As it follow out from Antonova's drawing (Antonova 1958: 915), the form is characterized by all the chambers longer than one whorl.

Azbel (1971) assigned the species in question to the genus *Cornuloculina*, reporting different lengths of chambers: flexostyle 1/4—2/3 of a whorl long, the third chamber — 1—1.5 a whorl long and the remaining chambers over half a whorl long.

The forms described above are smaller than those illustrated as *Ophthalmidium orbiculare* Burbach by Barieri (1964: 747, pl. 56: 12), 0.35—0.55 mm in size. They also differ slightly in appearance. Barbieri's photograph shows to the presence of a keel and the occurrence of a "ridge" in the middle part of last chambers which makes it more similar to *Cornuloculina pazdroae* sp.n. (rhomboidal shape of chambers in transverse section). The only feature typical of the species *C. orbiculare*, displayed by the specimen, is the nature of neck. However, the drawing is not very clear and the description too generalized.

The described species is very close to *Ophthalmidium* sp. 1 of Barbieri (1964: 747, pl. 56: 8) which, however, differs from it in size (0.32—0.57 mm).

Occurrence in Poland. — Pomerania: Carixian-Domerian.

Cornuloculina plana sp.n.

(pl. 34: 1—3; pl. 35: 5, fig. 20)

Holotype: IG 10118/80/f; pl. 34: 1.

Type horizon: Carixian-Domerian.

Type locality: Świnoujście-1 borehole, depth 759.6 m.

Derivation of the name: *Lat. planus* — even, flat.

Diagnosis. — Tests circular to ovate; thin, flattened in transversal section. Peripheral margin rounded, without keel. External sutures and subdivision into chambers invisible in reflected light. Internal sutures noticeable in transmitted light. Tests tightly coiled. Chambers 11 to 15 in number.

Material. — About 250 well-preserved specimens (15 specimens prepared for studies in transmitted light). Point diagrams (figs 8—10) and Table 2 present measurements of length and width of tests.

Description. — Imperforate calcareous tests, smooth, planispirally coiled, circular to ovate in outline, thin, flattened in transverse section (fig. 20: *F*; pl. 35: 5). Peripheral margin rounded, without keel. Specimens evolute or semi-involute in outer part, involute in the central part. Aperture small, circular, toothless. Neck very short, wide (especially at the base), usually without any additional elements (sometimes with some swelling close to the aperture), rarely deviating from the rest of specimen. Body chambers circular, cordate or ovate in transverse section (fig. 20: *F*; pl. 35: 5).

Tests highly translucent in transmitted light. Proloculus spherical, small (see Table 2 for dimensions). Flexostyle contacting proloculus at the right angle, usually half a whorl long (fig. 16). The third chamber and flexostyle connected at the angle close to 180° or somewhat lower (sometimes even at the right angle) and usually 3/4 of a whorl long but, occasionally, even over a whorl long (fig. 17). The

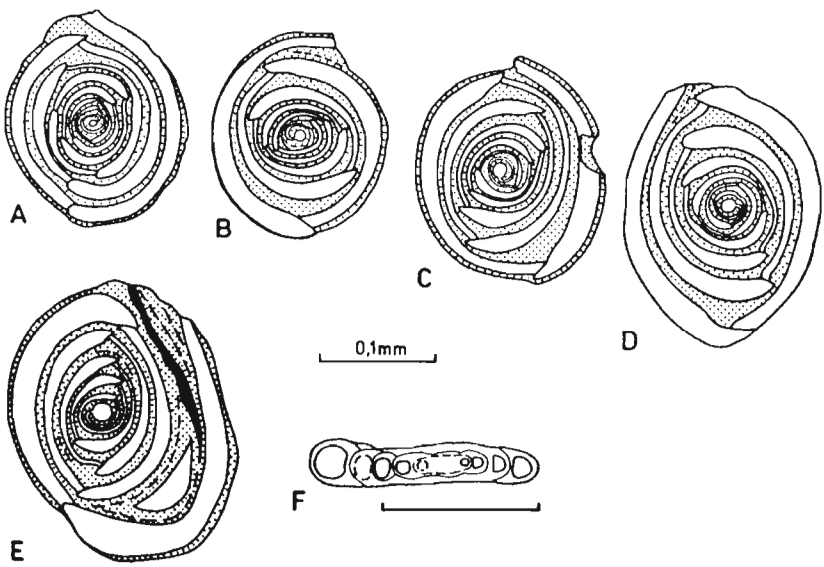


Fig. 20. *Cornuloculina plana* sp.n., drawings of specimens in transmitted light: *A* IG 10021/80/f, *B* IG 10022/80/f, *C* IG 10023/80/f, *D* IG 10024/80/f; *E* IG 10025/80/f — regenerated specimen; *F* IG 10063/80/f — transverse section, in the plane passing by the proloculus.

remaining chambers are usually about half a whorl long, being connected at the angle close to 180°. In some specimens, body chamber is bent at the right angle at its thinner end, close to the connection with the next one. When this is the case, chambers are also connected at the right angle.

Flexostyle narrow, tubular, uniform in diameter. Shapes of the remaining body chambers typical of the genus. The most common are 13-chambered forms (fig. 11). Megalospheric forms were not found in the material studied.

Individual variability is rather small. The variability in length and width of tests and diameter of proloculus is shown in table 2 and diagrams from figs. 8—10. It also concerns arrangement of chambers and their length (around half a whorl long).

Comparisons. — No similar forms were found in literature. The specimens are most close to those described as *Ophthalmidium lateseptatum* (Burbach) by Antonova (1959) in internal structure which differ from them in size (0.25 to 0.30 mm in diameter), less numerous chambers (5—6 in number) and peripheral margin "sharp or uneven due to breaking off".

The specimens are most similar to those of *Cornuloculina clausa* Antonova (1973: 11—12; pl. 1:1, pl. 2:1—7), differing in size (*C. clausa* is 0.20—0.34 mm in diameter and 0.07—0.1 mm thick), less numerous chambers (8), larger proloculus (0.016—0.040 mm in diameter) and length of chambers.

Occurrence. — Type horizon and type locality as above.

Cornuloculina polonica sp.n.

(pl. 34: 4—6; pl. 35: 7, 8; fig. 21)

Holotype: IG 10119/80/f; pl. 34: 4.

Type horizon: Carixian-Domerian.

Type locality: Świnoujście-1 borehole, depth 759.6 m.

Derivation of the name: After Poland, where this species was found.

Diagnosis. — Tests rounded triangular, circular or ovate in outline, thick, flattened, somewhat concave in the middle of transverse sections. Peripheral margin rounded, without keel. Coiling involute to semi-involute. In reflected light, only the last three chambers (forming outer whorl) are usually visible. External sutures rarely visible. The last three chambers always a third of a whorl long. Tests tightly coiled. Chambers 11 to 14 in number.

Material. — About 170 well-preserved specimens (10 specimens prepared for studies in transmitted light). Point diagrams (figs. 8—10) and table 2 present length and width values.

Description. — Imperforate calcareous tests, smooth, planispirally coiled, rounded triangular, circular or ovate in outline, thick, flattened, somewhat concave in the middle in transverse section (fig. 21: *G*, *H*; pl. 35: 7, 8). Peripheral margin rounded, without keel. Aperture circular, toothless. Neck very short, wide (especially at the base), usually without additional elements, rarely deviating from the rest of specimen. Body chambers semicircular or slightly bent in transversal section (pl. 35: 7, 8; fig. 21: *G*, *H*).

Internal structure untraceable in transmitted light until lateral surface of test is partly polished out. Proloculus spherical, moderately large (Table 2). Flexostyle connected with proloculus at the right angle and about a third of whorl long. The third chamber, connected with flexostyle at the angle of 180°, varies in length from 2/3 to 3/4 whorl and, sometimes, being almost a whorl long. The remaining chambers are usually connected with one another at the angle of 180° or by similar bends as in *C. orbiculare* and *C. plana* sp.n., at the angle of 90°. Flexostyle narrow, tubular, uniform in diameter. The remaining chambers display shape typical of the ge-

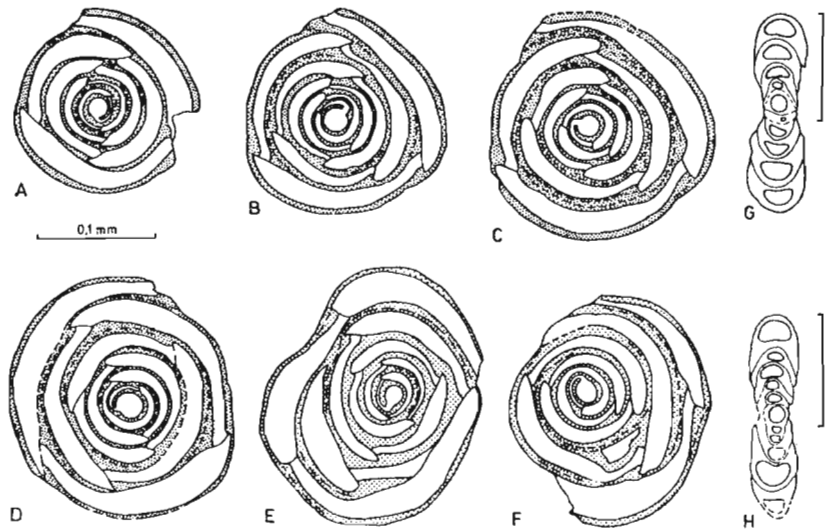


Fig. 21. *Cornuloculina polonica* sp.n., drawings of sections oriented in accordance with the coiling plane in transmitted light: *A* IG 10026/80/f, *B* IG 10027/80/f, *C* IG 10028/80/f, *D* IG 10029/80/f; *E* IG 10030/80/f — regenerated specimen; *F* IG 10031/80/f — regenerated specimen; *G* IG 10069/80/f — transverse section, in the plane passing through the proloculus; *H* IG 10068/80/f — transverse section, in the plane passing through the proloculus.

nus, being a third to two-thirds of a whorl long at early growth stages, half a whorl long at the middle, and always a third of a whorl long at the end. The middle stage (with chambers of half a whorl long) is sometimes missing. In some specimens, chamber body widens at its narrower end, in front of outlet to the next body chamber, similarly as in *C. orbiculare*. Individuals with 13 chambers are most common.

No megalospheric forms were found in the material studied.

Individual variability moderately high, mainly expressed in dimensions of test (fig. 10, table 2), size of proloculus and, on a smaller scale, length of chambers. Test outline is also varying, from regularly circular to rounded triangular or, sometimes, ovate.

No forms similar to the above described were found in literature.

Occurrence. — Type horizon and type locality.

Cornuloculina pazdroe sp.n.

(pl. 34: 7—12; pl. 35: 9: fig. 22)

Holotype: IG 10121/80/f; pl. 34: 8.

Type horizon: Carixian-Domerian.

Type locality: Świnoujście-1 borehole, depth 753.3 m.

Derivation of the name: In honour of Professor Olga Pazdro, an outstanding Polish student of foraminifera, especially miliolids.

Diagnosis. — Tests circular, ovate, triangular, or almost D-shaped in outline, fairly thin, flattened in transverse section. Peripheral margin sharp, with marked keel. Coiling evolute. External sutures and subdivision into chambers well visible in reflected light. Sutures depressed. Tests very loosely coiled. Chambers 4—6 in number.

Material. — About 90 fairly well-preserved specimens (10 specimens prepared for studies in transmitted light). Point diagrams (fig. 3) and table 2 present values of length and width of tests.

Description. — Imperforate calcareous tests, smooth, planispirally coiled, fairly thin, flattened in transverse section. Peripheral margin sharp, with a marked sharp keel (fig. 22: G; pl. 35: 9). Coiling markedly evolute. External sutures and subdivision into chambers fairly large in relation to that of the above described species, circular, toothless. Neck deviating from the test, fairly narrow, short, ending with marked ridge-like lip, strongly bent outwards; neck is often broken off or its lip is missing. Chambers rhomboidal in transverse section; body chamber circular, rather small (fig. 22: G; pl. 35: 9).

Tests not always sufficiently translucent in transmitted light. Proloculus spherical, large (see dimensions given in Table 2), usually connected with flexostyle at the right angle. Flexostyle tubular, wider than in the species described above, varying in diameter, from two-thirds to two whorls long (usually one and half — see fig. 16). The third chamber usually half a whorl long, sometimes up to a whorl long (fig. 17). The remaining chambers usually half a whorl long and connected at the angle close to 60°. Body chambers closer to those of the genus *Ophthalmidium* in shape, except for being somewhat stronger waved, and not so wide.

Internal suture is markedly separated from external suture due to the occurrence of keel. With some most translucent specimens both internal and external sutures look — in transmitted light — as if they were running along each other (see transverse section in fig. 2). Tests very loosely coiled. Number of chambers visible in transmitted light is the same as in reflected light, equally 4—6; 5-chambered individuals are the most common (fig. 11). No microspheric forms were found in the material studied.

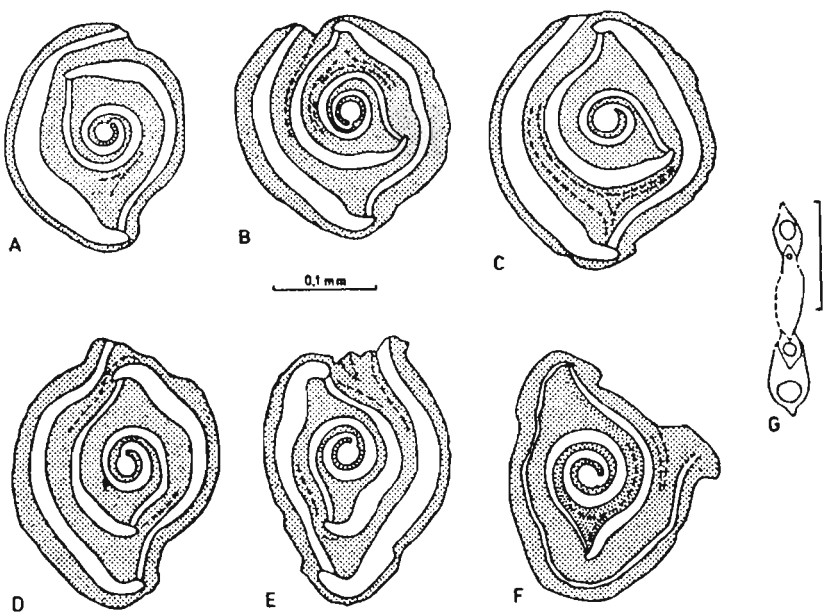


Fig. 22. *Cornuloculina pazdroe* sp.n., drawings of specimens in transmitted light: *A* IG 10032/80/f, *B* IG 10033/80/f, *C* IG 10034/80/f, *D* IG 10035/80/f; *E* IG 10036/80/f — damaged specimen, presumably regenerated; *F* IG 10037/80/f — regenerated specimen; *G* IG 10059/80/f — transverse section, in the plane passing by the proloculus.

Individual variability moderately high. Point diagrams (fig. 3) and Table 2 present data concerning the variability in length and width of tests and diameter of proloculus. The variability is also expressed by changes in general shape of tests and, on a smaller scale, length of chambers.

Comparisons. — The representatives of that species are somewhat similar to *Ophthalmidium minutum* Fuchs (1970: 74—75; pl. 2: 4—5) in their very loosely coiled tests. However, illustrations of the latter are insufficiently clear and the description rather laconic.

The specimen assigned by Loeblich and Tappan (1964) to the Recent species *Cornuloculina inconstans* (Brady) and illustrated by these authors on the fig. 340: 4 resembles *C. pazdroe* in: general outline of test, shape of chambers, loose coiling, marked keel and well visible subdivision into chambers (also in reflected light). It is, however, markedly larger being 1.5 mm in diameter, while *C. pazdroe* is 0.19—0.27 mm.

Of two specimens assigned to *Ophthalmidium orbiculare* Burbach by Brouwer (1969; pl. 2: 9, 10), as it follows out from their photos made in reflected light, one (pl. 32: 9) is very similar to *C. pazdroe* sp.n., whereas the other seems closer to that described here as *C. orbiculare* (Burbach). Brouwer (*l.c.*) did not give descriptions so it remains unclear why so different forms were assigned to the same species.

C. pazdroe appears markedly similar to a specimen described as *Ophthalmidium* sp. by Welzel (1968: 9, pl. 3: 5) which differs from representatives of the former in one 3-chambered whorl (all the whorls are 2-chambered in *C. pazdroe* sp.n.) and almost twice larger size.

In description of *Spirophthalmidium acutimargo* (Brady) in Wood and Barnard (1946), attention should be paid to specific features of flexostyle: two whorls long, gradually thickening to achieve its maximum thickness at the distance of half a whorl from the beginning, and narrowing thereafter. Such shape and proportions of flexostyle are typical of several representatives of *Cornuloculina pazdroe* sp.n. (see those figured in fig. 22: *A*, *E*, *F*). However, *C. pazdroe* sp.n. differs from *Spirophthalmidium acutimargo* (Brady) in shape and arrangement of body chambers.

Cornuloculina pazdroe sp.n. is most close in shape of body chambers and nature of connections between them to megalospheric form *Hauerinella inconstans* (Brady) figured by Wood and Barnard (1946, pl. 4: f), differing in less numerous chambers (8 in the latter). The lack of photos of the latter in reflected light greatly impedes further comparisons.

C. pazdroe sp.n. appears very similar to *C. sakhrajensis* Antonova (1973: 14—15; pl. 1:3, 4; pl. 2: 13—18) in general outline of tests, shape of body chambers and the character of connections between them, loose coiling and a marked keel. However, there remain some differences. The representatives of *C. sakhrajensis* are langer and wider (0.26—0.38 mm in width) than specimens described above with usually much longer chambers, except for flexostyle, which is surprisingly short (less than a third of a whorl long).

Occurrence. — Type horizon and type locality.

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IWONA REK

ŚRODKOWOLIASOWE MILIOLIDY Z POMORZA ZACHODNIEGO

Streszczenie

Przedmiotem niniejszego opracowania są środkowoliasowe miliolidy z otworu wiertniczego Świnoujście-1. Opisane otwornice zaliczono do podrodziny Ophthalmidiinae w rodzinie Miliolidae.

Przy obserwacji skorupek brano pod uwagę następujące cechy: długość i szerokość, średnicę komory początkowej czyli proloculusa, liczbę komór, długość fleksо-

stylu (drugiej komory) i trzeciej komory, długość pozostałych komór i kształt ich wnętrza, charakter połączeń między komorami, ścisłość zwinięcia (odległość między światłem sąsiednich komór), charakter szyjki (fig. 2). Dane z tych obserwacji zilustrowano na figurach 3—17.

Biorąc pod uwagę cechy do tej pory niezbyt doceniane przez badaczy, tzn. proporcje skorupki (stosunek długości do szerokości l/w), charakter połączeń między komorami i kąt ich zetknięcia, kształt komór i ich wnętrza, charakter szyjki, wyróżniono dwa rodzaje: *Ophthalmidium* i *Cornuloculina*, do których zaliczono następujące gatunki: *Ophthalmidium concentricum* (Terquem and Berthelin), *Ophthalmidium* sp., *Cornuloculina orbiculare* (Burbach), *C. plana* sp.n., *C. polonica* sp.n., *C. pazdroe* sp.n.

Na podstawie próby rekonstrukcji wahań głębokości i linii brzegowej liasowego zbiornika (Rek 1976) oraz udziału procentowego gatunków w próbkach wysunięto przypuszczenie, że *O. concentricum* jest związane z facją morza płytszego, natomiast *C. orbiculare* — z facją morza głębszego (tutaj: tabela 1; fig. 1).

EXPLANATION OF THE PLATES 32—35

Plate 32

Ophthalmidium concentricum (Terquem and Berthelin), Świnoujście-1

1. Specimen no. IG 10052/80/f, sample 7, scanning electron micrograph.
2. Specimen no. IG 10055/80/f, sample 7, scanning electron micrograph.
3. Specimen no. IG 10053/80/f, sample 7, scanning electron micrograph.
4. Specimen no. IG 10054/80/f, sample 7, scanning electron micrograph.
5. Specimen no. IG 10051/80/f, sample 5, scanning electron micrograph.
6. Specimen no. IG 10071/80/f, sample 7.
7. Specimen no. IG 10090/80/f, sample 7.
8. Specimen no. IG 10088/80/f, sample 7.
9. Specimen no. IG 10113/80/f, sample 3, regenerated specimen.
10. Regenerated specimen no. IG 10116/80/f, sample 6.

Plate 33

Ophthalmidium concentricum (Terquem and Berthelin), Świnoujście-1

1. Specimen no. IG 10099/80/f, sample 7.
2. Specimen no. IG 10075/80/f, sample 8.

Ophthalmidium sp., Świnoujście-1

3. Specimen no. IG 10078/80/f, sample 8.
4. Specimen no. IG 10077/80/f, sample 8.
5. Specimen no. IG 10046/80/f, sample 5, scanning electron micrograph.

Cornuloculina orbiculare (Burbach), Świnoujście-1

6. Specimen no. IG 10079/80/f, sample 8.
7. Specimen no. IG 10107/80/f, sample 8.
8. Specimen no. IG 10040/80/f, sample 7, scanning electron micrograph.
9. Specimen no. IG 10108/80/f, sample 8.
10. Regenerated specimen no. IG 10111/80/f, sample 8.
11. Regenerated specimen no. IG 10110/80/f, sample 8.
12. Regenerated specimen no. IG 10072/80/f, sample 7.

Plate 34

Cornuloculina plana sp.n., Świnoujście-1

1. Specimen no. IG 10118/80/f, sample 8, holotype.
2. Specimen no. IG 10042/80/f, sample 7, scanning electron micrograph.
3. Specimen no. IG 10102/80/f, sample 8.

Cornuloculina polonica sp.n., Świnoujście-1

4. Specimen no. IG 10119/80/f, sample 8, holotype.
5. Specimen no. IG 10104/80/f, sample 8.
6. Specimen no. IG 10045/80/f, sample 8, scanning electron micrograph.

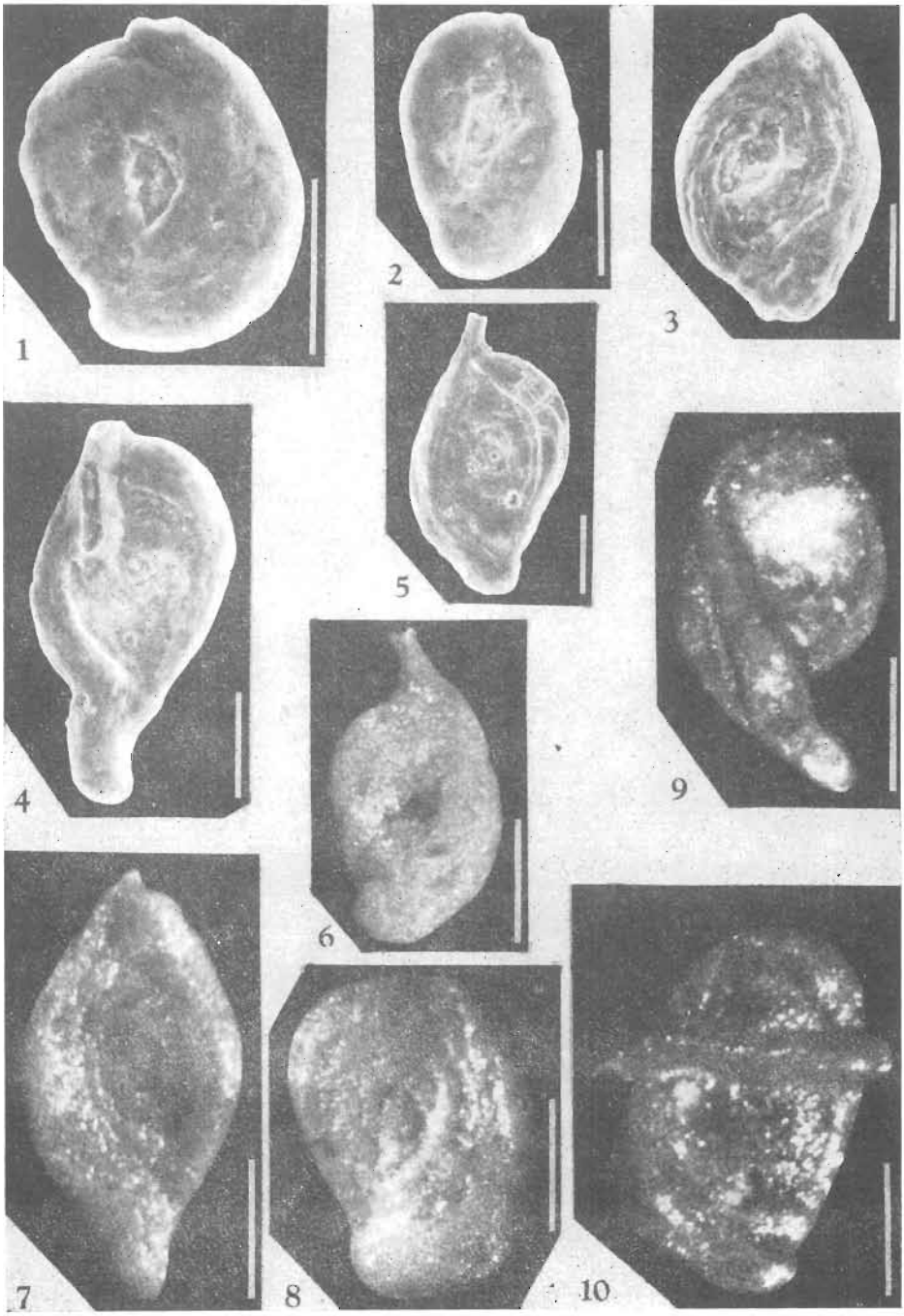
Cornuloculina pazdroe sp.n., Świnoujście-1

7. Specimen no. IG 10038/80/f, sample 7, scanning electron micrograph.
8. Specimen no. IG 10121/80/f, sample 3, holotype.
9. Specimen no. IG 10081/80/f, sample 8.
10. Specimen no. IG 10039/80/f, sample 8, scanning electron micrograph.
11. Specimen no. IG 10073/80/f, sample 7.
12. Specimen no. IG 10122/80/f, sample 6.

Plate 35

Transverse thin sections in transmitted light, Świnoujście-1, sample 8

1—4. *Ophthalmidium concentricum* (Terquem and Berthelin), specimens nos.: IG 10064/80/f, IG 10065/80/f, IG 10067/80/f, IG 10070/80/f.
5. *Cornuloculina plana* sp.n., specimen no. IG 10063/80/f.
6. *Cornuloculina orbiculare* (Burbach), specimen no. IG 10061/80/f.
7, 8. *Cornuloculina polonica* sp.n., specimens nos.: IG 10068/80/f, IG 10069/80/f.
9. *Cornuloculina pazdroe* sp.n., specimen no. IG 10059/80/f.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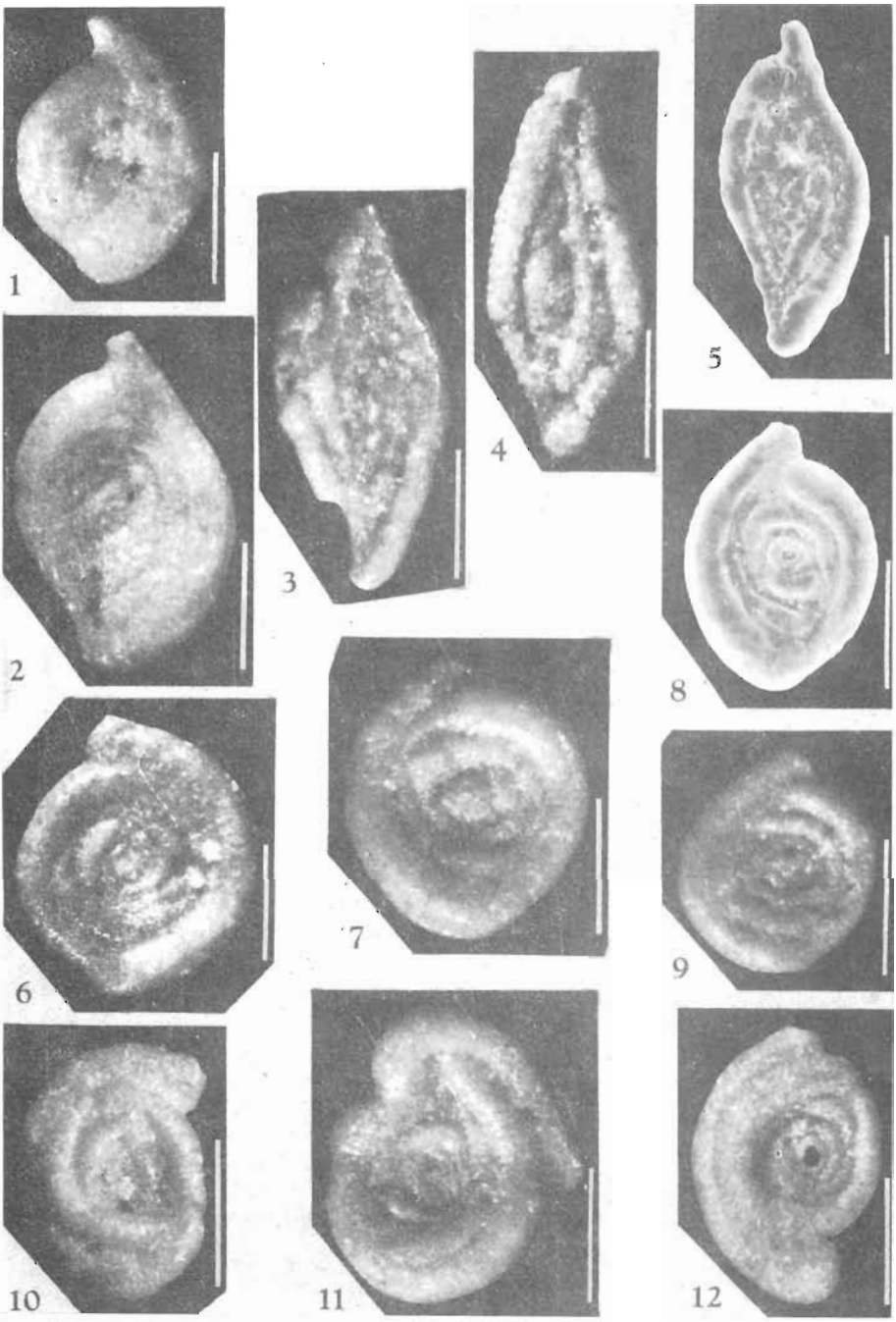
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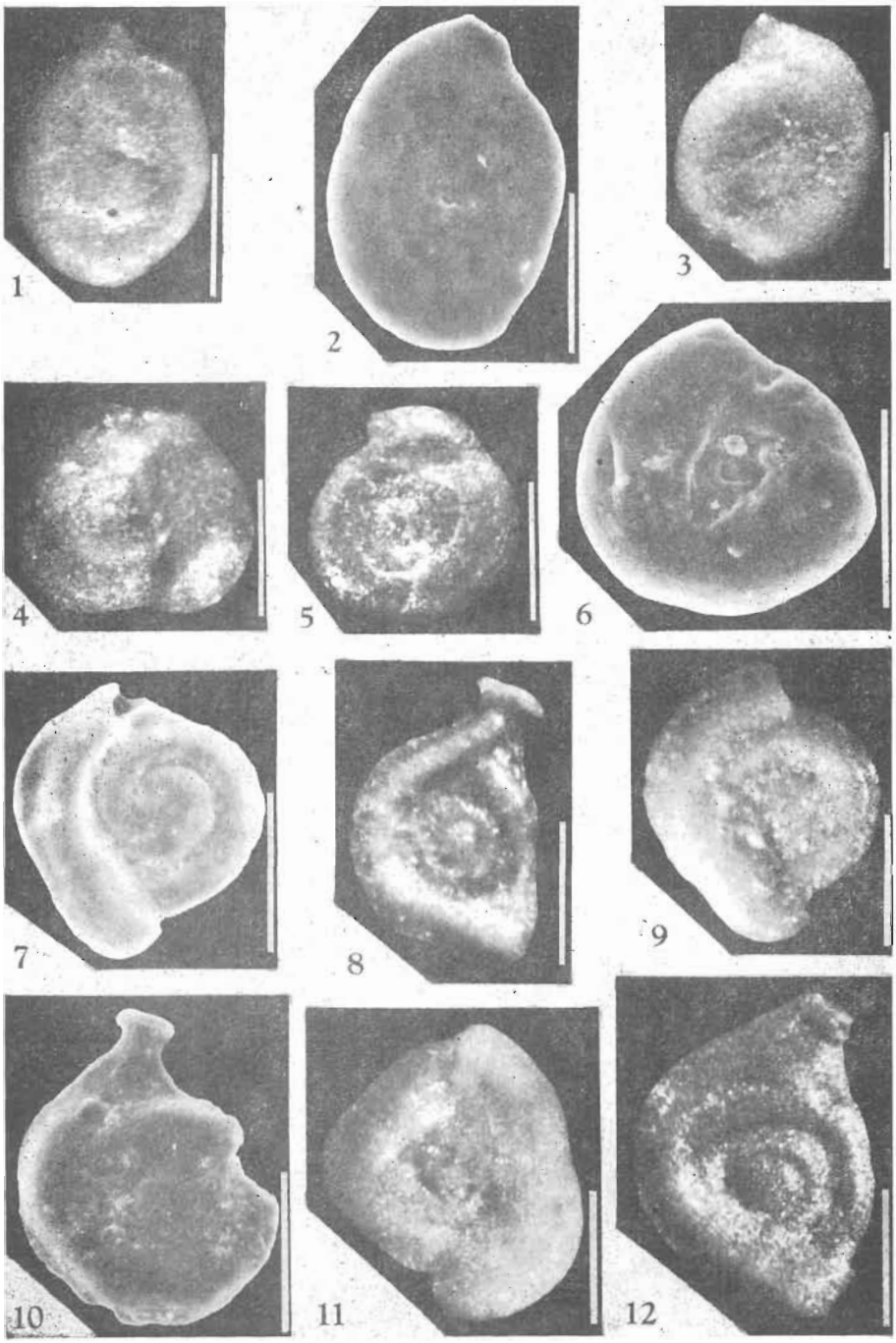
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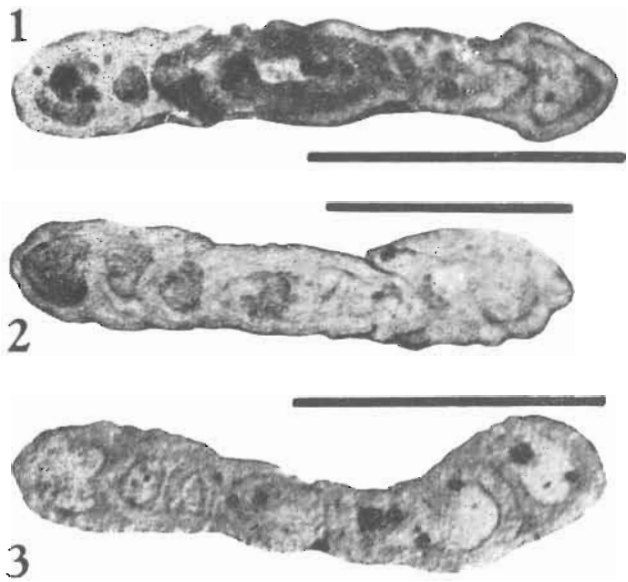
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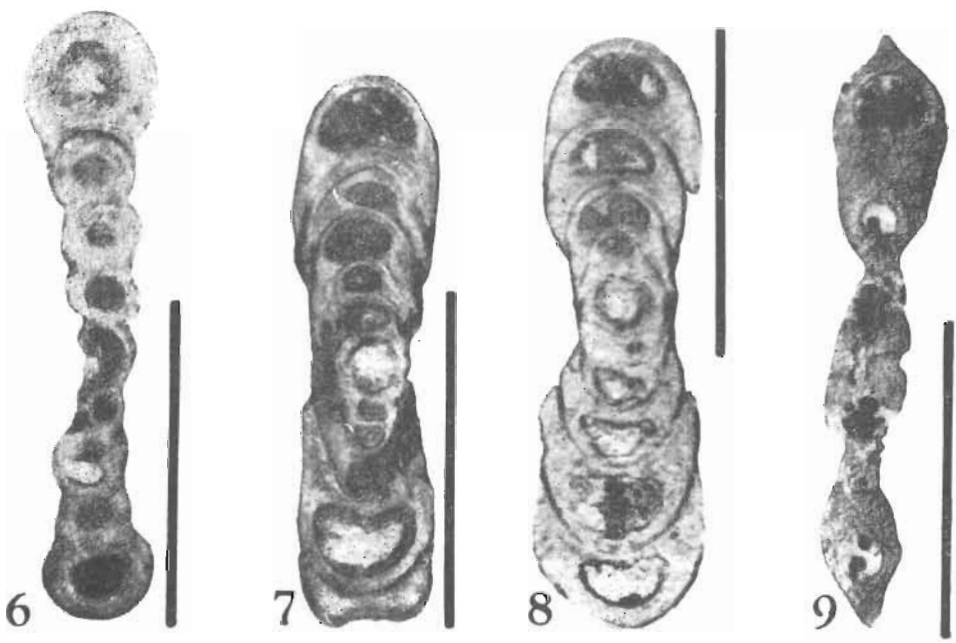
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