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PLANKTIC FORAMINIFERA ZONATION OF THE UPPER CRETACEOUS IN THE MIDDLE VISTULA RIVER VALLEY, POLAND

(plates 1–23)

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Abstract. — Planktic foraminifera from the Upper Cretaceous deposits of the Vistula River valley of Central Poland, the most complete exposed section of the Upper Cretaceous in Europe, have been studied. In this section, comprising Cenomanian to Maastrichtian deposits, 90 species of planktic foraminifera were identified, 5 of them being new: *Dicarinella longoriai*, *Marginotruncana caronae*, *Globotruncana pozaryskae*, *Chiloguembelina praecursor*, *Heterohelix vistulaensis*. On the basis of this assemblage 10 foraminiferal zones have been distinguished: *Hedbergella planispira* Assemblage-Zone, *Rotalipora cushmani* Range-Zone, *Helvetoglobotruncana helvetica* Interval-Zone, *Marginotruncana coronata* Interval-Zone, *Globotruncana lapparenti* Interval-Zone, *Globotruncana fornicata* Interval-Zone, *Globotruncana arca* Interval-Zone, *Globigerinelloides multispinus* Interval-Zone, *Rugoglobigerina pennyi* Interval-Zone, *Guembelitria cretacea* Range-Zone. This zonation has been correlated with other zonations based on cephalopods, inocerams and coccoliths of the region studied as well as with foraminiferal zonations proposed for other regions of the world.

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Streszczenie. — Opracowano otwornice planktoniczne z osadów górnej kredy, odsłaniających się w dolinie Wisły, stanowiących najbardziej kompletny, naturalnie odsłonięty profil osadów tego wieku w Europie. Ogółem, w osadach od cenomanu do mastrychtu, stwierdzono 90 gatunków, w tym 5 nowych: *Dicarinella longoriai*, *Marginotruncana caronae*, *Globotruncana pozaryskae*, *Chiloguembelina praecursor*, *Heterohelix vistulaensis*. W oparciu o ten zespół wyróżniono 10 poziomów: poziom zespołowy *Hedbergella planispira*, poziom zasięgu gatunku *Rotalipora cushmani*, poziomy niesamoistne: *Helvetoglobotruncana helvetica*, *Marginotruncana coronata*, *Globotruncana lapparenti*, *Globotruncana fornicata*, *Globotruncana arca*, *Globigerinelloides multispinus*, *Rugoglobigerina pennyi* i poziom zasięgu gatunku *Guembelitria cretacea*. Wyróżnione poziomy skorelowano z istniejącymi już podziałami biostratygraficznymi dla tego obszaru, opartymi na głowonogach, inoceramach i nannoplanktonie. Przeprowadzono też korelację wydzielonych poziomów otwornicowych z poziomami otwornicowymi z innych obszarów świata.

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CONTENTS

INTRODUCTION

Planktic foraminifera are thought to be one of the most suitable groups for local, regional and intercontinental stratigraphic correlations, because of their wide geographic occurrence, abundance and relatively fast rate of evolution.

Numerous stratigraphic subdivisions of the Upper Cretaceous are based upon the planktic foraminifera, especially upon species belonging to the superfamily Hedbergelloidea LONGORIA and GAMPER, 1975 (e. g., DALBIEZ 1955; BOLLI 1957; SALAJ and SAMUEL 1966; PESSAGNO 1969; STURM 1969; BELLIER 1973; MASLAKOVA 1977 — comp. table 6). However, these zonations reply mainly to the lower latitudes, where the rapidly evolving species dominate in warm circumequatorial waters. General zonations (BOLLI 1966; POSTUMA 1971; van HINTE 1972, 1976) were based on the data from the literature and they can be applied to lower latitudes only.

Endemic factors also create difficulties in the correlation of the Upper Cretaceous deposits; for example, ASANO and TAKAYANAGI (1965) established 6 zones of planktic foraminifera in the Upper Cretaceous profile of Hokkaido (Upper Albian — Campanian), but their subdivision appears to be only of regional interest as it is based on forms known endemic to only the Pacific basin.

To date, only a limited number of studies of the assemblages of planktic foraminifera from the areas of higher latitudes was undertaken, and they dealt with the assemblages from one or two, rarely three stages (e. g., BERGGREN 1962; DOUGLAS and RANKIN 1969; NORLING 1973; BAILEY 1978). No studies of planktic foraminifera for the whole of the Upper Cretaceous have yet been made from temperate or boreal zones.

The Upper Cretaceous deposits cropping out in the Vistula River valley of the Central Polish Uplands constitute the most complete profile of the Upper Cretaceous in Europe. They crop out over a distance of 60 km, from Piotrowice in the south to Bochotnica in the north (fig. 1), in many places in the steep Vistula riverside and in several quarries (fig. 1). I sampled 33 localities (fig. 1, table 1) situated there. The assemblage of planktic foraminifers occurring in the profile studied comprises 90 species, 5 of them being new (table 3). Several species are described in open nomenclature because of the bad preservation or insufficient number of specimens.

The purpose of this paper is to document the assemblages of planktic foraminifera, to distinguish biostratigraphic zones on the basis of these foraminifera, to correlate these zones with orthostratigraphic cephalopod zones and parastratigraphic inoceram zones and, finally, to correlate them with the foraminiferal zones distinguished in other areas.

This work was conducted in 1973–1977 at the Institute of Paleobiology of the Polish Academy of Sciences, Warszawa (abbr. ZPAL), where the collection described is housed.

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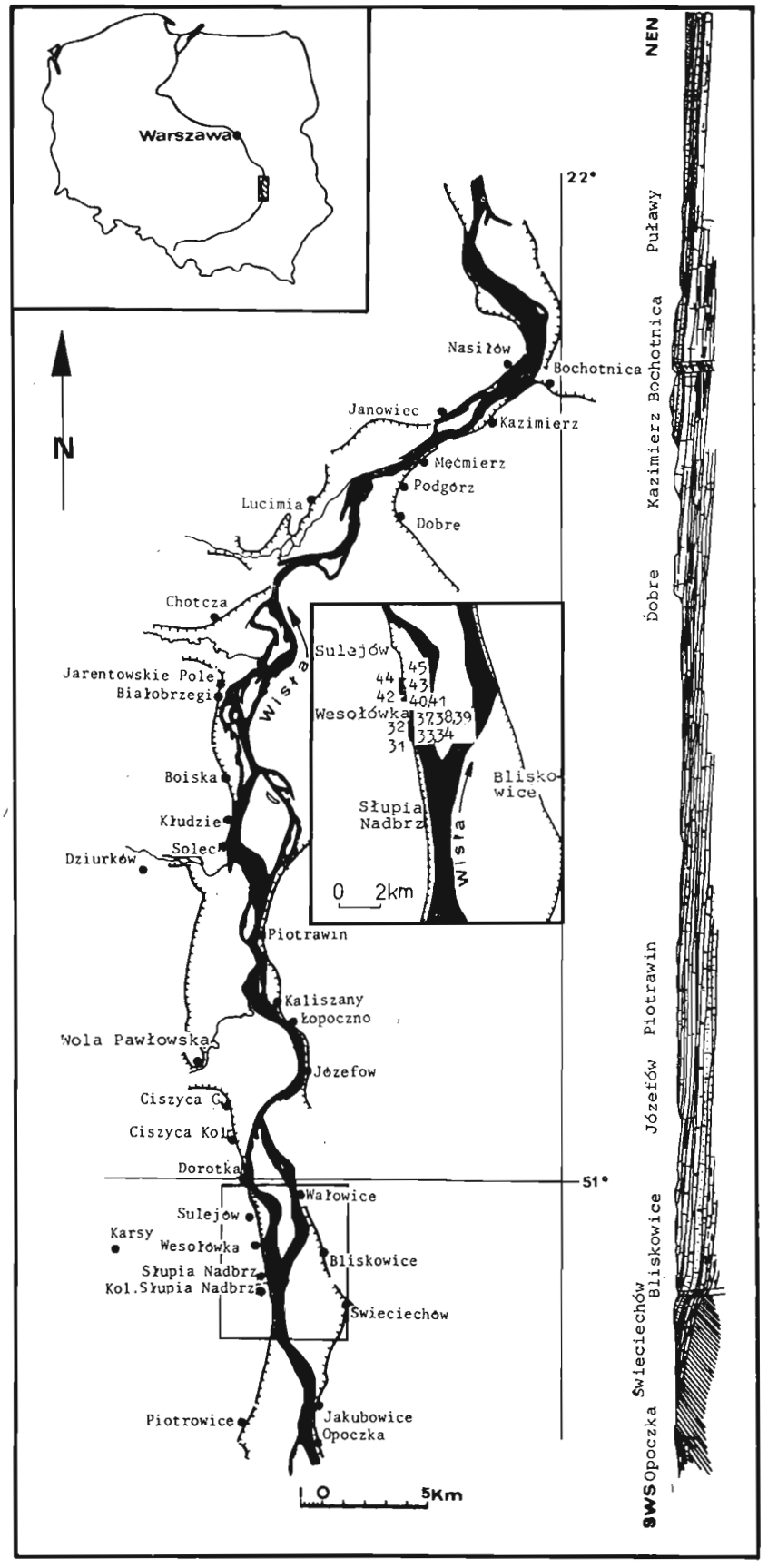

Fig. 1

Location of sampled outcrops and synthetic geologic profile in the area of Middle Vistula River valley (after Pożaryski, 1938)

Table 1

Location (comp. fig. 1) and characteristic of the outcrops studied

Locality	Detailed location	Lithology	Stratigraphical position	
			based upon macrofauna, after POŻARYSKI (1938, 1948) if not stated otherwise	based on planktic foraminifera
1	2	3	4	5
Jakubowice	800 m north of the bridge over Vistula river	glauconitic sandy marls 2 m thick, with phosphoritic bed of hard ground in the top	Cenomanian (SAMSONOWICZ, 1925, POŻARYSKI 1947, CIEŚLIŃSKI 1959)	*Hedbergella planispira* zone *Rotalipora cushmani* zone
Piotrowice	gorge 300 m south of the village	marly opoka with flints	Lower Turonian (*Inoceramus lamarcki* PARKINS.)	*Helvetoglobotruncana helvetica* zone
Karsy	small quarry 500 m N of Karsy and 900 m W of Ożarów-Tarłów road	white hard opoka with rare black flints	Lower Turonian (*Inoceramus lamarcki* PARKINS.)	*Helvetoglobotruncana helvetica* zone
Opoczka	outcrop in steep riverside 300 m S of the bridge over Vistula river	opoka with very abundant cherts of irregular shape	Upper Turonian (based on the lithological paralles to the faunistically determined strata at the left side of Vistula river)	*Helvetoglobotruncana helvetica* zone *Marginotruncana coronata* zone
Kolonia Słupia Nadbrzeżna	3 meters high escarp beside the road running from Słupia Nadbrzeżna, on the northern end of gorge lying in the northern end of village	limy opoka with plentiful cherts irregular in shape	Upper Turonian (*Inoceramus woodsi* FIEGL and *Inoceramus costellatus* WOODS)	*Marginotruncana coronata* zone
Słupia Nadbrzeżna	outcrop in the riverside, in the gorge separating Leopoldów and Wesołówka villages	white opoka with rare irregular cherts and flints	horizon "c"	*Marginotruncana coronata* zone
Wesołówka 31*	gorge S of village in place of being crossed by the road running to Słupia Nadbrzeżna	opoka	horizon "c"	*Marginotruncana coronata* zone
Wesołówka 32*	outcrop on a level of path 300 m N of the outlet of gorge mentioned above	opoka	horizon "c"	*Marginotruncana coronata* zone
Wesołówka 33–35*	escarp of the left riverside, 250 m N of preceding outcrop. Sample 33 taken on a level of path, sample 34 taken 4 m higher and sample 35 taken still 3m higher	opoka with black flints	horizon "d"	*Marginotruncana coronata* zone
Wesołówka 37–39*	northern slope of small gorge opened to the Vistula River valley N of Wesołówka. Sample 37 taken 2 m above the level of path, sample 38 taken 3m higher and sample 39 — still 2 m higher	marly opoka	horizon "d"	*Marginotruncana coronata* zone

Table 1
(continued)

1	2	3	4	5
Wesołówka 40*	150 m N of preceding outcrop, 10 m above the path level	glauconitic opoka	horizon "e"	*Globotruncana lapparenti* zone
Wesołówka 41*	10m higher, the same locality as Wesołówka 40	glauconitic opoka	horizon "e"	*Globotruncana fornicata* zone
Wesołówka 42*	70 m N of preceding outcrop	opoka with interlayers of flints	horizon "f"	*Globotruncana fornicata* zone
Wesołówka 43*	40 m N of preceding outcrop	opoka with interlayers of flints	horizon "f"	*Globotruncana fornicata* zone
Wesołówka 44*	outcrop in the middle of the Vistula riverside, 40m N of outcrop Wesołówka 43	opoka	horizon "g" (Santonian--Pożaryski, 1938, Campanian-Błaszkiewicz, 1966)	*Globotruncana arca* zone
Wesołówka 45*	quarry, 100 m N of outcrop Wesołówka 44	opoka	horizon "h" (Santonian--Pożaryski, 1938, Campanian-Błaszkiewicz, 1966) and horizon "i" (Campanian)	*Globotruncana arca* zone
Świeciechów	fields of the village, outcrop in the road 300 m NE church	marly opoka	horizons "f" and "g"	probably *Globotruncana arca* (very poor assemblage)
Sulejów	quarry in the village	opoka	horizon "k"	*Globigerinelloides multispinus* zone
Bliskowice	outcrop in the road coming to the road Annopol -Józefów near the chapel	opoka	horizon "k"	*Globigerinelloides multispinus* zone
Wałowice	side-space of the road Annopol-Józefów in the village	opoka	horizon "l"	*Globigerinelloides multispinus* zone
Dorotka	small quarry in the village	opoka	horizon "n"	*Globigerinelloides multispinus* zone
Ciszyca Kolonia	700m S of the village, small quarry in the left side of gorge opening to the Vistula River valley	opoka	horizon "p"	*Globigerinelloides multispinus* zone
Józefów	escarp at the river	opoka	horizon "r"	*Globigerinelloides multispinus* zone
Ciszyca Górna	outcrop in steep sidespace of the road Wólka Lipowa-Ciszyca Górna, in the village	opoka	horizon "r"	*Globigerinelloides multispinus* zone
Łopoczno	escarp several metres high, 500 metres long, in the steep riverside	opoka	horizon "s"	*Globigerinelloides multispinus* zone
Kaliszany	outcrop 5 metres above the valley bottom	opoka	horizon "s"	*Globigerinelloides multispinus* zone
Wola Pawłowska	northern slope of the Kamienna river valley, small quarry in place of its outlet to the Vistula River valley	marly opoka	horizon "s"	*Globigerinelloides multispinus* zone
Piotrawin	big quarry (500 m long, 30 m high)	opoka interlayered by marls in places	horizon "t" (boundary between Campanian and Maastrichtian-Kongiel 1962, Błaszkiewicz, 1966, Pożaryski, 1966 — being established in the quarry)	*Globigerinelloides multispinus* zone

Table 1

(continued)

1	2	3	4	5
Dziurków	outcrop beside the road Dziurków-Lipsko, 15 metres high escarp 200 m S of the bus stop	opoka	horizon "u"	*Globigerinelloides multispinus* zone
Solec	steep slope near the crossing of roads: Lipsko-Czekarzewice-Ostrowiec and that running to the centre of village	opoka	horizon "v"	*Globigerinelloides multispinus* zone
Kłudzie	outcrop in the Vistula riverside near the outlet of small gorge running from the village	marly opoka	horizon "v"	*Rugoglobigerina pennyi* zone
Boiska	outcrop in the middle part of the slope of riverside	marls	horizon "w"	*Rugoglobigerina pennyi* zone
Białobrzegi	lower part of the slope of riverside	marls	horizon "w"	*Rugoglobigerina pennyi* zone
Jarentowskie Pole	slope of the Vistula riverside, in half of distance between Białobrzegi and Jarentowskie Pole	marly opoka	horizon "w"	*Rugoglobigerina pennyi* zone
Chotcza	exploitation hole of chalk	chalk	horizon "w"	*Rugoglobigerina pennyi* zone
Lucimia	exploitation hole of chalk 1.5 km NE of the village, in the slope of the Vistula riverside, above the road to Baryczka	chalk	horizon "w"	*Guembelitria cretacea* zone
Dobre	steep escarp in the riverside between villages: Podgórz and Dobre	marls	horizon "w"	*Guembelitria cretacea* zone
Podgórz	outcrop in the riverside	marls	horizon "w"	*Guembelitria cretacea* zone
Męćmierz	escarp 25 metres high over the Vistula riverside	marly opoka and marls	horizon "w"	*Guembelitria cretacea* zone
Kazimierz	big quarry (500 m long, 30 m high)	opoka, in the top 2 layers of marls (of thickness 1 m)	horizon "x"	*Guembelitria cretacea* zone
Janowiec	outcrop in the Vistula riverside opposite Kazimierz	opoka	horizon "x"	*Guembelitria cretacea* zone
Nasiłów	big quarry	opoka covered with limestone with well developed hard ground	horizon "y"	*Guembelitria cretacea* zone
Bochotnica	gorge opened to the Vistula River valley	opoka interlayered with marl, covered with limestone (1 m thick) being the hard ground. Above — phosphoritic bed with numerous fragments of belemnites, higher — siwak.	horizon "y" horizon "z"	*Guembelitria cretacea* zone Danian

* Numbers of outcrops in Wesołówka after POŻARYSKA (1957) to enable comparison of benthic and planktic foraminifera.

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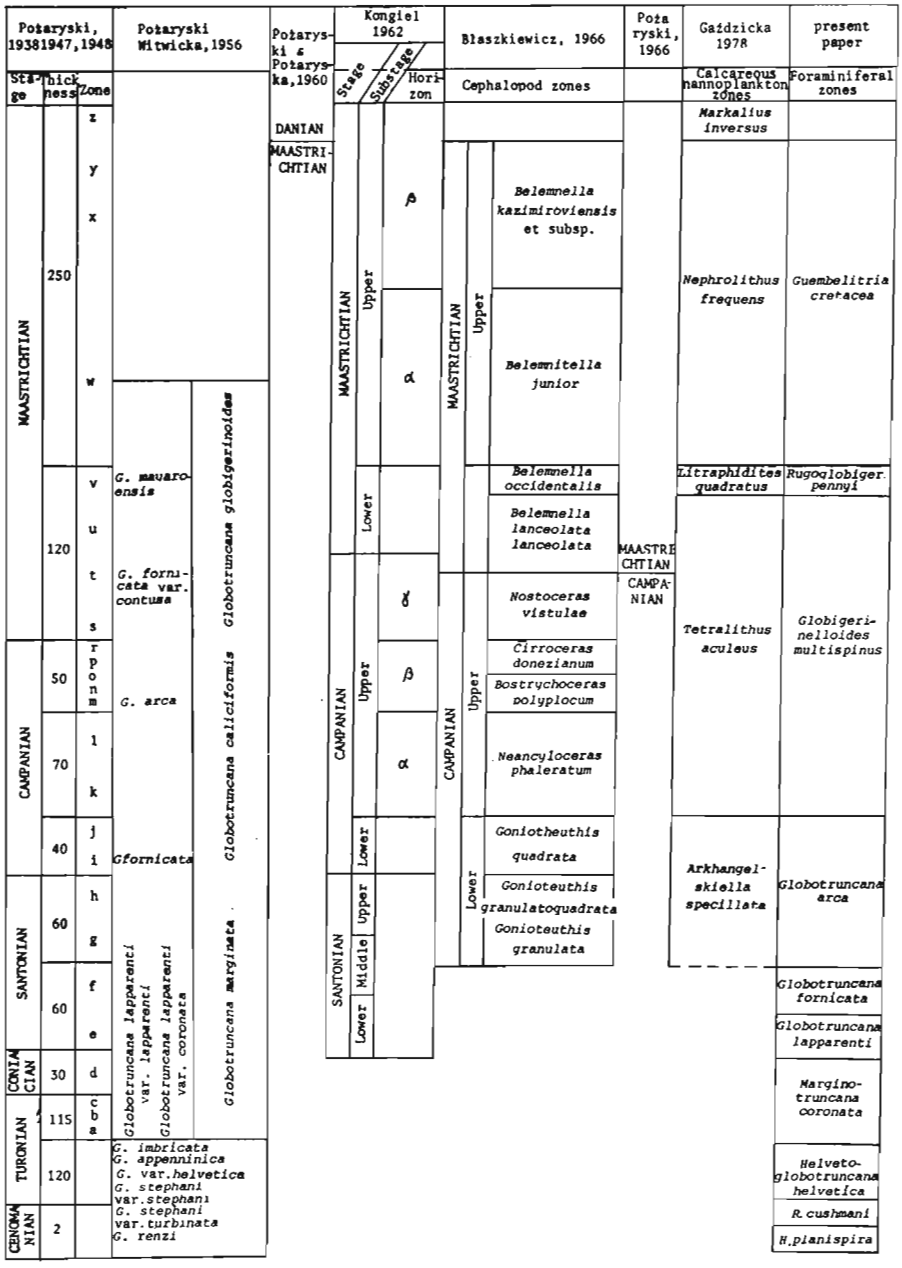
REVIEW OF STRATIGRAPHIC STUDIES

The Cretaceous deposits cropping out in the area studied have long interested geologists. Early papers date from the first half of the nineteenth century, but only KRISTAFOWICZ (1895, 1897, 1898 — *fide* POŻARYSKI 1938) properly interpreted the stratigraphy and tectonics of the region. SAMSONOWICZ (1924, 1925, 1934) demonstrated the existence of Albian and Cenomanian strata in the bottom of the Vistula River profile and discovered the Rachów anticline, an important tectonic structure in that area. ŁUNIEWSKI (1923) contributed to the geology of the southern part of the region discussed. POŻARYSKI (1938) established the detailed stratigraphy of the Upper Cretaceous of the Vistula River profile on the basis of macrofauna (Cephalopoda, Brachiopoda, Lamellibrachiata, Gastropoda and Echinoidea). He defined the boundaries between stages and subdivided the stages into local horizons (comp. table 2). Further studies of POŻARYSKI (1947, 1948, 1951) contributed mainly to the understanding of the stratigraphy and tectonics in that area. POŻARYSKI's stratigraphic subdivision of the Upper Cretaceous became a fertile ground for later studies which only slightly modified it, mainly at the stage boundaries (comp. table 2). POŻARYSKA (1965) demonstrated that the uppermost Maastrichtian strata, so called Żyrzyn Beds, are lacking in the Vistula River profile, the Paleocene directly overlying a hardground at the top of a limestone of low Upper Maastrichtian age. KONGIEL (1962) studying belemnites from the Santonian, Campanian and Maastrichtian deposits, changed the upper boundary of the Campanian, including in the latter stage the local horizons "s" and "t", formerly regarded as being the lowermost Maastrichtian (POŻARYSKI 1938). BŁASZKIEWICZ (1966) presented a new subdivision of the Campanian and Maastrichtian. He distinguished 10 cephalopod zones within the local horizons "g" to "y" (comp. table 2). He placed the boundary between the Campanian and Maastrichtian within the horizon "t". In addition, BŁASZKIEWICZ (1966) moved the lower boundary of the Campanian downwards, so as to include the horizons "g" and "h" in the Campanian, in contrast to POŻARYSKI (1938) and KONGIEL (1962) who put this boundary between the horizons "h" and "i" (table 2).

The following faunal groups, occurring in the Upper Cretaceous were studied: molluscs and gastropods (KRACH 1936, KURLENDA 1966, MATWIEJEWÓWNA 1935), echinoids (KONGIEL 1935, CIEŚLIŃSKI 1959), ammonites (CIEŚLIŃSKI 1959, BŁASZKIEWICZ 1966), belemnites (KONGIEL 1962, BŁASZKIEWICZ 1966, KURLENDA 1966), brachiopods (POPIEL-BARCZYK 1968), pelecypods (PUGACZEWSKA 1977). Besides, POŻARYSKA (1954) described 27 species of benthic index foraminifera for particular stages. POŻARYSKI and WITWICKA (1956) reported 18 species of *Globotruncana* (now assigned to other 5 genera) and on the basis of these species they established 3 stratigraphic assemblages: 1 — Cenomanian-Lower Turonian, 2. Upper Turonian-Lower Santonian, and 3. Upper Santonian-Maastrichtian (table 2). The important paleogeographic conclusion of

Table 2

The results of stratigraphic studies of the Upper Cretaceous deposits in the Middle Vistula River valley (after different authors)



POŻARYSKI and WITWICKA (1956) was that the fauna was free to disperse between the interconnected North-European epicontinental trough and the Tethys during Cenomanian to Santonian times, whereas in Campanian and Maastrichtian times the connection was restricted.

In her monography on the Lagenidae, POŻARYSKA (1957) described 200 species and discussed the relations between the number of foraminifera and the type of deposit. POŻARYSKI and POŻARYSKA (1960) verified the age of strata occurring in the top of the Upper Cretaceous profile near Puławy on the basis of Foraminifera. They demonstrated that Danian foraminifers occur in the phosphoritic layer (horizon "z"), overlying the Upper Maastrichtian opoka. The phosphoritic layer is packed with the index Upper Maastrichtian species of belemnites, but they

are evidently reworked. It should be mentioned that the Upper Cretaceous planktic foraminifera of the other regions in Poland were a subject of numerous studies (ALEXANDROWICZ 1956; ALEXANDROWICZ 1966; KSIĄŻKIEWICZ 1956; BIEDA 1958; WITWICKA 1958; SZCZECHURA 1958; LISZKOWA 1967; GAWOR-BIEDOWA 1972; TEISSEYRE 1975 and others).

From the Upper Maastrichtian of the Vistula River ostracods (SZCZECHURA 1964, 1965) and coccoliths (GÓRKA 1957) were described. Recently GAŹDZICKA (1978) studied the coccoliths from the Campanian and Maastrichtian and established coccolith zonation; her results will be discussed later.

LITHOLOGY

The Upper Cretaceous deposits of the Vistula River profile are a 900 m thick sequence of carbonate and carbonate-siliceous rocks. The lithology of these deposits has been studied by many authors. POŻARYSKI (1938) presented the general petrographic characteristics of the Upper Cretaceous deposits of the Vistula River profile, POŻARYSKA (1952) dealt with the sedimentologic problems of the Maastrichtian sequence, KURLENDA (1967) discussed the changes in petrographic development of the part of the Upper Cretaceous profile (Upper Turonian-Lower Campanian) and WYRWICKA (1977) gave the detailed lithologic characteristics of the Maastrichtian rocks, based upon examinations with the optical microscope, SEM, chemical determinations and studies of physical properties. Other papers (e. g., SUJKOWSKI 1931, POŻARYSKI 1947, 1951, UBERNA 1955, 1967, MORAWIECKI 1957, RADWAŃSKI 1960, KOWALSKI 1961, BŁASZKIEWICZ 1962, ŁOZIŃSKA-STĘPIEŃ 1964, 1965, KURLENDA 1967, POŻARYSKI and POŻARYSKA 1970, CIEŚLIŃSKI and WYRWICKA 1970) dealt with different aspects of the lithology.

The carbonate and carbonate/siliceous rocks of the Vistula River profile are extremely uniform, differing only in their content of quartz and glauconite. That is why these rock types are described jointly below. The observed differences in the rocks of different ages are mentioned when discussing the Upper Cretaceous lithologic profile. The environmental interpretation of the various rock-types was discussed by POŻARYSKA (1952) and will not be repeated here. Similarly, the sandy deposits described in detail by UBERNA (1967) will not be considered.

Rock types

Limestones are light grey to yellow-grey in colour, hard and massive, the fracture being most frequently rough. They are micritic or microsparitic organodetritic limestones, most frequently packed biomicrites containing relatively large numbers of quartz grains (of diameter less than 0·3 mm) and glauconite. In addition, pyrite occurs both as concentrations and as impregnations of tests. Foraminiferal tests, sponge spicules, inoceram fibres, fragments of echinoderms and shells of other molluscs are the main bioclastic components. The sparse biomicrites, not differing qualitatively in general when compared with the packed biomicrites, occur relatively rarely. SEM studies indicate that the matrix is detrital apart from the small amount of marly material; the organic detritus (mainly coccoliths) predominates.

Chalk is white, soft, highly porous. It is a very pure carbonate deposit with only trace amounts of detrital clay, silt or sand and virtually no glauconite or phosphate. In thin section, the carbonate fraction (95–96% of the rock) consists of sparse or packed biomicrites with numerous planktic and benthic foraminifera. Mollusc fragments, echinoderm plates and sponge spicules are important macrofossil components while belemnites and bryozoans are important at some horizons. SEM studies revealed that the predominant rock components are coccoliths. The non-carbonate fraction consists of quartz grains (generally 0·01–0·1 mm) and, more rarely, glauconite and pyrite.

Opokas are the prevailing principal rock type in the Upper Cretaceous profile of the Vistula River valley. They are yellow-white to light grey in colour, hard to very hard, light and porous. Most frequently they are sparse biomicrites, strongly impregnated by opal. Foraminiferal tests or sponge spicules prevail in the composition, more rarely fragments of brachiopods, molluscs and echinoids are present, while bryozoans and radiolarians occur rarely. Quartz grains (usually less than 0·15 mm diameter) occur in small amount (less than 10%), glauconite is rarer and forms light green, oval or reniform grains of 0·02–0·2 mm diameter; it also fills foraminiferal chambers and some spicule canals. In addition, piryte or ferrous hydroxides occur in form of the lumps unevenly distributed in the matrix and as impregnations of skeletal fragments.

Gaizes are yellow-green in colour, fragile, porous. The grain components form more than 50% of the rock; glauconite (often 25% of rock, forms grains of diameter 0·1–0·5 mm), quartz (less than 20%, of diameter 0·01–0·08, maximum 0·3 mm) and skeletal fragments (less than 10%; fragments of incocerams, other molluscs, gastropods, echinoids, foraminiferal tests filled most commonly by opal or glauconite and spicules of siliceous sponges) are the main skeletal components. Feldspar grains, lumps of ferroan hydroxides and single grains of phosphates and collophane fragments occur in subordinate amounts. The matrix, of contact type, is a siliceous-clayey mass with admixtures of ferroan hydroxides.

Marls are grey or light grey in colour, hard and massive. The matrix is composed of cryptocrystalline carbonate-clayey material, in which angular quartz grains (of diameter up to 0·1 mm) occur in variable amounts. Pyrite is common, while glauconite occurs only in trivial quantities. In the matrix foraminiferal tests are locally abundant, fragments of other molluscs, brachiopods and bryozoans or radiolarians are rare. Organic fragments composed of collophane are numerous.

Description of the Upper Cretaceous profile

The profile studied begins with glauconitic sandy marls of the Cenomanian, overlying Albian sandstones and phosphoritic layer (SAMSONOWICZ 1925; POŻARYSKI 1947). At the Lower-Upper Cenomanian boundary a hardground is observed. The thickness of the Cenomanian deposits is variable (UBERNA 1967); in Jakubowice (fig. 1; table 1) it ranges between 1 and 2 m.

The **Cenomanian** deposits are overlain by the **Turonian** deposits, 220 m thick (POŻARYSKI 1938). The lower part of the Lower Turonian, the *Inoceramus labiatus* zone, is developed as inoceram-oligostegine limestones, locally passing laterally into gaizes with glauconite and quartz and phosphoritic concretions (CIEŚLIŃSKI and WYRWICKA 1970). In the lower part of the *Inoceramus lamarcki* zone white marls occur, a few metres thick, without glauconite. Towards the top they pass into opokas with irregular cherts forming partings up to 15 cm thick arranged in layers. In the area of Piotrowice the opokas are decalcified (POŻARYSKI 1951) in the top part. In the uppermost part of the *Inoceramus lamarcki* zone opokas with bands of platy cherts several centimetres thick occur. The *Inoceramus costellatus — Inoceramus inconstans* zone is represented by white limy opokas (containing, according to KURLENDA 1967, about 50–65% of $CaCO_3$ and 30–47% of insoluble residue) with cherts and grey flints with white dots in places. The top part of the Turonian — the *Inoceramus schloenbachi* zone — is represented by white marls with grey flints.

The total thickness of the **Coniacian** deposits overlying the Turonian deposits is about 30 m. They are white marls, containing 73% of $CaCO_3$ and 20% of insoluble residue according to KURLNDA 1967 with light grey flints at the bottom and white limy opokas (53% of $CaCO_3$ and 40% of insoluble residue) with light grey flints in the top. In the topmost part of the Coniacian deposits, at the boundary with the Santonian deposits, a layer of light grey flints 25 cm

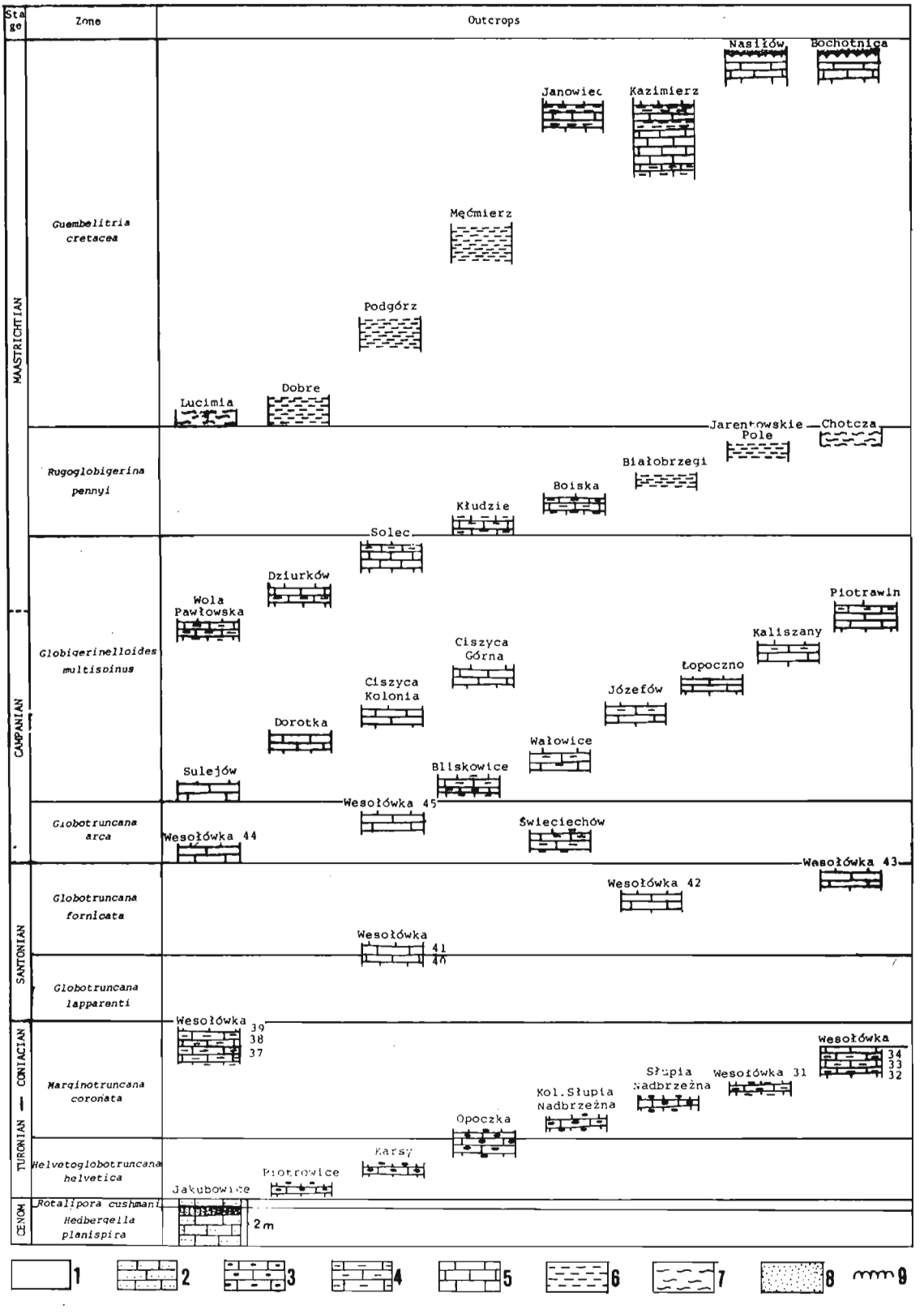


Fig. 2

Lithological profiles of studied outcrops 1 — limestones; 2 — glauconitic sandy marls; 3 — opokas with flints and/or cherts; 4 — marly opokas; 6 — gaizes; 6 — marls; 7 — chalk; 8 — glauconitic, phosphoritic sands; 9 — hard ground.

thick occurs. According to KURLENDA (1967) it originated by the washing out of the underlying flinty opokas during emersion at the end of the Coniacian.

The **Santonian** deposits, of total thickness of 60 m (comp. POŻARYSKI 1938), begin with light yellow opokas containing 43–50% of $CaCO_3$ and 45–47% of insoluble residue (comp. KURLENDA 1967) with light grey cherts. In the lowermost part of the Santonian deposits the sudden increase of the glauconite and quartz content is marked when compared with the Turonian and Coniacian deposits; 5% versus 1% for glauconite and 2% versus less than. 0·6% for quartz, respectively (KURLENDA 1967). The size of grains increases as well. It should be noted that this increase in the content of glauconite and quartz is marked only in the lowermost part of the Santonian deposits and later the content of both components decreases relatively sharply to 1% (comp. POŻARYSKI 1938, KURLENDA 1967). In the upper part of the Santonian profile there are light yellow limy opokas (containing, according to KURLENDA 1967, 53–56% of $CaCO_3$ and 40% of insoluble residue) together with light grey cherts.

The **Campanian** deposits, of total thickness 220 m are light yellow limy opokas, containing 55% of $CaCO_3$ and 38% of insoluble residue (KURLENDA 1967), interlayered with marls. At the bottom of the Campanian deposits a glauconite bed occurs (BŁASZKIEWICZ 1962). BŁASZKIEWICZ (1962) concluded that the association of belemnite rostra (showing traces of corrosion), phosphatic concretions and evidence of scouring activity of currents seem to testify to breaks in the sedimentation. The Campanian opokas pass gradually into the Maastrichtian opokas. They can be distinguished only by their fauna.

The **Maastrichtian** deposits are about 370 m thick and according to POŻARYSKI (1938), comprise two lithologic units. In the Lower Maastrichtian there are 120 m of marly opokas (containing 35–50% of $CaCO_3$) with intercalations of soft whitening rock (containing 60–70% of $CaCO_3$) (horizons "s", "t", "u", "v"). In the Upper Maastrichtian 200 m of marls with intercalations of chalk, containing 70–80% of $CaCO_3$, are present (horizon "w"). Higher in the profile, opokas with marls intercalations (the so called "Kazimierz opoka" of $CaCO_3$ content more than 20% and of thickness 50 m — horizon "x") occur. In the top of the Maastrichtian the white hard limestone containing more than 90% of $CaCO_3$ and of thickness 1 m (horizon "y"), known from outcrops in Bochotnica and Nasiłów (comp. figs. 1, 2) is present. WYRWICKA (1977) accepted the tripartite lithologic division of the Maastrichtian and distinguished two transitional series. Above the limestone, in Bochotnica, there is a bed 0·4 m thick of fine-grained glauconitic marly limestone with numerous phosphoritic concretions. It belongs to the Danian (POŻARYSKA 1967). The uppermost part of the Maastrichtian is not represented in the Vistula River profile (POŻARYSKA 1965).

FORAMINIFERAL BIOSTRATIGRAPHY

On the basis of the study of the planktic foraminifera from the Upper Cretaceous profile of the Vistula River valley (Table 3) it has been possible to distinguish 10 foraminiferal zones. These zones are of 3 types: 1. range-zones (e. g., *Guembelitria cretacea* Zone), 2. interval-zones (e.g., *Marginotruncana coronata* Zone), and 3. assemblage-zone (*Hedbergella planispira* Zone).

The assemblage characteristic for each zone, comprises the following groups of species:

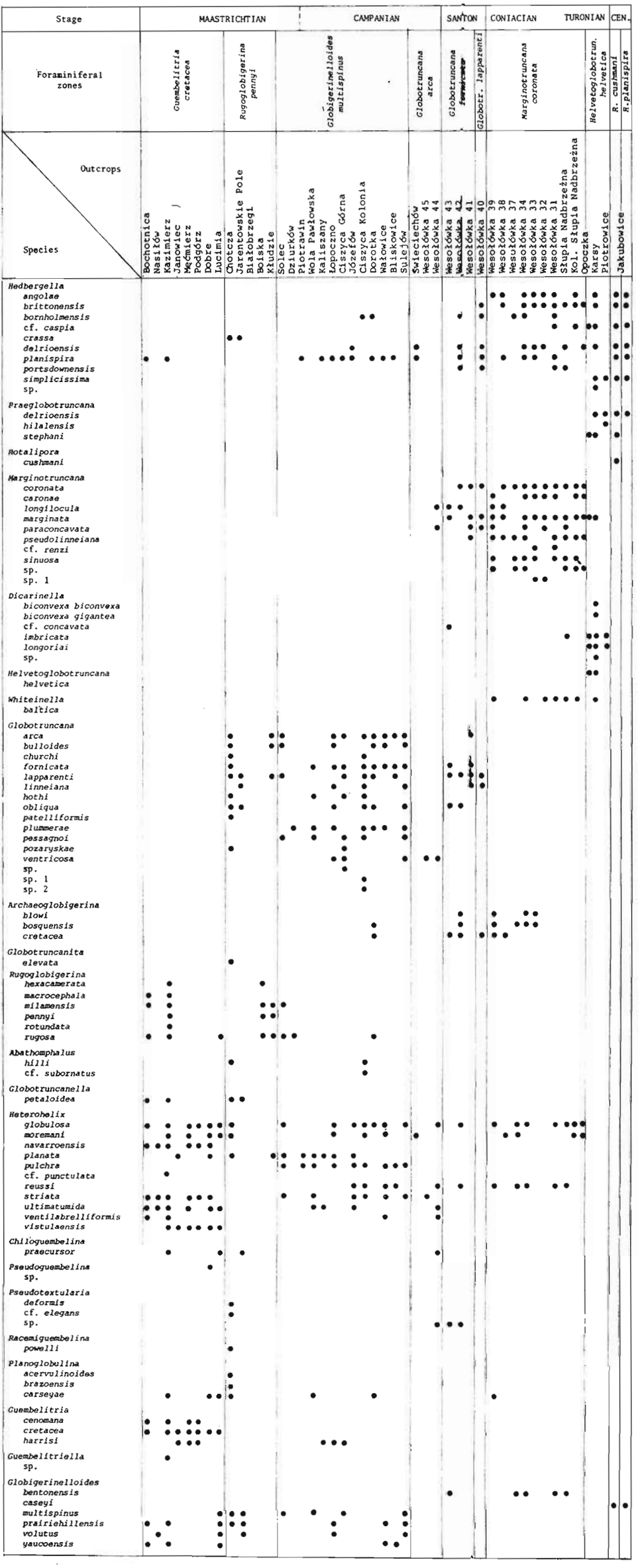
1. species occurring in a given zone only;
2. species appearing in a given zone and passing higher;
3. species occurring in a given zone and lower;
4. transit species, occurring both in a given zone and in adjacent zones.

In addition, some species may occur in a part of a given zone only. For establishing the boundaries of zones only the first two categories of species were taken into account.

The Upper Cretaceous successions in various parts of the world have been subdivided on the basis of planktic foraminifers, mainly globotruncanides, especially in the lower latitudes.

Table 3

Occurrence of planktic Foraminifera in the outcrops examined



The rate of evolution in populations of planktic foraminifera was more rapid in the warm Tethyan water than in the temperate or boreal zones. Furthermore, the species composition of assemblages is different in temperate and boreal zones compared with warm water zones, so that in these areas it is impossible to recognize the zones characteristic of lower latitudes, such as the *Dicarinella concavata* Zone, *Globotruncana calcarata* Zone, *Globotruncanita gansseri* Zone or *Abathomphalus mayaroensis* Zone, in temperate areas. Therefore, when distinguishing new zones, for the zonal index, I selected species of wide geographical distribution and with clearly defined futures, by which they can be easily and accurately identified.

The following biozones were recognized in upward succession:

1. *Hedbergella planispira* Zone
2. *Rotalipora cushmani* Zone
3. *Helvetoglobotruncana helvetica* Zone
4. *Marginotruncana coronata* Zone
5. *Globotruncana lapparenti* Zone
6. *Globotruncana fornicata* Zone
7. *Globotruncana arca* Zone
8. *Globigerinelloides multispinus* Zone
9. *Rugoglobigerina pennyi* Zone
10. *Guembelitria cretacea* Zone.

Hedbergella planispira Zone

Category: Assemblage-zone.

Age: Lower Cenomanian.

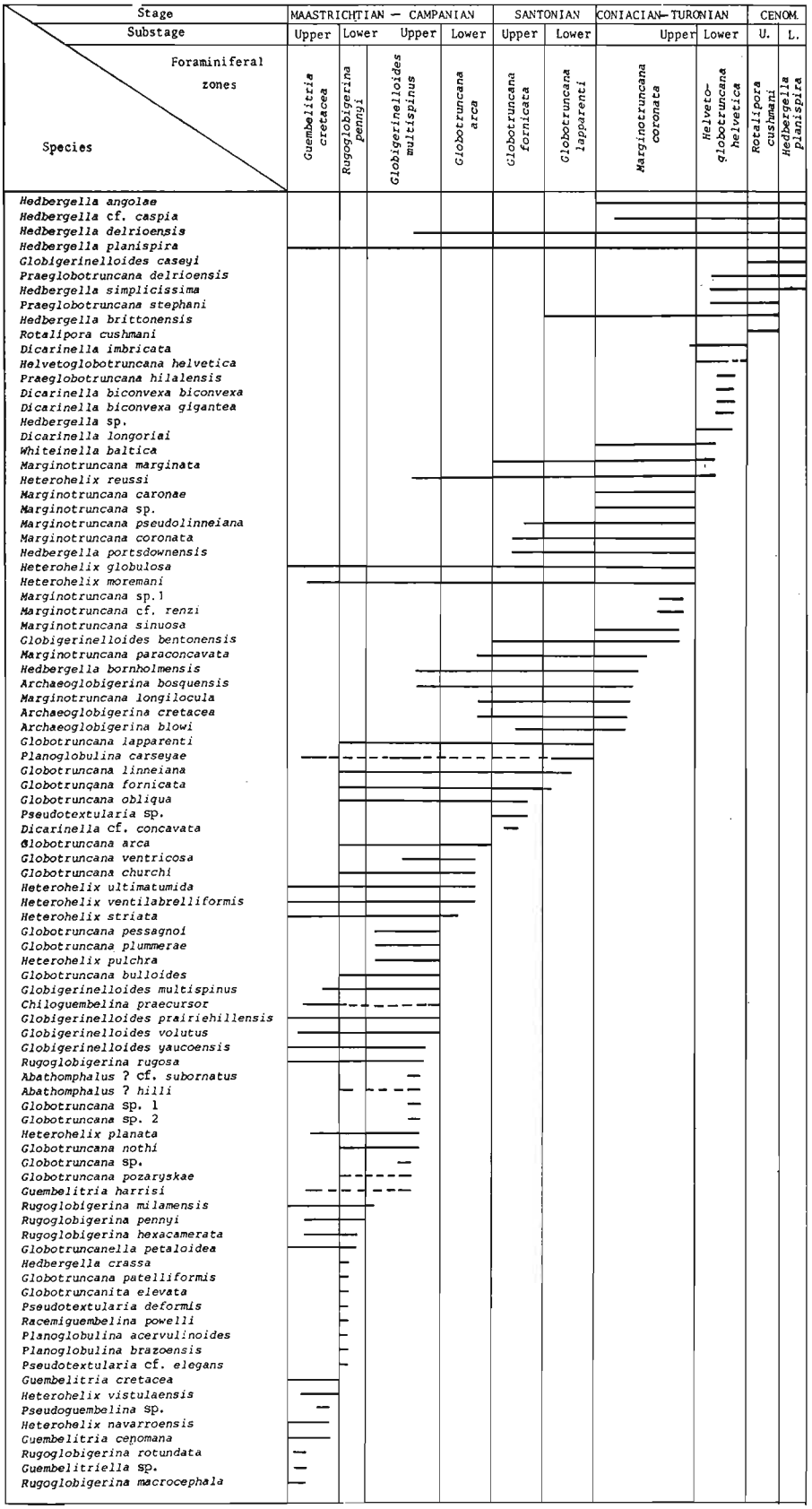
Definition: Interval, with abundant small hedbergellas to the first appearance of *Rotalipora cushmani* (MORROW) (tables 2, 4).

Characteristics: Characterized by common occurrence of *Hedbergella planispira* (TAPPAN), *H. angolae* CARON, *H.* cf. *caspia* (VASSILENKO), *H. delrioensis* (CARSEY) and absence of *Rotalipora cushmani* (MORROW). Besides, *Praeglobotruncana delrioensis* (PLUMMER), *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN) and *Hedbergella simplicissima* (MAGNE and SIGAL) occur in small number (tables 3, 4, 5).

Remarks. — In all earlier zonations, the Cenomanian stage was subdivided on the basis of species belonging to the genera *Rotalipora* and *Thalmanninella* (comp. table 6). In the Vistula River profile *Thalmanninella* is absent and *Rotalipora* is represented by one species, *R. cushmani* (MORROW), the index fossil for the Upper Cenomanian zone of the same name. Because of the absence of planktic foraminifera which could serve for establishing the age of the *Hedbergella planispira* Zone, the Lower Cenomanian age of the zone is accepted on the basis of its position in the profile and the earlier determination of its age on the basis of cephalopods (POŻARYSKI 1947, CIEŚLIŃSKI 1959). The *Hedbergella planispira* Zone differs from the previously established zones in the Lower Cenomanian in the world firstly in the lack of representatives of *Thalmanninella*. However, the presence of representatives of *Hedbergella*, especially *H. planispira* (TAPPAN) and *H. delrioensis* (CARSEY), the presence of *Praeglobotruncana delrioensis* (PLUMMER) and *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN), and the absence of *Rotalipora cushmani* (MORROW), permit correlation of the *Hedbergella planispira* Zone with the *Rotalipora voluta* zone of the Gulf Coastal Plain (PESSAGNO 1967) and the *Rotalipora appenninica* zone of California (DOUGLAS 1969) and Libya (BARR 1972). The *Hedbergella planispira* Zone is equivalent to the assemblage "IV" described by HELLER (1975) from the Łódź region and other equivalents (comp. table 6) are the "zone 3" recognized in Switzerland (CARON 1966), zones Cn_1 and Cn_2 in SE France (PORTHAULT 1974) and, in the general zonations, the following zones: *Rotalipora reicheli*, *Rotalipora brotzeni* and *Rotalipora appenninica* (BOLLI 1966) and *Rotalipora apenninica-Rotalipora buxtorfii* (van HINTE 1976).

Table 4

Ranges of planktic Foraminifera in the Middle Vistula River profile



Rotalipora cushmani Zone

Category: Range-zone
Age: Upper Cenomanian
Definition: Total range of *Rotalipora cushmani* (MORROW) (tables 3, 4).
Characteristics: In addition to the index fossil, *Praeglobotruncana stephani* (GANDOLFI) and *Hedbergella brittonensis* LOEBLICH and TAPPAN make their appearance in this zone. *Globigerinelloides caseyi* BOLLI, LOEBLICH and TAPPAN has its last occurrence. *Hedbergella angolae* CARON, *H.* cf. *caspia* (VASSILENKO), *H. delrioensis* (CARSEY) and *H. planispira* (TAPPAN) are transit species (table 3, 4, 5).
Remarks. — This zone was established in Italy (BORSETTI 1961) as a subzone. BOLLI (1966) recognized it as a zone. In other regions the assemblage of planktic foraminifera from the *Rotalipora cushmani* Zone if often more varied and abundant when compared with the Polish assemblage, especially in areas of warm water deposits. Taking into account its rather poor species composition, the *Rotalipora cushmani* Zone from central Poland is very similar to the zone of the same name recognized in Belgium (MOORKENS 1969). In the Polish assemblage, apart from the following species: *Rotalipora cushmani* (MORROW), *Hedbergella delrioensis* (CARSEY), *Praeglobotruncana stephani* (GANDOLFI), *P. delrioensis* (PLUMMER), being in common with the Belgium assemblage, the genus *Hedbergella* is prevailing, while in the Belgium assemblage the genus *Praeglobotruncana* prevails. In the *Rotalipora cushmani-greenhornensis* Zone from the Gulf Coast Plain (PESSAGNO 1967) almost all species found in Poland occur but in the Polish assemblage the representatives of *Schackoina* are lacking. The age equivalents of the *Rotalipora cushmani* Zone in Poland are the *Rotalipora* Zone in Austria (STURM 1969), the Upper *Rotalipora* Zone in Tunis (DALBIEZ 1955), the *Rotalipora cushmani-turonica* Zone in Romania (SANDULESCU 1969) and Western Carpathians (SALAJ and SAMUEL 1966) and the *Rotalipora cushmani* Zone in California (DOUGLAS 1969*b*), southern USSR (MASLAKOVA 1977), Bulgaria (VAPTZAROWA 1976*b*) and Libya (BARR 1972). Moreover, the horizons Cn3, Cn4, Cn5, Cn6, and Tu1 in SE France (PORTHAULT 1974) are equivalent; in all these zones *Rotalipora cushmani* (MORROW) is present while *Praeglobotruncana stephani* (GANDOLFI) and numerous species of *Hedbergella* and *Helvetoglobotruncana helvetica* (BOLLI) are absent. The "V" assemblage distinguished by HELLER (1975) in the Łódź region corresponds to the assemblage of the *Rotalipora cushmani* zone from the Vistula River profile. The equivalents of the *Rotalipora cushmani* zone of Central Poland are the *Rotalipora cushmani* Zone and *Rotalipora gandolfii-Rotalipora greenhornensis* Zone in general zonations (comp. table 6).

Helvetoglobotruncana helvetica Zone

Category: Interval-zone
Age: Lower Turonian
Definition: Interval, with zonal marker from the last occurrence of *Rotalipora cushmani* (MORROW) to the first occurrence of *Marginotruncana coronata* (BOLLI) (tables 3, 4).
Characteristics: *Helvetoglobotruncana helvetica* (BOLLI), *Dicarinella imbricata* (MORNOD), *D. longoriai* sp. n., *D. biconvexa biconvexa* (SAMUEL and SALAJ), *D. biconvexa gigantea* (SAMUEL and SALAJ), *Praeglobotruncana hilalensis* BARR, *Hedbergella* sp. occur only in this zone. The last occurrences of *Praeglobotruncana delrioensis* (PLUMMER), *P. stephani* (GANDOLFI), *Hedbergella simplicissima* (MAGNÉ and SIGAL) were noted within this zone. *Marginotruncana marginata* (REUSS), *Whiteinella baltica* DOUGLAS and RANKIN and *Heterohelix reussi* (CUSHMAN) make their appearance in this zone in the profile studied. *Hedbergella angolae* CARON, *H. brittonensis* (LOEBLICH and TAPPAN), *H.* cf. *caspia* (VASSILENKO), *H. delrioensis* (CARSEY), *H. planispira* (TAPPAN) are transit species (tables 3, 4, 5).
Remarks. — This zone was established in Tunis (DALBIEZ 1955). The index species was well chosen and this zone has been accepted by most of workers, although it has not always been

pistinguished within the range proposed by DALBIEZ. The *H. helvetica* Zone from the Vistula river profile can be correlated with the zone of the same name recognized in Tunis (DALBIEZ 1955), Italy (BORSETTI 1962), Bulgaria (VAPTZAROVA 1976b), southern USSR (MASLAKOVA 1977), Romania (SANDULESCU 1969), Belgium (MOORKENS 1969), NW Pacific (DOUGLAS 1971) and Libya (BARR 1972) and with the *Marginotruncana helvetica* assemblage zone of the Gulf Coast Plain (PESSAGNO 1967). It is coeval also with the *Praeglobotruncana* Zone established in Austria (STURM 1969), Tu2 zone of France (PORTHAULT 1974) and zone "VI" of Préalpes médianes (CARON 1966). The composition of assemblages "VI" and "VII" described from the Łódź region (HELLER 1975) is similar to that of the *H. helvetica* Zone. In general zonation its equivalents are: *Globotruncana helvetica* Zone (van HINTE 1976) and *Praeglobotruncana gigantea* and *Hedbergella lehmanni Globotruncana helvetica* Zones (BOLLI 1966) (comp. table 6).

Marginotruncana coronata Zone

Category: Interval-zone

Age: Upper Turonian-Coniacian

Definition: Interval, from the first occurrence of *Marginotruncana coronata* (BOLLI) to the first occurrence of *Globotruncana lapparenti* BROTZEN (tables 3, 4).

Characteristics: In addition to the index species at the base of the zone *Marginotruncana pseudolinneiana* PESSAGNO, *M. caronae* sp. n., *Heterohelix globulosa* (EHRENBERG), *H. moremani* (CUSHMAN) and *Hedbergella portsdownensis* (WILLIAMS-MITCHELL) make their appearance. *Marginotruncana* sp.$_1$ and *Marginotruncana* cf. *renzi* (GANDOLFI) occur only in the middle part of the zone. *Hedbergella bornholmensis* DOUGLAS and RANKIN, *Marginotruncana paraconcavata* PORTHAULT, *M. sinuosa* PORTHAULT, *M. longilocula* (GANDOLFI), *Archaeoglobigerina blowi* PESSAGNO, *A. bosquensis* PESSAGNO, *A. cretacea* (d'ORBIGNY) and *Globigerinolloides bentonensis* (MORROW) first appear in the upper part of the zone while *Planoglobulina carseyae* (PLUMMER) first appear near the top. *Hedbergella angolae* CARON, *H.* cf. *caspia* (VASSILENKO) and *Whiteinella baltica* DOUGLAS and RANKIN die out within the uppermost part of the zone. *Marginotruncana marginata* (REUSS), *Hedbergella brittonensis* LOEBLICH and TAPPAN, *H. delrioensis* (CARSEY), *H. planispira* (TAPPAN) and *Heterohelix reussi* (CUSHMAN) are transit species (tables 3, 4, 5).

Remarks. — The time range of the *Marginotruncana coronata* Zone has been designated in many ways (comp. table 6). It was established in Tunis (DALBIEZ 1955) as the *Globotruncana schneegansi* Zone. BOLLI (1957) designated in Trinidad this horizon the *Globotruncana renzi* Zone, later changed (BOLLI 1966) into *Globotruncana schneegansi* Zone. These two names are most frequently used. DOUGLAS (1969b) designated the coeval horizon the *Globotruncana cachensis* Zone and BARR (1972) the *Globotruncana sigali* Zone. It was established in Belgium (MOORKENS 1969) as the *Globotruncana coronata* Zone. Analysis of the assemblage of planktic foraminifera and of their vertical distribution shows that this horizon is coeval to the *Marginotruncana coronata* Zone of the Vistula River profile. Another equivalent of the *Marginotruncana coronata* Zone of the profile studied is the horizon with "big, flat *Globotruncana*" established in Romania (SANDULESCU 1969). In Poland, the flat, large marginotruncans — *M. coronata* (BOLLI), *M. pseudolinneiana* PESSAGNO, *M.* sp., *M.* cf. *renzi* (GANDOLFI) do indeed dominate — while the forms used in the lower latitudes for distinguishing this zone (i. e., *M. angusticarinata* (GANDOLFI), *M. canaliculata* (REUSS), *M. sigali* (REICHEL)) are absent. On the same basis the *Marginotruncana coronata* Zone can be correlated with the *Globotruncana renzi* Zone of Bulgaria (VAPTZAROVA 1976*a*, *b*), Iraq (DARMOIAN 1975) and the Gulf Coast Plain (PESSAGNO 1967, 1969), with the *Globotruncana schneegansi* Zone of Austria (STURM 1969) and the Carribean (PREMOLI SILVA and BOLLI 1973,) with the *Globotruncana lapparenti lapparenti* Zone and *Globotruncana lapparenti tricarinata* Zone of Italy (BORSETTI 1962), with the *Globotruncana sigali* Zone of Libya (BARR 1972) and the *Globotruncana cachensis* Zone of California (DOUGLAS 1969*b*). In the zones Tu_3, Tu_4, Tu_5, Co_1, Co_2, St_1 established in SE France (PORTHAULT 1974)

the following species occur: *Marginotruncana coronata* (BOLLI), *M. pseudolinneiana* PESSAGNO, *M. marginata* (REUSS), *M. paraconcavata* PORTHAULT, *M. sinuosa* PORTHAULT, two last species as well as *M. renzi* (GANDOLFI) becoming extinct at the end of St_1 zone. This corresponds to the extinction of these species at the end of the *Marginotruncana coronata* Zone in Poland. Assemblages "VIII", "IX" and "X" of the Łódź region (HELLER 1975) also indicate the *Marginotruncana coronata* Zone. The equivalent of the *Marginotruncana coronata* Zone in general zonation of van HINTE (1976) are the *Globotruncana sigali-renzi, Globotruncana schnezgansi* Zones (comp. table 6).

Globotruncana lapparenti Zone

Category: Interval-zone
Age: Lower Santonian
Definition: Interval, from the first appearance of *Globotruncana lapparenti* BROTZEN to the first appearance of *Globotruncana fornicata* PLUMMER (tables 3, 4).

Characteristics: In this zone, the genus *Marginotruncana* is considerably impoverished quantitatively compared with the preceding zone whereas the first representatives of *Globotruncana* make their appearance here. Of 10 species of *Marginotruncana* occurring in the *Marginotruncana coronata* zone, only *Marginotruncana coronata* (BOLLI), *M. longilocula* (GANDOLFI), *M. pseudolinneiana* PESSAGNO, *M. marginata* (Reuss) and *M. paraconcavata* PORTHAULT cross the lower boundary of the *Globotruncana lapparenti* Zone. The representatives of *Whiteinella* are lacking in this zone. At the base of the zone, in addition to the index species, *Globotruncana linneiana* (d'ORBIGNY) makes its appearance. The upper boundary of the *Globotruncana lapparenti* Zone is not crossed by *Hedbergella brittonensis* LOEBLICH and TAPPAN. *Hedbergella delrioensis* (CARSEY), *H. planispira* (TAPPAN), *H. portsdownensis* (WILLIAMS-MITCHELL), *H. bornholmensis* DOUGLAS and RANKIN, *Marginotruncana marginata* (REUSS), *M. pseudolinneiana* PESSAGNO, *M. coronata* (BOLLI), *M. paraconcavata* PORTHAULT, *Heterohelix reussi* (CUSHMAN), *H. globulosa* (EHRENBERG), *H. moremani* (CUSHMAN), *Globigerinelloides bentonensis* (MORROW), *Archaeoglobigerina blowi* PESSAGNO, *A. bosquensis* PESSAGNO are transit species (tables 3, 4, 5).

Remarks. — The *Globotruncana lapparenti* Zone was established in the Upper Turonian of Italy (BORSETTI 1962) and recognized by MASLAKOVA (1977) in the southern USSR. The recent classifications of planktic foraminifera (PESSAGNO 1967; LONGORIA and GAMPER 1975) assume that the position of the primary aperture, the development of apertural apparatus and the presence of accessory apertures are the basic criteria of classification at the family level. On this basis the genus *Globotruncana* previously thought to occur from the Turonian to the Maastrichtian was included into several families and genera, and the genus *Globotruncana s. s.* was defined on the basis of the following criteria: umbilical primary aperture, umbilicus covered by tegilla with infralaminal and intralaminal accessory apertures, chambers truncated by two keels, rugosities irregularly distributed. *Globotruncana* makes its appearance in the Santonian, and one of its earliest representatives is *G. lapparenti* BROTZEN. In the studied profile, *G. lapparenti* BROTZEN appears at the base of the Santonian and it serves for the designation of the zone comprising the Lower Santonian deposits. The Lower Santonian foraminiferal zone is commonly named after *Dicarinella concavata* (BROTZEN); however, this species, with the exception of one specimen determined as *Dicarinella* cf. *concavata* (BROTZEN), was not found in the profile studied. Its absence at that latitude is probably related to its limitation to warm-waters. *Globotruncana lapparenti* BROTZEN was more cosmopolitan than *Dicarinella concavata* (BROTZEN); as it is easy to identify and appears in the studied profile at the Coniacian-Santonian boundary, it has been chosen as the index species of the zone. It should be stressed that there are many similarities between the assemblages of planktic foraminifera from the Vistula river profile and from the Gulf Coast Plain (comp. PESSAGNO 1967) at the Coniacian-

Santonian boundary and in the Lower Santonian. Thus, the genus *Whiteinella* is absent with the exception of the lowermost part of the *Globotruncana lapparenti* Zone in the studied profile as in the *Marginotruncana concavata* Zone in the Gulf Coast Plain. In the *Marginotruncana concavata* Zone, only 2 species of the genus *Marginotruncana* occur in great numbers while 5 other species occur only sporadically; the first ones are: *Marginotruncana angusticarinata* (GANDOLFI), *M. coronata* (BOLLI) and *M. renzi* (GANDOLFI). The genus *Archaeoglobigerina* is represented in the Gulf Coast Plain by the same species as in Poland; they appear in both areas not before the end of the Coniacian and become numerous in the Lower Santonian. Furthermore, *Globotruncana lapparenti* first appears at the base of the Santonian in both Poland and the Gulf Coast Plain. The next zone — *Globotruncana fornicata* Zone, is distinguished on the basis of the same criteria as the *Globotruncana fornicata* zone of the Gulf Coast Plain. All those characteristics enable us the *Globotruncana lapparenti* zone from the Vistula River profile to be correlated with the *Marginotruncana concavata* Zone from the south-eastern part of the USA. Another equivalent of the *Globotruncana lapparenti* Zone is the lower part of St2 zone established in SE France (PORTHAULT 1974). As in the Vistula River profile, the boundary between zones St1 and St2 is not crossed by several species of *Marginotruncana*, among them *M. sinuosa* PORTHAULT and the first species of *Globotruncana* (*C. bulloides* VOGLER and *G. fornicata* PLUMMER) make their appearance. The upper part of the St_2 zone, in which *Globotruncana fornicata* PLUMMER occurs in great number, corresponds to the succeeding zone in the Vistula river profile. Almost all workers put the boundary between the Coniacian and the Santonian at the base of the Lower Santonian *Dicarinella concavata* Zone (comp. table 6), e. g., BOLLI 1957, 1966; PESSAGNO 1967; MASLAKOVA 1977; VAPTZAROVA 1976b; commonly being recognized in lower latitudes. The *Globotruncana lapparenti* Zone is the age equivalent of the *Globotruncana concavata* Zone of Belgium (MOORKENS 1969), the southern USSR (MASLAKOVA 1977), Iraq (DARMOIAN 1975) and Trinidad (BOLLI 1957) and in general zonations (BOLLI 1966, van HINTE 1976), and of the *Marginotruncana concavata* zone of the Gulf Coast Plain (PESSAGNO 1967). Other equivalents are: the *Globotruncana concavata cyrenaica* zone of Libya (BARR 1972) and the zone "A" in Austria (IBRAHIM 1976).

Globotruncana fornicata Zone

Category: Interval-zone
Age: Upper Santonian
Definition: Interval, from the first abundant occurrence of the zonal marker to the first appearance of *Globotruncana arca* (CUSHMAN) (tables 3, 4).

Characteristics: At the base of the zone *Globotruncana fornicata* PLUMMER appears in great number and a little higher *Globotruncana obliqua* HERM.; *Dicarinella* cf. *concavata* (BROTZEN) and *Pseudotextularia* sp. are rare. *Marginotruncana coronata* (BOLLI), *M. marginata* (REUSS), *M. pseudolinneiana* PESSAGNO, *Archaeoglobigerina blowi* PESSAGNO and *Globigerinelloides bentonensis* (MORROW) die out within this zone. *Hedbergella bornholmensis* DOUGLAS and RANKIN, *H. delrioensis* (CARSEY), *H. planispira* (TAPPAN), *Marginotruncana longilocula* (GANDOLFI), *M. paraconcavata* PORTHAULT, *Globotruncana lapparenti* BROTZEN, *G. linneiana* d'ORBIGNY, *Archaeoglobigerina bosquensis* PESSAGNO, *A. cretacea* (d'ORBIGNY), *Heterohelix globulosa* (EHRENBERG), *H. moremani* (CUSHMAN) and *H. reussi* (CUSHMAN) are transit species (tables 3, 4, 5).

Remarks. — This zone was established by BOLLI (1957) and emended by PESSAGNO (1969) who recognized it as a subzone. According to PESSAGNO (1969), the assemblages from this zone are characterized by the absence of the representatives of *Marginotruncana*. Species of *Globotruncana*, such as *G. lapparenti* BROTZEN, *G. fornicata* PLUMMER, *G. bulloides* VOGLER increase in abundance. *Dicarinella concavata* (BROTZEN) is absent in the Upper Cretaceous Vistula River profile, and therefore the lower boundary of the zone is established on the basis of the first

abundant occurrence of *Globotruncana fornicata* PLUMMER. The other species of *Globotruncana* (*G. lapparenti* BROTZEN, *G. linneiana* (d'ORBIGNY), *G. obliqua* HERM) that replace the species of *Marginotruncana* terminating within this zone, become more abundant. PESSAGNO (1967) stated in the definition of the *Globotruncana fornicata* Zone that species of *Marginotruncana* do not occur in it, the last representatives of that genus having become extinct at the boundary of the *Marginotruncana concavata* Zone and the *Globotruncana fornicata* Zone. However, many authors report the presence of species of *Marginotruncana* not only in the Upper Santonian but still in the lowermost Campanian (e. g., PORTHAULT 1974; DOUGLAS 1969*a*, *b*; OWEN 1973, IBRAHIM 1976, VAPTZAROVA 1976*b*). The *Globotruncana fornicata* Zone of central Poland is correlated with the same zone in the Gulf Coast Plain on the basis of the abundant occurrence in both places of *Globotruncana fornicata* PLUMMER, the occurrence of *Globotruncana bulloides* VOGLER, *G. lapparenti* BROTZEN and representatives of *Archaeoglobigerina*. It may be also correlated with the zone of the same name of Trinidad (BOLLI 1957, 1966), Iraq (DARMOIAN 1975) and the southern USSR (MASLAKOVA 1977), as well as with the upper part of St_2 and lower part of St_3 zones established in SE France (PORTHAULT 1974). In all these localities, the representatives of *Globotruncana fornicata* PLUMMER, *G. lapparenti* BROTZEN, *G. bulloides* VOGLER, occur in great number coeval with a less common *Marginotruncana coronata* (BOLLI), *M. pseudolinneiana* Pessagno and *M. marginata* (REUSS); but *Globotruncana arca* (CUSHMAN) is absent. In addition, the zone "B" established in Austria (IBRAHIM 1976) in which the genus *Marginotruncana* is replaced by *Globotruncana* (*G. fornicata* PLUMMER, *G. bulloides* VOGLER, *G. plummerae* GANDOLFI, *G.* cf. *arca* (CUSHMAN) and others) and *Archaeoglobigerina cretacea* (d'ORBIGNY) may be also correlated with the *Globotruncana fornicata* Zone of central Poland (table 6).

Globotruncana arca Zone

Category: Interval-zone

Age: Lower Campanian

Definition: Interval, from the first appearance of *Globotruncana arca* (CUSHMAN) to the first appearance of *Globigerinelloides multispinus* (LALICKER) (tables 3, 4).

Characteristics: In addition to the index species, *Globotruncana churchi* MARTIN, *G. ventricosa* (WHITE), *Heterohelix striata* (EHRENBERG), *H. ultimatumida* (WHITE and *H. ventilabrelliformis* (van der SLUIS) make their appearance in this zone. Within the lower part of the zone, the last marginotruncans: *M. longilocula* (GANDOLFI) and *M. paraconcavata* PORTHAULT terminate. Transit species are: *Hedbergella bornholmensis* DOUGLAS and RANKIN, *H. delrioensis* (CARSEY), *H. planispira* (TAPPAN), *Globotruncana fornicata* PLUMMER, *G. lapparenti* (BROTZEN), *H. linneiana* (d'ORBIGNY), *G. obliqua* HERM, *Archaeoglobigerina bosquensis* PESSAGNO, *A. cretacea* (d'ORBIGNY), *Heterohelix globulosa* (EHRENBERG), *H. moremani* (CUSHMAN) and *H. reussi* (CUSHMAN).

Remarks. — This zone was established in the Western Carpathians (SALAJ and SAMUEL 1966). The lower boundary of the zone is marked by the appearance of *Globotruncana rugosa* (MARIE). Its stratigraphic range is the Lower Campanian. DOUGLAS (1969*b*) recognized the *Globotruncana arca* zone in California but he admitted its greater stratigraphic range. He designated two subzones within it: *Globotruncana stuartiformis* subzone and *Globotruncana churchi* Subzone. In the DOUGLAS' scheme, the age equivalent of the *Globotruncana arca* Zone *sensu* SALAJ and SAMUEL (1966) is the *Globotruncana stuartiformis* Zone. In the Upper Cretaceous Vistula River profile the *Globotruncana arca* Zone was distinguished according to the principle of priority both in regard to the name of zone and its stratigraphic range. It should be mentioned that the most frequently used name for defining the age range of the *Globotruncana arca* Zone is the *Globotruncana elevata* Zone although it is not in accordance to the priority principle in regard to the range of the latter, established by DALBIEZ (1955) in Tunis for the entire Campanian section. STURM (1969) in Upper Austria delimited its stratigraphic range to the Lower Campanian

only. In such stratigraphic meaning that zone was distinguished in the southern part of the USSR (MASLAKOVA 1977) and Bulgaria (VAPTZAROVA 1975). The *Archaeoglobigerina blowi* Subzone of the Gulf Coast Plain (PESSAGNO 1967, 1969) may be correlated with the *Globotruncana arca* Zone of the Vistula River profile as well; both zones are characterized by similar assemblages of planktic foraminifera, differing only in the absence of single keeled globotruncans from stuarti group in the Vistula River profile. *Globotruncanita* is represented by *Globotruncanita elevata* only, occurring sporadically and only in the upper part of its world stratigraphic range. The zones "C" and "D" established in Austria (IBRAHIM 1976) yield richer assemblage of globotruncans, but all species from the *Globotruncana arca* Zone of the Vistula river profile can be found in these zones. *Globotruncana arca* (CUSHMAN) appears not before the beginning of the "C" zone and *Globotruncana plummerae* GANDOLFI in the "E" zone. That is why I treat the "C" and "D" zones as coeval with the *Globotruncana arca* Zone. The upper part of St_3 zone established in SE France (PORTHAULT 1974) is correlated with the *Globotruncana arca* Zone of central Poland; starting from the middle part of St_3 zone, *Globotruncana arca* (CUSHMAN) occurs in great number together with *Globotruncana plummerae* GANDOFI, *G. linneiana* (d'ORBIGNY), *G. lapparenti* BROTZEN, *G. bulloides* VOGLER and other species occurring in the *Globotruncana arca* Zone in the Vistula river profile (table 6).

Globigerinelloides multispinus Zone

Category: Interval-zone

Age: Upper Campanian-Lowermost Maastrichtian

Definition: Interval, from the first appearance of *Globigerinelloides multispinus* (LALICKER) to the first appearance of *Rugoglobigerina pennyi* BRÖNNIMANN (tables 3, 4).

Characteristics: The zone is dominated by representatives of *Globotruncana*. The genus *Heterohelix* is an important element of the assemblage whereas the other genera are less common. In the lowermost part, in addition to the index species, *Globigerinelloides prairiehillensis* PESSAGNO, *G. volutus* (WHITE), *Globotruncana bulloides* VOGLER, *G. pessagnoi* LONGORIA, *G. plummerae* GANDOLFI and *Heterohelix pulchra* (BROTZEN) appear. The last three named species in the profile studied are limited to the *Globigerinelloides multispinus* Zone. Moreover, *Chiloguembelina praecursor* sp. n. is reported for the first time in the lowermost part of the Zone. *Abathomphalus? subornatus* (GANDOLFI), *Globotruncana* sp., *G.* sp.$_1$ and *G.* sp.$_2$ occur in the middle part of the Zone. *Globigerinelloides yaucoensis* PESSAGNO, *Rugoglobigerina rugosa* (PLUMMER), *Globotruncana pożaryskae* sp.n., *G. nothi* BRÖNNIMANN, *Heterohelix planata* (CUSHMAN) and *Guembelitria harrisi* TAPPAN, appear in the lower and middle parts of the Zone and pass higher. In the uppermost part of the Zone *Rugoglobigerina milamensis* SMITH and PESSAGNO, *Hedbergella delrioensis* (CARSEY), *H. bornholmensis* DOUGLAS and RANKIN and *Heterohelix reussi* (CUSHMAN) make their appearance. *Archaeoglobigerina bosquensis* PESSAGNO dies out within the middle part of the Zone. Other species present in that Zone (tables 3, 4, 5) are transit species.

Remarks. — The long time span of this Zone makes it the longest so far distinguished. However, I do not find any evidence to subdivide it. Taking into account its total range, the Zone can be correlated only with Zones: *Globotruncana elevata* and *Rugotruncana subcircumnodifer*, recognized in the Gulf Coast Plain (PESSAGNO 1967, 1969). *Globigerinelloides multispinus* (LALICKER) and *G. volutus* (WHITE) occur in the Gulf Coast Plain profile starting from the base of the *Globotruncana elevata* Zone. *Heterohelix pulchra* (BROTZEN) and *Globotruncana plummerae* GANDOLFI are present only within the *Globotruncana elevata* Zone while the representatives of the genus *Rugoglobigerina* become numerous in the uppermost part of this Zone. These similarities and the simultaneous presence of many common species from the genera *Heterohelix* and *Globotruncana* permit acceptance of the *Globotruncana elevata* and *Rugotruncana subcircumnodifer* zones of the Gulf Coast Plain as coeval with the *Globigerinelloides multispinus* Zone of central Poland. The local horizons "E", "F", "G" established in Austria (IBRAHIM 1976)

on the basis of globotruncans are most probably coeval with the *Globigerinelloides multispinus* zone of central Poland. IBRAHIM (1976) gives no information about the identity of other genera of planktic foraminifers at these horizons, so the correlation is less well founded. However, the presence of common species such as *Globotruncana arca* (CUSHMAN), *C. fornicata* PLUMMER, *G. lapparenti* BROTZEN, *G. bulloides* VOGLER, *G. ventricosa* (WHITE) and *G. plummerae* GANDOLFI (the last in the Vistula River profile occurring in the *Globigerinelloides multispinus* Zone only) in zones "E", "F", "G" of Austria and in the *Globigerinelloides multispinus* Zone of central Poland, permits correlation with these Zones. In the general zonation by van HINTE (1976) the age equivalents to the *Globigerinelloides multispinus* Zone are the following Zones: *Globotruncana stuartiformis*, *G. subspinosa*, *G. calcarata* and *G. scutilla*, and in that by BOLLI (1976) the Zones: *Globotruncana stuarti s. l.*, *G. tricarinata* and *G. lapparenti lapparenti* (table 6).

Rugoglobigerina pennyi Zone

Category: Interval-zone

Age: Upper part of Lower Maastrichtian

Definition: Interval, from the first appearance of *Rugoglobigerina pennyi* BRÖNNIMANN to the first appearance of *Guembelitria cretacea* CUSHMAN (tables 3, 4).

Characteristics: At the base of the Zone, in addition to the index species, *Rugoglobigerina hexacamerata* BRÖNNIMANN and *Globotruncanella petaloidea* (GANDOLFI) make their appearance. *Hedbergella crassa* (BOLLI), *Globotruncana patelliformis* GANDOLFI, *Globotruncanita elevata* (GANDOLFI), *Pseudoguembelina* sp., *Pseudotextularia deformis* (KIKOINE), *Racemiguembelina powelli* SMITH and PESSAGNO, *Planoglobulina acervulinoides* (EGGER) and *P. brazoensis* MARTIN are restricted to the upper part of the zone. All species of *Globotruncana* crossing the *Globigerinelloides multispinus-Rugoglobigerina pennyi* Zone boundary die out within the uppermost part of the latter Zone. *Rugoglobigerina rugosa* (PLUMMER) and the species of *Heterohelix* occurring in the Zone pass to the higher Zone.Generally speaking, the Zone is characterized by the sudden bloom of *Rugoglobigerina* in its lower part, the mass occurrence of *Globigerinelloides* in its upper part and the complete extinction of *Globotruncana* at the end of the Zone (tables 3, 4, 5).

Remarks. The time span of the *Rugoglobigerina pennyi* Zone corresponds to the *Globotruncana gansseri* Zone established in Trinidad (BOLLI 1957). The base of the latter zone is marked by the appearance of *Globotruncana gansseri* BOLLI and the upper boundary by the *appearance* of *Abathomphalus mayaroensis* (BOLLI). The definition of the *Globotruncana gansseri* Zone was emended by PESSAGNO (1969). According to him, the *Globotruncana gansseri* Zone is characterized by common to abundant *Globotruncana gansseri* BOLLI, *G. aegyptiaca* NAKKADY, *G. duwi* NAKKADY, *G. trinidadensis* GANDOLFI, *Pseudotextularia deformis* (KIKOINE), *Pseudoguembelina palpebra* BRÖNNIMANN and BROWN and *Guembelitria cretacea* CUSHMAN. *Globotruncana stuarti s. s.* (de LAPPARENT), *G. conica* WHITE, *Racemiguembelina fructicosa* (EGGER) and *Planoglobulina acervulinoides* (EGGER) make their appearance in the upper part of the *Globotruncana gansseri* Zone. Comparison of the species composition of the *Globotruncana gansseri* and *Rugoglobigerina pennyi* Zones reveals the complete absence of single-keeled globotruncans (with the exception of *Globotruncanita elevata* (BROTZEN)), in the Polish assemblage. However, in the *Rugoglobigerina pennyi* zone there occur several species known only from (or first appearing in) the *Globotruncana gansseri* Zone (*Globotruncana patelliformis* GANDOLFI, *Rugoglobigerina hexacamerata* BRÖNNIMANN, *R. pennyi* BRÖNNIMANN, *Pseudotextularia deformis* (KIKOINE), *Racemiguembelina powelli* SMITH and PESSAGNO, *Planoglobulina acervulinoides* (EGGER), *P. brazoensis* MARTIN, *Pseudoguembelina* sp.) and these permit correlation of the *Rugoglobigerina pennyi* Zone with the *Globotruncana gansseri* Zone. *Guembelitria cretacea* CUSHMAN does not appear in Poland below the base of the next zone. The *Rugoglobigerina pennyi* Zone is correlated with the *Globotruncana gansseri* Zone of Libya (BARR 1972), Iraq

(KASSAB 1973; DARMOIAN 1975), India (GOVINDAN 1972) and the *Globotruncana contusa* Zone of Western Australia (WRIGHT and APTHORPE 1976). The *Globotruncana gansseri*, *Globotruncana stuarti* and *Globotruncana contusa* Zones of the general zonation by van HINTE (1976) are equivalent to the *Rugoglobigerina pennyi* Zone (table 6).

***Guembelitria cretacea* Zone**

Category: Range-zone
Age: Upper Maastrichtian
Definition: Total range of *Guembelitria cretacea* Cushman (tables 3, 4).
Characteristics: Coeval with the index species, *Heterohelix vistulaensis* sp. n. makes it appearance and, slightly higher, *Heterohelix navarroensis* LOEBLICH and *Guembelitria cenomana* (KELLER). In the uppermost part of the Zone *Rugoglobigerina rotundata* BRÖNNIMANN, *R. macrocephala* BRÖNNIMANN and *Guembelitriella* sp. occur. In addition, the zone yields the following species, known also from the *Rugoglobigerina pennyi* Zone: *Rugoglobigerina hexacamerata* BRÖNNIMANN, *R. milamensis* SMITH and PESSAGNO, *R. pennyi* BRONNIMANN, *R. rugosa* (PLUMMER), *Heterohelix globulosa* (EHRENBERG), *H. moremani* (CUSHMAN), *H. planata* (CUSHMAN), *H. striata* (EHRENBERG), *H. ultimatumida* (WHITE), *H. ventilabrelliformis* (van der SLUIS), *Guembelitria harrisi* (TAPPAN), *Globigerinelloides prairiehillensis* PESSAGNO, *G. volutus* (WHITE) and *G. yaucoensis* PESSAGNO. In the lowermost part of the zone *Globigerinelloides multispinus* (LALICKER) occurs for the last time. In general, this zone may be easily recognized by the presence of abundant representatives of *Heterohelix* and *Guembelitria*, considerable numbers of *Rugoglobigerina* and *Globigerinelloides* and the absence of *Globotruncana* (tables 3, 4, 5).
Remarks. — Almost all workers recognize a single zone — the *Abathomphalus mayaroensis* Zone — spanning the Upper Maastrichtian. Because of the lack of this zonal marker in the Upper Maastrichtian of Poland I attempted to find an acceptable substitute for the higher latitudes. *Guembelitria cretacea* CUSHMAN, known from the Middle and Upper Maastrichtian, was thus chosen as an index species for the Upper Maastrichtian of Poland. The associated assemblage and especially the presence of *Rugoglobigerina rotundata* BRÖNNIMANN and *R. macrocephala* BRÖNNIMANN, known only from the *Abathomphalus mayaroensis* Zone, enables me to correlate the *Guembelitria cretacea* Zone with the *Abathomphalus mayaroensis* Zone of Trinidad (BOLLI 1957, 1959, 1966), the Gulf Coast Plain (PESSAGNO 1967, 1969), Carribean (PREMOLI SILVA and BOLLI 1973), Austria (STURM 1969), Romania (SANDULESCU 1969), the USSR (MASLAKOVA 1977), NW Pacific (DOUGLAS 1971), Libya (BARR 1972), Iraq (KASSAB 1973), India (GOVINDAN 1972) and Australia (WRIGHT and APTHORPE 1976). Further equivalents of the *Guembelitria cretacea* Zone in central Poland are zones "E" and "F" in Austria (HERM 1962) and, in general zonation, the *Abathomphalus mayaroensis* Zone (table 6).

DISCUSSION

Within the Upper Cretaceous deposits of the Vistula River profile I distinguish 10 zones on the basis of planktic foraminifera. The age of the zones discussed was established on the basis of:

1. Direct correlation of the species occurring in the Vistula River profile with the species occurring in the stratotypes of stages;
2. All available data on the stratigraphic range of individual species found in the Vistula river profile;
3. Data from the associated macrofauna, mainly of inocerams and cephalopods.

Table 5

Established zones with characteristic species

Stage	Sub-stage	Foraminiferal zones	Characteristic species
MAASTRICHTIAN	Upper	*Guembelitria cretacea*	*Guembelitria cretacea* Cushman, *Heterohelix vistulaensis* n. sp. *Heterohelix navarroensis* Loeblich, *Rugoglobigerina macrocephala* Bronnimann, *Rugoglobigerina rotundata* Bronnimann
	Lower	*Rugoglobigerina pennyi*	*Rugoglobigerina pennyi* Bronnimann, *Rugoglobigerina milamensis* Smith & Pessagno, *Globotruncana patelliformis* Gandolfi, *Pseudotextularia deformis* (Kikoine), *Racemiguembelina powelli* Smith & Pessagno
CAMPANIAN	Upper	*Globigerinelloides multispinus*	*Globigerinelloides multispinus* (Lalicker), *Globotruncana pessagnoi* Longoria, *Globotruncana plummerae* Gandolfi, *Heterohelix pulchra* (Brotzen)
	Lower	*Globotruncana arca*	*Globotruncana arca* (Cushman), *Globotruncana churchi* Martin, *Globotruncana ventricosa* (White)
SANTONIAN	Upper	*Globotruncana fornicata*	*Globotruncana fornicata* Plummer, *Dicarinella* cf. *concavata* (Brotzen), *Globotruncana lapparenti* Brotzen, *Globotruncana linneiana* (d'Orbigny)
	Lower	*Globotruncana lapparenti*	*Marginotruncana longilocula* (Gandolfi), *Archaeoglobigerina cretacea* (d'Orbigny), *Archaeoglobigerina bosquensis* Pessagno, *Archaeoglobigerina blowi* Pessagno *Globotruncana lapparenti* Brotzen
CONIACIAN		*Marginotruncana coronata*	*Marginotruncana coronata* (Bolli), *Marginotruncana pseudolinneiana* Pessagno, *Marginotruncana sinuosa* Porthault, *Marginotruncana paraconcavata* Porthault, *Marginotruncana* cf. *renzi* (Gandolfi), *Marginotruncana caronae* n. sp.
TURONIAN	Upper		
	Lower	*Helvetoglobotruncana helvetica*	*Helvetoglobotruncana helvetica* (Bolli), *Dicarinella imbricata* (Mornod), *Dicarinella longoriai* n. sp., *Dicarinella biconvexa biconvexa* (Samuel & Salay), *Dicarinella biconvexa gigantea* (Samuel & Salaj)
CENOMANIAN	Upper	*Rotalipora cushmani*	*Rotalipora cushmani* (Morrow), *Hedbergella simplicissima* (Magne & Sigal), *Praeglobotruncana stephani* (Gandolfi), *Praeglobotruncana delrioensis* (Plummer)
	Lower	*Hedbergella planispira*	common: *Hedbergella planispira* (Tappan), *Hedbergella angolae* Caron *Hedbergella* cf. *caspia* (Vassilenko), *Hedbergella delrioensis* (Carsey); *Globigerinelloides caseyi* (Bolli, Loeblich & Tappan) rare: *Praeglobotruncana delrioensis* (Plummer), *Hedbergella simplicissima* (Magne & Sigal).

It should be stressed that there are problems in the estimation of the age of the Upper Cretaceous deposits on the basis of planktic foraminifera through direct comparison of species recorded from the stratotypes with the species found in any other profile. These problems stem mainly from the fact that many stratotype profiles are in marginal parts of basins incomplete and contain poor planktic microfauna. The stratotypes of the Cenomanian, Turonian, Campanian and Maastrichtian represent only a part of the interval which in recent literature is related to these stages. The correlation of Coniacian, Santonian and Maastrichtian deposits encounters

significant difficulties not only because of their incomplete development in the stratotypes, and the controversy over the definition of the stages, but also due to the restricted distribution of key planktic markers used to recognize these ages (comp. DOUGLAS 1969*b*).

Recently, the planktic foraminifera from all stratotype profiles of the Upper Cretaceous were studied: from Cenomanian — MARKS (1967), Turonian — BUTT (1966) and BELLIER (1971), Coniacian — SERONIE-VIVIEN (1972), Santonian — SERONIE-VIVIEN (1972), Campanian — SERONIE-VIVIEN (1972) and van HINTE (1965) and Maastrichtian — HOFKER (1966) and BELLIER and VILLAIN (1975).

Cenomanian

The Cenomanian deposits of the Vistula River profile, in the Annopol anticline, are well documented on the basis of macrofauna (SAMSONOWICZ 1924, 1925, 1934; POŻARYSKI 1947; CIEŚLIŃSKI 1959). The subdivision of the Cenomanian into 3 parts used earlier in Poland (e. g., SAMSONOWICZ 1925; POŻARYSKI 1947) was based on inadequate biostratigraphic evidence. The forms regarded by the previous workers as index fossils were found in the whole Cenomanian (CIEŚLIŃSKI 1959; MARCINOWSKI 1970). Therefore, CIEŚLIŃSKI (1959) proposed bipartite subdivision of Cenomanian, following a subdivision of the English Cenomanian introduced by WRIGHT and WRIGHT (1951). In recent years, the ammonite fauna from the classical Cenomanian profiles in England and France was reexamined. The studies made it possible to establish 3 well-defined zones in the Cenomanian (HANCOCK 1959; KENNEDY 1969, 1971).

Recently, MARCINOWSKI (1974) recorded a very rich ammonite assemblage in the Polish Jura Chain, which made it possible to adopt the division of the Cenomanian into three zones proposed by KENNEDY (1969).

In the present paper, however, the bipartite subdivision of the Cenomanian after CIEŚLIŃSKI (1959) is used. The paper of CIEŚLIŃSKI (1959) is the last one dealing with the Cenomanian macrofauna of the region studied and therefore I correlate the foraminiferal biozonation with his bipartite subdivision.

In the Lower Cenomanian of Jakubowice (figs. 1, 2), in the *Schloenbachia varians* horizon, the following species were recorded: *Schloenbachia varians* (SOW.), *S. subvarians* SPATH, *S. ventricosa* STIELER, *S. lymensis* SPATH, *S. subplana* (MANTELL), *Mantelliceras mantelli* (SOWERBY), *M. hyatti* SPATH, *M. tuberculatus* (MANTELL), *M. saxbii* (SHARPE), *Turrilites costatus* LAMARCK, *Neohibolites ultimus* (d'ORBIGNY), and others. In the Upper Cenomanian the fauna is poorer, and the following forms were recorded: *Actinocamax plenus* (BLAINVILLE) and *Holaster subglobosus* LESKE, the latter being the index species of that substage. The assemblage of planktic foraminifera confirms the bipartite nature of the Cenomanian in the area studied. In the Lower Cenomanian I recognize the *Hedbergella planispira* Zone. It differs from the overlying *Rotalipora cushmani* Zone in lacking the index species of the latter zone. The *Hedbergella planispira* Zone contains an assemblage of long-ranging species, of limited value for age difinition; however, the associated fauna clearly indicates a Lower Cenomanian age. The appearance of *Rotalipora cushmani* (Morrow) coincides with the base of the *Holaster subglobosus* horizon. MARKS (1967) stated that *Rotalipora cushmani* (MORROW) occurs jointly with *Praeglobotruncana stephani* (GANDOLFI) in the upper part of the Middle Cenomanian in the stratotype of that stage. *Rotalipora cushmani* (MORROW) is thought to be the earliest representative of *Rotalipora* and according to many authors it does not cross the Cenomanian-Turonian boundary (e. g., PESSAGNO 1967; MASLAKOVA 1977). Reports of occurrences of that species in younger deposits are due to inaccurate age determination of those deposits (MARKS 1967).

In the Vistula River profile the *Hedbergella planispira* Zone is correlated with the *Schloenbachia varians* horizon and the *Rotalipora cushmani* Zone with the *Holaster subglobosus* horizon, the *Rotalipora cushmani* Zone confirming the Upper Cenomanian age of the *Holaster subglobosus* horizon (comp. table 2).

Turonian, Coniacian

POŻARYSKI (1938, 1947, 1948) distinguished 4 horizons in the Turonian of the Vistula River profile on the basis of inocerams: *Inoceramus labiatus* Zone and *Inoceramus lamarcki* Zone in the Lower Turonian and *Inoceramus inconstans- I. costellatus* Zone and *Inoceramus schloenbachi* Zone in the Upper Turonian. The assemblages of planktic foraminifera also support the twofold subdivision of the Turonian, the *Helvetoglobotruncana helvetica* Zone (Lower Turonian) and *Marginotruncana coronata* Zone (Upper Turonian-Coniacian). It should be mentioned that POŻARYSKI and WITWICKA (1956) reported the assemblage of planktic foraminifera from the Cenomanian and Lower Turonian deposits and their assemblage differs only slightly from that recorded here. POŻARYSKI and WITWICKA (1956) did not figure the foraminifera identified and therefore I can only suppose that *Rotalipora appenninica* (RENZ) reported by them may have been misidentified and is actually *Rotalipora cushmani* (MORROW). POŻARYSKI and WITWICKA (1956) took the upper boundary of their first stratigraphic assemblage at the Lower Turonian-Upper Turonian boundary.

BUTT (1966) and BELLIER (1971) studied the planktic foraminifers from the stratotype of the Turonian but they are not unanimous in their determinations of species. On the basis of their illustrations it seems that the following species occur: *Dicarinella imbricata* (MORNOD), *D.* cf. *hagni* (SCHEIBNEROVA) and *Praeglobotruncana stephani* (GANDOLFI). The specimens illustrated as *Hedbergella delrioensis* (CARSEY) by BUTT (1966) and as *Rotundina cretacea* (d'ORBIGNY) by BELLIER (1973) are conspecific (at least some of them) with *Hedbergella brittonensis* LOEBLICH and TAPPAN. All the above mentioned species occur in the Lower Turonian deposits in the *Inoceramus labiatus* horizon. In the upper part of the Turonian stratotype planktic foraminifera are lacking. On the basis of the lack of *Helvetoglobotruncana helvetica* (BOLLI) in the assemblage discussed, BELLIER (1971) concluded that *H. helvetica* (BOLLI) characterizes the upper part of the Turonian. The studies on the material from the Vistula River valley profile do not support this conclusion because *H. helvetica* (BOLLI) was found in the *Inoceramus labiatus* Zone as well. Therefore, in spite of the absence of *H. helvetica* (BOLLI) in the Turonian stratotype, the assemblage of planktic foraminifera in the lower part of the Turonian stratotype can be correlated with the *Helvetoglobotruncana helvetica* Zone typical of the Lower Turonian of Central Poland.

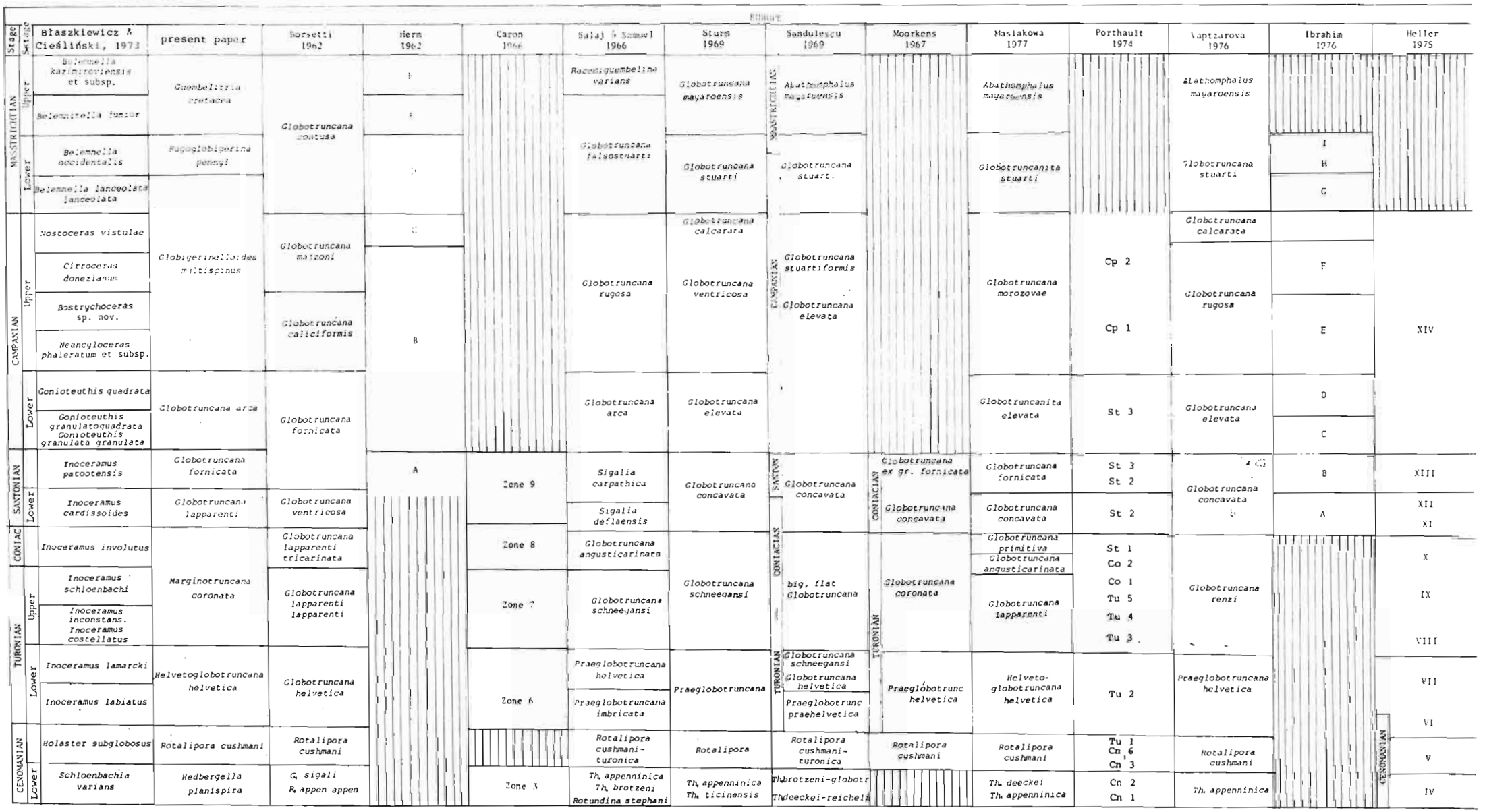
The Lower Turonian-Upper Turonian boundary is marked by a significant change in the composition of planktic foraminifera (comp. tables 3, 4). Of the genus *Dicarinella*, typical of the *Helvetotruncana helvetica* Zone, only *D. imbricata* (MORNOD) crosses that boundary. Remaining *Dicarinella* are here replaced by other "keeled" species of *Marginotruncana* (of which only *Marginotruncana marginata* (REUSS) appeared in the upper part of *Helvetoglobotruncana helvetica* Zone). This important change in the composition of assemblages at the boundary of the Lower and Upper Turonian has been noted by most workers worldwide. Generally speaking, the zone with "big, flat globotruncans" begins here (comp. table 6).

The boundary between the Turonian and Coniacian is poorly defined in the stratotype profiles. According to WRIGHT (1959) and DALBIEZ (1959), the separation of late Turonian ammonite lineages from these of early Coniacian age is extremely difficult. Similar difficulties exist in the use of planktic foraminifera. The species appearing at the boundary of the Lower and Upper Turonian are long-ranging forms, often crossing the lower boundary of the Upper Santonian (comp. table 4). The lack of planktic foraminifera in the stratotype of the Coniacian (SERONIE-VIVIEN 1972) makes correlation of Coniacian deposits more difficult.

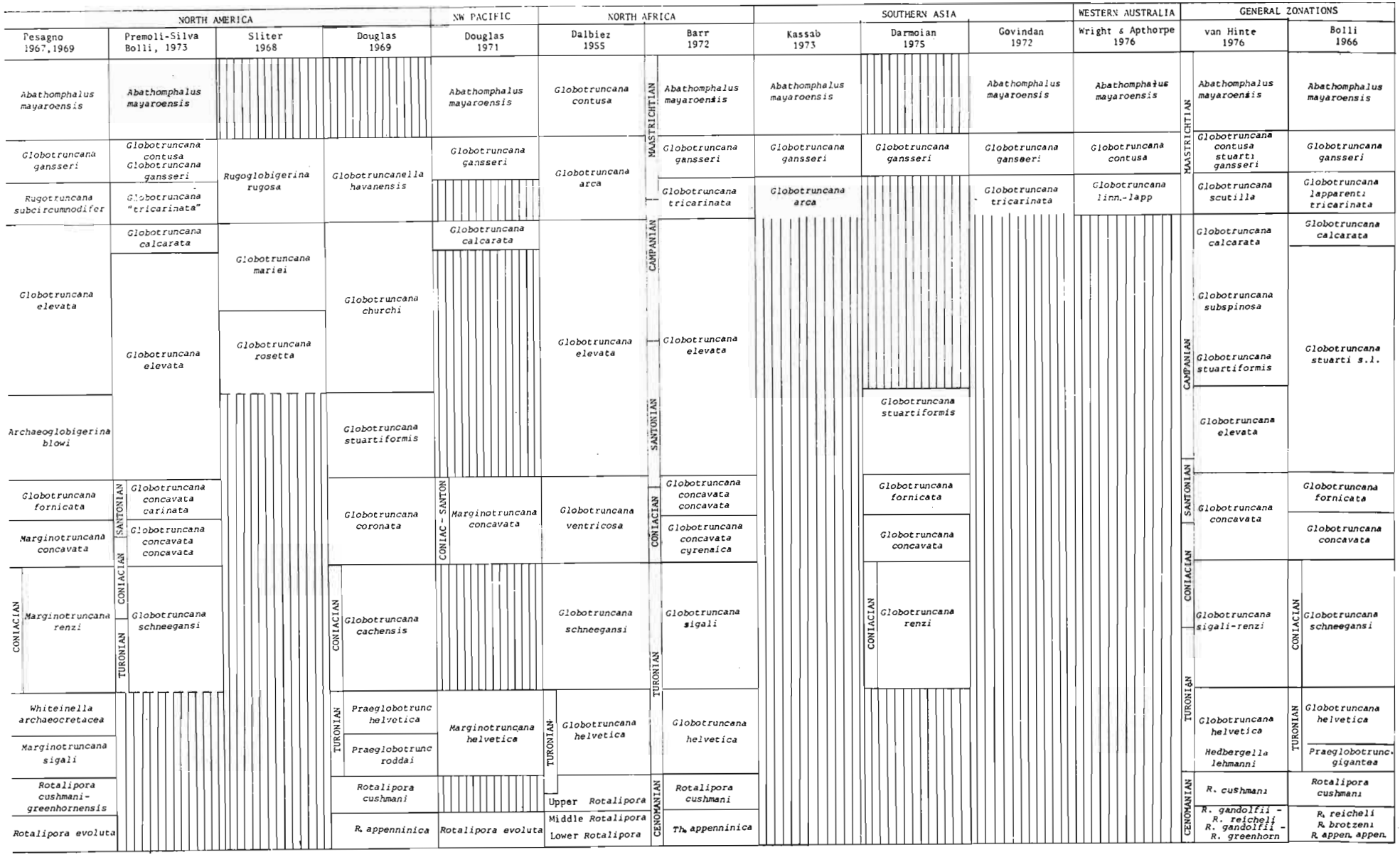
The Coniacian deposits in the Vistula River profile are not faunistically documented hitherto. These deposits were distinguished by SAMSONOWICZ (1924, 1925) as a lithological complex distinct from the Upper Turonian and Lower Santonian deposits and cropping out between Wesołówka and Sulejów (comp. fig. 1*a*). POŻARYSKI (1938) accepted the lower boundary of the Coniacian as defined by SAMSONOWICZ and lowered the upper boundary. According

Table 6

Correlation of zonations of the Upper Cretaceous deposists on the basis of planktic Foraminifera



for table continuity see backside


NORTH AMERICA
NW PACIFIC
NORTH AFRICA
SOUTHERN ASIA
WESTERN AUSTRALIA
GENERAL ZONATIONS
Pesagno 1967, 1969
Premoli-Silva Bolli, 1973
Sliter 1968
Douglas 1969
Douglas 1971
Dalbiez 1955
Barr 1972
Kassab 1973
Darmoian 1975
Govindan 1972
Wright & Apthorpe 1976
van Hinte 1976
Bolli 1966
MAASTRICHTIAN
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMANIAN
CONIAC - SANTON
Abathomphalus mayaroensis
Globotruncana gansseri
Rugotruncana subcircumnodifer
Globotruncana contusa
Globotruncana "tricarinata"
Globotruncana arca
Globotruncana tricarinata
Globotruncana linn.-lapp
Globotruncana calcarata
Globotruncana elevata
Globotruncana mariei
Globotruncana rosetta
Globotruncana churchi
Globotruncana stuartiformis
Archaeoglobigerina blowi
Globotruncana fornicata
Globotruncana concavata carinata
Globotruncana concavata concavata
Globotruncana concavata cyrenaica
Marginotruncana concavata
Marginotruncana renzi
Globotruncana schneegansi
Globotruncana sigali
Globotruncana renzi
Globotruncana cachensis
Globotruncana coronata
Globotruncana ventricosa
Globotruncana helvetica
Praeglobotrunc. helvetica
Praeglobotrunc. roddai
Marginotruncana helvetica
Hedbergella lehmanni
Praeglobotrunc. gigantea
Whiteinella archaeocretacea
Marginotruncana sigali
Rotalipora cushmani-greenhornensis
Rotalipora evoluta
Rotalipora cushmani
R. appenninica
Rotalipora evoluta
Upper Rotalipora
Middle Rotalipora
Lower Rotalipora
Th. appenninica
R. cushmani
R. gandolfii - R. reicheli
R. gandolfii - R. greenhorn
R. reicheli
R. brotzeni
R. appen. appen.
Globotruncana contusa stuarti gansseri
Globotruncana scutilla
Globotruncana lapparenti tricarinata
Globotruncana subspinosa
Globotruncana stuartiformis
Globotruncana stuarti s.l.
Globotruncana sigali-renzi
Globotruncanella havanensis
Rugoglobigerina rugosa

to his subdivision of the Upper Cretaceous of the Vistula River valley (POŻARYSKI 1938), the Coniacian deposits correspond to the horizon "d". It should be mentioned that POŻARYSKI's investigations did not yield paleontological data for determining the precise age of horizon "d". POŻARYSKI (1938) shifted the upper boundary of the Coniacian deposits in comparison to that given by SAMSONOWICZ (1925) to coincide with a change from a marly facies (typical of the Coniacian) into a marly-glauconitic facies (typical of the Santonian). KURLENDA (1967), carrying out detailed investigations of the Upper Turonian, Coniacian, Santonian and Lower Campanian strata between Wesołówka and Sulejów, found *Inoceramus inconstans* WOODS (known to appear in the Upper Turonian) and several other species of no stratigraphic significance within horizon "d". Therefore, the Coniacian in the Vistula River profile is not faunistically documented. As mentioned above, the assemblage of planktic foraminifera of the Upper Turonian and Coniacian age comprises long-ranging species that do not permit placing of the boundary between these stages. On the other hand a marked change in the composition of foraminiferal assemblages takes place at the Coniacian-Santonian boundary (comp. tables 3, 4).

Santonian

The opokas cropping out in the Vistula riverside between Wesołówka and Sulejów (figs. 1, 2) were recognized by POŻARYSKI (1938) as belonging to the Santonian. POŻARYSKI distinguished 4 Santonian horizons "e", "f", "g" and "h", the first being insufficiently documented paleontologically and only provisionally included to the Santonian. The changes in foraminiferal assemblages, as observed in the Vistula River valley profile, are very similar to those on the Coniacian-Santonian boundary in the Gulf Coast Plain; the termination of the majority of marginotruncans is accompanied by the appearance of *Globotruncana lapparenti* BROTZEN in both these areas. Therefore, it seems that the hitherto tentative Coniacian-Santonian boundary may be regarded as being confirmed.

KURLENDA (1967), on the basis of different groups of macrofauna, confirmed POŻARYSKI'S subdivision and KONGIEL (1962) accepted the position of the Santonian-Campanian boundary between the horizons "h" and "i" (comp. table 2). BŁASZKIEWICZ (1966) shifted this boundary, placing it between the horizons "f" and "g" (comp. table 2), and this was the result of his different interpretation of the ranges of forms of the genus *Gonioteuthis*. BŁASZKIEWICZ (1966) placed the boundary according to the JELETZKY'S scheme (1958) in which the Santonian-Campanian boundary is fixed by the appearance of typical *Gonioteuthis granulata* (BLAINVILLE). The thickness of the Santonian deposits so defined decreased from 120 to 60 m. The subdivision based on planktic foraminifera supports the conclusion of BŁASZKIEWICZ (1966).

The Santonian-Campanian boundary coincides with the lower boundary of the *Globotruncana arca* zone.

In the Santonian deposits two foraminiferal zones were distinguished: *Globotruncana lapparenti* Zone and *Globotruncana fornicata* Zone.

The Santonian planktic foraminifera are characterized first of all by the common occurrence of representatives of *Globotruncana* and *Marginotruncana*. In the *Globotruncana lapparenti* Zone the genus *Globotruncana* is represented by *G. lapparenti* BROTZEN and *G. linneiana* (d'ORBIGNY) and the genus *Marginotruncana* by *M. pseudolinneiana* PESSAGNO, *M. paraconcavata* PORTHAULT, *M. marginata* (REUSS), *M. longilocula* (GANDOLFI) and *M. coronata* (BOLLI). *Globotruncana fornicata* PLUMMER and *G. obliqua* HERM persist into the *Globotruncana fornicata* Zone while the marginotruncan assemblage becomes impoverished as *M. paraconcavata* dies out. SERONIE-VIVIEN (1972) reports the following species from the stratotype profile: *G. bulloides* VOGLER, *G.* cf. *angusticarinata* GANDOLFI, *G. coronata* BOLLI, *G. fornicata* PLUMMER, *G. lapparenti* BROTZEN, *G. tricarinata* (QUEREAU) and *G.* aff. *semsalvensis* CORMINBOEUF. This assemblage can be compared with the assemblages of the *Globotruncana lapparenti* and *G. fornicata* zones of the Vistula River valley profile.

Campanian

The base of this stage was discussed above. The upper boundary was placed between horizons "r" and "s". KONGIEL (1962) demonstrated that it should be raised, so as to include zones "s" and partially "t" being in the Santonian. His conclusion was supported by BŁASZKIEWICZ (1966) and accepted by POŻARYSKI (1966). According to them, the boundary between the Campanian and Maastrichtian deposits lies half way up the quarry face in Piotrawin.

BŁASZKIEWICZ (1966) distinguished 6 zones in the Campanian on the basis of cephalopods: 1. *Gonioteuthis granulata-G. granuloquadrata*, 2. *Gonioteuthis quadrata-Eupachydiscus lewyi* in the Lower Campanian, 3. *Neancyloceras pholeratum* et subsp., 4. *Bostrychoceras polyplocum* et sp. nov., 5. *Cirroceras donezianum* et sp. nov. and 6. *Nostoceras vistulae* in the Upper Campanian. On the basis of planktic foraminifera I recognize two zones in the Campanian: the *Globotruncana arca* Zone and the *Globigerinelloides multispinus* Zone. The former one corresponds to the horizons "f", "g", "h" and "i" of POŻARYSKI (1938) and to the two lower zones of BŁASZKIEWICZ (1966). The *Globigerinelloides multispinus* Zone comprises the entire Upper Campanian — from horizon "h" to the middle of horizon "v" — and the lowermost part of the Maastrichtian, the *Belemnella lanceolata lanceolata* Zone of BŁASZKIEWICZ (1966). This is a very long time span, but the assemblage of planktic foraminifera is monotonous and almost constant in composition, so that there is no foraminiferal basis for subdividing it into smaller units.

The third foraminiferal assemblage of POŻARYSKI and WITWICKA (1956), comprising the Campanian and Lower Maastrichtian, contains the following species: *Globotruncana fornicata* PLUMMER, *G. arca* (CUSHMAN), *G. fornicata* var. *contusa* (thought here probably to be *G. patelliformis* GANDOLFI), *G. mayaroensis* (most probably, *G. obliqua* HERM) and *G. stuarti* (probably *G. elevata* (BROTZEN)). The upper part of this assemblage lies in the middle of the *Belemnitella junior* horizon, i. e. inside the *Guembelitria cretacea* zone in my subdivision. The recent studies of nannoplankton (GAŹDZICKA 1978) lead to the recognition of 2 zones: 1. *Arkhangelskiella specillata*, being equivalent to the *Globotruncana arca* Zone and to the two lowermost Campanian belemnite zones, and 2. *Tetralithus aculeus* Zone, which embraces — as does the *Globigerinelloides multispinus* Zone — not only the Upper Campanian but also the lowermost part of the Maastrichtian, the *Belemnella lanceolata-lanceolata* Zone.

Van HINTE (1965) described, and SERONIE-VIVIEN (1972) listed the planktic foraminifera from the stratotype. Both authors recorded the presence of the following species: *Globotruncana arca* (CUSHMAN), *G. fornicata* (PLUMMER), *G. tricarinata* (QUEREAU), *G. linneiana* (d'ORBIGNY) — although from the illustrations by van HINTE (1965) it appears that it is rather *G. obliqua* HERM — and *Archaeoglobigerina cretacea* (d'ORBIGNY). Van HINTE (1965) illustrates *G.* cf. *plummerae* GANDOLFI, *Pseudotextularia elegans* (RZEHAK) and *G. marginata* (REUSS) (probably *G. bulloides* VOGLER). The species reported by van HINTE (1965) belong to the *Globotruncana stuartiformis* Zone in his general zonation. SERONIE-VIVIEN (1972) found also *Globotruncanita elevata* (BROTZEN), *Globotruncana stuartiformis* (DALBIEZ) and *G. conica* (WHITE), confirming that the assemblage from the stratotype should be referred to the *Globotruncana stuartiformis* Zone. The assemblage discussed above may be regarded as coeval with the assemblage of the *Globotruncana arca* Zone of the Vistula River profile.

Maastrichtian

The lower boundary of the Maastrichtian was discussed above. POŻARYSKI (1938) in the Upper Maastrichtian distinguished the horizons "x", "y" and "z". The horizons "y" and "z" crop out in a quarry in Nasiłów and in a gorge in Bochotnica (fig. 1, table 1). The uppermost horizon contains glauconitic sandstones with phosphorites, with an abundant Cretaceous fauna, and overlying the hardground. POŻARYSKI and POŻARYSKA (1960) found in this horizon a Danian microfauna and so regarded these deposits as lowermost Tertiary; the Cretaceous auna mentioned above is reworked (POŻARYSKI and POŻARYSKA 1960). POŻARYSKA (1965)

demonstrated that in the Vistula River profile the uppermost Maastrichtian, the so called Żyrzyn Beds), is lacking. Therefore, the highest horizon in the Cretaceous profile in the Vistula River valley is the horizon "y".

BŁASZKIEWICZ (1966) distinguished 4 zones in the Maastrichtian: 1. *Belemnella lanceolata lanceolata*, 2. *Belemnella occidentalis*, 3. *Belemnitella junior* and 4. *Belemnella kasimiroviensis* et subsp. On the basis of planktic foraminifera I recognize two zones: the *Rugoglobigerina pennyi* Zone, being equivalent to the *Belemnella occidentalis* Zone, and *Guembelitria cretacea* Zone. The assemblage of foraminifers in the latter zone occurs in the deposits of the belemnite Zone: *Belemnitella junior* and *Belemnella kasimiroviensis*. The calcareous nannoplankton also permits recognition of two zones in the Maastrichtian (GAŹDZICKA 1978). The lower zone, the *Litraphidites quadratus* Zone, is equivalent to the *Belemnella occidentalis* and *Rugoglobigerina pennyi* Zones, and the upper zone, the *Nephrolithus frequens* Zone, is equivalent to the *Belemnitella junior* and *Belemnella kasimiroviensis* Zones in the belemnite zonation and to the *Guembelitria cretacea* Zone in the foraminiferal zonation.

From the base of the Upper Campanian the cosmopolitan and rather long-ranging forms begin to dominate in the Vistula River profile. Species such as *Globotruncana stuarti* (de LAPPARENT), *G. gansseri* (BOLLI), *G. calcarata* (CUSHMAN) and *Abathomphalus mayaroensis* (BOLLI), which are the index species in the Upper Campanian and Maastrichtian in the lower latitudes, are absent here. With the end of the *Rugoglobigerina pennyi* Zone the globotruncans become extinct, and the heterohelix-rugoglobigerin-globigerinelloid assemblage becomes dominant. The Upper Campanian and Maastrichtian deposits were subdivided on the basis of this assemblage. Judging from the literature, the genera prevailing in the Campanian and Maastrichtian of central Poland are represented in the lower latitudes by the same species, belonging to the genera *Rugoglobigerina* or *Guembelitria*, *Racemiguembelina* or *Pseudotextularia*.

In the higher latitudes the "keeled" forms are absent or only long-ranging forms occur. Therefore, when establishing the zonations, the genera belonging to the family Heterohelicidae and the genus *Rugoglobigerina* (from the family Globotruncanidae) should be used.

The recent study of planktic foraminifera from the stratotype of the Maastrichtian by BELLIER and VILLAIN (1975) and VILLAIN (1977) contains illustrations and descriptions of species belonging to *Globotruncana* and *Globotruncanita* and also of *Rugoglobigerina rugosa* (PLUMMER)—the last being known from the Upper Campanian and Maastrichtian. The authors only mention that the genera *Heterohelix* and *Globigerinelloides* form the main constituent of the planktic fraction of chalk *à la craie tigrée*. Because of the lack of *Globotruncana* and *Globotruncanita* in the Upper Maastrichtian of central Poland and the presence there of only cosmopolitan long-ranging species in the Lower Maastrichtian, it cannot yet be correlated with its stratotype.

CONCLUSIONS

The rich assemblage of planktic foraminifera recorded from the Upper Cretaceous Vistula River profile of central Poland permits recognition of 10 zones in the Cenomanian to Maastrichtian deposits. They are, in stratigraphical order:

Hedbergella planispira Assemblage-Zone
Rotalipora cushmani Range-Zone
Helvetoglobotruncana helvetica Interval-Zone
Marginotruncana coronata Interval-Zone
Globotruncana lapparenti Interval-Zone
Globotruncana fornicata Interval-Zone
Globotruncana arca Interval-Zone
Globigerinelloides multispinus Interval-Zone

Rugoglobigerina pennyi Interval-Zone
Guembelitria cretacea Range-Zone.

These zones have been correlated with the zonation based on cephalopods and inocerams of that region (POŻARYSKI 1938, 1948; CIEŚLIŃSKI 1959, BŁASZKIEWICZ 1966). The conclusions are:

Hedbergella planispira Zone = *Schloenbachia varians* horizon (Lower Cenomanian)
Rotalipora cushmani Zone = *Holaster subglobosus* horizon (Upper Cenomanian)
Helvetoglobotruncana helvetica Zone = *Inoceramus labiatus* + *Inoceramus lamarcki* Zones (Lower Turonian)
Marginotruncana coronata Zone = *Inoceramus costellatus* - *I. inconstans* + *Inoceramus schloenbachi* + *Inoceramus involutus* Zones (Upper Turonian-Coniacian)
Globotruncana lapparenti Zone = *Inoceramus cardissoides* Zone (Lower Santonian)
Globotruncana fornicata Zone = *Inoceramus patootensis* Zone (Upper Santonian)
Globotruncana arca Zone = *Gonioteuthis granulata-granulatoquadrata* + *G. quadrata* Zones (Lower Campanian)
Globigerinelloides multispinus Zone = *Neancyloceras phaleratum* et subsp. + *Bostrychoceras* sp. nov. + *Cirroceras donezianum* + *Nostoceras vistulae* + *Belemnella lanceolata* Zones (Upper Campanian — lowermost Maastrichtian)
Rugoglobigerina pennyi Zone = *Belemnella occidentalis* Zone (upper Lower Maastrichtian)
Guembelitria cretacea Zone = *Belemnitella junior* + *Belemnella kasimiroviensis* et subsp. Zones (Upper Maastrichtian)

Foraminiferal zones distinguished in the Campanian and Maastrichtian were correlated with coccolith zones recognized by GAŹDZICKA (1978), and it has been concluded that:

Globotruncana arca Zone = *Arkhangelskiella specillata* Zone
Globigerinelloides multispinus Zone = *Tetralithus aculeus* Zone
Rugoglobigerina pennyi Zone = *Lithraphidites quadratus* Zone
Guembelitria cretacea Zone = *Nephrolithus frequens* Zone

The foraminiferal zonation has also been compared with zonations in other areas (table 6).

It was found that although in the Upper Cretaceous and especially in the Campanian and Maastrichtian of the Vistula River profile some species from the genera *Globotruncana*, *Globotruncanita* and *Abathomphalus* that are the basis of zonations in the lower latitudes, do not occur, it is possible to distinguish a foraminiferal zonation based upon other genera, not hitherto used as index fossils (e. g., *Guembelitria*, *Rugoglobigerina* and *Globigerinelloides*).

SYSTEMATIC PALAEONTOLOGY

LONGORIA and GAMPER's (1975) systematics has been applied in the present paper when describing particular species. The species not contained in it are classified according to LOEBLICH and TAPPAN's (1964) systematics.

Abbreviations used:

L — length of the test
W — width of the test
T — thickness of the test

Family **Heterohelicidae** CUSHMAN, 1928
Subfamily **Guembelitrinae** MONTANARO GALLITELLI, 1957
Genus *Guembelitria* CUSHMAN, 1933
Guembelitria cenomana (KELLER, 1935)
(pl. 1: 2–6)

1935. *Guembelina cenomana* KELLER; KELLER, 547, pl. 2: 13, 14 (*fide* ELLIS and MESSINA, Catalogue Foram.).
1972. *Guembelitria cenomana* (KELLER); GAWOR-BIEDOWA, 60–61, pl. 5: 4.

part. 1973. *Guembelitria cretacea* CUSHMAN; SMITH and PESSAGNO, pl. 1: 2, 3, 4, 5, 7, 8, non pl. 1: 1, 6.
1975. *Guembelitria cenomana* (KELLER); HELLER, pl. 1: 15.
1977. *Guembelitria cenomana* (KELLER); ALIJULLA, pl. 1: 1.

Material. — 17 well preserved specimens.
Dimensions (in mm):

	L	T
ZPAL FXXIII/2	0·20	0·09
ZPAL FXXIII/3	0·17	0·08

Description. — Test triserial, tapering throughout, somewhat twisted; chambers spherical, increasing slowly in size as added; sutures depressed; wall finely perforate, each pore surrounded by a blunt pore cone of microgranular calcite; primary aperture interiomarginal, rather high, bordered by a thickened rim.

Remarks. — The specimens described above as *G. cenomana* are larger than cooccurring specimens of *G. cretacea* CUSHMAN and *G. harrisi* TAPPAN and the proportions of their test dimensions differ. While the length to width ratio in *G. cenomana* is usually 2·2, in *G. cretacea* it is 1·2 and in *G. harrisi* it is 1·6. The test of *G. cenomana* (KELLER) is usually somewhat twisted and almost smooth and the chambers increase gradually in size whereas the chambers of *G. harrisi* and especially of *G. cretacea* increase sharply in size.

Specimens figured by SMITH and PESSAGNO (1973, pl. 1: 2, 4, 7) as *G. cretacea* increase gradually sometimes irregularly in size, and they also possess more elongated tests than the holotype of *Guembelitria cretacea* CUSHMAN and therefore I refer them in *Guembelitria cenomana.*

Occurrence. — USSR: Albian-Cenomanian; USA: Maastrichtian; NW Poland: Albian-Cenomanian; Central Poland (Kazimierz, Dobre, Podgórz, Bochotnica): Upper Maastrichtian.

Guembelitria cretacea CUSHMAN, 1933
(pl. 1: 7*a–b*, 8)

1933. *Guembelitria cretacea* CUSHMAN; CUSHMAN, 37–38, pl. 4: 12a–b.
1946. *Guembelitria cretacea* CUSHMAN; CUSHMAN, 103, pl. 44: 14a–c.
1957. *Guembelitria cretacea* CUSHMAN; MONTANARO GALLITELLI, 136, pl. 31: 1a–b.
1960. *Guembelitria cretacea* CUSHMAN; OLSSON, 27–28, pl. 4.
1964. *Guembelitria cretacea* CUSHMAN; LOEBLICH and TAPPAN, C652, fig. 523: 1a–b.
1967. *Guembelitria cretacea* CUSHMAN; PESSAGNO, 258, pl. 87: 1, 2, 3.
part. 1973. *Guembelitria cretacea* CUSHMAN; SMITH and PESSAGNO, 15–16, pl. 1: 1, 6 *non* pl. 1: 2, 3, 4, 5, 7, 8.

Material. — 40 well preserved specimens.
Dimensions (in mm):

	L	T
ZPAL FXXIII/5	0·11	0·09
ZPAL FXXIII/6	0·12	0·10

Description. — Test triserial throughout, tapering rapidly; chambers globular, spherical increasing rapidly in size as added; sutures strongly depressed; wall finely perforate, each pore surrounded by a blunt cone of microgranular calcite; aperture interiomarginal, semicircular, highly arched, bordered by a thickened rim.

Variability. — Some variability can be observed in test size, degree of convexity of chambers and position of aperture sometimes slightly asymmetrically located.

Remarks. — The specimens described correspond with the holotype in general test shape, in the way that the chambers increase sharply in size and in the position of the aperture; they differ from the holotype in having a smaller test.

Specimens figured as *G. cretacea* CUSHMAN by SMITH and PESSAGNO (1973, pl. 1: 2, 4, 7)

possess chambers increasing irregularly in size as added but not so sharply as in *G. cretacea.* Therefore, their tests have quite different proportions, being long with smaller width in the latest portion contrary to *Guembelitria cretacea* CUSHMAN which is short but very wide in the youngest portion. Because of the cooccurrence of *G. cretacea* and *G. cenomana* in the Polish Maastrichtian it seems probable that the specimens discussed by SMITH and PESSAGNO (1973) properly belong to *G. cenomana.*

Occurrence. — USA (Texas, Arkansas, Alabama): Middle-Upper Maastrichtian; Central Poland (Lucimia, Dobre, Podgórz, Męćmierz, Janowiec, Kazimierz, Bochotnica): Upper Maastrichtian.

Guembelitria harrisi TAPPAN, 1940
(pl. 1: 1)

1940. *Guembelitria harrisi* TAPPAN; TAPPAN, 115, pl. 19: 2*a–b*.
1967. *Guembelitria harrisi* TAPPAN; PESSAGNO, 258, pl. 48: 12, 13.
1970. *Guembelitria harrisi* TAPPAN; EICHER and WORSTELL, 296, pl. 8: 1–2.
1973. *Guembelitria harrisi* TAPPAN; SMITH and PESSAGNO, pl. 2: 1–2.
1977. *Guembelitria harrisi* TAPPAN; PETTERS, pl. 1: 1.

Material. — 16 specimens.
Dimensions (in mm):

	L	T
ZPAL FXXIII/1	0·16	0·10

Description. — Test triserial throughout, somewhat twisted; chambers globular, spherical, increasing moderately in size as added; sutures depressed; wall finely perforate; primary aperture interiomarginal, moderately arched, semicircular, bordered by a thickened rim; each chamber is covered by well developed but rather rare pore cones.

Remarks. — *G. harrisi* TAPPAN differs from *G. cenomana* (KELLER) in having a faster growth rate, fewer chambers, and a more tapered shape. It differs from *G. cretacea* CUSHMAN in being larger, in having chambers which increase more gradually in size as added, and in possessing fewer pore-cones on the wall.

Occurrence. — USA: Albian-Turonian; Central Poland (Ciszyca, Łopoczno, Kaliszany, Podgórz, Męćmierz, Bochotnica): Campanian-Maastrichtian.

Genus *Guembelitriella* TAPPAN, 1940
Guembelitriella sp.
(pl. 1: 9–10)

Material. — 2 specimens.
Dimensions (in mm):

	L	T
ZPAL FXXIII/7	0·17	0·10

Description. — Test triserial in earliest portion, somewhat twisted, multiserial in later portion; chambers globular, spherical, increasing moderately in size as added; sutures distinct, depressed; wall finely perforate, each pore surrounded by a blunt cone, except for two terminal chambers which are smooth; primary aperture interiomarginal, moderately arched, semicircular, bordered by a thickened rim.

Remarks. — *Guembelitriella* sp. differs from *G. graysonensis* TAPPAN in possessing a more elongated test and in having chambers which only gradually increase in size.

Occurrence. — Central Poland (Kazimierz): Upper Maastrichtian.

Subfamily **Heterohelicinae** CUSHMAN, 1927

Genus *Heterohelix* EHRENBERG, 1843

Heterohelix globulosa (EHRENBERG, 1840)

(pl. 2: 11, 12; pl. 5: 6, 7; pl. 7: 12)

1840. *Textularia globulosa* EHRENBERG; EHRENBERG, 135, pl. 4: 2β, 4β, 5β, 7β, 8β.
1951. *Guembelina globulosa* (EHRENBERG); LOEBLICH, 108, pl. 12: 4, 5.
1957. *Heterohelix globulosa* (EHRENBERG); MONTANARO GALLITELLI, 137, pl. 31: 12–15.
1967. *Heterohelix globulosa* (EHRENBERG); PESSAGNO, 260, pl. 87: 5–9, 11–13.
1968. *Heterohelix globulosa* (EHRENBERG); SLITER, 94–95, pl. 14: 1–3.
1970. *Heterohelix globulosa* (EHRENBERG); NORTH and CALDWELL, 47—49, pl. 4: 6a, b.
1970. *Heterohelix globulosa* (EHRENBERG); TODD, 148, pl. 5: 7.
1971. *Heterohelix globulosa* (EHRENBERG); MORRIS, 280, pl. 7: 3.
1972. *Heterohelix globulosa* (EHRENBERG); GOVINDAN, 167–168, pl. 1: 1–2.
1972. *Heterohelix globulosa* (EHRENBERG); HANZLIKOVA, 91, pl. 23: 2–4.
1974. *Heterohelix globulosa* (EHRENBERG); KASSAB, 80, 81, pl. 1: 1.
1975. *Heterohelix globulosa* (EHRENBERG); NORTH and CALDWELL, pl. 4: 8a–b.

Material. — 43 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/18	0·28	0·14	0·10

Description. — Test biserial, medium in size, consisting usually of 6–8 pairs of chambers; chambers spherical or subspherical, increasing regularly in size as added; sutures distinct, depressed, straight wall finely costate; aperture as a broad, low arch with slight lip at the inner margin of ultimate chamber.

Remarks. — *H. globulosa* is very similar to *H. striata* (EHRENBERG) but differs in having slightly less distinct ornamentation and slightly greater dimensions.

Occurrence. — USA (Gulf Coast Plain, California): Campanian-Maastrichtian; Canada: ?Cenomanian-Maastrichtian; Iraq: Upper Campanian-Maastrichtian; Central Poland (Opoczka, Kolonia Słupia Nadbrzeżna, Słupia Nadbrzeżna, Wesołówka 31, 33, 34, 39, 42, 44, Sulejów, Wałowice, Dorotka, Ciszyca Kolonia, Józefów, Łopoczno, Solec, Chotcza, Lucimia, Dobre, Podgórz, Męćmierz, Kazimierz, Bochotnica): Upper Turonian-Maastrichtian.

Heterohelix moremani (CUSHMAN, 1938)

(pl. 2: 3, 8)

part. 1938. *Guembelina moremani* CUSHMAN; CUSHMAN, 10, pl. 2: 1–2, *non* pl. 2: 3 (*fide* ELLIS and MESSINA, Catalogue Foram.).
part. 1946. *Guembelina moremani* CUSHMAN; CUSHMAN, 103, 104, pl. 44: 15—16, *non* pl. 44: 17.
1967. *Heterohelix moremani* (CUSHMAN); PESSAGNO, 260, 261, pl. 48: 10–11, pl. 89: 1, 2.
1969. *Heterohelix moremani* (CUSHMAN); BROWN, 35–36, pl. 1: 8.
1975. *Heterohelix moremani* (CUSHMAN); NORTH and CALDWELL, pl. 4: 9a–c.
1975. *Heterohelix moremani* (CUSHMAN); DARMOIAN, 191–192, pl. 1: 3.

Material. — 17 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/16	0·16	0·09	0·05
ZPAL FXXIII/17	0·16	0·09	0·06

Description. — Test biserial, elongated, tapering gradually; periphery indented; chambers spherical, slightly laterally flattened, increasing moderately in size as added; test consisting of 7–9 pairs of chambers; sutures distinct, depressed, straight to slightly curved; wall finely

ornamented by discontinuous costae; aperture interiomarginal, moderately high, a low arch with slight lip.

Remarks. — CUSHMAN (1938) stated that the holotype of *G. moremani* possesses a smooth wall, and this was later confirmed by PESSAGNO (1967). However, some authors (e. g., BROWN, 1969 and DARMOIAN, 1975) also included finely costate specimens in this species. DARMOIAN (1975) claimed that only the Cenomanian representatives of *G. moremani* are smooth whereas younger ones are finely costate. Polish specimens also possess fine discontinuous striae, especially in the older portion of the test, and are slightly smaller than the holotype (which, according to PESSAGNO 1967, represents the gerontic stage), and are closer to the paratype.

Occurrence. — USA, Mexico: Albian-Turonian; Iraq: Turonian; Central Poland (Opoczka, Kol. Słupia Nadbrzeżna, Wesołówka 37, 38, Świeciechów, Wałowice, Ciszyca Kolonia, Łopoczno, Chotcza, Lucimia, Dobre, Męćmierz, Kazimierz): Turonian-Maastrichtian.

Heterohelix navarroensis LOEBLICH, 1951

(pl. 3: 5, 9*a–b*)

1951. *Heterohelix navarroensis* LOEBLICH; LOEBLICH, 107–108, pl. 13: 1, 2, 3a–b, fig. 2.
1951. *Heterohelix americana* (EHRENBERG); LOEBLICH, 108, fig. 1.
1957. *Heterohelix navarroensis* LOEBLICH; MONTANARO GALLITELLI, 137, pl. 31: 5a–b, 6, 7, 8, 9, 10, 11.
1960. *Heterohelix navarroensis* LOEBLICH; OLSSON, 27, pl. 2: 5.
non 1962. *Heterohelix navarroensis* LOEBLICH; PESSAGNO, 358, pl. 1: 4.
1964. *Heterohelix americana* (EHRENBERG); LOEBLICH and TAPPAN, C652–654, fig. 523: 5a–b.
1967. *Heterohelix navarroensis* LOEBLICH; PESSAGNO, 261, pl. 89: 8, 9.
1969. *Heterohelix navarroensis* LOEBLICH; BROWN, 33–34, pl. 1: 1, 2, 3, 4, 5, 6a–b.
part. 1969. *Heterohelix globulosa* (EHRENBERG); FUNNEL *et al.*, 20, pl. 1: 1, 2 non fig. 1.
1972. *Heterohelix navarroensis* LOEBLICH; HANZLIKOVA, 91, 92, pl. 23: 12, 13.
1973. *Heterohelix navarroensis* LOEBLICH; SMITH and PESSAGNO, 18–19, pl. 3: 4–5, 6–7.
1973. *Heterohelix navarroensis* LOEBLICH; OWEN, 54, pl. 14: 1–2.
1974. *Heterohelix navarroensis* LOEBLICH; KASSAB, 81, 82, pl. 1: 2.

Material. — 15 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/28	0·23	0·12	0·09

Description. — Test biserial, slightly laterally flattened, subtriangular in side view; initial chambers planispirally coiled, the others biserially arranged; planispiral part nearly smooth with subglobular chambers, separated by radial, depressed sutures; chambers in biserial portion inflated and subglobular, nodulose, nodules often merging, forming thus longitudinal striae parallel to test periphery, separated by oblique, slightly depressed sutures; primary aperture as a low arch at the inner margin of the ultimate chamber.

Remarks. — *H. navarroensis* is easily recognized by the planispiral coiling in the initial portion of the test. It differs from *H. striata* (EHRENBERG) in having an initial coiled stage, more delicate striation and in being smaller.

Occurrence. — USA (Texas, Arkansas, New Jersey): Middle-Upper Maastrichtian; Papua New Guinea: Lower Maastrichtian; Iraq: Upper Maastrichtian; Spain: Upper Maastrichtian; Czechoslovakia (Moravia): Maastrichtian; Central Poland (Dobre, Podgórz, Męćmierz, Kazimierz, Bochotnica, Nasiłów): Uppermost Campanian-Maastrichtian.

Heterohelix planata (CUSHMAN, 1938)

(pl. 2: 9, 10; pl. 3: 13, 14)

1938. *Guembelina planata* CUSHMAN; CUSHMAN, 12, pl. 2: 13–14 (*fide* ELLIS and MESSINA, Catalogue Foram.).
1946. *Guembelina planata* CUSHMAN; CUSHMAN, 105, pl. 45: 6a–b, 7.
1960. *Heterohelix pulchra* (BROTZEN); OLSSON, 27, pl. 4: 6.

1962. *Heterohelix pulchra* (BROTZEN); PESSAGNO, 358, pl. 1: 3.
1965. *Heterohelix* cf. *planata* (CUSHMAN); TAKAYANAGI, 196, pl. 20: 2.
1967. *Heterohelix planata* (CUSHMAN); PESSAGNO, 261, 262, pl. 86: 3, 4, 89: 6, 7.
1972. *Heterohelix pulchra* (BROTZEN); GOVINDAN, 168, 169, pl. 1: 9–10.
part. 1972. *Heterohelix pulchra* (BROTZEN); HANZLIKOVA, 92, pl. 23: 11, *non* pl. 23: 10a, b.
1974. *Heterohelix pulchra* (BROTZEN); VAPTZAROVA, 33, pl. 1: 3–7.
1974. *Heterohelix planata* (CUSHMAN); KASSAB, 82, 83, pl. 1: 3.
1975. *Heterohelix planata* (CUSHMAN); DARMOIAN, 192, pl. 1: 8.
1977. *Heterohelix pulchra* (BROTZEN); SLITER, 541, pl. 6: 7–9.

Material. — 17 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/24	0·28	0·14	0·07
ZPAL FXXIII/26	0·28	0·14	0·09

Description. — Test biserial, with the greatest breadth formed by the ultimate pair of chambers, consisting of about 7 pairs of chambers, slightly flattened; chambers broader than high throughout; shape of ultimate pair of chambers reniform-like; sutures depressed: slightly in the earlier portion, distinctly in younger portion; wall delicately costated except for the ultimate chamber which is almost smooth; aperture high, arched, with distinct lateral flanges extending onto the preceding chamber.

Remarks. — *H. planata* is very similar to *H. pulchra* (BROTZEN) but is slightly larger and differs in shape of the ultimate pair of chambers. The reniform shape, typical of *H. pulchra* is only very slightly marked in *H. planata* (CUSHMAN) in which the chambers do not overlap. *H. planata* possesses quite well developed longitudinal striae whereas *H. pulchra* is smooth. Transitional specimens between these species are known.

Occurrence. — Southern Atlantic Ocean: Lower Campanian-Lower Maastrichtian; USA (Texas, California, New Jersey): Upper Campanian-Lower Maastrichtian; Puerto Rico: Campanian-Lower Maastrichtian; India: Maastrichtian; Iraq: Santonian-Middle Maastrichtian; Bulgaria: Upper Campanian-Middle Maastrichtian; Czechoslovakia (Moravia): Santonian-Campanian; Central Poland (Józefów, Łopoczno, Kaliszany, Wola Pawłowska, Piotrawin, Solec, Kłudzie, Chotcza, Dobre, Męćmierz): Campanian-Upper Maastrichtian.

Heterohelix pulchra (BROTZEN, 1936)
(pl. 3: 8)

part. 1936. *Guembelina pulchra* BROTZEN; BROTZEN, 121, pl. 9: 3a–b, *non* pl. 9: 1a–b.
1946. *Guembelina pseudotessera* CUSHMAN; CUSHMAN, 106–107, pl. 45: 16–20.
1957. *Heterohelix pulchra* (BROTZEN); MONTANARO GALLITELLI, 137, pl. 31: 20.
non 1960. *Heterohelix pulchra* (BROTZEN); OLSSON, 27, pl. 4: 6.
non 1962. *Heterohelix pulchra* (BROTZEN); PESSAGNO, 358, pl. 1: 3.
1965. *Heterohelix pulchra* (BROTZEN); TAKAYANAGI, 197, pl. 20: 3a–b.
1967. *Heterohelix pulchra* (BROTZEN); PESSAGNO, 282, pl. 87: 4.
part. 1968. *Heterohelix pulchra* (BROTZEN); SLITER, 96, pl. 14: 4–6, *non* pl. 14: 9.
1969. *Heterohelix pulchra* (BROTZEN); DOUGLAS and RANKIN, 190, 191, fig. 4.
1969. *Heterohelix pulchra* (BROTZEN); STENESTAD, 654–656, fig. 9.
1969. *Heterohelix pulchra* (BROTZEN); DOUGLAS, 158, pl. 11: 3, 14.
1970. *Heterohelix pulchra* (BROTZEN); EICHER and WORSTELL, 296, pl. 8: 9–10.
part. 1972. *Heterohelix pulchra* (BROTZEN); HANZLIKOVA, 92, pl. 23: 10a, b, *non* pl. 23: 11.
non 1972. *Heterohelix pulchra* (BROTZEN); GOVINDAN, 168—169, pl. 1: 9–10.
non 1973. *Heterohelix pulchra* (BROTZEN); SLITER, pl. 1: 19.
1974. *Heterohelix pulchra* (BROTZEN); KASSAB, 83, 84, pl. 1: 4.
1975. *Heterohelix pulchra* (BROTZEN); DARMOIAN, 192, 193, pl. 1: 9–15.
non 1977. *Heterohelix pulchra* (BROTZEN); SLITER, 541, pl. 6: 7–9.

Material. — 14 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/38	0·16	0·10	0·06

Description. — Test biserial, tapering, flattened; about 6 pairs of chambers increasing regularly in size as added; chambers reniform, inflated, wider than high, increasing in width towards the apertural end; chambers more and more overlapping as test grows; sutures depressed straight in earlier portion, depressed, curved in terminal portion; aperture as a high arch at the base of ultimate chamber.

Variability. — Expressed in degree of development of the reniform shape of the chambers: from very strongly overlapping to only weakly defined. Numerous transitional forms to *H. planata* (CUSHMAN) are known.

Remarks. — *H. pulchra* is easily distinguishable by the reniform shape of its chambers and its smooth wall. Polish specimens are almost identical with the holotype. Specimens illustrated as *H. pulchra* by OLSSON (1960, pl. 4: 6), HANZLIKOVA (1972, pl. 23: 11), GOVINDAN (1972, pl. 1: 9, 10) and SLITER (1973, pl. 1: 19) possess subglobular rather than reniform chambers and therefore should be regarded as *Heterohelix planata* (CUSHMAN). The specimen illustrated by SLITER (1968, pl. 14: 9) as *H. pulchra* belongs to GUBLERINA. I agree with PESSAGNO (1967) that *Guembelina pulchra* illustrated by BROTZEN in pl. 9: 2a–b properly belongs to *Gublerina*.

Occurrence. — USA (California, New Jersey): Campanian-Maastrichtian; Iraq: Coniacian-Santonian, Upper Campanian-Maastrichtian; Italy: Campanian-Maastrichtian; Czechoslovakia (Moravia): Santonian-Campanian; Sweden: Coniacian-Santonian; Denmark (Bornholm): Lower Santonian; Central Poland (Sulejów, Bliskowice, Wałowice, Ciszyca Kolonia, Józefów, Łopoczno, Wola Pawłowska, Piotrawin, Solec): Upper Campanian-Maastrichtian.

Heterohelix aff. *punctulata* (CUSHMAN, 1938)
(pl. 7: 10, 11)

Material. — 15 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/217	0·28	0·16	0·11
ZPAL FXXIII/218	0·27	0·14	0·10

Description. — Test biserial, initial portion rapidly tapering, later portion of nearly uniform width; periphery of early portion straight, smooth, nonindented, of later portion indented; initial chambers slightly compressed; sutures flush, limbate; terminal chambers globular, of uniform size but increasing rapidly in size in relation to initial chambers; sutures depressed; wall delicately, discontinuously costated, especially in initial portion; terminal chambers considerably faintly costated, wall often coarsely punctate; primary aperture interiomarginal, a low, broad arch with slight lip.

Remarks. — The specimens described differ from typical *H. punctulata* (CUSHMAN) in being more costate on the major part of the wall and in lacking a keel in the earlier part of the test. The holotype of *H. punctulata* possesses sutural supplementary apertures not observed in the material examined; however these apertures are often lacking and their taxonomical value is limited. The apertures have some significance for *Pseudoguembelina* in which the small secondary sutural supplementary apertures are covered by elongate, tubelike apertural flaps.

Occurrence. — Central Poland (Lucimia): Upper Maastrichtian.

Heterohelix reussi (CUSHMAN, 1938)
(pl. 3: 10, pl. 7: 13)

1938. *Guembelina reussi* CUSHMAN; CUSHMAN, 11, pl. 2: 6–9.
1946. *Guembelina reussi* CUSHMAN; CUSHMAN, 104, pl. 44: 18a–b, 19.
non 1956. *Guembelina reussi* CUSHMAN; SAID and KENAVY, 139, pl. 3: 32.
1967. *Heterohelix reussi* (CUSHMAN); PESSAGNO, 263, pl. 85: 1–9, pl. 86: 1–2.
1969. *Heterohelix reussi* (CUSHMAN); DOUGLAS, 158, 159. pl. 11: 15.
1969. *Heterohelix reussi* (CUSHMAN); ESKER III, pl. 2: 19.
1972. *Heterohelix reussi* (CUSHMAN); HANZLIKOVA, 92, pl. 23: 8. 9.
1974. *Heterohelix reussi* (CUSHMAN); KASSAB, 85, 86, pl. 1: 6–8.
1974. *Heterohelix reussi* (CUSHMAN); HERB, pl. 4: 14, 15.
1975. *Heterohelix reussi* (CUSHMAN); DARMOIAN, 194, pl. 1: 16—20.

Material. — 16 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/39	0·31	0·18	0·08
ZPAL FXXIII/40	0·24	0·18	0·07

Description. — Test biserial, tapering; periphery of earlier portion usually entire, later indented; chambers globular; between terminal chambers characteristic depressed triangle area; sutures slightly depressed; wall finely costate; primary apertures semicircular, bordered by thickened rim.

Remarks. — *H. reussi* was originally described by CUSHMAN (1938) as *Guembelina reussi.* According to CUSHMAN, its wall is smooth but PESSAGNO (1967), after examining the holotype and paratypes has recorded the presence of delicate costae, which are also visible on Polish specimens. The specimen illustrated by SAID and KENAWY (1956) as *Guembelina reussi* CUSHMAN does not possess globular chambers nor a triangular area in side view. The subrectangular shape of the chambers in apertural view and a slightly flattened test in side view place this specimen in *Pseudotextularia.*

Occurrence. — USA, Mexico: Turonian-Lower Campanian; Jamaica: Upper Coniacian-Santonian; southern Indian Ocean: Coniacian; Iraq: Upper Coniacian-Lower Santonian; Czechoslovakia (Moravia): Coniacian-Santonian; Central Poland (Opoczka, Słupia Nadbrzeżna, Kol. Słupia Nadbrzeżna, Wesołówka 33, 34, 39, 42, 44, Wałowice, Bliskowice, Ciszyca Kolonia, Józefów): Upper Turonian-Upper Campanian.

Heterohelix striata (EHRENBERG, 1840)
(pl. 2: 4, 5, 7, 13; pl. 5: 8, 9)

part. 1840. *Textularia striata* EHRENBERG; EHRENBERG, 135, pl. 4: 1, 2, 3, *non* pl. 1: 9 (*fide* ELLIS and MESSINA, Catalogue Foram.).
1946. *Guembelina striata* (EHRENBERG); CUSHMAN, 104, 105, pl. 45: 4, 5.
1962. *Heterohelix striata* (EHRENBERG); PESSAGNO, 358, pl. 1: 5.
1962. *Heterohelix navarroensis* LOEBLICH; PESSAGNO, 358; pl. 1: 4.
1962. *Heterohelix striata* (EHRENBERG); BERGGREN, 21, 22, pl. 6: 1a–5b.
1963. *Heterohelix striata* (EHRENBERG); GRAHAM and CHURCH, p. 62, 63, pl. 7: 12a, b.
1964. *Heterohelix striata* (EHRENBERG); MARTIN, 85, pl. 11: 1.
1965. *Heterohelix striata* (EHRENBERG); TAKAYANAGI, 198, pl. 20: 4.
1967. *Heterohelix striata* (EHRENBERG); PESSAGNO, 264, pl. 78: 4, 5, pl. 88: 3–7, pl. 98: 16 (here additional synonymy included).
1968. *Heterohelix striata* (EHRENBERG); SLITER, 96 pl. 13: 13.
1969. *Heterohelix striata* (EHRENBERG); STENESTAD, 653–654, pl. 1: 4, pl. 2: 1, 1a, 1b, fig. 1a–c.
1969. *Heterohelix striata* (EHRENBERG); DOUGLAS, 159—160, pl. 11: 4, 7, 8.
non 1969. *Heterohelix striata* (EHRENBERG); FUNNELL *et al.*, 21, 22, pl. 1: 2, 3, fig. 2.
1971. *Heterohelix striata* (EHRENBERG); EL-NAGGAR, pl. 7: i.

1972. *Heterohelix striata* (EHRENBERG); HANZLIKOVA, 93, pl. 23: 14—18.
1972. *Heterohelix striata* (EHRENBERG); GOVINDAN, 168, pl. 1: 13–14.
1973. *Heterohelix striata* (EHRENBERG); SMITH and PESSAGNO, 19, pl. 3: 1–2, 3–4.
1974. *Heterohelix striata* (EHRENBERG); KASSAB, 86, 87, pl. 1: 9–12.
non 1975. *Heterohelix striata* (EHRENBERG); NORTH and CALDWELL, pl. 4: 10a–b.
1975. *Heterohelix striata* (EHRENBERG); STAPLETON, pl. 3: 6a–c.

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

	L	W	T
ZPAL FXXIII/10	0·31	0·19	0·10

Description. — Test small to average in size, biserial; chambers slightly flattened in the earlier part of test, later spherical, regularly increasing in size as added; sutures distinct, straight, depressed; periphery lobate; primary aperture as a broad, low arch with rather distinct lip on inner margin of the ultimate chamber; wall ornamented by longitudinal striae.

Variability. — It is mainly expressed by test size and shape of chambers changing from subglobular to globular.

Remarks. — *H. striata* resembles *H. globulosa* (EHRENBERG) in test size and in the shape of its chambers, differing mainly from it in its possession of well-developed longitudinal ribs. The difference is especially clear when the lectotypes of *H. striata* and *H. globulosa*, designated by PESSAGNO (1967), are compared. DARMOIAN (1975) assumed a very high specific variability of *H. striata* and included *H. globulosa* in the synonymy of this species. The two species do not appear simultaneously in the profile studied. Smooth-tested or very finely striated *H. globulosa* occurs from the Upper Turonian whereas *H. striata* does not appear before the Campanian. The variability of *H. striata* was, in my opinion, overestimated by DARMOIAN (1975) and it is necessary to distinguish the two species *H. striata* and *H. globulosa.*

Occurrence. — USA (Gulf Coast Plain, California), Iraq, Moravia: Campanian-Maastrichtian; South Africa, India, Denmark: Maastrichtian; Poland (studied area): Campanian--Maastrichtian.

Heterohelix ultimatumida (WHITE, 1929)
(pl. 2: 6)

1929. *Guembelina ultimatumida* WHITE; WHITE, 39, pl. 4: 13a–b.
non 1946. *Guembelina ultimatumida* WHITE; CUSHMAN, 107, pl. 46: 6–7.
1962. *Heterohelix ultimatumida* (WHITE); PESSAGNO, 356, pl. 1: 8.
1967. *Heterohelix ultimatumida* (WHITE); PESSAGNO, 264–265.
1972. *Heterohelix ultimatumida* (WHITE); GOVINDAN, 168, pl. 1: 3–4.
1974. *Heterohelix ultimatumida* (WHITE); KASSAB, 87, 88, pl. 1: 13–14.
1975. *Heterohelix striata* (EHRENBERG); NORTH and CALDWELL, pl. 4: 10a–b.

Material. — 19 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/15	0·32	0·23	0·08

Description. — Test biserial; chambers spherical, increasing gradually in size as added in the earlier portion and more sharply in the terminal portion, so two terminal pairs of chambers constitute 1/2 to 3/4 of the total test length; sutures distinctly depressed, oblique in regard to test axis; wall ornamented by longitudinal striae; primary aperture broad, with slight apertural lip.

Variability. — Expressed mainly in growth rate of 2 final pairs of chambers and in ratio of length of 2 final pairs of chambers to test length.

Remarks. — The distinct longitudinal striae and inflated chambers bring *H. ultimatumida* close to *H. striata* (EHRENBERG). They differ, however, in the rate of increase of the size of the chambers which is sharp in the 3 to 4 terminal chambers of *H. ultimatumida*, but gradual in all chambers of *H. striata*. The specimen illustrated by NORTH and CALDWELL (1975) as *H. striata* and possessing 2 terminal pairs of chambers forming more than half of the total length of the test should be referred to *H. ultimatumida*.

Occurrence. — USA, Mexico: Upper Campanian-Maastrichtian; Puerto Rico: Campanian-Lower Maastrichtian; Canada: Upper Santonian; India: Upper Campanian-Maastrichtian; Iraq: Upper Campanian-Maastrichtian; Central Poland (Wesołówka 44, Łopoczno, Kaliszany, Wola Pawłowska, Lucimia, Dobre, Męćmierz, Kazimierz, Nasiłów, Bochotnica): Campanian-Maastrichtian.

Heterohelix ventilabrelliformis (van der SLUIS, 1950)
(pl. 3: 2, 4, 11, 12)

1950. *Guembelina ventilabrelliformis* van der SLUIS; van der SLUIS, 21, pl. 1: 2a–c (*fide* ELLIS and MESSINA, Catalogue Foram.).
1965. *Heterohelix ventilabrelliformis* (van der SLUIS); TAKAYANAGI, 199—200, pl. 20: 5a–b.
1972. *Pseudotextularia carseyae* (PLUMMER); HANZLIKOVA, 94, pl. 23: 20–23.

Material. — 8 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/32	0·27	0·12	0·07
ZPAL FXXIII/33	0·26	0·13	0·07

Description. — Test biserial, tapering; periphery lobate; chambers rectangular in earlies portion, globular in terminal portion, increasing regularly in size as added with exception of penultimate chamber that may be bigger or smaller than antipenultimate one; ultimate chamber deflected from normal biserial alignment becoming nearly central in position; sutures depressed, almost straight; wall covered by inconspicuous fine costae; primary aperture highly arched, sometimes on reverse side of test small supplementary aperture is placed.

Variability. — Expressed in number of chambers, in size and ornamentation of ultimate chamber and in the presence or lack of an additional aperture at the base of the ultimate chamber. Apart from forms with smaller ultimate chamber with nodules instead of striae, specimens with very big, globular, intensively ornamented ultimate chamber often more than one third of the test length, also occur. The longitudinal striae in the latter forms are parallel to the outer margin of the ultimate chamber, running from the primary aperture to additional apertures.

Remarks. — The central position of the final chamber and the presence of an additional aperture makes *H. ventilabrelliformis* a transitional form between *Heterohelix* and *Planoglobulina*.

The characteristic feature of the species is a deflection of the last chamber from the normal biserial alignment to become nearly central in position. Van der SLUIS (1950) did not mention the additional aperture, although it has been observed in some specimens (e. g. TAKAYANAGI 1965). Specimens illustrated by CUSHMAN (1938, pl. 2: 3, 5; 1946, pl. 44: 17) as *Guembelina moremani* CUSHMAN and as *Guembelina globocarinata* CUSHMAN and by HANZLIKOVA (1972, pl. 23: 21, 22) as *Pseudotextularia carseyae* have ultimate chambers placed in the central part of the test, sometimes with two apertures, which allows us to regard them as *H. ventilabrelliformis*.

Occurrence. — USA (California): Campanian, Texas: Upper Turonian-Coniacian); Indonesia (Ceram): Maastrichtian; Czechoslovakia (Moravia): Lower Maastrichtian; Central Poland (Wesołówka 44, Wałowice, Kazimierz, Bochotnica): Santonian-Maastrichtian.

Heterohelix vistulaensis sp. n.
(pl. 4: 1–9, pl. 21: 4)

Holotype: ZPAL FXXIII/42; pl. 4, fig. 2.
Type horizon: Upper Maastrichtian.
Type locality: Męćmierz.
Derivation of the name: after the Vistula river.
Diagnosis: Test biserial, consisting of 5–6 pairs of chambers. Early chambers inflated, globular. Chambers of ultimate pair somewhat inflated, reniform, overlapping, overlap penultimate pair of chambers. Width of terminal pair equals often the total test length while length of terminal pair varies from $^1/_2$ to $^1/_2$ of total test length.

Material. — 30 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/42	0·11	0·12	0·05
ZPAL FXXIII/46	0·12	0·10	0·06
ZPAL FXXIII/49	0·14	0·12	0·07

Description. — Test biserial, usually consisting of 5–6 pairs of chambers; periphery in initial portion entire, later indented; chambers slightly inflated, barrel-shaped to subglobular, increasing regularly in size as added with the exception of chambers of the final pair which increase sharply in size and constitute 1/2–1/3 of test length; chambers of final pair somewhat flattened, reniform, overlapping; chambers of the penultimate pair partly or completely overlapped; chambers of final pair are deflected in one side thus forming a depression between final pair and earlier part of test; final pair of chambers is nearly twice as wide as long and often wider than the length of the test; sutures distinctly depressed, slightly oblique in regard to test axis; wall with discontinuous, delicate costae; primary aperture interiomarginal, a high arch; gerontic specimens with one additional pair of chambers, globular, lying in normal surface to the earlier part of test, and equal in size to the remainder of the test.

Variability. — Specimens included among this species may differ to some extent in test length, in size and shape of the last pair of chambers as well as in degree of its deflection from the axis of test.

Remarks. — The position of the last pair of chambers not in the plane of the other part of the test distinguishes the new species from all species of genus *Heterohelix* hitherto described. *H. vistulaensis* sp. n. is similar to *H. pulchra* (BROTZEN) in having two reniform terminal chambers but differs in (1) the development of the older part of the test, (2) the size of the ultimate pair of chambers compared with the size of the whole test, (3) the position of the last pair of chambers not in the test axis, (4) smaller test, and (5) test ornamentation.

Occurrence. — Central Poland (Lucimia, Męćmierz, Podgórz, Dobre, Janowiec, Kazimierz): Upper Maastrichtian.

Genus *Chiloguembelina* LOEBLICH and TAPPAN, 1956
Chiloguembelina praecursor sp. n.
(pl. 3: 1, 3, 6, 7)

Holotype: ZPAL FXXIII/36; pl. 3, fig. 6.
Type horizon: Upper Maastrichtian.
Type locality: Kazimierz.
Derivation of the name: from Latin praecursor, the earliest representative of the genus.
Diagnosis: Test biserial, consisting of 6–8 pairs of chambers, in initial portion entire, in later portion indented; chambers subglobular, striate, primary aperture eccentric in position, bordered by two parallel lateral flan ges.

Material. — 12 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/36	0·33	0·18	0·10
ZPAL FXXIII/37	0·21	0·14	0·08

Description. — Test small, biserial, tapering, sometimes with curved initial part of test; in initial portion periphery entire, in later portion indented; first chambers subrectangular, in adult stage subglobular; sutures flush in initial portion, depressed in later portion; wall distinctly ornamented by longitudinal discontinuous striae; primary aperture eccentric, bordered by two parallel lateral flanges.

Variability. — Marked in shape of test — from straight to slightly twisted, in number of chambers, intensity of ornamentation, shape and position of ultimate chamber and in position of aperture.

Remarks. — LOEBLICH and TAPPAN (1956) erected the genus *Chiloguembelina* so as to include some Tertiary species that were previously referred to *Guembelina*. *Chiloguembelina* is distinguished from *Heterohelix* mainly in the presence of neck-like apertural extensions, the tendency to develop a twisted test and the asymmetrical aperture. The oldest occurrences of this genus were previously reported from the Lowermost Paleocene in association with *Chiloguembelina crinita* (GLAESSNER) and *Chiloguembelina midwayensis* (CUSHMAN). *Ch. praecursor* sp. n. is the transitional species between the genera *Heterohelix* and *Chiloguembelina*. Possessing ornamentation of Upper Cretaceous *Heterohelix* type it has an asymmetrically placed primary aperture and slightly twisted test. As the presence of an asymmetrically placed aperture is one of the diagnostic features of the genus *Chiloguembelina*, this species was included in that genus. *Ch. praecursor* sp. n. found in the Upper Campanian and Upper Maastrichtian deposits of the Vistula river profile, is the oldest known representative of *Chiloguembelina*. *Ch. praecursor* sp. n. is similar to *Ch. crinita* (GLAESSNER) and *Ch. midwayensis* (CUSHMAN) in test size but differs in possessing discontinuous longitudinal striae instead of a hispid surface. It differs from *Ch. crinita* in having chambers increasing less sharply in size as added and in having weaker developed lateral flanges. *Ch. praecursor* sp. n. differs from *Ch. midwayensis* in having chambers subglobular to globular in shape and possessing less strongly developed lateral flanges.

Occurrence. — Central Poland (Wesołówka 44, Jarentowskie Pole, Lucimia, Kazimierz): Campanian-Maastrichtian.

Genus *Pseudoguembelina* BRÖNNIMANN and BROWN, 1953

Pseudoguembelina sp.

(pl. 2: 1)

Material. — 1 specimen.

Dimensions (in mm):

	L	W	T
ZPAL FXXIII/240	0·19	0·11	0·07

Description. — Test biserial, tapering throughout, consisting of 5 pairs of chambers; chambers increasing moderately in size as added, globular, in ultimate pair slightly ovate; sutures slightly limbate and slightly depressed initially, depressed finally; wall ornamented throughout with fine longitudinal costae, becoming somewhat curved and nearly parallel to the periphery in final part; primary aperture semicircular, with a slightly thickened rim; sutural supplementary apertures with nearly flat apertural flaps.

Remarks. — *Pseudoguembelina* sp. differs from *Pseudoguembelina excolata* (CUSHMAN) in having a more slender test and more delicate striae. It differs from *Pseudoguembelina palpebra* BRÖNNIMANN and BROWN in being more slender, in having a moderate rate of increase of chamber size compared with a sharp increase in *Pseudoguembelina palpebra* BRÖNNIMANN and BROWN and in having only weakly developed sutural apertural flaps. *Pseudoguembelina* sp. differs from *Pseudoguembelina costulata* (CUSHMAN) in being much smaller and in having chambers of different shape.

Occurrence. — Central Poland (Dobre): Lower Maastrichtian.

Genus *Pseudotextularia* RZEHAK, 1891
Pseudotextularia deformis (KIKOINE, 1948)
(pl. 6: 6*a*, *b*)

1948. *Guembelina striata* (EHRENBERG) var. *deformis* KIKOINE; KIKOINE, 20, pl. 1: 8a–c (*fide* ELLIS and MESSINA, Catalogue Foram.).
1960. *Pseudotextularia elegans* (RZEHAK); OLSSON, 28, pl. 4: 9–10.
1967. *Pseudotextularia deformis* (KIKOINE); PESSAGNO, 269, pl. 90: 16, pl. 92: 19–21, pl. 97: 16, 17, pl. 98: 15, 17–18.
part. 1969. *Pseudotextularia elegans* (RZEHAK); BROWN, 47–54, fig. 9a–b, 10a–b, *non* fig. 13a–c, *non* pl. 2: 4a–b, *non* pl. 3: 2–3.
1970. *Pseudotextularia elegans* (RZEHAK); TODD, p. 151–152, pl. 5: 5.
1973. *Pseudotextularia deformis* (KIKOINE); SMITH and PESSAGNO, 29–30, pl. 9: 1–4, pl. 10: 1, pl. 11: 1–3.
1977. *Pseudotextularia deformis* (KIKOINE); HAMAM and HAYNES, 53–54, pl. 2: 9.

Material. — One well preserved specimen.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/58	0·26	0·15	0·07

Description. — Test biserial; apical portion sharply pointed, followed closely by sharp expansion of chambers in width, later chambers increase slowly in width as added; sutures depressed, straight to slightly curved in peripheral view, gently curved in side view; wall ornamented by coarse discontinuous costae; aperture wide, highly arched opening at the base of ultimate chamber; constricted final chamber and a small, basal, supplementary chamber visible in abapertural view.

Remarks. — Polish specimen is identical with the holotype. This species in an important guide fossil for Upper Maastrichtian strata.

Occurrence. — Trinidad: Upper Maastrichtian; USA (Texas, Arkansas), Mexico: Middle Maastrichtian; USA (New Jersey): Middle-Upper Maastrichtian; South Africa: Upper Maastrichtian; Central Poland (Chotcza): uppermost Lower Maastrichtian.

Pseudotextularia cf. *elegans* (RZEHAK, 1891)
(pl. 6: 1, 2)

Material. — Two well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/59	0·30	0·18	0·14

Description. — Test biserial, slightly flattened in lateral view; test consisting of about 7 pairs of chambers increasing sharply in size as added; chambers in the initial portion of test flattened to weakly inflated, greater in width than in height; ultimate and penultimate chambers subglobular; sutures straight, flush initially, becoming curved abapically in apertural and abapertural views; wall finely costate; costae closely spaced, discontinuous; primary aperture terminal, low and broad slit-like arch with a thick apertural rim.

Remarks. — *P.* cf. *elegans* differs from *P. elegans* (RZEHAK) in being less flattened and having a triangular test in side view compared with almost parallel walls in the latter species, in having chambers becoming greater in thickness than in height less sharply in apertural and adapertural views, and in having higher primary aperture and sutures not so strongly arched in apertural and adapertural views in the final portion of test.

Occurrence. — Central Poland (Kazimierz, Chotcza): Upper Maastrichtian.

Pseudotextularia sp.
(pl. 6: 3, 4)

Material. — 6 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/60	0·27	0·18	0·12
ZPAL FXXIII/61	0·23	0·15	0·10

Description. — Test biserial, consisting of 6–7 pairs of chambers, increasing sharply in size as added; chambers slightly inflated, subrectangular in apertural view, of width twice the height with the exception of a subglobular penultimate chamber; ultimate chamber globular, quite strongly flattened in abapertural view; sutures straight, flush initially, depressed finally; wall finely costate, costae closely spaced, discontinuous, generally following the contour of the chambers; aperture large, semilunar.

Remarks. — *Pseudotextularia* sp. differs from *Pseudotextularia elegans* (RZEHAK) mainly in having chambers slightly inflated in the initial portion, in possessing chambers more wide than high, in having globular ultimate and penultimate chambers, in having straight, depressed sutures in apertural and adapertural views as against curved and highly arched adapically in *P. elegans* and in having highly arched primary aperture.

Occurrence. — Central Poland (Wesołówka 42, 44, 45): Upper Maastrichtian.

Genus *Racemiguembelina* MONTANARO GALLITELLI, 1957
Racemiguembelina powelli SMITH and PESSAGNO, 1973
(pl. 6: 7*a–c*)

part. 1946. *Pseudotextularia varians* RZEHAK; CUSHMAN, 110, pl. 47: 4a–b, *non* pl. 47: 5a–b, 6, 7a–b.
part. 1946. *Planoglobulina acervulinoides* (EGGER); CUSHMAN, 111, pl. 47: 15a–b, non pl. 47: 12a–b, 13a–b, 14a–b.
1957. *Racemiguembelina fructicosa* (EGGER); MONTANARO GALLITELLI, 142–143, pl. 32: 14a–b, 15a–b.
1964. *Racemiguembelina fructicosa* (EGGER); LOEBLICH and TAPPAN, C656; fig. 525: 8a–b.
1967. *Racemiguembelina fructicosa* (EGGER); PESSAGNO, 270, pl. 90: 14–15.
1968. *Racemiguembelina fructicosa* (EGGER); SLITER, 98, pl. 24: 16.
1970. *Racemiguembelina fructicosa* (EGGER); TODD, 152, pl. 5: 7.
1972. *Racemiguembelina fructicosa* (EGGER); GOVINDAN, 171, pl. 1: 7–8, pl. 2: 8–9.
1973. *Racemiguembelina powelli* SMITH and PESSAGNO; SMITH and PESSAGNO, 35–37, pl. 11: 4–6, 7–9, 10–12.
1975. *Racemiguembelina fructicosa* (EGGER); STAPLETON, pl. 2: 10a–c.
1977. *Racemiguembelina fructicosa* (EGGER); ALIULLA, pl. 2: 2.

Material. — One well preserved specimen.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/57	0·32	0·18	0·14

Description. — Test initially biserial, from midway becoming multiserial due to chamber proliferation, resulting in a conical test; in lateral view multiserial portion consists of chambers lying in two planes only; 5 initial chambers flattened, increasing gradually in size as added, next 2 chambers increasing sharply in size; in multiserial portion chambers convex, of different size, terminal chambers are even a little smaller than preceding ones; initial sutures very obscure, terminal sutures strongly depressed; wall coarsely perforate, costate; pores closely spaced, aligned in irregularly vertical columns in intercostal areas; costae massive, highly raised, widely spaced, vertically arranged in a discontinuous pattern; each terminal chamber possessing a basal, wide and highly arched aperture in central portion of test; ponticulus not observed in specimen examined.

Remarks. — Polish specimen is identical with the holotype.

Occurrence. — USA (Texas, Alabama, Arkansas), Mexico: Upper Maastrichtian; India: Upper Maastrichtian; South Africa: Upper Maastrichtian; Poland — Carpathians (Kruhel): Maastrichtian, Central Poland (Chotcza): Lower Maastrichtian.

Genus *Planoglobulina* CUSHMAN, 1927
Planoglobulina acervulinoides (EGGER, 1899)
(pl. 5: 5)

1926. *Pseudotextularia acervulinoides* (EGGER); CUSHMAN, 17, pl. 2: 5.
part. 1946. *Planoglobulina acervulinoides* (EGGER); CUSHMAN, 111, pl. 47: 12, 13, *non* pl. 47: 14, 15.
1969. *Planoglobulina acervulinoides* (EGGER); FUNNELL *et al.*, 22, 23, fig. 4, pl. 1: 7, 8.
1974. *Planoglobulina acervulinoides* (EGGER); VAPTZAROVA, 37, pl. 1: 23–25.
1975. *Planoglobulina acervulinoides* (EGGER); STAPLETON, pl. 3: 7a.
1976. *Planoglobulina acervulinoides* (EGGER); WRIGHT and APTHORPE, 238, pl. 1: 2.

Material. — 2 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/56	0·32	0·22	0·12

Description. — Test biserial in earlier portion, multiserial in later portion, consisting of 6 chambers in biserial portion and more than 13 in multiserial portion; test inflated in the biserial portion and initial portion of the multiserial stage (as observed in edge view), somewhat flattened in the terminal portion; chambers subglobular; sutures depressed; heavy, closely spaced, longitudinal costae relatively continuous over early chambers, slightly finer and discontinous over later chambers; apertures rather highly arched to rectilinear openings, outermost two terminal chambers with apertures on front only, facing inward.

Remarks. — *P. acervulinoides* is similar to *P. brazoensis* MARTIN but differs in having more chambers in the multiserial portion of the test and by possessing a less inflated test in the multiserial portion.

Occurrence. — USA (Texas, Arkansas), Mexico: Middle and Late Maastrichtian; Australia: Late Maastrichtian; South Africa: Middle and Late Maastrichtian; Spain: Late Maastrichtian; Bulgaria: Middle and Late Maastrichtian; Central Poland (Chotcza): uppermost Lower Maastrichtian.

Planoglobulina brazoensis MARTIN, 1972
(pl. 5: 4*a*, *b*)

1962. *Pseudotextularia (Racemiguembelina) fructicosa* (EGGER); BERGGREN, 22, pl. 6: 6a, b.
1967. *Planoglobulina acervulinoides* (EGGER); PESSAGNO, 271, pl. 87: 14.
1972. *Planoglobulina brazoensis* MARTIN; MARTIN, 82–83, pl. 3: 7a–c, pl. 4: 1–2.
1973. *Planoglobulina brazoensis* MARTIN; SMITH and PESSAGNO, 20–21, pl. 4: 5–7, 8–10, pl. 5: 1–2.

Material. — 4 broken specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/55	0·33	0·24	0·16

Description. — Test initially biserial, later multiserial; chambers in biserial portion flattened, increasing slowly in size as added; chambers in multiserial portion greatly inflated, somewhat offsetting laterally from biserial arrangements; sutures depressed, indistinct, in biserial portion depressed zigzag sutures between pairs of chambers.

Remarks. — *P. brazoensis* is somewhat similar to *P. carseyae* (PLUMMER). It differs, however, in (1) its multiserial portion, which comprises more than a half of the total height of the

test, (2) terminal portion of the multiserial stage which consists of 5 to 7 chambers against 3 in *P. carseyae* and (3) its ornamentation which consists of thick, quite rare, discontinuous longitudinal striae against delicate, bushy, discontinuous longitudinal striae in *P. carseyae*. *P. brazoensis* differs from *P. acervulinoides* (EGGER) in having less chambers in its multiserial stage and more chambers in its biserial stage and in having a triangular test against an almost ovate one in *P. acervulinoides*.

Occurrence. — USA (Texas), Mexico: Middle Maastrichtian; Denmark: Middle Maastrichtian; Central Poland (Chotcza): Lower Maastrichtian.

Planoglobulina carseyae (PLUMMER 1931)
(pl. 5: 1, 2, 3; pl. 6: 5)

1931. *Ventilabrella carseya* PLUMMER; PLUMMER, 178, pl. 9: 7–9.
1957. *Planoglobulina carseyae* (PLUMMER); MONTANARO GALLITELLI, pl. 32: 13.
1960. *Planoglobulina carseyae* (PLUMMER); OLSSON, 29, pl. 4: 13.
1967. *Planoglobulina carseyae* (PLUMMER); PESSAGNO, 271, pl. 87: 10, 15, 16.
1970. *Planoglobulina carseyae* (PLUMMER); TODD, 152, pl. 5: 6.
1972. *Planoglobulina carseyae* (PLUMMER); GOVINDAN, 171–172, pl. 1: 17.
1972. *Planoglobulina* (?) *carseyae* (PLUMMER); MARTIN, 83—84, pl. 4: 4—7.
1973. *Planoglobulina carseyae* (PLUMMER); SMITH and PESSAGNO, 21–22, pl. 5: 3–4, 5–7, 8–10, 11–12.

Material. — Nine well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/52	0·27	0·22	0·10
ZPAL FXXIII/53	0·23	0·19	0·16

Description. — Test flattened, biserial in earliest portion, multiserial later; youngest portion consisting usually of 3 chambers; initial chambers flattened, increasing slowly in size as added, becoming rapidly globular to spherical and increasing only slightly in size as added in terminal portion; sutures initially weakly marked, terminally strongly depressed; wall coarsely costate; costae closely spaced, discontinuous, generally following the contour of chambers; aperture interiomarginal, wide; 2 exterior final chambers possessing a single basal aperture directed towards the median line of test.

Remarks. — Polish specimens are identical with the holotype described from the Middle Maastrichtian of Texas.

Occurrence. — USA (Texas, Arkansas, Mississippi, Alabama), Mexico: Middle-Upper Maastrichtian; India: Upper Maastrichtian; South Africa: Maastrichtian; Central Poland (Wesołówka 39, Ciszyca Kolonia, Wola Pawłowska, Chotcza, Lucimia, Dobre, Kazimierz): Coniacian-Upper Maastrichtian.

Family **Planomalinidae** BOLLI, LOEBLICH and TAPPAN, 1957
Genus *Globigerinelloides* CUSHMAN and TEN DAM, 1948
Globigerinelloides bentonensis (MORROW, 1934)
(pl. 7: 5*a–b*, 6, 9)

1934. *Anomalina bentonensis* MORROW; MORROW, 201, pl. 30: 4a–b.
1961. *Globigerinelloides bentonensis* (MORROW); LOEBLICH and TAPPAN, 267, pl. 2: 8—10.
1967. *Globigerinelloides bentonensis* (MORROW); PESSAGNO, 275, pl. 76: 10–11.
1970. *Globigerinelloides bentonensis* (MORROW); EICHER and WORSTELL, 297, pl. 8: 17a–b, 19a–b, pl. 9: 3a–b.
1972. *Globigerinelloides bentonensis* (MORROW); MICHAEL, 208, pl. 1: 4–6.
1975. *Globigerinelloides bentonensis* (MORROW); HELLER, pl. 1: 16.
1975. *Globigerinelloides bentonensis* (MORROW); NORTH and CALDWELL, pl. 4: 13a–c.

Material. — 27 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/67	0·26	0·24	0·12
ZPAL FXXIII/68	0·28	0·25	0·13

Description. — Test planispiral, biumbilical; peripheral outline circular; chambers nearly spherical in apertural view; final whorl consisting of 7–8 chambers increasing moderately in size as added; sutures depressed, oblique to radial; wall coarsely papillose; ultimate chamber almost smooth; umbilicus shallow, wide; aperture equatorial, interiomarginal, a low semicircular arch, bordered by a thin lip; the lateral portion of the previous apertures and lips remaining uncovered by later chambers so that relict supplementary apertures are preserved around the umbilical region.

Remarks. — The specimens described are the same as the holotype.

Occurrence. — USA: Cenomanian; Canada: Coniacian-Santonian; Poland — Łódź region: Upper Cenomanian-Turonian, Central Poland (Słupia Nadbrzeżna, Wesołówka 31, 33, 34, 43): Upper Turonian-Santonian.

Globigerinelloides caseyi (BOLLI, LOEBLICH and TAPPAN, 1957)
(pl. 7: 3, 4)

1957. *Planomalina caseyi* BOLLI, LOEBLICH and TAPPAN; BOLLI, LOEBLICH and TAPPAN, 24. pl. 1: 4–5.
1961. *Globigerinelloides eaglefordensis* (MOREMAN); LOEBLICH and TAPPAN, 268, pl. 2: 3a–7b.
1964. *Globigerinelloides eaglefordensis* (MOREMAN); LOEBLICH and TAPPAN, C657–658, fig. 526: 7a, b.
1967. *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN); PESSAGNO, 276, pl. 49: 2–5.
1969. *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN); DOUGLAS, 161, pl. 5: 9.
1970. *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN); EICHER and WORSTELL, 297, 298, pl. 8: 11, 15a–b, 16.
1971. *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN); EL-NAGGAR, pl. 3: 1–0.
1971. *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN); BELFORD and SCHEIBNEROVA, pl. 3: 17–19.
1974. *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN); HERB, 751, pl. 2: 9.

Material. — 17 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/64	0·23	0·18	0·10
ZPAL FXXIII/65	0·24	0·18	0·11

Description. — Test planispiral; peripheral outline ovate, lobulate; chambers spherica to ovate in apertural view, trapezoid in lateral view; final whorl consisting of 7–9 chambers increasing regularly in size as added; sutures distinctly depressed, slightly curved; wall finely papillose, nearly smooth; umbilicus shallow, wide; aperture equatorial, interiomarginal, a low semicircular arch, bordered by thin lip; the lateral portions of the previous apertures and lips remaining uncovered by later chambers, so that relict supplementary apertures are preserved around the umbilical region.

Remarks. — The specimens described correspond with the holotype of *G. caseyi*, differing only in possessing a slightly ornamented wall. They differ from *G. bentonensis* (MORROW) in being somewhat smaller, in having an ovate outline, in being less ornamented and in possessing more chambers in the final whorl.

Occurrence. — USA — Gulf Coast Plain: Cenomanian, California: Lower Turonian-Coniacian; Australia: Lower Turonian; southern Indian Ocean: Albian-Cenomanian; England: Albian; Central Poland (Jakubowice): Cenomanian.

Globigerinelloides multispinus (LALICKER, 1948)

(pl. 8: 5–11)

1948. *Biglobigerinella multispina* LALICKER; LALICKER, pl. 92: 1–3, (*fide* ELLIS and MESSINA, Catalogue Foram.).
1956. *Globigerinella biforaminata* (HOFKER); BUKOWY and GEROCH, 317, 318, pl. 28: 3.
1957. *Biglobigerinella multispina* LALICKER; LOEBLICH *et al.*, 24, pl. 1: 11–12b.
1962. *Planomalina multispina* (LALICKER); BARR, 563–564, pl. 69: 5a, b.
part. 1962. *Planomalina (Globigerinelloides) messinae* (BRÖNNIMANN); BERGGREN, 44–46, pl. 8: 4a–c, 6a–c, 8a–c, non pl. 8: 7a–c, fig. 6: 2a, b, 5a–b, non fig. 6: 1a–b, 3a–e, 4a, b, 6a–c, fig. 7: 6a–b, 7a–c, 8a, b, non fig. 7: 1a–b, 2a–b, 3a–b, 4a–b, 5a–b.
1962. *Globigerinella voluta pinguis* HERM; HERM, 52, pl. 1: 2.
1962. *Biglobigerinella multispina* LALICKER; HERM, 53, pl. 3: 8.
1964. *Globigerinelloides messinae* (BRÖNNIMANN); OLSSON, 174—176, pl. 7: 6a–b, 7a–b, 8a–b.
1964. *Biglobigerinella multispina* LALICKER; LOEBLICH and TAPPAN, C656, fig. 526: 5a–b.
1967. *Globigerinelloides multispina* (LALICKER); PESSAGNO, 276–277, pl. 70: 1–2, pl. 82: 10–11, pl. 91: 1–2.
1968. *Globigerinelloides messinae* (BRÖNNIMANN); SLITER, 99 pl. 15: 3, 5.
1969. *Globigerinelloides multispina* (LALICKER); DOUGLAS, 161, 162, pl. 9: 6.
1970. *Globigerina (Biglobigerinella) biforminata* HOFKER; TODD, 152, pl. 5: 10.
1970. *Globigerinelloides messinae* (BRÖNNIMANN); NORTH and CALDWELL, 49, 50, pl. 4: 4a–c.
1972 *Globigerinelloides multispina* (LALICKER); HANZLIKOVA, 99, pl. 25: 2–4.
1972. *Globigerinelloides messinae* (BRÖNNIMANN); GOVINDAN, 172, pl. 2: 20–23.
1973. *Globigerinelloides multispina* (LALICKER); SMITH and PESSAGNO, 38–39, pl. 13: 1–2, 3–6, 7, 8–9, 10–11.
1974. *Globigerinelloides messinae* (BRÖNNIMANN); VAPTZAROVA, 38, pl. 2: 1, 2.
1975. *Globigerinelloides messinae* (BRÖNNIMANN); STAPLETON, pl. 2: 4a–c.
1975. *Globigerinelloides messinae* (BRÖNNIMANN); NORTH and CALDWELL, pl. 4: 12a–c.
1977. *Globigerinelloides multispina* (LALICKER); RODRIGUEZ, 90, pl. 1: 6.

Material. — 40 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/76	0·18	0·16	0·10
ZPAL FXXIII/79	0·17	0·13	0·09
ZPAL FXXIII/82	0·18	0·16	0·11

Description. — Test planispiral, slightly involute; axial periphery rounded, equatorial periphery lobate; final whorl consisting of 5 or 6 chambers successively increasing slightly in size as added; chambers in lateral view subcircular to ovate, strongly inflated; early chambers in apertural view spherical, increasing rapidly in width as added; ultimate or ultimate and penultimaze chambers elongated in axial cross section; ultimate chamber slightly flattened and broadly ovate, sometimes partially or completely divided into paired chambers; sutures radial, straight, strongly depressed; wall coarsely papillose, more strongly ornamented on early chambers of final whorl, ultimate chamber frequently almost smooth; umbilicus wide, deep; aperture bipartite, interiomarginal, a wide and highly arched opening at each side of the ultimate chamber; each aperture bordered by a thickened well developed lip and apertural flap.

Variability. — Great in position of aperture and in shape of the ultimate chamber. Apertutes of numerous uniserial biapertural forms are often umbilical in position. Uniserial individuals where apertures become more strongly equatorial, almost merging at the crest of the initial whorl of the final whorl, also occur. Biserial (in the youngest portion), biapertural forms, usually with the ultimate chamber divided into paired chambers are quite common. Specimens with a greater number of paired chambers in the final whorl, and with a single biapertural ultimate chamber, were also recorded.

Remarks. — *Globigerinelloides multispinus* (LALICKER) is known from deposits not older than Upper Campanian in age. It is one of the most cosmopolitan species amongst the planktic foraminifera and was described under different names from different climatic zones of both hemispheres. I agree with PESSAGNO (1967) and SMITH and PESSAGNO (1973) that the species is characterized by great individual variability and I accept their view that *Globigerinella biforami-*

nata HOFKER is a junior synonym of *Globigerinelloides multispinus* (LALICKER) and represents an immature form of this species.

Occurrence. — Europe (France, England, Denmark, Germany, Moravia, Western Carpathians, Bulgaria, Spain, Central Poland): Upper Campanian-Maastrichtian; USA (New Jersey, California, Texas, Arkansas): Upper Campanian-Lower Maastrichtian; Mexico: Upper Campanian-Lower Maastrichtian; Canada: Upper Campanian-Maastrichtian; South Africa: Middle-Upper Maastrichtian; India: Upper Maastrichtian; Poland — Carpathians (Kruhel): Maastrichtian, Central Poland (Sulejów, Józefów, Wola Pawłowska, Solec, Jarentowskie Pole, Chotcza, Lucimia): Upper Campanian-Upper Maastrichtian.

Globigerinelloides prairiehillensis PESSAGNO, 1967
(pl. 7: 8, 14; pl. 8: 1–4)

1967. *Globigerinelloides prairiehillensis* PESSAGNO; PESSAGNO, 267, pl. 83: 1, pl. 90: 1–2, 4, pl. 97: 3–4.
1973. *Globigerinelloides prairiehillensis* PESSAGNO; SMITH and PESSAGNO, 39, pl. 14: 1–2, 3–4.

Material. — 25 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/72	0·16	0·13	0·07

Description. — Test planispiral; chambers spherical, increasing fastly in size as added; final whorl consisting of 6–7 chambers; sutures radial, straight, distinct; wall papillose; umbilicus deep, relatively large primary aperture equatorial, a lowly arched opening at the base of the ultimate chamber; relict apertures and relict apertural flaps well developed.

Remarks. — *G. prairiehillensis* differs from cooccurring *G. volutus* (WHITE) in having a deeper, narrower umbilicus and in possessing chamber that increase sharply in size as added. Polish specimens differ from the holotype in possessing a higher primary aperture and according to SMITH and PESSAGNO (1973) they are referred to *G. prairiehillensis s. l.*

Occurrence. — USA: Upper Santonian-Lower Maastrichtian; Central Poland (Sulejów, Wałowice, Łopoczno, Jarentowskie Pole, Chotcza, Lucimia, Kazimierz, Bochotnica): Upper Campanian-Maastrichtian.

Globigerinelloides volutus (WHITE, 1929)
(pl. 7: 1, 2)

1929. *Globigerina voluta* WHITE; WHITE, 197, 198, pl. 28: 5a–b.
non 1962. *Globigerinella voluta voluta* (WHITE); HERM, 51, pl. 3: 7.
1967. *Globigerinelloides volutus* (WHITE); PESSAGNO, 278–279, pl. 62: 9, 10–11, pl. 100: 9.
1973. *Globigerinelloides volutus* (WHITE); SMITH and PESSAGNO, 41, 42, pl. 16: 1–2, 3–4.

Material. — 37 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/62	0·22	0·14	0·08
ZPAL FXXIII/63	0·21	0·16	0·09

Description. — Test planispiral, flattened; final whorl consisting of 5–6 chambers increasing gradually in size as added; ultimate chamber commonly smaller than penultimate one, in lateral view slightly ovoid to sectorial, in apertural view spherical to elliptical; chambers bulging, closely arranged in whorl, of wedge-shape in equatorial plane; sutures depressed, straight, radial; wall ornamented by small papillae; umbilicus shallow, broad; aperture equatorial, symmetrical, highly arched, with thin lip; sometimes lateral continuations of lips of previous apertures marked in umbilical plane as relict additional apertures.

Variability. — Expressed mainly in general outline of test (ranging from ovate to almost round).

Remarks. — PESSAGNO (1967: 278) stated that the holotype of *G. volutus* was lost. He studied samples from the type locality and found there only two species of *Globigerinelloides*, namely *G. messinae* (BRÖNNIMANN) and *G. subcarinatus* (BRÖNNIMANN). PESSAGNO suggested that although WHITE's figures are not accurate, the only individuals in the type material similar to WHITE's drawings were specimens of *G. messinae*. He admitted, in fact, that *G. messinae* is a junior synonym of *G. volutus*. Polish specimens are very similar to those described and illustrated by PESSAGNO (1967) and SMITH and PESSAGNO (1973).

Occurrence. — USA, Mexico: Upper Campanian-Maastrichtian; Central Poland (Sulejów, Łopoczno, Jarentowskie Pole, Chotcza, Lucimia, Kazimierz, Bochotnica): Upper Campanian-Maastrichtian.

Globigerinelloides yaucoensis (PESSAGNO, 1960)
(pl. 7: 7)

1960. *Planomalina yaucoensis* PESSAGNO; PESSAGNO, 98, pl. 2: 14–15, pl. 5: 4.
1967. *Globigerinelloides yaucoensis* (PESSAGNO); PESSAGNO, 279, pl. 75: 9–10, pl. 97: 5–6.

Material. — 16 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/69	0·19	0·16	0·07

Description. — Test planispiral, slightly flattened, consisting of 7–8 chambers increasing very slowly in size as added; sutures markedly depressed, slightly curved; chambers sectorial in lateral view, globular to ellipsoidal in apertural view; wall finely papillate; umbilicus wide, shallow; aperture equatorial, broad, moderately arched, bordered by a thin lip, with lateral lip-like projections extending into the umbilicus.

Remarks. — Polish specimens are almost identical with the holotype.

Occurrence. — USA (Texas, Arkansas), Mexico: Upper Campanian-Lower Maastrichtian; Puerto Rico: Campanian; Central Poland (Bliskowice, Wałowice, Lucimia, Kazimierz, Bochotnica): Upper Maastrichtian.

Superfamily **Hedbergelloidea** LONGORIA and GAMPER, 1975
Family **Hedbergellidae** LONGORIA and GAMPER, 1975
Subfamily **Hedbergellinae** LOEBLICH and TAPPAN, 1961
Genus *Hedbergella* BRÖNNIMANN and BROWN, 1958
Hedbergella angolae CARON, 1978
(pl. 10: 2*a–d*)

1978. *Hedbergella angolae* CARON; CARON, 658–659, pl. 10: 5–7; text-fig. 6a–c.

Material. — 30 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/95	0·21	0·16	0·10

Description. — Test low trochospiral, consisting of 2–3 whorls; equatorial periphery strongly lobate; chambers spherical; final whorl consisting of 5–6 chambers increasing rapidly in size as added; sutures radial, depressed; wall covered by pustulae; umbilicus wide, shallow; primary aperture extraumbilical, with a small imperforate flap.

Remarks. — The Polish specimens differ from the holotype only in being a little more spherical.

Occurrence. — SE Atlantic: Albian-Cenomanian; Central Poland (Jakubowice, Karsy, Kolonia Słupia Nadbrzeżna, Wesołówka 31, 32, 33, 34, 38, 39): Cenomanian-Coniacian.

Hedbergella bornholmensis DOUGLAS and RANKIN, 1969
(pl. 9: 8, 9, 10)

1969. *Hedbergella bornholmensis* DOUGLAS and RANKIN; DOUGLAS and RANKIN, 193, fig. 6.
1972. *Hedbergella bornholmensis* DOUGLAS and RANKIN; HANZLIKOVA, 100, pl. 25: 5–7.
1973. *Hedbergella bornholmensis* DOUGLAS and RANKIN; NORLING, 109–110, pl. 5: 1a–c.

Material. — 19 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/90	0·25	0·18	0·13
ZPAL FXXIII/92	0·23	0·17	0·12

Description. — Test low trochospiral; equatorial periphery lobate, axial periphery rounded; final whorl consisting of 3 1/2 to 4 chambers increasing sharply in size; ultimate chamber much bigger than penultimate, placed in opposition to each other, giving the test a trilobate shape; sutures distinct, radial to slightly curved, depressed; wall ornamented by small pustules; umbilicus narrow, deep; primary aperture extraumbilical-umbilical, with a narrow bordering lip.

Remarks. — *H. bornholmensis* is somewhat similar to *Whiteinella baltica* DOUGLAS and RANKIN but differs in having the extraumbilical-umbilical primary aperture, trilobate test and a sharper rate of chamber expansion in the final whorl.

Occurrence. — Denmark (Bornholm): Coniacian-Lower Santonian; South Sweden: Coniacian-Lower Santonian; Czechoslovakia (Moravia): Coniacian-Lower Santonian; Central Poland (Wesołówka 31, 34, 37, 40, 42, Dorotka, Ciszyca Kolonia): Turonian-Campanian.

Hedbergella brittonensis LOEBLICH and TAPPAN, 1961
(pl. 9: 5, 6, 7, pl. 10: 4)

1961. *Hedbergella brittonensis* LOEBLICH and TAPPAN; LOEBLICH and TAPPAN, 274–275, pl. 4: 1–8.
1967. *Hedbergella brittonensis* LOEBLICH and TAPPAN; PESSAGNO, 282, pl. 52: 9–12.
1969. *Hedbergella brittonensis* LOEBLICH and TAPPAN; NEAGU, 139, pl. 13: 7–13, pl. 14: 1–6, 16–18, pl. 15: 1–2.
1972. *Hedbergella brittonensis* LOEBLICH and TAPPAN; BARR, 13, pl. 1: 9.
1975. *Hedbergella brittonensis* LOEBLICH and TAPPAN; HELLER, 239, pl. 1: 19.
1975. *Hedbergella postdownensis* (WILLIAMS-MITCHELL); NORTH and CALDWELL, pl. 5: 2a–c, 3a, b.
1975. *Hedbergella brittonensis* LOEBLICH and TAPPAN; LUTERBACHER, pl. 2: 1.

Material. — 34 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/88	0·35	0·33	0·24
ZPAL FXXIII/93	0·41	0·38	0·26

Description. — Test trochospiral of not very high spiral, consisting of 2 to 2 1/2 whorls; chambers much inflated, nearly spherical; final whorl consisting of 5–6 chambers increasing regularly in size as added; sutures distinct, depressed, radial to slightly curved; wall distinctly pustulose; aperture extraumbilical, bordered by distinct flaps.

Remarks. — *H. brittonensis* differs from *H. delrioensis* (CARSEY) in being larger, higher

spired and less hispid. It differs from *H. portsdownensis* (WILLIAMS-MITCHELL) in having a less elevated spire.

Occurrence. — USA (Texas), Mexico: Coniacian; Libya: Upper Cenomanian-Lower Turonian; Canada: Cenomanian; Eastern Carpathians: Cenomanian; Poland — Łódź region: Upper Albian-Turonian, Central Poland (Jakubowice, Karsy, Opoczka, Słupia Nadbrzeżna, Kol. Słupia Nadb., Wesołówka 31–40): Turonian-Santonian.

Hedbergella cf. *caspia* (VASSILENKO, 1961)
(pl. 10: 3*a–c*)

Material. — 30 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/96	0·22	0·18	0·12

Description. — Test trochospiral, nearly flat on spiral and umbilical sides; inner whorls slightly depressed; equatorial periphery lobate; test consisting of 2–2$^1/_2$ whorls; chambers spherical; final whorl consisting of 5–6 chambers increasing rapidly in size as added, ultimate chamber being 3–4 times greater than first one of the final whorl; spiral sutures curved, depressed; umbilical sutures radial, depressed; wall covered with coarse pustulae; umbilicus small, deep; primary aperture extraumbilical with small imperforate flaps.

Remarks. — This form differs from the holotype of *H. caspia* (VASSILENKO) first of all in having a lower spiral side. *H. caspia* is slightly spiroconvex while in the form described the internal whorls are slightly concave. *H.* cf. *caspia* differs from the commonly cooccurring *H. angolae* CARON in having a slightly concave spiral side, a less incised periphery, a narrower and deeper umbilicus, and in possessing a more intensive wall ornamentation.

Occurrence. — Central Poland (Jakubowice, Karsy, Opoczka, Kolonia Słupia Nadbrzeżna, Wesołówka 31): Cenomanian-Coniacian.

Hedbergella crassa (BOLLI, 1959)
(pl. 9: 2, 3, 4)

1959. *Praeglobotruncana crassa* BOLLI; BOLLI, 265, pl. 21: 1a–2.
1962. *Praeglobotruncana crassa* BOLLI; PESSAGNO, 358, pl. 6: 5–6.
1965. *Hedbergella crassa* (BOLLI); TAKAYANAGI, 203–204, pl. 21: 2a–c.
1969. *Hedbergella crassa* (BOLLI); DOUGLAS, 165–166, pl. 5: 2.
1974. *Hedbergella crassa* (BOLLI); HERB, 752, pl. 4: 12, 13.

Material. — 18 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/84	0·17	0·13	0·07
ZPAL FXXIII/86	0·16	0·14	0·06

Description. — Test very low trochospiral; spiral side planiform, umbilical side considerably convex; chambers subglobular, flattened on spiral side; final whorl consisting of 4–5 chambers; sutures distinctly marked, radial to slightly curved on spiral side, radial on umbilical side; wall almost smooth; primary aperture interiomarginal, extraumbilical-umbilical, with narrow imperforate flaps.

Remarks. — *H. crassa* differs from the majority of species of *Hedbergella* in possessing an umbilicoconvex test; only *H. planispira* (TAPPAN) is umbilicoconvex whereas the others are usually biconvex. *H. crassa* differs from *H. planispira* in having a slightly larger test and a significantly smaller number of chambers in the final whorl.

Occurrence. — Trinidad: Turonian-Lower Santonian; Puerto Rico: Upper Santonian; USA (California): Lower Turonian-Upper Campanian; Central Poland (Chotcza, Jarentowskie Pole): Lower Maastrichtian.

Hedbergella delrioensis (CARSEY, 1926)

(pl. 10: 1*a–c*)

1926. *Globigerina cretacea* d'ORBIGNY var. *delrioensis* CARSEY; CARSEY, 43 (*fide* ELLIS and MESSINA, Catalogue Foram.).
1967. *Hedbergella delrioensis* (CARSEY); PESSAGNO, 282–283, pl. 48: 1, 2, 3–5.
1966. *Hedbergella delrioensis* (CARSEY); BUTT, 173, 174, pl. 2: 1–8.
1970. *Hedbergella delrioensis* (CARSEY); EICHER and WORSTELL, 302, pl. 9: 10, 11a–b.
1971. *Hedbergella delrioensis* (CARSEY); EL-NAGGAR, pl. 6: a–c.
1972. *Hedbergella delrioensis* (CARSEY); BARR, 13, pl. 2: 1a–c.
1973. *Hedbergella delrioensis* (CARSEY); DAILEY, 82, pl. 17: a–c.
1974. *Hedbergella delrioensis* (CARSEY); HERB, 752, pl. 3: 15–18.
1974. *Hedbergella delrioensis* (CARSEY); LONGORIA, pl. 10: 1–3.
1975. *Hedbergella delrioensis* (CARSEY); NORTH and CALDWELL, pl. 4: 16a–c, 18a–c.
1975. *Hedbergella delrioensis* (CARSEY); LUTERBACHER, pl. 1: 8.
1975. *Hedbergella delrioensis* (CARSEY); HELLER, pl. 2: 12.
1976. *Hedbergella delrioensis* (CARSEY); MASTERS, 328, pl. 2: 1–3.

Material. — 30 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/94	0·20	0·18	0·10

Description. — Test low trochospiral, almost planispiral; equatorial periphery lobate, axial periphery rounded; chambers subglobular, flattened on spiral side, convex on umbilical side; final whorl consisting of 5 chambers increasing slowly in size, as added; sutures distinctly depressed, curved on spiral side, radial to slightly curved on umbilical side; wall pustulose, especially on earlier chambers of the final whorl; umbilicus small, deep; primary aperture interiomarginal, extraumbilical-umbilical, with a relatively large apertural flap.

Remarks. — The holotype of *Globigerina cretacea* var. *delrioensis* CARSEY 1926 was lost. Recently two authors selected a neotype for this taxon: LONGORIA (1974) and MASTERS (1976), with the priority of LONGORIA (1974) being accepted by MASTERS (1977). Polish specimens correspond well with the neotype, differing only in being less pustulose and slightly smaller.

Occurrence. — USA — California: Early Cretaceous, Gulf Coast: Albian-Lower Campanian; Canada: Cenomanian-Santonian; Indian Ocean: Upper Albian; Libya: Upper Albian-Cenomanian; France: Turonian; Switzerland: Albian; Poland—Łódź region: Turonian, Central Poland (Jakubowice, Karsy, Opoczka, Słupia Nadbrzeżna, Wesołówka 32, 33, 34, 40, 42, Świeciechów, Ciszyca Kolonia): Cenomanian-Campanian.

Hedbergella planispira (TAPPAN, 1940)

(pl. 10: 5, 6)

1940. *Globigerina planispira* TAPPAN; TAPPAN, 12, pl. 19: 12.
1967. *Hedbergella planispira* (TAPPAN); PESSAGNO, 283, 284, pl. 52: 1, pl. 53: 1, 2, 3, 4 (here additional synonymy included).
1968. *Hedbergella planispira* (TAPPAN); BARR, 314, pl. 37: 4, 5.
1969. *Hedbergella planispira* (TAPPAN); DOUGLAS, 168, pl. 5: 1.
1969. *Hedbergella planispira* (TAPPAN); PORTHAULT, 530, pl. 1: 4a–c.
1970. *Hedbergella planispira* (TAPPAN); EICHER and WORSTELL, 302, 303, pl. 9: 12, 13a–c.
1971. *Hedbergella planispira* (TAPPAN); EL-NAGGAR, pl. 6: d–t.
1972. *Hedbergella planispira* (TAPPAN); GOVINDAN, 172–173, pl. 2: 17–19.

1972. *Hedbergella planispira* (TAPPAN); BARR, 14, pl. 1: 6a–c.
non 1972. *Hedbergella planispira* (TAPPAN); HANZLIKOVA, 101, pl. 26: 1, 2, pl. 25:15.
1973. *Hedbergella planispira* (TAPPAN); DAILEY, 82, 83, pl. 17: 4a–c.
1974. *Hedbergella planispira* (TAPPAN); HERB, 752, pl. 1: 1–5, pl. 2: 5–8, pl. 3: 1–8, pl. 4: 10, 11.
non 1975. *Hedbergella planispira* (TAPPAN); NORTH and CALDWELL, pl. 5: 1a–c.

Material. — 40 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/97	0·11	0·10	0·05

Description. — Test very low trochospiral, nearly planispiral; equatorial periphery lobulated, axial periphery rounded; chambers subglobular, increasing slightly in size as added, flattened on spiral side; final whorl consisting of 7–8 chambers; spiral sutures slightly depressed, slightly curved; umbilical sutures radial; wall almost smooth; primary aperture interiomarginal, extraumbilical, with a narrow, bordering flap.

Remarks. — This species is distinctly different from other species of *Hedbergella*. *H. crassa* (BOLLI) possesses a smooth planoconvex test but is larger and possesses less chambers in the final whorl (5–6 against 7–8 in *H. planispira*).

Occurrence. — Trinidad: Albian-Cenomanian; Cuba: Cenomanian; Mexico, Texas: Cenomanian-Coniacian; California: Turonian-Campanian; India: Campanian-Maastrichtian; USSR: Albian-Cenomanian; Central Poland (Jakubowice, Wesołówka 31, 33, 34, 38, 40, 42, Świeciechów, Bliskowice, Wałowice, Dorotka, Ciszyca Górna, Józefów, Łopoczno, Kaliszany, Piotrawin, Kazimierz, Bochotnica): Cenomanian-Maastrichtian, NW Poland and Łódź region: Albian-Cenomanian.

Hedbergella portsdownensis (WILLIAMS-MITCHELL, 1948)
(pl. 9: 1*a–c*)

1948. *Globigerina portsdownensis* WILLIAMS-MITCHELL; WILLIAMS-MITCHELL, 96, pl. 8: 4.
1961. *Hedbergella portsdownensis* (WILLIAMS-MITCHELL); LOEBLICH and TAPPAN, 277, pl. 5: 3.
1969. *Hedbergella portsdownensis* (WILLIAMS-MITCHELL); DOUGLAS and RANKIN, 194–196, fig. 7.
1969. *Hedbergella portsdownensis* (WILLIAMS-MITCHELL); PORTHAULT, 530, pl. 1: 5a–c.
1970. *Hedbergella portsdownensis* (WILLIAMS-MITCHELL); EICHER and WORSTELL, p. 304, pl. 10: 1a–c, 2a–b.
1973. *Hedbergella portsdownensis* (WILLIAMS-MITCHELL); DAILEY, 83, pl. 17: 5a–c.
non 1975. *Hedbergella portsdownensis* (WILLIAMS-MITCHELL); NORTH and CALDWELL, pl. 5: 2a–c, 3a, b.

Material. — 8 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/83	0·28	0·23	0·20

Description. — Test highly trochospiral, consisting of 2 $^1/_2$ to 3 whorls; equatorial periphery lobate, axial periphery rounded; final whorl consisting of 5–6 sublobular chambers successively regularly larger; sutures depressed, radial to slightly curved; umbilicus small, deep; wall pustulose; primary aperture extraumbilical, bordered by narrow flaps.

Remarks. — *H. portsdownensis* is very similar to *H. brittonensis* LOEBLICH and TAPPAN but differs mainly in having a much more elevated spire.

Occurrence. — USA (Great Plains): Upper Cenomanian-Middle Turonian; California: Early Cretaceous; France: Cenomanian; England: Cenomanian; Denmark (Bornholm): Middle Cenomanian; Central Poland (Słupia Nadbrzeżna, Wesołówka 31, 40, 42): Turonian.

Hedbergella simplicissima (MAGNÉ and SIGAL, 1953)
(p. 10: 7, 8)

1953. *Hastigerinella simplicissima* MAGNÉ and SIGAL; MAGNÉ and SIGAL, 487, pl. 14: 11a–c (*fide* ELLIS and MESSINA, Catalogue Foram.).
1959. *Globigerina cretacea* d'ORBIGNY; BOLLI, 270, pl. 22: 8, 9.
1961. *Hedbergella amabilis* LOEBLICH and TAPPAN; LOEBLICH and TAPPAN, 274, pl. 3: 1a–c — 10a–c.
part. 1961. *Clavihedbergella simplex* (MORROW); LOEBLICH and TAPPAN, pl. 3: 11a–c, *non* pl. 3: 12a–c — 14a–c.
1963. *Hedbergella amabilis* LOEBLICH and TAPPAN; RENZ, LUTERBACHER and SCHNEIDER, 1084, pl. 9: 4a–c, 6a–c.
1966. *Clavihedbergella simplicissima* (MAGNÉ and SIGAL); CARON, 71, pl. 6: 5a–c.
1966. *Clavihedbergella amabilis* (LOEBLICH and TAPPAN); SALAJ and SAMUEL, 173, pl. 10: 3a–c.
1967. *Hedbergella amabilis* LOEBLICH and TAPPAN; PESSAGNO, 281–282, pl. 52: 6–8.
1969. *Hedbergella simplicissima* (MAGNÉ and SIGAL); NEAGU, 140, pl. 13: 1–6.
1969. *Hedbergella amabilis* LOEBLICH and TAPPAN; DOUGLAS, 165, pl. 4: 8.
1970. *Hedbergella amabilis* LOEBLICH and TAPPAN; EICHER and WORSTELL, 300, 301, pl. 9: 6–7, 9a–c.
1972. *Hedbergella amabilis* LOEBLICH and TAPPAN; BARR, 13, pl. 2: 3a–c.
1972. *Clavihedbergella simplex* (MORROW); BARR, 14, 15, pl. 2: 2a–b.
1972. *Clavihedbergella simplicissima* (MAGNÉ and SIGAL); GAWOR-BIEDOWA, 72–73, pl. 7: 3a–c.
1973. *Hedbergella amabilis* LOEBLICH and TAPPAN; DAILEY, 82, pl. 16: 4a–c.
1974. *Hedbergella simplicissima* (MAGNÉ and SIGAL); HERB, 752, 753, pl. 3: 9–13, pl. 4: 6–9.
1974. *Hedbergella amabilis* LOEBLICH and TAPPAN; KRASHENINNIKOV, 665, pl. 2: 1–3.
1975. *Hedbergella amabilis* (LOEBLICH and TAPPAN); NORTH and CALDWELL, pl. 4: 15a–c.

Material. — 9 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/99	0·36	0·25	0·16

Description. — Test low trochospiral, biconvex, strongly lobulate, consisting of 2 $^1/_2$–3 whorls; chambers subglobular, insignificantly elongated radially; final whorl consisting of 5–6 chambers increasing moderately in size as added; sutures depressed, radial; wall prominently pustulose; umbilicus broad, shallow; primary aperture extraumbilical, bordered by distinct flaps.

Remarks. — Polish specimens are contained within the variability of *Hedbergella simplicissima* as defined by MAGNÉ and SIGAL (1953). I agree with CARON (1966) and HERB (1974) that *Hedbergella amabilis* LOEBLICH and TAPPAN is a junior synonym of *Hedbergella simplicissima* and that the illustrations of that species given by LOEBLICH and TAPPAN (1961) (pl. 3: 2–10) illustrate well the individual variability in *H. simplicissima.*

Occurrence. — USA: Cenomanian-Turonian; Trinidad: Cenomanian; Canada: Cenomanian-Santonian; eastern Indian Ocean: Albian-Coniacian; Libya: Upper Cenomanian-Lower Coniacian; France: Lower Cenomanian; Switzerland: Cenomanian; Western and Eastern Carpathians: Cenomanian; NW Poland: Upper Albian-Lower Turonian, Central Poland (Jakubowice, Piotrowice, Karsy): Cenomanian-Lower Turonian.

Hedbergella sp.
(pl. 12: 5*a–c*)

Material. — 4 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/113	0·42	0·31	0·22

Description. — Test trochospiral, strongly spiroconvex; peripheral margin subcircular, strongly lobate; chambers globular to subglobular, 4 terminal chambers strongly radially elongated; test consisting of 3 whorls; final whorl consisting of 6 chambers increasing moderately

in size as added except for 3 terminal chambers that are of almost the same size; sutures radial, strongly depressed; wall covered by irregularly distributed pustules; umbilicus small, deep; primary aperture slit-like, extraumbilical, with well developed imperforate flaps extending into umbilicus.

Remarks. — *Hedbergella* sp. differs from *Hedbergella simplicissima* (MAGNÉ and SIGAL) = *Hedbergella amabilis* LOEBLICH and TAPPAN first of all in possessing a higher spiral side. *Hedbergella* sp. is strongly convex on the spiral side while *H. simplicissima* is low trochospiral, almost planispiral. *Hedbergella* sp. differs also from *H. simplicissima* in having 3 terminal chambers almost equal in size while subglobular chambers of *H. simplicissima* are successively larger. *Hedbergella* sp. differs from *H. simplex* (MORROW) in possessing a higher spiral side, a greater number of chambers in the final whorl and in having chambers not so strongly radially elongated.

Occurrence. — Central Poland (Karsy): Lower Turonian.

Genus *Praeglobotruncana* BERMÚDEZ, 1952
Praeglobotruncana delrioensis (PLUMMER) 1931
(pl. 13: 4, 5, 6)

1931. *Globorotalia delrioensis* PLUMMER; PLUMMER, 199, pl. 13: 2 (*fide* ELLIS and MESSINA, Catalogue Foram.).
1946. *Globorotalia marginaculeata* LOEBLICH and TAPPAN; LOEBLICH and TAPPAN, 257, pl. 37: 19–21, fig. 4a.
1957. *Praeglobotruncana delrioensis* (PLUMMER); BOLLI, LOEBLICH and TAPPAN, 39, pl. 9: 1.
1961. *Praeglobotruncana delrioensis* (PLUMMER); LOEBLICH and TAPPAN, 280–284, pl. 6: 9–12.
1967. *Praeglobotruncana delrioensis* (PLUMMER); PESSAGNO, pl. 52: 3–5, pl. 100: 7.
1969. *Praeglobotruncana delrioensis* (PLUMMER); NEAGU, 141, pl. 16: 4–6, pl. 18: 1–3, 7–8, pl. 21: 3–8, pl. 22: 1–3.
1972. *Praeglobotruncana delrioensis* (PLUMMER); BARR, 15, pl. 2: 7a–c.
1973. *Praeglobotruncana delrioensis* (PLUMMER); DAILEY, 83, pl. 18: 1a–c.
1974. *Praeglobotruncana delrioensis* (PLUMMER); HERB, 753, pl. 3: 14, fig. 5, 6.
1977. *Praeglobotruncana delrioensis* (PLUMMER); SLITER, 542, pl. 8: 1–3, 6.

Material. — 17 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/117	0·29	0·22	0·15

Description. — Test trochospiral, biconvex, consisting of 2 $^1/_2$ to 3 whorls; periphery lobate, bordered by a single keel; nodose in early whorls, dying out in later chambers; chambers subglobular on spiral side, sectorial on umbilical side; final whorl consisting of 6–7 chambers increasing regularly in size as added; spiral sutures curved, depressed; umbilical sutures radial, depressed; wall spinose to nodose, most prominently in peripheral region; umbilicus small shallow; primary aperture extraumbilical-umbilical, bordered by broad spatulate flaps.

Remarks. — *P. delrioensis* occurs in the profile studied together with *P. stephani* (GANDOLFI); the species can be easily separated as *P. delrioensis* is almost flat on the spiral side and is more strongly ornamented, especially on the periphery of the test.

Occurrence. — Southern Atlantic Ocean: Albian-Cenomanian; USA: Upper Albian-Cenomanian; southern Indian Ocean: Upper Albian; Eastern Carpathians: Cenomanian; Libya: Lower Cenomanian; Central Poland (Jakubowice, Piotrowice, Karsy): Cenomanian-Lower Turonian.

Preaglobotruncana hilalensis BARR, 1972
(pl. 12: 3*a–c*)

1972. *Praeglobotruncana hilalensis* BARR; BARR, p. 15, pl. 2: 4a–c.

Material. — One specimen.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/111	0·35	0·31	0·20

Description. — Test trochospiral, spiroconvex, consisting of 3 whorls; equatorial periphery circular, weakly lobulate, truncated by a weakly developed single keel; chambers petaloid on spiral side, subtrapezoidal on umibilical side; final whorl consisting of 6 chambers; spiral sutures raised, curved; umbilical sutures radial, depressed; umbilicus small, shallow; primary aperture extraumbilical-umbilical, bordered by imperforate flaps.

Remarks. — *P. hilalensis* differs from *P. stephani* (GANDOLFI) in having a higher spiral side and a more distinct keel, in increasing more regularly in the size of chambers and in having a distinctly more perforated test. It differs from *P. delrioensis* (PLUMMER) in having a higher spiral side, a weaker ornamentation, and in being larger.

Occurrence. — Libya: Coniacian; Central Poland (Piotrowice): Lower Turonian.

Praeglobotruncana stephani (GANDOLFI, 1942)

(pl. 13: 7, 8, 9)

1942. *Globotruncana stephani* GANDOLFI; GANDOLFI, 130–133, pl. 3: 4, 5, pl. 4: 36, 37, 41–45, pl. 6: 4, 6, pl. 9: 5, 8, pl. 14: 2.
1953. *Rotundina stephani* (GANDOLFI); SUBBOTINA, 165, pl. 2: 5–7, pl. 3: 1–2.
1954. *Globotruncana stephani* GANDOLFI var. *turbinata* REICHEL; HAGN and ZEIL, 34, pl. 2: 2, pl. 5: 3, 4.
1957. *Praeglobotruncana stephani* (GANDOLFI); BOLLI, LOEBLICH and TAPPAN, 39, pl. 9: 2.
1958. *Globotruncana stephani* var. *stephani* GANDOLFI; WITWICKA, 209, 210, pl. 14: 26a–c.
1961. *Praeglobotruncana stephani* (GANDOLFI); LOEBLICH and TAPPAN, 284, 286, 288, 290, pl. 6: 1–8.
1963. *Rotundina stephani* (GANDOLFI); SALAJ and SAMUEL, 103, 104, pl. 6: 2a–c, 3a–c.
1963. *Praeglobotruncana stephani* (GANDOLFI); RENZ, LUTERBACHER and SCHNEIDER, 1086, pl. 9: 1a–c.
1964. *Praeglobotruncana stephani* (GANDOLFI); LOEBLICH and TAPPAN, C659, fig. 527: 3a–c.
1965. *Praeglobotruncana stephani* (GANDOLFI); TAKAYANAGI, 207, pl. 22: 3.
1966. *Praeglobotruncana stephani* (GANDOLFI); DOUGLAS and SLITER, 107, pl. 5: 1.
1966. *Praeglobotruncana stephani stephani* (GANDOLFI); CARON, 73, pl. 2: 3a–c.
1967. *Praeglobotruncana stephani* (GANDOLFI); PESSAGNO, 287, pl. 50: 9–11.
1969. *Praeglobotruncana stephani* (GANDOLFI); MOORKENS, 446, pl. 1: 5.
1969. *Praeglobotruncana stephani* (GANDOLFI); DOUGLAS, 173, pl. 2: 1a–c.
1969. *Praeglobotruncana stephani stephani* (GANDOLFI); NEAGU, 140, pl. 16: 1–3, 7–12, pl. 18: 4–6, 9–10, pl. 21: 9–10, pl. 23: 3.
1969. *Praeglobotruncana stephani* (GANDOLFI); CARON and LUTERBACHER, 26, pl. 8: 7.
1970. *Praeglobotruncana stephani* (GANDOLFI); EICHER and WORSTELL, 308, pl. 10: 9, pl. 11: 2a–c, 3.
1971. *Praeglobotruncana stephani stephani* (GANDOLFI); BELFORD and SCHEIBNEROVA, 331, 332, pl. 1: 1–7.
1972. *Praeglobotruncana stephani* (GANDOLFI); BARR, 15, 16, pl. 2: 6a–c.
1972. *Praeglobotruncana stephani* (GANDOLFI); GAWOR-BIEDOWA, 76, 77, pl. 8: 1a–c.
1973. *Praeglobotruncana stephani* (GANDOLFI); DAILEY, 84, pl. 18: 2a–c.

Material. — 18 specimens.

Dimensions (in mm):

	L	W	T
ZPAL FXXIII/120	0·54	0·45	0·30
ZPAL FXXIII/122	0·51	0·43	0·28

Description. — Test trochospiral, spiroconvex, consisting of 3 whorls; chambers subrounded on spiral side, sectorial on umbilical side; final whorl consisting of 5–7 chambers increasing regularly in size as added; spiral sutures curved, depressed; umbilical sutures radial, depressed; wall finely nodose, most prominently on spiral side; beaded peripheral keel bordering early whorls, less distinct in terminal 2 or 3 chambers; umbilicus shallow, narrow; primary aperture umbilical-extraumbilical, bordered by narrow flaps.

Remarks. — I agree with LOEBLICH and TAPPAN (1961) that this species possesses great variability, expressed mainly in the height of spiral side. Specimens from the Vistula River

profile are contained within the variability described and illustrated by LOEBLICH and TAPPAN (1961).

Occurrence. — USA (California, Gulf Coast Plain): Upper Cenomanian-Lower Turonian; Australia: Turonian; Libya: Upper Cenomanian-Lower Turonian; USSR: Cenomanian; France: Upper Cenomanian-Turonian; Switzerland: Upper Cenomanian-Lower Turonian; Western Carpathians: Upper Albian-Lower Cenomanian; Eastern Carpathians: Cenomanian; NW and Central Poland: Upper Cenomanian-Turonian (area studied: Jakubowice, Karsy, Opoczka-Upper Cenomanian-Lower Turonian), E Poland (Chełm): Upper Cenomanian, Carpathians (Bachowice): Uppermost Cenomanian-Lower Turonian, Sudetes: Upper Cenomanian-Lower Turonian.

Family **Rotaliporidae** SIGAL, 1958
Genus *Rotalipora* BROTZEN, 1942
Rotalipora cushmani (MORROW, 1934)
(pl. 11: 1*a–c* — 4*a–c*)

1934. *Globorotalia cushmani* MORROW; MORROW, 199, pl. 31: 2, 4 (*fide* ELLIS and MESSINA, Catalogue Foram.).
part. 1942. *Rotalipora turonica* BROTZEN; BROTZEN, 32, fig. 10, non fig. 11: 4.
1944. *Globorotalia alpina* BOLLI; BOLLI, 224, 255, pl. 9: 3, 4.
1946. *Globorotalia cushmani* MORROW; CUSHMAN, pl. 62: 9a–c.
1956. *Rotalipora cushmani* (MORROW); BRONNIMANN and BROWN, 537, pl. 20: 10–12.
1957. *Rotalipora turonica* (BROTZEN); BOLLI, LOEBLICH and TAPPAN, 41, pl. 9: 6a–c.
1957. *Globorotalia (Rotalipora)* cf. *Globorotalia (Rotalipora) turonica* BROTZEN; EDGELL, 109, pl. 1: 16–18.
part. 1961. *Rotalipora cushmani* (MORROW); LOEBLICH and TAPPAN, 297, 298, pl. 8: 2–8, 10, non pl. 8: 1, 9.
1964. *Rotalipora cushmani* (MORROW); LOEBLICH and TAPPAN, 659–661, fig. 528: 1a–c, 2a–c.
1967. *Rotalipora cushmani* (MORROW); PESSAGNO, 292–293, pl. 51: 6–9, pl. 101: 5–7.
1969. *Rotalipora cushmani cushmani* (MORROW); NEAGU, 145, 146, pl. 25: 7–9, pl. 26: 1–9.
1969. *Rotalipora cushmani* (MORROW); MOORKENS, 444–445, pl. 1: 1, 2.
1969. *Rotalipora cushmani* (MORROW); DOUGLAS, 173, 174, pl. 1: 1–2.
1969. *Rotalipora cushmani* (MORROW); PORTHAULT, 534, 535, pl. 1: 11a–c.
1970. *Rotalipora cushmani* (MORROW); EICHER and WORSTELL, 310, pl. 12: 3a–c, 4a–b, pl. 13: 1a–b.
1972. *Rotalipora cushmani* (MORROW); BARR, 16, pl. 3: 1–2.
1972. *Rotalipora cushmani cushmani* (MORROW); GAWOR-BIEDOWA, 79–80, pl. 10: 1, 2.
1972. *Rotalipora cushmani thomei* HAGN and ZEIL; GAWOR-BIEDOWA, 81–82, pl. 10: 3–4.
1973. *Rotalipora cushmani* (MORROW); DAILEY, 84, pl. 18: 3a–c.
1973. *Rotalipora cushmani* (MORROW); LONGORIA, 457–458, pl. 23: 1a–d, pl. 24: 1, 3a.
1976. *Rotalipora cushmani* (MORROW); ROBASZYŃSKI and LIVIN, pl. 1: 1, 2, 3.

Material. — 5 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/101	0·35	0·25	0·20
ZPAL FXXIII/103	0·48	0·39	0·21

Description. — Test low trochospiral, biconvex, with well developed single keel; chambers petaloid, inflated, marginally flattened toward the peripheral keel on spiral side; chambers inflated, sectorial on umbilical side; inflation is most prominent in a radial line extending from the umbilicus across the midportion of the chamber about half the distance to the periphery; final whorl consisting of 5–6 chambers increasing gradually in size as added; spiral sutures curved, somewhat raised; umbilical sutures radial, depressed; umbilicus wide, shallow; with perforate lingula; edge of lingula with one to two supplementary apertures, often located on suture; primary aperture extraumbilical-umbilical.

Remarks. — The genus *Rotalipora* was created by BROTZEN (1942), with *Rotalipora turonica* BROTZEN as the type species. BROTZEN illustrated two specimens, not indicating which of them is the holotype. The problem that *R. turonica*, is a junior synonym of *R. cushmani*

(MORROW), was discussed for many years. LOEBLICH and TAPPAN (1961) and PESSAGNO (1967) admitted that *R. turonica* is a junior synonym of *R. cushmani* while LONGORIA (1973) included the specimen illustrated by BROTZEN (*l. c.*) in fig. 10 in the synonymy of *R. cushmani* and designated the specimen presented in fig. 11–4 as a lectotype for *R. turonica*. I agree with LOEBLICH and TAPPAN (1961) and PESSAGNO (1967) that there is a wide range of the spiral convexity of *Rotalipora cushmani* (MORROW) but I agree with LONGORIA (1973) that *R. cushmani* and *R. turonica* are two separate species. I agree also with PESSAGNO (1967) that *Globotruncana alpina* BOLLI, known only from transverse sections, should be regarded as a junior synonym of *R. cushmani*.

Occurrence. — USA, Mexico: Upper Cenomanian; Libya: Upper Cenomanian; France: Middle Cenomanian-Lower Turonian; Eastern Carpathians, Switzerland: Cenomanian; NW Poland, Łódź region: Cenomanian, Central Poland (Jakubowice): Upper Cenomanian, Sudetes: Middle Cenomanian.

Family **Marginotruncanidae** PESSAGNO, 1967

Marginotruncana caronae sp. n.

(pl. 15: 1*a–c*)

Holotype: ZPAL FXXIII/132; pl. 15, fig. 1*a*.

Type horizon: Upper Turonian.

Type locality: Słupia Nadbrzeżna.

Derivation of the name: dedicated to Dr. MICHÈLE CARON, a Suiss micropaleontologist.

Diagnosis: Test low trochospiral, planoconvex with stronger convex umbilical than spiral side, bordered by raised, beaded double keel. Chambers petaloid on spiral side, subrectangular on umbilical side. Wall spinose except terminal one or two chambers. Primary aperture extraumbilical-umbilical.

Material. — 17 specimens.

Dimensions (in mm):

	L	W	T
ZPAL FXXIII/132	0·46	0·36	0·19

Description. — Test low trochospiral, planoconvex, nearly flat on spiral side, convex on umbilical side, lobulate; chambers arranged in 2 $^1/_2$–3 whorls; chambers petaloid, slightly inflated on spiral side, subrectangular, convex most strongly around umbilicus, on umbilical side; final whorl consisting of 4$^1/_2$–5 chambers increasing regularly in size as added, truncated by raised, beaded double keel; wall covered by pustulae except one or two terminal chambers that are smooth; sutures raised, curved; umbilicus broad, bordered by mildly elevated umbilical shoulder; primary aperture extraumbilical-umbilical; portici broken in material examined.

Remarks. — *M. caronae* sp. n. is easily distinguishable from other cooccurring species of *Marginotruncana*. It differs from *M. pseudolinneiana* PESSAGNO in being planoconvex rather than planiform and in having fewer chambers in the final whorl; from *M. marginata* (REUSS) in being planoconvex rather than biconvex, in possessing less chambers in the final whorl (4½ to 5 against 6–8) and in having planoconvex chambers in cross-section rather than subglobular or globular as in *M. marginata*.

Occurrence. — Central Poland (Opoczka, Kolonia Słupia Nadbrzeżna, Wesołówka 31, 32, 33, 34, 39): Upper Turonian-Lower Santonian.

Marginotruncana coronata (BOLLI, 1944)

(pl. 16: 1*a–c*, 2*a–c*)

part. 1944. *Globotruncana lapparenti coronata* BOLLI; BOLLI, 233, fig. 1: 21, 22, pl. 9: 15, *non* pl. 9: 14.

1954. *Globotruncana lapparenti coronata* BOLLI; KSIĄŻKIEWICZ, 273, 274, pl. 31: 17, 18; text-fig. 43–44.

1966. *Globotruncana lapparenti coronata* BOLLI; CARON, 80, pl. 4: 1a–c.

1967. *Marginotruncana coronata* (BOLLI); PESSAGNO, 305, 306, pl. 65: 11–13, pl. 100: 6 (here additional synonymy).

1969. *Globotruncana coronata* BOLLI; MOORKENS, 449–450, pl. 2: 5.
part. 1969. *Globotruncana coronata* BOLLI; DOUGLAS, 177, 178, pl. 3: 6–8, *non* pl. 3: 5.
1969. *Marginotruncana coronata* (BOLLI); ESKER III, 214, pl. 1: 9–11.
1970. *Marginotruncana coronata* (BOLLI); PORTHAULT, 53, pl. 11: 1–3.
1972. *Globotruncana coronata* BOLLI; HANZLIKOVA, 104, pl. 28: 1.
1972. *Globotruncana coronata* BOLLI; BARR, 10–20, pl. 9: 1a–c, pl. 10: 1a–c.
1973. *Globotruncana coronata* BOLLI; OWEN, 58, pl. 15: 10–12.
1976. *Globotruncana coronata* BOLLI; ROBASZYŃSKI and LIVIN, pl. 1: 10, 11, 12.
1976. *Globotruncana coronata* BOLLI; VAPTZAROVA, 53, 54, pl. 1: 4, 5, 6.
part. 1976. *Globotruncana coronata* BOLLI; IBRAHIM, 98, pl. 2: 1–3, 5–7, 8a–c, 9–11, *non* pl. 98: 4a, b, c.

Material. — 27 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/105	0·68	0·57	0·28

Description. — Test large, trochospiral, biconvex; equatorial periphery lobate, axial periphery rounded; test bordered by well developed double keel, consisting of 2½ to 3 whorls; chambers petaloid on spiral side, subrectangular on umbilical side; final whorl consisting of 6–8 chambers increasing gradually in size as added; sutures curved, raised, beaded on spiral side, insignificantly sigmoid on umbilical side; umbilicus shallow, broad, bordered by weakly developed, only slightly raised umbilical shoulder; primary aperture extraumbilical-umbilical, covered by portici with infralaminal accessory apertures.

Remarks. — BOLLI (1944) described *Globotruncana lapparenti coronata* from thin sections. He presented 4 illustrations but did not designate the holotype so as to avoid mistakes in identification of *M. coronata* and *M. angusticarinata* (GANDOLFI). PESSAGNO (1967) designated the lectotype of *Globotruncana lapparenti coronata* (specimen figured in pl. 9: 15), designating other specimens (figured in fig. 1: 21, 22) as paralectotypes. The original diagnosis of *G. coronata* stressed its large size, compressed biconvex form and a tendency for the closely spaced keels to merge on the ultimate chamber of the final whorl (BOLLI, 1944). All these features are present in Polish specimens.

Occurrence. — USA, Mexico, Jamaica: Upper Turonian-Lower Santonian; Papua New Guinea: Upper Santonian; Libya: Upper Turonian-Santonian; USSR: Santonian; Bulgaria: Upper Turonian-Lower Santonian; Austria (Tirol): Upper Santonian; France: Upper Turonian-Lower Santonian; Switzerland: Upper Turonian-Santonian; Central Poland (Opoczka, Słupia Nadbrzeżna, Kol. Słupia Nadbrzeżna, Wesołówka 31–42) and Sudetes: Upper Turonian-Santonian, eastern Poland: Upper Turonian-Lower Santonian; Carpathians (Bachowice): Turonian.

Marginotruncana longilocula (GANDOLFI, 1955)
(pl. 14: 1*a–c*)

1955. *Globotruncana longilocula* GANDOLFI; GANDOLFI, 17–19, pl. 1: 1a–c. pl. 3, pl. 4: 4a–c.

Material. — 21 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/127	0·56	0·41	0·20

Description. — Test trochospiral, planiform or very weakly convex on both sides, lobulate, truncated peripherally by well developed double keel; chambers on spiral side initially petaloid, slightly overlapping; terminal whorl consisting of 6–7 chambers, narrow, elongated, semilunar, strongly overlapping on spiral side, subrectangular on umbilical side; spiral sutures curved, raised, beaded; umbilical sutures sigmoidal; umbilicus small, shallow; primary aperture umbilical-extraumbilical; portici broken in material examined.

Remarks. — The species described differs from *M. pseudolinneiana* PESSAGNO in having fewer chambers in the final whorl (5–6 against 7–8), in having chambers of a different shape (although semilunar on the spiral side, they are narrower and more elongated) and in having a test that is ovate rather than round. It differs from *M. canaliculata* (REUSS) in having subrectangular chambers on the umbilical side (compared with sectorial ones in *M. canaliculata*). PESSAGNO (1967) included *Marginotruncana longilocula* (GANDOLFI) in the synonymy of *Globotruncana lapparenti* (BROTZEN). However, it differs clearly from the latter species in possessing sutures more finely raised and in having arched, more elongated and semilunar rather than petaloid chambers.

Occurrence. — Columbia: Coniacian; Switzerland: Coniacian-Lower Santonian; Central Poland (Wesołówka 38, 39, 42, 43, 44): Santonian.

Marginotruncana marginata (REUSS, 1845)

(pl. 17: 2*a–c*, 3*a–c*)

1845. *Rosalina marginata* REUSS; REUSS, 36, pl. 8: 54a, b, 74a, b, pl. 13: 68a, b.
1956. *Globotruncana marginata* (REUSS); JIROVA, 239–255, pl. 1: 1a–c (here additional synonymy).
part. 1962. *Globotruncana marginata* (REUSS); BARR, 574, 575.
non 1965. *Globotruncana marginata* (REUSS); TAKAYANAGI, 218, pl. 26: 3, 4.
non 1965. *Globotruncana marginata* (REUSS); van HINTE, 23, pl. 1: 2.
non 1967. *Marginotruncana marginata* (REUSS); PESSAGNO, 307–310, pl. 54: 7–12, 16–18, pl. 56: 10, pl. 99: 5–7.
non 1968. *Globotruncana marginata* (REUSS); SLITER, 104, pl. 17: 5, 6.
1969. *Globotruncana marginata* (REUSS); DOUGLAS and RANKIN, 203–207, fig. 14a–e, 15a–f.
non 1969. *Globotruncana marginata* (REUSS); DOUGLAS, 182–183, pl. 8: 4–5.
1970. *Marginotruncana marginata* (REUSS); PORTHAULT, 74, pl. 20: 18–20.
1972. *Globotruncana marginata* (REUSS); HANZLIKOVA, 108, pl. 30: 3, 4.
1972. *Globotruncana marginata* (REUSS); BARR, 22, pl. 4: 8a–c.
non 1972. *Globotruncana marginata* (REUSS); GOVINDAN, 179, 180, pl. 4: 10–1.
1973. *Globotruncana marginata* (REUSS); NORLING, 111, pl. 8: 1a–c.
1975. *Globotruncana lapparenti bulloides* VOGLER; HELLER, pl. 3: 11.
1976. *Globotruncana marginata* (REUSS); VAPTZAROVA, 54, 55, pl. 1: 14, 16.
1976. *Globotruncana marginata* (REUSS); IBRAHIM, 123, pl. 4: 11–12a, b.

Material. — 70 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/149	0·50	0·40	0·15

Description. — Test low trochospiral, biconvex, lobulate; periphery truncated by weakly developed double keel; test consisting of 2 1/2–3 whorls; chambers subglobular, petaloid on spiral side, subrectangular on umbilical side; final whorl consisting of 6–8 chambers increasing moderately in size as added; spiral sutures curved, raised; umbilical sutures radial, slightly sigmoid; wall finely hispid; umbilicus broad, bordered by a slightly elevated umbilical shoulder; primary aperture extraumbilical-umbilical; portici broken in material examined.

Remarks. — JÍROVA (1956), after stating that the type specimen of *R. marginata* has been lost, designated a neotype from specimens collected at the type locality of Lužice in Czechoslovakia. Polish specimens correspond well with the neotype and topotypes. *M. marginata* was often mistaken for *Globotruncana bulloides* VOGLER although it differs from the latter mainly in possessing an extraumbilical-umbilical primary aperture and portici instead of tegilla and in having a symmetrically arranged keel.

Occurrence. — USA, Mexico: Turonian-Lower Santonian; Libya: Turonian-Santonian; Bulgaria: Upper Turonian; Austria (Tirol): Upper Santonian; France: Coniacian; England: Coniacian-Santonian; Czechoslovakia: Upper Turonian-Coniacian; Sweden: Turonian-

Santonian; Poland — Łódź region: Upper Turonian-Santonian, Central Poland (Opoczka, Kolonia Słupia Nadbrzeżna, Słupia Nadbrzeżna, Wesołówka 31, 32, 33, 34, 38, 39, 40, 41, 43): Turonian-Santonian.

Marginotruncana paraconcavata PORTHAULT, 1970
(pl. 14: 3*a–c*)

1970. *Marginotruncana paraconcavata* PORTHAULT; PORTHAULT, 77–78, pl. 10: 21–23.

Material. — 20 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/130	0·50	0·42	0·20
ZPAL FXXIII/219	0·46	0·40	0·19

Description. — Test trochospiral, planoconvex to biconvex, strongly umbilicoconvex, lobulate, consisting of 3 whorls, truncated by closely spaced double keel; chambers petaloid, very slightly elongated in coiling direction on spiral side, subtrapezoidal on umbilical side; final whorl consisting of 5–7 chambers increasing regularly in size as added; spiral sutures curved, raised, slightly beaded; umbilical sutures slightly curved, raised, beaded; umbilicus broad, bordered by mildly elevated umbilical shoulder; primary aperture extraumbilical-umbilical; portici with infralaminal accessory apertures.

Remarks. — Polish specimens are generally in conformity with the holotype differing from it in having a higher spiral side, in possessing a greater number of chambers in the final whorl and in having chambers of a more petaloid shape.

Occurrence. — SE France: Upper Coniacian-Lower Santonian; Central Poland (Słupia Nadbrzeżna, Wesołówka 32, 34, 39, 40, 41, 44): Upper Turonian-Lowermost Campanian.

Marginotruncana pseudolinneiana PESSAGNO, 1967
(pl. 14: 2*a–c*)

part. 1966. *Globotruncana linneiana* (d'ORBIGNY); DOUGLAS and SLITER, 112, pl. 4: 4, 6, 9, non pl. 5: 6, 7, 8.
1967. *Marginotruncana pseudolinneiana* PESSAGNO; PESSAGNO, 310, pl. 65: 24–27, pl. 76: 1–3.
part. 1969. *Globotruncana pseudolinneiana* (PESSAGNO); DOUGLAS, 184, pl. 3: 2–3, *non* pl. 3: 4, fig. 6.
1969. *Globotruncana pseudolinneiana* (PESSAGNO); DOUGLAS and RANKIN, 207, 208, fig. 16, 17.
1970. *Marginotruncana pseudolinneiana* PESSAGNO; PORTHAULT, 54, pl. 11: 9–10.
1971. *Globotruncana pseudolinneiana* (PESSAGNO); BELFORD and SCHEIBNEROVA, pl. 2: 13–16.
1972. *Globotruncana pseudolinneiana* (PESSAGNO); HANZLIKOVA, 109, pl. 29.
1973. *Globotruncana pseudolinneiana* (PESSAGNO); OWEN, 59, pl. 17: 4–6.
1975. *Globotruncana lapparenti lapparenti* BROTZEN; HELLER, pl. 3: 13.
1977. *Marginotruncana pseudolinneiana* PESSAGNO; LAMOLDA, 400–401, pl. 2: 5.

Material. — 28 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/128	0·44	0·33	0·13
ZPAL FXXIII/163	0·51	0·34	0·14

Description. — Test trochospiral, slightly oval, with nearly parallel spiral and umbilical sides; periphery lobate, truncated by a wide double keel; test consisting of 2½–3 whorls; chambers crescent-shaped on spiral side, subrectangular on umbilical side; final whorl consisting of 6 to 8 chambers; sutures raised, curved; umbilicus broad, bordered by mildly elevated umbilical shoulder; primary aperture extraumbilical-umbilical in position; portici with infralaminal accessory apertures.

Variability. — Small individual variability marked in number of chambers in final whorl and in test convexity.

Remarks. — The Polish specimens correspond almost entirely with PESSAGNO's description of the holotype. Specimens illustrated by DOUGLAS and SLITER (1966, pl. 4: 4, 6, 9) as *Globotruncana linneiana* (d'ORBIGNY) possess crescent-shape rather than petaloid chambers on the spiral side and have a narrower intrakeel area as well as a more oval test than is observed in *G. linneiana*. These features show that the specimens of DOUGLAS and SLITER should be referred to *Marginotruncana pseudolinneiana* PESSAGNO.

Occurrence. — USA (Texas, California), Mexico: Upper Turonian-Lower Santonian; Australia: Turonian; Papua New Guinea: Upper Santonian; France: Upper Turonian-Santonian; Czechoslovakia (Moravia): Upper Turonian-Lower Santonian; Denmark (Bornholm): Coniacian-Lower Santonian; Central Poland (Opoczka, Kolonia Słupia Nadbrzeżna, Słupia Nadbrzeżna, Wesołówka 31, 34, 37, 38, 39, 41) and Łódź region: Upper Turonian-Santonian.

Marginotruncana cf. *renzi* (GANDOLFI, 1942)
(pl. 14: 6*a–c*)

Material. — 13 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/225	0·70	0·60	0·38

Description. — Test trochospiral, biconvex, with strongly convex spiral side; periphery slightly lobular, truncated by closely spaced double keel; test consisting of 3 whorls; chambers petaloid on spiral side, subrectangular on umbilical side; final whorl consisting of 6 chambers; spiral sutures curved, raised; umbilical sutures sigmoid; umbilicus broad, shallow, bordered by mildly elevated umbilical shoulder; primary aperture extraumbilical-umbilical; portici broken in material examined.

Remarks. — The highly complex taxonomical history of *Marginotruncana renzi* (GANDOLFI) was discussed in detail by CARON (1966) and PESSAGNO (1967). The existing confusion in the interpretation of this species results from the fact that GANDOLFI (1942) illustrated it with two specimens markedly differing from one another and did not designate a holotype. One specimen is planoconvex, double-keeled and its last whorl consists of five chambers of which the last was missing. The other specimen also consists of five chambers, the last whorl differing from that of the formed specimen in being biconvex. PESSAGNO (1967) designed the planoconvex specimen from fig. 45 in GANDOLFI (1942: 124) as the lectotype of the species *Marginotruncana renzi* (GANDOLFI), stating that the other form is very similar to *Marginotruncana angusticarinata* (GANDOLFI) except for a smaller number of chambers in the last whorl. In turn, CARON (1966), after inspection of the specimens, selected the biconvex one from GANDOLFI's fig. 1 on pl. 3 as the lectotype, stating that the planoconvex form is too poorly preserved (the last chamber is incomplete and the umbilicus obscure) for it to be designated as the lectotype. Several authors consider this species as characterized by a biconvex test. The second specimen is well-preserved and, most importantly it should be noted that the cell containing it is labelled in GANDOLFI's handwriting with the word "holotype". It would follow that GANDOLFI designated the holotype without making a proper statement in the text.

The specimens from the Vistula River gorge, assigned to *Marginotruncana* cf. *renzi* (GANDOLFI), differ from the lectotype designated by CARON (1966) in having a somewhat more ovate test, a higher dorsal side and more prominently developed keels on the last whorl.

Occurrence. — Central Poland (Wesołówka 31, 33): Upper Turonian-Coniacian.

Marginotruncana sinuosa PORTHAULT, 1970
(pl. 15: 3)

? 1966. *Globotruncana fornicata* (PLUMMER); CARON, 80, pl. 4: 6a–c.
1970. *Marginotruncana sinuosa* PORTHAULT; PORTHAULT, 81–82, pl. 11: 11–13.
1970. *Globotruncana renzi* GANDOLFI; KUHRY, pl. 2: 13–15.
part. 1976. *Globotruncana coronata* BOLLI; IBRAHIM, 99, pl. 2: 4a, b, c, *non* pl. 2: 1–3, 5–7, 8a–c, 9–11.

Material. — 70 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/136	0·47	0·46	0·25

Description. — Test trochospiral, biconvex, with strongly convex spiral side, lobulate, truncated by well developed double keel; carinal band of sigmoid shape in apertural view; test consisting of 3 whorls; chambers semilunar, crenulate, overlapping on spiral side, subrectangular on umbilical side; final whorl consisting of 5½ to 6 chambers increasing moderately in size as added; spiral sutures curved, raised; umbilical sutures sigmoid; umbilicus broad, shallow, bordered by slightly elevated umbilical shoulder; primary aperture extraumbilical-umbilical; portici broken in material examined.

Variability. — Individual variability mainly in degree of convexity of spiral side, ranging from almost flat to slightly convex.

Remarks. — *M. sinuosa* differs from *Globotruncana fornicata* (PLUMMER) in having a less marked crenulation of the chambers, more widely spaced double keel, a different position of the primary aperture and in the structure of the apertural apparatus. The specimen illustrated by CARON (1966) as *Globotruncana fornicata* (PLUMMER) possesses tegilla with distinct infralaminar accessory apertures but intralaminar accessory apertures are lacking. Therefore it belongs to *Marginotruncana*. PORTHAULT (1970) suggested that *M. sinuosa* is an ancestor of *Globotruncana fornicata* (PLUMMER). He believed that *M. sinuosa* disappeared at the end of the Lower Santonian and was replaced in the Upper Santonian by *Globotruncana fornicata*. It seems probable that the specimens described as *Globotruncana fornicata* (PLUMMER) from pre-Upper Santonian deposits most probably belong to *M. sinuosa*. The specimen illustrated by KUHRY (1970, pl. 2: 13–15) as *Globotruncana* renzi possesses 4 semilunar, undulated chambers in the final whorl, a slightly biconvex test and sinusoidal shape of the carinal band; these features enable us to refer it to *M. sinuosa*. IBRAHIM (1976) in one of his illustrations (pl. 2: 4*a–b*) presents a form determined as *Globotruncana coronata* BOLLI, possessing 5 semilunar, undulated chambers in the final whorl and a slightly sinusoidal carinal band enabling us to identify this specimen as *M. sinuosa*.

Occurrence. — France: Upper Turonian-Lowermost Santonian; Israel: Upper Santonian; Switzerland: Coniacian-Santonian; Central Poland (Kolonia Słupia Nadbrzeżna, Słupia Nadbrzeżna, Wesołówka 31, 33, 34, 37, 39): Upper Turonian-Coniacian.

Marginotruncana sp.
(pl. 15: 4*a–c*)

Material. — 13 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/135	0·50	0·40	0·19

Description. — Test rather large, massive, trochospiral, flat both on spiral and umbilical sides, consisting of 2½–3 whorls; chambers semilunar on spiral side, subrectangular on umbilical side; truncated by distinct, beaded, widely spaced double keel; final whorl consisting of 6 chambers increasing gradually in size as added; sutures curved, beaded; surface of chambers

slightly elevated in the vicinity of umbilicus; umbilicus wide, shallow, bordered by mildly elevated umbilical shoulder; primary aperture extraumbilical-umbilical; portici broken in material examined.

Remarks. — *Marginotruncana* sp. differs from *Marginotruncana coronata* (BOLLI) in possessing a flat spiral side, in having less chambers in the final whorl and in the different shape of its chambers (rather semilunar against petaloid in *M. coronata*). It has also more prominent and a more intensively ornamented double keel and well developed periumbilical shoulder as compared with that of *M. coronata*. *Marginotruncana* sp. differs from *Marginotruncana pseudolinneiana* PESSAGNO in having a more rounded equatorial outline against an ovate outline in *M. pseudolinneiana*, in having keels more widely spaced and in being wider in the axial view.

Occurrence. — Central Poland (Opoczka, Kolonia Słupia Nadbrzeżna, Słupia Nadbrzeżna, Wesołówka 31, 34, 37, 39): Upper Turonian-Lower Santonian.

Marginotruncana sp.$_1$
(pl. 17: 4*a–c*)

Material. — 11 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/222	0·49	0·35	0·14

Description. — Test trochospiral, biconvex, with stronger convex umbilical side; periphery lobulate, truncated by a raised, beaded double keel; test consisting of 3 whorls; chambers inflated, semilunar on spiral side, subrectangular on umbilical side, except the ultimate chamber which is petaloid on the spiral side and strongly convex on the umbilical side; final whorl consisting of 5–6 chambers; sutures curved, raised on spiral side, sigmoid on umbilical side; wall finely hispid in initial portion, smooth in later portion; umbilicus rather small, bordered in 2 terminal chambers by a moderately to markedly elevated umbilical shoulder; primary aperture extraumbilical-umbilical; portici broken in material examined.

Remarks. — *Marginotruncana* sp.$_1$ can be easily distinguished from *Marginotruncana pseudolinneiana* PESSAGNO by its biconvex to umbilicoconvex test and by having inflated chambers on the spiral side and strongly convex on the umbilical side. It differs from *Marginotruncana caronae* sp. n. in having a sharp increase in the size of successive chambers, semilunar chambers on the spiral side and a characteristic development of the ultimate chamber.

Occurrence. — Central Poland (Wesołówka 32, 33): Upper Turonian-Coniacian.

Dicarinella biconvexa biconvexa (SAMUEL and SALAJ, 1962)
(pl. 12: 1*a–c*)

1962. *Globotruncana biconvexa biconvexa* SAMUEL and SALAJ; SAMUEL and SALAJ, pl. 9: 4a–c.
1966. *Praeglobotruncana biconvexa biconvexa* (SAMUEL and SALAJ); SALAJ and SAMUEL, 186, 188, pl. 16: 4a–c, pl. 17: 2, 3a–c.

Material. — 17 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/109	0·46	0·40	0·23

Description. — Test trochospiral, biconvex, consisting of 2½ whorls; chambers inflated, petaloid on spiral side, inflated, sectorial on umbilical side; final whorl consisting of 7–8 chambers of almost the same size, truncated by a weakly developed double keel which on the ultimate chamber is single and also weakly developed; ultimate chamber reflected in umbilical direction,

forming thus the square with test margin, often smaller than preceding one; spiral sutures curved, depressed; umbilical sutures radial, depressed; wall ornamented by nodules with exception of ultimate chamber which is smooth; umbilicus narrow, deep; primary aperture extraumbilical-umbilical; imperforate portici and infralaminal accessory apertures.

Remarks. — The subspecies described differs from *Dicarinella biconvexa gigantea* (SAMUEL and SALAJ) in having a less biconvex test, slightly imbricated arrangement of chambers in the final whorl, and in the gradual but regular increase in the size of chambers against an irregular increase in *D. biconvexa gigantea*. Both subspecies differ from other representatives of *Dicarinella* present in the Lower Turonian of the Vistula river valley in having, generally speaking, a more weakly developed double keel which is absent on the final chambers, more chambers in the final whorl, stronger convex chambers on the spiral side and in having a strongly biconvex test instead of the rather convexoconcave tests of other Turonian species of *Dicarinella*. Because of their short time-range *D. biconvexa biconvexa* and *D. biconvexa gigantea* are very good index fossils for the lower Middle Turonian.

Occurrence. — Czechoslovakia (Western Carpathians): Middle Turonian; Central Poland (Karsy): Lower Turonian.

Dicarinella biconvexa gigantea (SAMUEL and SALAJ, 1962)
(pl. 12: 2*a–c*)

1962. *Globotruncana biconvexa gigantea* SAMUEL and SALAJ; SAMUEL and SALAJ, 317, pl. 9: 5a–d.
1966. *Praeglobotruncana biconvexa gigantea* (SAMUEL and SALAJ); SALAJ and SAMUEL, 187, 188, pl. 16: 3a–c.

Material. — 8 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/110	0·48	0·37	0·26

Description. — Test trochospiral, biconvex, consisting of 2½ whorls; chambers inflated, petaloid on spiral side, inflated, sectorial, truncated by weakly developed double keel on umbilical side; final whorl consisting of 8 chambers gradually increasing successively in size; ultimate chamber sometimes with 1 keel only, which is commonly almost invisible; ultimate chamber reflected in relation to preceding ones in umbilical direction forming almost the square with the test margin; spiral sutures depressed, curved to radial; umbilical sutures radial, depressed; wall covered by nodules; primary aperture extraumbilical-umbilical; portici broken in material examined; strongly convex chambers on spiral side make the umbilicus relatively deep and narrow.

Remarks. — See *Dicarinella biconvexa biconvexa* (SAMUEL and SALAJ).

Occurrence. — Czechoslovakia (Western Carpathians): Middle Turonian; Central Poland (Karsy): Lower Turonian.

Dicarinella cf. *concavata* (BROTZEN, 1934)
(pl. 15: 2*a–c*)

Material. — One specimen.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/133	0·34	0·27	0·18

Description. — Test trochospiral, planoconvex, strongly umbilico-convex, consisting of 2½ whorls; weakly developed, closely spaced double keel; final whorl consisting of 5 petaloid, slightly inflated chambers on spiral side, conical on umbilical side; initial chambers globular;

spiral sutures curved, depressed; umbilical sutures radial, depressed; wall ornamented by quite numerous nodules, 2 terminal chambers on spiral side almost smooth; umbilicus deep, broad; primary aperture extraumbilical, bordered by portici with infralaminal accessory apertures.

Remarks. — The specimen described differs from *Dicarinella concavata* (BROTZEN) in having a weakly developed double keel, in possessing slightly convex chambers instead of flat or concave chambers on the spiral side in *Dicarinella concavata* (BROTZEN) and in lacking a distinct umbilical shoulder.

Occurrence. — Central Poland (Wesołówka 45): Upper Santonian.

Dicarinella imbricata (MORNOD, 1950)
(pl. 13: 10, 11, 12)

1950. *Globotruncana imbricata* MORNOD; MORNOD, 589, 590, pl. 15: 21–34, fig. 5: 2a–c, 3a–d.
1965. *Globotruncana imbricata* MORNOD; TAKAYANAGI, 215, pl. 24: 5, pl. 25: 1, 2.
1966. *Globotruncana imbricata* MORNOD; DOUGLAS and SLITER, 111, pl. 5: 2.
1966. *Praeglobotruncana imbricata* (MORNOD); CARON, 76, pl. 6: 4a–c.
1967. *Marginotruncana imbricata* (MORNOD); PESSAGNO, 306, 307, pl. 57: 3–5.
1969. *Globotruncana imbricata* MORNOD; DOUGLAS, 180, 181, pl. 2: 4–7.
1971. *Praeglobotruncana imbricata* (MORNOD); BELLIER, 88–89, pl. 1: 5.
1971. *Praeglobotruncana* cf. *imbricata* (MORNOD); BELFORD and SCHEIBNEROVA, pl. 3: 1–11.
1972. *Praeglobotruncana imbricata* (MORNOD); HANZLIKOVA, 102, pl. 26: 7–10.
1976. *Dicarinella imbricata* (MORNOD); CARON, 332, 333, fig. 3 — neotype; pl. 3: 1–6.

Material. — 14 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/123	0·37	0·35	0·16

Description. — Test trochospiral, concavo-convex, apiral side convex, umbilical side concave; double keel beaded; dorsal keel running obliquely to horizontal plane, made by umbilical side of chambers, giving an illusion of imbricated arrangement of chambers; surface of chambers on spiral side flat or slightly raised relative to keel; chambers slightly convex, trapezoidal on umbilical side; final whorl consisting of 4–6 chambers; spiral sutures convex, curved; umbilical sutures depressed, straight, radial; umbilicus small, deep; primary aperture extraumbilical-umbilical; portici broken in material examined.

Remarks. — The holotype of *Dicarinella imbricata* (MORNOD) described by MORNOD (1950) was never publically available. CARON (1976) has selected the neotype and topotypes for this species from the samples taken in each type level. *D. imbricata* from Central Poland agrees with the neotype selected by CARON (1976, pl. 3: 1–6) in having a convexo-concave test, the same number, shape and imbricated arrangement of chambers in the final whorl and in possessing a weakly developed double keel. Specimens from Switzerland and from Central Poland also possess a double keel, which is, however, raised and beaded in the CARON'S neotype, but rather weakly developed in the material examined.

Occurrence. — USA, California: Turonian-Coniacian, Gulf Coast Plain: Lower Turonian; Australia: Lower Turonian; Czechoslovakia (Moravia): Coniacian-? Santonian; Switzerland: Turonian; France: Turonian; NW Poland: Turonian, Central Poland (Piotrowice, Karsy, Opoczka, Słupia Nadbrzeżna): Turonian, Sudetes: Lower Turonian.

Dicarinella longoriai sp. n.
(pl. 13: 1, 2, 3)

Holotype: ZPAL FXXIII/114; pl. 13, fig. 1.
Type horizon: Lower Turonian.
Type locality: Karsy.

Derivation of the name: dedicated to Dr. José F. LONGORIA, a Mexican micropaleontologist.

Diagnosis: Test low trochospiral, slightly convex on spiral side, slightly concave on umbilical side; periphery lobate; chambers petaloid on spiral side, sectorial on umbilical side; final whorl consisting of $4^1/_2$–5 whorls; spiral sutures curved, depressed; umbilical sutures radial, depressed.

Material. — 16 specimens.

Dimensions (in mm):

	L	W	T
ZPAL FXXIII/114	0·37	0·29	0·16
ZPAL FXXIII/116	0·35	0·28	0·15

Description. — Test trochospiral, slightly convex spiral side, flat or even slightly concave umbilical side, consisting of 2 whorls; periphery strongly lobate, truncated by distinct, closely spaced double keel; chambers petaloid, slightly inflated on spiral side; trapezoidal, flattened to weakly inflated on umbilical side; final whorl consisting of $4^1/_2$ chambers increasing sharply as added; spiral sutures curved, depressed in peripheral part, raised by keel coinciding with sutures in internal part; umbilical sutures radial, depressed; wall finely papillate; umbilicus narrow, rather deep; primary aperture extraumbilical-umbilical; portici with infralaminal accessory apertures.

Remarks. — *Dicarinella longoriai* sp. n. differs from *Dicarinella imbricata* (MORNOD) in having less chambers in the final whorl, in being lower trochospiral, in not possessing the imbricated arrangement of chambers, and in having successive chambers increasing sharply in size. It differs from *Dicarinella biconvexa biconvexa* (SAMUEL and SALAJ) and *Dicarinella biconvexa gigantea* (SAMUEL and SALAJ) in being smaller, in having fewer chambers in the final whorl, chambers of different shape, a more incised peripheral margin and a convexo-concave test.

Occurrence. — Central Poland (Karsy, Piotrowice, Opoczka): Lower Turonian.

Dicarinella sp.

(pl. 12: 4*a–c*)

Material. — One specimen.

Dimensions (in mm):

	L	W	T
ZPAL FXXIII/112	0·48	0·42	0·19

Description. — Test trochospiral, biconvex; spiral and umbilical sides slightly convex, almost flat; 3 whorls; chambers petaloid, flat on spiral side, subtrapezoidal on umbilical side, convex near umbilicus, increasing regularly in size as added, except for the ultimate chamber which is smaller and slightly reflected in umbilicus direction; periphery truncated by well developed, beaded double keel, weaker developed on ultimate chamber; spiral sutures curved, beaded; umbilical sutures radial, depressed; umbilicus small, deep; primary aperture slit-like, umbilical-extraumbilical; portici often broken in material examined.

Remarks. — *Dicarinella* sp. is easily distinguishable from other species of *Dicarinella* occurring in the material examined. It differs from *Dicarinella longoriai* sp. n. in being larger, in having more chambers in the final whorl, successive chambers increasing more regularly in size and in being biconvex rather than convexo-concave. *Dicarinella* sp. is similar to *Dicarinella biconvexa biconvexa* SAMUEL and SALAJ and *Dicarinella biconvexa gigantea* SAMUEL and SALAJ in length and differs from those species in having a more circular outline in the equatorial plane, in being almost planiform against the strongly biconvex test of *D. biconvexa biconvexa* and *D. biconvexa gigantea*, in possessing fewer chambers in the final whorl, and in having more strongly developed, raised, beaded double keel than that of *D. biconvexa biconvexa* and *D. biconvexa gigantea*. *Dicarinella* sp. differs from *Dicarinella imbricata* (MORNOD) in having a different

arrangement of chambers in the final whorl and in possessing biconvex test compared with the convexo-concave test of *Dicarinella imbricata* (MORNOD). *Dicarinella* sp. differs from *Dicarinella* cf. *concavata* (BROTZEN) in being larger, in having a biconvex test instead of planoconvex in the latter species and in having a greater number and a different arangement of chambers in the final whorl.

Occurrence. — Central Poland (Karsy): Lower Turonian.

Genus *Helvetoglobotruncana* REISS, 1957
Helvetoglobotruncana helvetica (BOLLI, 1944)
(pl. 21: 8, 9, 10)

1944. *Globotruncana helvetica* BOLLI; BOLLI, 226, 227, fig. 1: 9–12, pl. 9: 6–8.
1956. *Globotruncana helvetica* BOLLI; ALEXANDROWICZ, 53, 54, text-fig. 5.
1957. *Globotruncana helvetica* BOLLI; BOLLI, 56, pl. 13: 1a–c.
1966. *Praeglobotruncana ? helvetica* (BOLLI); CARON, 74, pl. 3: 2a–c.
1967. *Marginotruncana helvetica* (BOLLI); PESSAGNO, 306, pl. 53: 9–13, pl. 54: 1–3.
1969. *Praeglobotruncana helvetica* (BOLLI); MOORKENS, 447–448, pl. 1: 3, pl. 2: 6, pl. 3: 11.
1969. *Globotruncana helvetica* BOLLI; ROBLES-RAMOS and FLORES-COVARRUBIAS, 81–82, fig. 17: 1–3.
1969. *Praeglobotruncana helvetica* (BOLLI); DOUGLAS, 169–170, pl. 4: 4–5.
1972. *Praeglobotruncana helvetica* (BOLLI); GAWOR-BIEDOWA, 73–74, pl. 8: 4a–c.
1976. *Praeglobotruncana helvetica* (BOLLI); ROBASZYŃSKI and LIVIN, pl. 1: 19, 20, 21.

Material. — 13 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/184	0·42	0·39	0·22

Description. — Test low trochospiral, planoconvex, consisting of 2–3 whorls; spiral side nearly flat; inner whorls slightly raised; umbilical side strongly inflated; equatorial periphery lobate; chambers subglobular and petaloid on spiral side, strongly inflated on umbilical side; final whorl consisting of 5 chambers increasing gradually in size as added; single keel often weakened in ultimate chamber; spiral sutures curved, depressed; umbilical sutures radial, depressed; spiral side nearly smooth; margins and umbilical side beaded to strongly rugose; umbilicus wide, deep; primary aperture extraumbilical-umbilical; portici broken in material examined.

Remarks. — The Polish specimens often possess weaker developed keels and less strongly convex chambers on the umbilical side than the holotype. However, these differences are within the specific variability as defined by BOLLI (1944). The distinctive shape of the test, subglobular chambers and single keel on the spiral side make *H. helvetica* easy to identify. Its limitation to the Lower Turonian qualified it to be a generally accepted Lower Turonian index species.

Occurrence. — Trinidad: Lower Turonian; USA: Turonian; Switzerland: Turonian; France: Lower Turonian; Poland — NW Poland: Upper Cenomanian?-Lower Turonian, Sudetes: Lower Turonian, Carpathians (Bachowice): ?Upper Cenomanian, Central Poland (Karsy, Opoczka): Lower Turonian.

Genus *Whiteinella* PESSAGNO, 1967
Whiteinella baltica DOUGLAS and RANKIN, 1969
(pl. 23: 4, 5, 6)

1969. *Whiteinella baltica* DOUGLAS and RANKIN; DOUGLAS and RANKIN, 197, fig. 9a–i.
1972. *Whiteinella baltica* DOUGLAS and RANKIN; HANZLIKOVA, 100, pl. 25: 8–10.
1974. *Whiteinella baltica* DOUGLAS and RANKIN; HERB, 733, pl. 5: 7–13.
1977. *Whiteinella baltica* DOUGLAS and RANKIN; PETTERS, pl. 3: 8, 9.
1977. *Whiteinella baltica* DOUGLAS and RANKIN; SLITER, 542, pl. 8: 8, 9, pl. 9: 1, 2.

Material. — 25 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/208	0·21	0·18	0·11
ZPAL FXXIII/210	0·20	0·17	0·10

Description. — Test low trochospiral; axial periphery rounded; equatorial periphery strongly lobulate; test consisting of 2 to 2½ whorls; chambers inflated, subspherical; final whorl consisting of 4–5 chambers successively regularly increasing in size; sutures radial, depressed; wall coarsely hispid; umbilicus shallow, wide; primary aperture extraumbilical-umbilical, covered by imperforate flap.

Remarks. — The Polish specimens are almost identical with the DOUGLAS and RANKIN'S description, differing slightly in the rate of increase of chambers size in the final whorl as compared with the typical material. In the holotype the increase in size is irregular, the ultimate and penultimate chambers being smaller than the antipenultimate chamber, while in the illustrated paratypes the increase in size is regular. As Polish specimens are characterized by the regular increase in size of chambers in the final whorl, they are closer to the paratypes than the holotype.

Occurrence. — USA (New Jersey): Lower Santonian; southern Atlantic Ocean: Upper Santonian; Denmark (Bornholm): Coniacian-Lower Santonian; Czechoslovakia (Moravia): Coniacian-Santonian; eastern Indian Ocean: Coniacian-Santonian; Central Poland (Karsy, Słupia Nadbrzeżna, Kol. Słupia Nadbrz., Wesołówka 31, 32, 34, 39): Turonian-Santonian.

Family **Globotruncanidae** BROTZEN, 1942
Subfamily **Globotruncaninae** BROTZEN, 1942
Genus *Globotruncana* CUSHMAN, 1927
Globotruncana arca (CUSHMAN, 1926)
(pl. 16: 4*a–c*)

1926. *Puvinulina arca* CUSHMAN; CUSHMAN, 23, pl. 3: 1a–c (*fide* ELLIS and MESSINA, Catalogue Foram.).
1967. *Globotruncana arca* (CUSHMAN); PESSAGNO, 321–323, pl. 79: 5–8, pl. 90: 6–8, pl. 96: 7, 8, 17 (here additional synonymy).
1965. *Globotruncana arca* (CUSHMAN); van HINTE, 20, 21, pl. 2: 3, pl. 3: 3.
1966. *Globotruncana arca* (CUSHMAN); DOUGLAS and SLITER, 107, pl. 2: 6, 7.
part. 1966. *Globotruncana coronata* BOLLI; DOUGLAS and SLITER, 109, pl. 5: 5, *non* pl. 4: 7, 8, *non* pl. 5: 4.
1969. *Globotruncana arca* (CUSHMAN); DOUGLAS, 176, pl. 9: 1–3, pl. 10: 4–7.
1969. *Globotruncana arca* (CUSHMAN); FUNNELL *et al.*, 28, pl. 2: 11–13, pl. 3: 1–3, fig. 11.
1970. *Globotruncana arca* (CUSHMAN); LONGORIA, 25–28, pl. 3: 1–3, pl. 8: 1–3, pl. 17: 4–6.
1970. *Globotruncana arca* (CUSHMAN); TODD, 153, pl. 6: 2–4.
1971. *Globotruncana arca* (CUSHMAN); EL-NAGGAR, pl. 5: g–1.
1972. *Globotruncana arca* (CUSHMAN); BARR, 18, pl. 6: 7a–c.
1972. *Globotruncana arca* (CUSHMAN); HANZLIKOVA, 102, pl. 26: 11–13, pl. 27: 1.
1973. *Globotruncana arca* (CUSHMAN); OWEN, 57, pl. 14: 17–19.
1974. *Globotruncana tricarinata* (QUEREAU); VAPTZAROVA, 44, pl. 2: 23–25, pl. 3: 16–18.
1975. *Globotruncana arca* (CUSHMAN); STAPLETON, pl. 1: 2a–c.
1976. *Globotruncana arca* (CUSHMAN); WRIGHT and APTHORPE, 239, pl. 1: 5.
part. 1976. *Globotruncana arca* (CUSHMAN); IBRAHIM, 81, pl. 3: 1a, b–2, 4a, b–5, *non* pl. 3: 3a, b, c, *non* pl. 4: 7a, b–8.

Material. — 40 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/108	0·46	0·40	0·21

Description. — Test trochospiral, biconvex; equatorial periphery lobate, axial periphery angular, truncated with well developed double keel which tends to be inturned umbilically;

chambers petaloid to crescent-shaped on spiral side, subrectangular on umbilical side; final whorl consisting of 5–7 chambers increasing slowly in size as added; spiral sutures curved, thickened, beaded, raised; umbilical sutures slightly curved, raised and occasionally beaded, with adumbilical and periumbilical extensions on umbilical keel; umbilicus broad, deep; primary aperture interiomarginal, umbilical; tegilla with infralaminal and intralaminal supplementary apertures.

Remarks. — The species described is somewhat similar to *Globotruncana churchi* MARTIN, differing from the latter in being less spiroconvex and in possessing a more strongly developed beaded double keel which tends to be inturned umbilically.

Occurrence. — *Globotruncana arca* (CUSHMAN) is one of the most cosmopolitan species within the Upper Cretaceous planktic foraminifera. USA (Texas, Arkansas, California), Mexico, Papua New Guinea, Bulgaria: Campanian-Maastrichtian; W Australia, SW Africa, USSR: Maastrichtian; N Africa (Libya): Maastrichtian; Moravia: Upper Campanian-Maastrichtian; Austria (Tirol): Lower Maastrichtian; West Spain: Upper Maastrichtian; Eastern Poland (Mielnik, Chełm Lub.): Campanian-Maastrichtian; Central Poland (Wesołówka 44, Sulejów, Bliskowice, Wałowice, Dorotka, Ciszyca Kolonia, Ciszyca Górna, Łopoczno, Solec, Kłudzie, Chotcza): Campanian-Lowermost Maastrichtian.

Globotruncana bulloides VOGLER, 1941
(pl. 17: 6, 7, 8)

1941. *Globotruncana linnei* (d'ORBIGNY) subsp. *bulloides* VOGLER; VOGLER, 287, pl. 23: 32–39 (*fide* ELLIS and MESSINA, Catalogue Foram.).
1962. *Globotruncana marginata* (REUSS); HERM, 85, pl. 5: 5.
1962. *Globotruncana lapparenti bulloides* VOGLER; HERM, 84, pl. 6: 6.
1969. *Globotruncana bulloides* VOGLER; ESKER III, pl. 3: 4, 5.
1970. *Globotruncana bulloides* VOGLER; LONGORIA, 29–32, pl. 3: 4–6, pl. 7: 1–3, pl. 19: 5–6 (here additional synonymy).
1970. *Globotruncana bulloides* VOGLER; PORTHAULT, 83, 84, pl. 11: 20–22.
1975. *Globotruncana bulloides* VOGLER; VAPTZAROVA, 24, pl. 1: 1, 2, 3.
1976. *Globotruncana bulloides* VOGLER; IBRAHIM, 88, pl. 5: 4a, b, 5a, b.
1976. *Globotruncana bulloides* VOGLER; WRIGHT and APTHORPE, 239, pl. 1: 7.

Material. — 9 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/151	0·38	0·33	0·24

Description. — Test low trochospiral, biconvex, consisting of 2½–3 whorls; spiral side slightly convex, umbilical side almost flat; equatorial periphery lobate, axial periphery rounded; periphery truncated by widely spaced, well developed, beaded double keel; chambers petaloid to crescent-shaped, highly vaulted, on spiral side; subrectangular on umbilical side; spiral sutures curved, weakly beaded; umbilical sutures nearly radial, depressed; chambers ornamented by pustules and rugosities on both sides; umbilicus wide, deep, pecularly notched spirally and having a somewhat imbricate appearance peripherally, bordered by a slightly elevated umbilical shoulder; primary aperture umbilical; tegilla broken in material examined.

Remarks. — The species described was originally designated in thin sections as *Globotruncana linnei* (d'ORBIGNY) subsp. *bulloides* VOGLER from syntypic series from the Upper Cretaceous of Indonesia. PESSAGNO (1967) designated the specimen illustrated in figure 33 of VOGLER (1941) as the lectotype and the specimen in figure 34 as the paralectotype of *Globotruncana linnei bulloides* VOGLER. To establish the external morphology of *Globotruncana bulloides* VOGLER, PESSAGNO (1967) studied thin sections of many specimens classified as *Globo-*

truncana bulloides VOGLER and compared them with the lectotype. The Polish specimens correspond with the specimens illustrated by PESSAGNO (1967).

Occurrence. — USA (Gulf Coast Plain): Upper Santonian-Lower Maastrichtian; Mexico: Upper Santonian-Lower Maastrichtian; Puerto Rico: Upper Santonian-Upper Maastrichtian; Western Australia: Lower Maastrichtian; Bulgaria: Campanian; Austria: Upper Campanian-Lower Maastrichtian; France: Upper Santonian-Campanian; Poland — Eastern Poland: Campanian-Lower Maastrichtian (Mielnik), Upper Cretaceous (Chełm), Carpathians (Bachowice): ?Turonian-?Lower Coniacian, Central Poland (Sulejów, Dorotka, Wałowice, Łopoczno, Solec, Chotcza): Upper Santonian-Lower Maastrichtian.

Globotruncana churchi MARTIN, 1964
(pl. 16: 3*a–c*)

1964. *Globotruncana churchi* MARTIN; MARTIN, 79, pl. 9: 5a–c.
part. 1965. *Globotruncana arca* (CUSHMAN); TAKAYANAGI, 209, pl. 22: 6a–c, *non* pl. 23: 1a–2c.
1966. *Globotruncana churchi* MARTIN; DOUGLAS and SLITER, 108, pl. 2: 10, pl. 4: 2.
1968. *Globotruncana churchi* MARTIN; SLITER, 102, pl. 16: 2.
1969. *Globotruncana churchi* MARTIN; DOUGLAS, 177, pl. 8: 1–2.
1973. *Globotruncana churchi* MARTIN; SLITER, pl. 2: 11–13.
1975. *Globotruncana churchi* MARTIN; VAPTZAROVA, 25, pl. 1: 13, 14, 15.
part. 1976. *Globotruncana arca* (CUSHMAN); IBRAHIM, 81, pl. 3: 3a, b, c, *non* pl. 3: 1a, b–2, 4a, b–5, *non* pl. 4: 7a, b–8.

Material. — 8 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/107	0·46	0·41	0·24

Description. — Test highly trochospiral, spiroconvex, umbilical side slightly concave; equatorial periphery lobulate, axial periphery truncate, with double keel, occasionally merging and forming single keel in the ultimate chamber; final whorl consisting of 6–7 chambers increasing regularly in size as added; spiral sutures raised, curved, occasionally beaded; umbilical sutures slightly curved, nearly radial, slightly raised; aperture interiomarginal; tegilla broken in material examined.

Remarks. — The Polish specimens differ from the holotype in being a slightly less trochospiral and in possessing 6–7 chambers in the final whorl versus 7–8 chambers in the holotype. *Globotruncana churchi* is very similar to *Globotruncana arca*. It differs from the latter in having more elevated inner whorls on the spiral side.

Occurrence. — USA (California): Upper Santonian-Campanian; Canada (British Columbia): Campanian; Austria (Tirol): Lower Campanian; Bulgaria: Campanian; Central Poland (Chotcza, Ciszyca Kolonia): Upper Campanian.

Globotruncana fornicata PLUMMER, 1931
(pl. 18: 5, 6, 7)

1931. *Globotruncana fornicata* PLUMMER; PLUMMER, 198, pl. 13: 4a–c (*fide* ELLIS and MESSINA, Catalogue Foram.).
1968. *Globotruncana fornicata* PLUMMER; SLITER, 103, pl. 16: 5–7.
1969. *Globotruncana fornicata* PLUMMER; ESKER III, pl. 3: 6, 7.
1969. *Globotruncana fornicata* PLUMMER; DOUGLAS, 179, pl. 7: 6.
1969. *Globotruncana morozovae* VASSILENKO; DOUGLAS, 184, pl. 7: 4, 5.
1970. *Globotruncana fornicata* PLUMMER; LONGORIA, 47–51, pl. 1: 7–9, pl. 8: 5–6, pl. 17: 1–3 (here additional synonymy).
1970. *Globotruncana fornicata* PLUMMER; PORTHAULT, 82–83, pl. 11: 14—16.
1972. *Globotruncana fornicata* PLUMMER; HANZLIKOVA, 106, pl. 28: 6, 7.

1972. *Globotruncana fornicata* PLUMMER; BARR, 20, pl. 7: 4—5.
1972. *Globotruncana fornicata* PLUMMER; GOVINDAN, 175, pl. 5: 13–15.
1973. *Globotruncana fornicata* PLUMMER; OWEN, 58, pl. 15: 13.
1975. *Globotruncana fornicata* PLUMMER; STAPLETON, pl. 1: 4a–c.
1976. *Globotruncana fornicata fornicata* PLUMMER; IBRAHIM, 112, pl. 6: 6a, b–11a, b, 12a, b, c, pl. 4: 5a, b–6a, b.

Material. — 19 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/140	0·36	0·32	0·23

Description. — Test low trochospiral to moderately high trochospiral, spiroconvex, slightly convex to umbilico-concave; axial periphery angular, truncate by well developed double keel, usually reflected umbilically, equatorial periphery nearly circular; chambers narrow, elongated spirally, crescent-shaped and crenulate, strongly overlapping on spiral side; narrow, elongated, crescentic to comma-shaped, also strongly overlapping on umbilical side; final whorl consisting of 4–5 chambers increasing slowly in size as added; spiral sutures strongly curved, raised, beaded; umbilical sutures curved, thickened by adumbilical extension of umbilical keel, continuing further around umbilicus as periumbilical extension; wall initially pustulose, later smooth on spiral side, slightly pustulose on umbilical side; umbilicus rather broad, deep; primary aperture interiomarginal, umbilical; tegilla broken in material examined.

Remarks. — *G. fornicata* is somewhat similar to *G. plummerae* GANDOLFI, but differs in possessing more chambers in the final whorl, a smooth wall, and non-inflated chambers on the spiral side. *G. fornicata* differs from *G. patelliformis* GANDOLFI mainly in being less spiroconvex and in having a rounded equatorial periphery.

Occurrence. — USA (California): Campanian; Mexico: Santonian-Campanian; Cuba: Upper Cretaceous; Papua New Guinea: Upper Santonian-Lower Maastrichtian; India: Campanian-Lower Maastrichtian; South Africa: Lower Maastrichtian; Libya: Campanian-Lower Maastrichtian; USSR: ?Coniacian-Maastrichtian; Czechoslovakia (Moravia): Lower Campanian; France: Lower Santonian-Campanian; Poland — Eastern Poland: Mielnik — Upper Campanian, Chełm — Upper Santonian-Maastrichtian, Central Poland (Wesołówka 41, 43, Sulejów, Bliskowice, Wałowice, Dorotka, Ciszyca Kolonia, Ciszyca Górna, Łopoczno, Wola Pawłowska, Chotcza): Upper Santonian-Lower Maastrichtian.

Globotruncana lapparenti BROTZEN, 1936
(pl. 19: 4, 5, 6)

1936. *Globotruncana lapparenti* BROTZEN; BROTZEN, 175–176, pl. 5, fig. 2: a, d, m, n.
1965. *Globotruncana linneiana* (d'ORBIGNY); TAKAYANAGI, 217, pl. 25: 6, pl. 26: 2.
1967. *Globotruncana lapparenti* BROTZEN; PESSAGNO, 344–346, pl. 71: 6–13, pl. 97: 8–9.
1969. *Globotruncana linneiana* (d'ORBIGNY); ESKER III, pl. 2: 1, 2, 3.
1972. *Globotruncana linneiana* (d'ORBIGNY); HANZLIKOVA, 107–108, pl. 29: 6, 7.
1973. *Globotruncana lapparenti* BROTZEN; OWEN, 59, pl. 16: 9–11.
1975. *Globotruncana lapparenti* BROTZEN; VAPTZAROVA, 26–27, pl. 1: 16, 18, 19.
1976. *Globotruncana lapparenti* BROTZEN; WRIGHT and APTHORPE, 239, pl. 1: 12, 13.
1976. *Globotruncana tricarinata* (QUEREAU); IBRAHIM, 138, pl. 1: 8–13.

Material. — 17 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/157	0·50	0·44	0·16
ZPAL FXXIII/159	0·39	0·30	0·13

Description. — Test low trochospiral, flat on umbilical side, flat to slightly convex on spiral side; chambers petaloid on spiral side, subrectangular on umbilical side, truncated by a well developed double keel; final whorl consisting of 5–7 chambers; sutures raised, beaded,

curved; primary aperture interiomarginal, umbilical; umbilicus moderately large; tegilla with infralaminal and intralaminal accessory apertures, broken in many specimens examined.

Remarks. — *G. lapparenti* was described in syntypic series and BROTZEN (1936) cited numerous specimens figured by de LAPPARENT (1918) as the syntypes. To stabilize the taxonomic status of *G. lapparenti*, a lectotype (pl. 2: n, p. 5 in de LAPPARENT, 1918) and a paralectotype (pl. 2: m, p. 5 in de LAPPARENT, 1918) were selected by PESSAGNO (1967). *G. lapparenti* is frequently mistaken with *G. linneiana* (d'ORBIGNY) although it differs in being much narrower (in apertural and abapertural views) and in having a slightly convex spiral side.

Specimens illustrated as *G. linneiana* (d'ORBIGNY) by ESKER III (1969, pl. 3: 1, 2, 3), HANZLIKOVA (1972, pl. 29: 6, 7) and TAKAYANAGI (1965, pl. 25: 6, pl. 26: 2) and as *G. tricarinata* (QUEREAU) by IBRAHIM (1976, pl. 1: 8–13) possess a closely spaced double keel so they belong to *Globotruncana lapparenti* BROTZEN. PESSAGNO (1967) included *G. longilocula* GANDOLFI in *G. lapparenti*. The chambers on the spiral side of *G. longilocula* are semilunar, however, whereas those of *G. lapparenti* are petaloid, and for this reason I believe that the two forms should be regarded as separate species.

Occurrence. — USA (California, Gulf Coast Plain): Santonian-Lower Maastrichtian; Mexico: Upper Santonian-Lower Maastrichtian; Western Australia: Lower Maastrichtian; Bulgaria: Campanian; Austria: Upper Santonian; Czechoslovakia (Moravia): Santonian-Campanian; France: Upper Santonian-Lower Maastrichtian; Sweden: Upper Cretaceous; Poland — Eastern Poland (Mielnik): Campanian, Carpathians (Bachowice): ?Turonian-Santonian, Central Poland (Wesołówka 40, 41, 42, 43, Bliskowice, Dorotka, Ciszyca Kolonia, Ciszyca Górna, Solec, Kłudzie, Jarentowskie Pole, Chotcza): Lower Santonian-Lower Maastrichtian.

Globotruncana linneiana (d'ORBIGNY, 1839)

(pl. 19: 1, 2, 3)

1839. *Rosalina linneiana* d'ORBIGNY; d'ORBIGNY, 110, pl. 5: 10–12 (*fide* ELLIS and MESSINA, Catalogue Foram.)
1929. *Globotruncana canaliculata* (REUSS); WHITE, 282–284, pl. 38: 3.
1953. *Globotruncana linneiana* (d'ORBIGNY); SUBBOTINA, 176—178, pl. 5: 7–9, pl. 6: 1–4.
1954. *Globotruncana lapparenti lapparenti* BOLLI; KSIĄŻKIEWICZ, 274, pl. 31: 7–9, text-fig. 45, 46.
1956. *Globotruncana linneiana* (d'ORBIGNY); BRONNIMANN and BROWN, 540–542, pl. 20: 13–17, pl. 21: 16–18.
1962. *Globotruncana lapparenti lapparenti* BROTZEN; HERM, 82, pl. 6: 2.
part. 1964. *Globotruncana linneiana* (d'ORBIGNY); OLSSON, 166–167, pl. 2: 6, 8, *non* pl. 2: 7.
1964. *Globotruncana tricarinata* (QUEREAU); OLSSON, 171–172, pl. 5: 4, 5.
1964. *Globotruncana tricarinata* (QUEREAU); MARTIN, 81, pl. 10: 2.
non 1965. *Globotruncana linneiana* (d'ORBIGNY); van HINTE, 23, pl. 1: 3.
part. 1965. *Globotruncana linneiana* (d'ORBIGNY); TAKAYANAGI, 217, 26: 1, *non* pl. 26: 2, *non* pl. 25: 6.
part. 1966. *Globotruncana linneiana* (d'ORBIGNY); DOUGLAS and SLITER, 112, pl. 5: 6, 8, *non* pl. 5: 7, *non* pl. 4: 4, 6, 9.
1967. *Globotruncana linneiana* (d'ORBIGNY); PESSAGNO, 346—349, pl. 72: 1–4, 7–9, pl. 97: 11–13.
1968. *Globotruncana tricarinata* (QUEREAU); SLITER, 107, pl. 19: 1.
1968. *Globotruncana marginata* (REUSS); SLITER, 104, pl. 17: 5.
part. 1969. *Globotruncana pseudolinneiana* (PESSAGNO); DOUGLAS, pl. 3: 4, *non* pl. 3: 2, 3.
1969. *Globotruncana linneiana* (d'ORBIGNY); DOUGLAS, 181–182, pl. 3: 1.
1970. *Globotruncana linneiana* (d'ORBIGNY); LONGORIA, 65–69, pl. 3: 4–6, pl. 7: ?9–10, pl. 13: 5–6.
non 1972. *Globotruncana linneiana* (d'ORBIGNY); HANZLIKOVA, 107–108, pl. 29: 6, 7.
1976. *Globotruncana linneiana* (d'ORBIGNY); WRIGHT and APTHORE, 239, pl. 1: 8, 11.
1976. *Globotruncana lapparenti* BROTZEN; IBRAHIM, 119, pl. 1: 1–7.

Material. — 65 well preserved specimens.

Dimensions (in mm):

	L	W	T
ZPAL FXXIII/154	0·39	0·34	0·16
ZPAL FXXIII/155	0·40	0·34	0·16

Description. — Test low trochospiral, double keeled, with broad interkeel area, flat on spiral and umbilical sides; chamber petaloid on spiral side, subrectangular on umbilical side; final whorl consisting of 5–7 chambers increasing regularly in size as added; spiral sutures raised, beaded, curved; umbilical sutures raised, straight to slightly curved, beaded; umbilicus moderately large, often flanked by prominent beaded, umbilical shoulder; primary aperture interiomarginal, umbilical; tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — Numerous transitional specimens to *Globotruncana lapparenti* BROTZEN and *Globotruncana obliqua* HERM have been observed in the material examined. *G. linneiana* is nearly homeomorphic externally with *Marginotruncana pseudolinneiana* PESSAGNO, differing from the latter in having a wider-spacer double keel peripherally and in having petaloid chambers on the spiral side (against slightly crescent-shaped in *M. pseudolinneiana*). Both species differ also in the position of the primary aperture.

Occurrence. — Cuba: Upper Cretaceous; Puerto Rico: Late Campanian-Lower Maastrichtian; USA — New Jersey: Late Maastrichtian, California: Upper Campanian, Gulf Coast Plain: Campanian; Mexico: Campanian-Lower Maastrichtian; Western Australia: Lower Maastrichtian; Papua New Guinea: Campanian-Lower Maastrichtian; Libya: Campanian; USSR: Coniacian-Campanian; Poland — Eastern Poland (Chełm): ?Upper Turonian-Maastrichtian, Carpathians (Bachowice): ?Turonian-Santonian, Central Poland (Wesołówka 40, 41, Sulejów, Ciszyca Kolonia, Łopoczno, Jarentowskie Pole): Upper Santonian-Lower Maastrichtian.

Globotruncana nothi (BRÖNNIMANN and BROWN, 1956)
(pl. 20: 14, 15)

1956. *Rugotruncana nothi* BRÖNNIMANN and BROWN; BRÖNNIMANN and BROWN, 551, pl. 22: 16–18.
1964. *Globotruncana nothi* (BRÖNNIMANN and BROWN); OLSSON, 168, pl. 4: 9a–c.
1966. *Globotruncana nothi* (BRÖNNIMANN and BROWN); DOUGLAS and SLITER, 113, pl. 2: 5.
1967. *Globotruncana nothi* (BRÖNNIMANN and BROWN); PESSAGNO, 350, 351, pl. 67: 4–9, pl. 68: 6–8, pl. 96: 10.
1969. *Globotruncana nothi* (BRÖNNIMANN and BROWN); DOUGLAS, 184, 185, pl. 10: 1, 2.
1972. *Globotruncana nothi* (BRÖNNIMANN and BROWN); HANZLIKOVA, 109, pl. 29: 10.
1973. *Globotruncana nothi* (BRÖNNIMANN and BROWN); OWEN, pl. 17: 1–3.
1974. *Globotruncana nothi* (BRÖNNIMANN and BROWN); VAPTZAROVA, 43, 44, pl. 3: 13, 14, 15.

Material. — 7 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/166	0·56	0·52	0·33
ZPAL FXXIII/167	0·53	0·51	0·32

Description. — Test low trochospiral, biconvex; chambers varying between petaloid and crescentic on spiral side, subrectangular on umbilical side, truncated by a double keel; keel rims raised, beaded, often spinose; equatorial periphery lobate, axial periphery truncate; final whorl consisting of 4½–5 chambers; chambers spinose and rugose spirally; spiral sutures moderately curved, raised, thickened; umbilical sutures depressed, nearly radial; umbilicus moderately deep; primary aperture umbilical; tegilla with intralaminal and infralaminal accessory apertures.

Remarks. — The Polish specimens are almost identical with the holotype, differing only in having a less lobulate equatorial periphery and a less spinose surface of the wall on the spiral side.

Occurrence. — USA (California, New Jersey): Upper Campanian-Maastrichtian; Cuba: Upper Maastrichtian; Papua New Guinea: Lower Maastrichtian; Czechoslovakia (Moravia): Campanian-Maastrichtian; Bulgaria: Maastrichtian; Central Poland (Ciszyca): Upper Campanian.

Globotruncana obliqua HERM, 1965
(pl. 19: 7, 8, 9)

1958. *Globotruncana mayaroensis* BOLLI; WITWICKA, 225–226, pl. 18: 36a–c.
1962. *Globotruncana* sp.; HERM, 85, pl. 4: 6.
1965. *Globotruncana linneiana* (d'ORBIGNY) *obliqua* HERM; HERM, 336–338, pl. 8: 1–4, fig. 14.
1965. *Globotruncana linneiana* (d'ORBIGNY); van HINTE, 23, pl. 1: 3.
1967. *Globotruncana loeblichi* PESSAGNO; PESSAGNO, 349–350, pl. 73: 1–4, pl. 97: 10.
1968. *Globotruncana obliqua* HERM; BARR, 316–318, pl. 39: 5–6.
1972. *Globotruncana obliqua* HERM; BARR, 22–23, pl. 9: 5–6.
1976. *Globotruncana obliqua* HERM; IBRAHIM, 125, pl. 7: 8a, b–11a, b.

Material. — 15 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/160	0·38	0·30	0·17
ZPAL FXXIII/161	0·37	0·31	0·18

Description. — Test low trochospiral, planiform, slightly concave on spiral side, lobulate, truncated by well developed, widely spaced, raised, beaded double keel; test consisting of 2 to 2½ whorls; chambers increasing sharply in size added in the earliest portion, later increasing in size considerably more gently; chambers petaloid on spiral side, subrectangular on umbilical side, arranged obliquely in relation to the whorl axis; sutures curved, raised, beaded; umbilicus broad, covered by tegilla randomly preserved.

Remarks. — *G. obliqua* is phylogenetically related to *G. linneiana* (d'ORBIGNY), commonly differing from the latter in the concave nature of its spiral side and the imbricate nature of its chambers in peripheral view. As *Globotruncana loeblichi* PESSAGNO possesses well developed all characteristics of *Globotruncana obliqua* HERM, it is included in the synonymy of *G. obliqua*.

Occurrence. — Austria (Tirol): Lower Maastrichtian; USA (Texas), Mexico: Campanian; Tunis: Upper Campanian-Lower Maastrichtian; Libya: Lower Maastrichtian; France: Campanian; Central Poland (Wesołówka 42, 43, Sulejów, Dorotka, Ciszyca Kolonia, Łopoczno, Jarentowskie Pole, Chotcza): Upper Santonian-Lower Maastrichtian.

Globotruncana patelliformis GANDOLFI, 1955
(pl. 20: 13)

1951. *Globotruncana contusa* (CUSHMAN); BOLLI, 196, pl. 34: 7–9.
1955. *Globotruncana (Globotruncana) contusa* (CUSHMAN) subsp. *patelliformis* GANDOLFI; GANDOLFI, 54, pl. 4: 2a–c.
part. 1964. *Globotruncana contusa* (CUSHMAN); OLSSON, 163, 164, pl. 2: 5a–c, pl. 3: 9a–c, *non pl.* 3: 6a–c.
1966. *Globotruncana contusa patelliformis* GANDOLFI; EL-NAGGAR, 93–95, pl. 8: 1a–c.
part. 1967. *Globotruncana contusa* (CUSHMAN); PESSAGNO, 330–333, pl. 75: 18–20, pl. 77: 1–3, pl. 96: 11, 13, *non* pl. 77: 4–6, 7–9, *non* pl. 78: 6–8, 9–11, *non* pl. 92: 10–12, *non* pl. 96: 14, 15, 16.
1967. *Globotruncana caliciformis patelliformis* GANDOLFI; EL-NAGGAR and HAYNES, 8–10, pl. 1: 1a–c.
1973. *Globotruncana patelliformis* GANDOLFI; SMITH and PESSAGNO, 50, 51, pl. 21: 6–8.

Material. — One well preserved specimen.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/165	0·68	0·66	0·50

Description. — Test highly trochospiral, spiral side strongly convex, umbilical side flat; equatorial periphery nearly circular with 2 distinct keels, distinctly beaded, except for the ultimate chamber where keels are poorly marked; chambers narrow, elongate, crenulate and strongly overlapping, crescentic on spiral side, narrow, elongate, crenulate, subrectangular on

umbilical side; final whorl consisting of 4 chambers increasing slowly in size as added; sutures strongly curved, raised and beaded on umbilical side; wall of initial whorls distinctly pustulose, wall of later whorls smooth; umbilicus very deep, narrow; primary aperture interiomarginal, umbilical; tegilla broken in material examined.

Remarks. — The Polish specimen is identical with the holotype of *G. patelliformis*. This species was often confused with *G. contusa* (CUSHMAN); it differs from the latter in being slightly smaller, in being less convex spirally, in having a more, nearly circular, peripheral outline and in lacking pronounced spiral plications.

Occurrence. — Columbia: Maastrichtian; USA (Texas, Arkansas, New Jersey): Maastrichtian; Egypt: Middle and Late Maastrichtian; Central Poland (Chotcza): Lower Maastrichtian.

Globotruncana pessagnoi LONGORIA, 1973
(pl. 20: 6, 7, 8)

1973. *Globotruncana pessagnoi* LONGORIA; LONGORIA, 97–100, pl. 1: 1–9.

Material. — 16 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/168	0·33	0·27	0·18
ZPAL FXXIII/169	0·29	0·24	0·16

Description. — Test trochospiral, biconvex; chambers petaloid on spiral side, subrectangular on umbilical side, truncated by umbilically reflected, weakly developed double keel; final whorl consisting of 5½ to 6 chambers increasing regularly in size as added; spiral sutures curved, beaded; umbilical sutures radial, depressed; umbilicus narrow, deep; primary aperture interiomarginal, umbilical; tegilla broken in material studied.

Remarks. — The specimens described correspond well with the holotype. There is a slight difference in the shape of the chambers on the umbilical side, these being subrectangular rather than subtrapezoidal as in the holotype.

Occurrence. — USA (Texas), Mexico: latest Campanian-earliest Maastrichtian; Central Poland (Sulejów, Ciszyca Kolonia, Ciszyca Górna, Wola Pawłowska, Solec): Upper Campanian.

Globotruncana plummerae GANDOLFI, 1955
(pl. 17: 1, 2, 3)

1955. *Globotruncana fornicata* PLUMMER subsp. *plummerae* GANDOLFI; GANDOLFI, 42, pl. 2: 3a–c, 4a–c.
part. 1955. *Globotruncana fornicata* PLUMMER subsp. *ackermani* GANDOLFI; GANDOLFI, 42, pl. 2: 5a–c, *non* pl. 2: 6a–c, 7a–c.
1967. *Globotruncana plummerae* GANDOLFI; PESSAGNO, 351, 351, pl. 66: 3–8.
1973. *Globotruncana plummerae* GANDOLFI; SMITH and PESSAGNO, 51, pl. 21: 9–11.
1976. *Globotruncana plummerae* GANDOLFI; IBRAHIM, 126, pl. 4: 13a, b, pl. 5: 6a, b–7, 8a, b.

Material. — 19 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/146	0·46	0·37	0·24
ZPAL FXXIII/147	0·46	0·40	0·26

Description. — Test trochospiral, biconvex; equatorial periphery lobate, axial periphery rounded; chambers semilunar, highly vaulted on spiral side, subrectangular on umbilical side, truncated by umbilically reflected double keel; final whorl consisting of 4 chambers, wall of the

first chamber is ornamented by nodules of different size; spiral and umbilical sutures depressed, slighty curved; umbilicus small, deep; primary aperture umbilical; tegilla broken in material examined.

Remarks. — *G. plummerae* is somewhat similar to *G. fornicata* PLUMMER in possessing the elongated semilunar chambers on the spiral side and subrectangular on the umbilical side and the umbilically reflected double keel. It differs from the latter species in possessing vaulted, spinose chambers spirally and in weakly marked, often slightly depressed, curved sutures both on the spiral and umbilical sides.

Occurrence. — Columbia: Campanian; USA, Mexico: Upper Campanian-Lower Maastrichtian; Austria (Tirol): Santonian-Lower Maastrichtian; Central Poland (Sulejów, Wałowice, Dorotka, Ciszyca, Łopoczno, Wola Pawłowska, Dziurków): Upper Campanian-Lower Maastrichtian.

Globotruncana pozaryskae sp. n.
(pl. 20: 1, 5, 9, 10, 11, 12)

Holotype: ZPAL FXXIII/174; pl. 20, fig. 1.
Type horizon: Upper Campanian.
Type locality: Ciszyca Górna.
Derivation of the name: dedicated to Professor KRYSTYNA POŻARYSKA, a Polish micropaleontologist.
Diagnosis: Test low trochospiral, planiform both spirally and umbilically, bordered by weakly developed, wide, double keel of linneiana type. Initial chambers globular, in later portion inflated, petaloid on spiral side, subrectangular on umbilical side. Wall nodulose throughout.

Material. — 16 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/174	0·33	0·30	0·18
ZPAL FXXIII/178	0·38	0·35	0·20

Description. — Test low trochospiral, planiform both spirally and umbilically, truncated peripherally by wide, weakly developed double keel of linneiana type; periphery lobulate; test consisting of 2½ to 3 whorls; early chambers globular; final whorl consisting of 5–6 chambers increasing rapidly in size; chambers petaloid; slightly inflated on spiral side; subrectangular on umbilical side; spiral sutures curved; wall finely perforate, nodulose throughout; first chambers of final whorl intensively ornamented, without keels that appear on terminal chambers; umbilicus wide, shallow, bordered by a weakly developed umbilical shoulder; tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — *G. pozaryskae* sp. n. is somewhat similar to *G. hilli* PESSAGNO but differs from it in that the chambers of the final whorl are successively sharply larger, in the well developed nodule ornamentation on the whole wall and in having more convex chambers on the spiral side; equivalent chambers of *G. hilli* are flat or even slightly concave.

Occurrence. — Central Poland (Ciszyca Górna, Chotcza): Upper Campanian-Maastrichtian.

Globotruncana ventricosa WHITE, 1929
(pl. 18: 1*a–c*)

1929. *Globotruncana canaliculata* var. *ventricosa* WHITE; WHITE, 284, pl. 38: 3a–c.
1965. *Globotruncana ventricosa* WHITE; TAKAYANAGI, 226, pl. 29: 1.
part. 1968. *Globotruncana ventricosa* WHITE; SLITER, 107, pl. 18: 7, *non* pl. 18: 8.
1968. *Globotruncana ventricosa* WHITE; BARR, 319, pl. 40: 3a–c.
1969. *Globotruncana ventricosa* WHITE; DOUGLAS, 188, pl. 7: 1, 3.

1970. *Globotruncana ventricosa* WHITE; LONGORIA, 82–85, pl. 1: 1–3, pl. 8: 4, 7–8, pl. 16: 6 (here additional synonymy).
1972. *Globotruncana ventricosa* WHITE; BARR, 25–26, pl. 8: 8a–c.
1972. *Globotruncana ventricosa* WHITE; HANZLIKOVA, 113, pl. 31: 5–7.
1973. *Globotruncana ventricosa* WHITE; OWEN, 61, pl. 19: 4–6.
1975. *Globotruncana ventricosa* WHITE; VAPTZAROVA, 28, 29, pl. 2: 13, 14, 15.
1976. *Globotruncana ventricosa* WHITE; WRIGHT and APTHORPE, 240, pl. 2: 8, 9, 12.

Material. — 9 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/134	0·66	0·40	0·35

Description. — Test trochospiral, planoconvex, spiral side flat or slightly convex, umbilical side strongly convex; periphery truncated by well developed closely spaced double keel; chambers typically planiform, petaloid to crescentic on spiral side; highly convex, crudely subrectangular on umbilical side; spiral sutures curved, raised, coarsely beaded; umbilical sutures slightly depressed, curved, finely beaded to non-beaded; umbilicus deep, bordered by well developed often coarsely beaded umbilical shoulder; primary aperture interiomarginal, umbilical, covered by tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — Polish specimens have many characters in common with the holotype, from which they differ slightly in having a less convex umbilical side and more closely spaced keels.

Occurrence. — Trinidad: Campanian; Haiti: Campanian; USA (Texas, Arkansas, California): Campanian; Mexico: Campanian; Western Australia: Upper Campanian; Papua New Guinea: Upper Santonian-Lower Maastrichtian; Libya: Campanian-Lower Maastrichtian; Bulgaria: Campanian; Austria: Campanian-Lower Maastrichtian; England: Campanian; Czechoslovakia (Moravia): Lower Campanian; Central Poland (Wesołówka 44, 45, Sulejów, Ciszyca Górna, Łopoczno): Upper Campanian.

Globotruncana sp.
(pl. 18: 2, 3, 4)

Material. — 6 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/137	0·41	0·31	0·18
ZPAL FXXIII/138	0·33	0·27	0·15

Description. — Test trochospiral, biconvex, truncated by well developed, widely spaced, beaded double keel; chambers semilunar, flat on spiral side, subrectangular on umbilical side; final whorl consisting of 4 chambers increasing sharply in size as added; peripheral margins of chambers of final whorl on spiral side distinctly reflected umbilically; spiral sutures curved, raised, beaded, umbilical sutures slightly depressed, curved to slightly radial; spiral side ornamented by nodules and spines occurring in some parts of central portion of wall, on spiral side with exception of ultimate chamber which is smooth; umbilical side smooth; umbilicus rather broad, bordered by slightly elevated umbilical shoulder; primary aperture umbilical; tegilla broken in material examined.

Remarks. — *Globotruncana* sp. differs from *Globotruncana lunaris* MASTERS in having a smaller test without the characteristic nonperforated lunar surface on spiral side. *Globotruncana* sp. differs from *Globotruncana plummerae* GANDOLFI in possessing highly arched chambers spirally and usually raised beaded sutures spirally.

Occurrence. — Central Poland (Ciszyca Górna): Upper Campanian.

Globotruncana sp.$_1$
(pl. 19: 10, 11, 12)

Material. — 19 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/143	0·52	0·39	0·25
ZPAL FXXIII/144	0·50	0·38	0·25

Description. — Test trochospiral, medium in size, consisting of 2½–3 whorls, truncated by closely spaced, weakly developed double keel; chambers inflated, petaloid; final whorl consisting of 6–7 chambers increasing gradually and irregularly in size as added; ultimate chamber often smooth and smaller than penultimate one, reflected umbilically; keels often barely developed or even absent; spiral sutures curved, depressed; umbilical sutures radial, depressed; spiral side ornamented by rare, high spines, mainly in the older part of test but not in terminal chambers; primary aperture umbilical; tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — *Globotruncana* sp.$_1$ resembles *Globotruncana nothi* BRÖNNIMANN and BROWN, from which it differs in having irregular increase of chamber size, a greater number of chambers in the final whorl, and different development of the ultimate chamber that is smaller than penultimate one, without keel and umbilically reflected.

Occurrence. — Central Poland (Ciszyca Kolonia): Campanian.

Globotruncana sp.$_2$
(pl. 19: 10–12)

Material. — 14 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/131	0·40	0·32	0·17

Description. — Test biconvex, medium in size, consisting of 2 to 2½ whorls; chambers inflated, petaloid on spiral side, subrectangular on umbilical side; final whorl consisting of 6 chambers increasing moderately in size as added; sutures curved, beaded on spiral side; in central parts of chambers nonperforated wall ornamented by nodules on spiral side; double keel distinctly developed on umbilical side forming periumbilical shoulder; umbilicus narrow, deep; primary aperture umbilical; tegilla broken in material examined.

Remarks. — *Globotruncana* sp.$_2$ differs from *Globotruncana arca* (CUSHMAN) in having a less convex spiral side, a nonperforated wall ornamented by nodules, and in the different position of keels on the peripheral margin of the test. It differs from *Globotruncana bulloides* VOGLER in having less convex chambers on the spiral side, a nonperforated wall ornamented by nodules on the spiral side, and in the different position of its keels relative to the peripheral margin of the test.

Occurrence. — Central Poland (Ciszyca Kol.): Upper Campanian.

Genus *Archaeoglobigerina* PESSAGNO, 1967
Archaeoglobigerina blowi PESSAGNO, 1967
(pl. 21: 1, 2, 3)

1967. *Archaeoglobigerina blowi* PESSAGNO; PESSAGNO, 316, pl. 59; 1–10, pl. 94: 2, 3.
1971. *Rugoglobigerina (Archaeoglobigerina) blowi* (PESSAGNO); EL-NAGGAR, pl. 4: a–c.

Material. — 23 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/180	0·44	0·34	0·17

Description. — Test trochospiral, spiral side slightly convex, strongly lobulate peripherally; periphery truncated by 2 weakly developed keels; chambers spherical, nearly as long as wide; final whorl consisting of 4–5 chambers increasing sharply in size as added; spiral sutures depressed, oblique; umbilical sutures radial to somewhat curved; umbilicus medium-sized; primary aperture umbilical; tegilla broken in material examined.

Remarks. — *A. blowi* differs from *A. cretacea* (d'ORBIGNY) in possessing more spherical chambers, in showing a sharper rate of increase in chamber size, and a more lobulate periphery.

Occurrence. — USA (Texas): Coniacian-Santonian; Mexico: Campanian; Central Poland (Wesołówka 32, 33, 39, 42): Coniacian-Santonian.

Archaeoglobigerina bosquensis PESSAGNO, 1967
(pl. 21: 11, 12, 13)

1967. *Archaeoglobigerina bosquensis* PESSAGNO; PESSAGNO, 316, 317, pl. 60: 7–12.
1969. *Archaeoglobigerina bosquensis* PESSAGNO; DOUGLAS and RANKIN, 199, 200, fig. 10.
1970. *Archaeoglobigerina* cf. *blowi* PESSAGNO; NORTH and CALDWELL, 50, 51, pl. 4: 5a–b.
1973. *Archaeoglobigerina bosquensis* PESSAGNO; NORLING, 110, 111, pl. 6: 1–2.
1974. *Archaeoglobigerina bosquensis* PESSAGNO; HERB, 753, pl. 5: 1–6.
1977. *Archaeoglobigerina bosquensis* PESSAGNO; SLITER, 542, pl. 9: 3–5.

Material. — 6 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/185	0·28	0·24	0·12
ZPAL FXXIII/187	0·28	0·24	0·12

Description. — Test highly trochospiral, lobulate; chambers subspherical; final whorl consisting of 5–6 chambers; sutures depressed, radial; wall ornamented by nodules of different size; primary aperture umbilical.

Remarks. — *A. bosquensis* differs from *A. blowi* PESSAGNO in being higher spiral, in having a less lobulate periphery, a thicker ornamentation and in lacking keels or imperforate peripheral bands.

Occurrence. — Southern Atlantic Ocean: Upper Santonian; USA: Coniacian-Santonian; Canada: Upper Campanian; South Sweden: Coniacian-Santonian; Denmark (Bornholm): Coniacian-Santonian; Central Poland (Wesołówka 32, 33, 37, 39, 42, Dorotka): Santonian-Upper Campanian.

Archaeoglobigerina cretacea (d'ORBIGNY, 1840)
(pl. 21: 5, 6, 7)

1840. *Globigerina cretacea* d'ORBIGNY; d'ORBIGNY, 34, pl. 3: 12–14 (*fide* ELLIS and MESSINA, Catalogue Foram.).
1954. *Globotruncana globigerinoides* BROTZEN; KSIĄŻKIEWICZ, 280, pl. 30: 2, 3, text-fig. 56, 57.
1956. *Globotruncana saratogensis* (APPLIN); BRÖNNIMANN and BROWN, 544, pl. 21: 13–15.
1962. *Globotruncana globigerinoides* BROTZEN; HERM, 80, pl. 5: 6.
1964. *Globotruncana mariai* GANDOLFI; MARTIN, 82, pl. 9: 7a–c.
1965. *Globotruncana marginata* (REUSS); van HINTE, 23, pl. 1: 2.
part. 1971. *Rotundina cretacea* (d'ORBIGNY); BELLIER, 87–88, pl. 1: 1, 2, *non* pl. 1: 3.
1972. *Globotruncana marginata* (REUSS); GOVINDAN, 179–180, pl. 4: 10–12.
1972. *Globotruncana cretacea* (d'ORBIGNY); HANZLIKOWA, 105, pl. 28: 3–5.

1975. *Globotruncana globigerinoides* BROTZEN; VAPTZAROVA, 26, pl. 1: 7, 8, 9.
1976. *Globotruncana cretacea* (d'ORBIGNY); IBRAHIM, 103, pl. 5: 10a–c.
1977. *Archaeoglobigerina cretacea* (d'ORBIGNY); RODRIGUEZ, 72–77, pl. 4: 1–2.

Material. — 9 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/181	0·35	0·31	0·13

Description. — Test low trochospiral, consisting of 2½–3 whorls; equatorial periphery lobate; chambers subspherical; final whorl consisting of 5–6 chambers successively increasing in size with the exception of the ultimate chamber that is somewhat smaller than the penultimate one; spiral sutures curved, depressed; umbilical sutures radial, depressed; periphery occasionally with weakly developed double keel; wall coarsely hispid, in ultimate chamber less than in others; umbilicus wide, deep; primary aperture umbilical; tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — *A. cretacea* differs from *A. bosquensis* PESSAGNO in being a more delicately ornamented and in possessing a better developed double keel.

Occurrence. — India: Upper Campanian-Lower Maastrichtian; Bulgaria: Campanian; Austria: Campanian-Maastrichtian; France: Turonian; Czechoslovakia (Moravia): Santonian-Lower Campanian; Poland — Mielnik: Campanian-Lower Maastrichtian, Chełm: Upper Turonian-Campanian, Central Poland (Wesołówka 38, 39, 40, 42, 43, Dorotka): Coniacian-Campanian; Carpathians (Bachowice): Upper Turonian-Coniacian.

Genus *Globotruncanita* REISS, 1957

Globotruncanita elevata (BROTZEN, 1934)

(pl. 20: 2, 3, 4)

1934. *Rotalia elevata* BROTZEN; BROTZEN, 66, pl. 3: c (*fide* ELLIS and MESSINA, Catalogue Foram.).
1963. *Globotruncana elevata* (BROTZEN); GRAHAM and CHURCH, 63, pl. 7: 13a–c.
1966. *Globotruncana elevata* (BROTZEN); DOUGLAS and SLITER, 110, pl. 3: 2.
1968. *Globotruncana elevata* (BROTZEN); SLITER, 102, pl. 16: 3.
1969. *Globotruncana elevata* (BROTZEN); ESKER III, pl. 2: 16, 17, 18.
1969. *Globotruncana elevata* (BROTZEN); DOUGLAS, 179, pl. 1: 6.
1970. *Globotruncana elevata* (BROTZEN); LONGORIA, 43–47, pl. 6: 7–9, pl. 11: 7, pl. 18: 5, pl. 19: 4 (here additional synonymy).
part. 1970. *Globotruncana elevata* (BROTZEN); KUHRY, 292–295, pl. 1: 1–3 (lectotype), fig. 1 (three views), 4a–b, 4e–f, 4g–h, *non* pl. 1: 4–6, 7–9, *non* fig. 4c–d.
1972. *Globotruncana elevata* (BROTZEN); CARON, 554, pl. 1: 1, fig. 3a.
1972. *Globotruncana elevata* (BROTZEN); BARR, 20, pl. 6: 5a–c.
1973. *Globotruncana elevata* (BROTZEN); OWEN, pl. 16: 3–5.
1973. *Globotruncana elevata* (BROTZEN); SMITH and PESSAGNO, 47, 48, pl. 19: 1–3, 4–6.
1975. *Globotruncana stuartiformis* DALBIEZ; STAPLETON, pl. 1: 1a–c.
1975. *Globotruncana elevata* (BROTZEN); VAPTZAROVA, 25, pl. 1: 4, 5, 6.

Material. — 8 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/171	0·40	0·34	0·24

Description. — Test trochospiral, planoconvex, umbilicoconvex, flat to slightly concave spiral side with an elevation in the centre, consisting of 3 whorls; equatorial periphery rounded, slightly lobulate; the angle between umbilical and spiral sides of chambers is 80–90° in the ultimate chamber and 60–70° on the opposite side of final whorl; chambers petaloid on spiral side, subrectangular on umbilical side; final whorl consisting of 5–7 chambers successively

slightly larger in size, truncated by well developed, beaded, single keel; spiral sutures curved, raised, nodose; umbilical sutures curved, beaded; wall finely perforate, smooth except for the earliest chambers of the final whorl which are often rugose; umbilicus small, deep; primary aperture umbilical; tegilla broken in material examined.

Remarks. — KUHRY (1970) studying the type material of *Globotruncanita elevata* (BROTZEN) stated that slides labelled *Rotalia elevata* and *Globotruncana elevata* contain specimens belonging to several species. He showed also that slides A 264 NR and A 266 NR labelled *Rotalia elevata* contain the original type material. Because BROTZEN in his paper did not show the holotype, 4 specimens present in the slide can be regarded as syntypes. One of the syntypes possessing all the important characteristics of the BROTZEN's type figure and corresponding to most micropaleontologists' images of that species, was chosen as the lectotype of *Globotruncanita elevata* (BROTZEN). At the same time KUHRY (1970) included in the synonymy of that species the following: *Globotruncanita andori* (DE KLASZ), *Globotruncanita stuartiformis* (DALBIEZ) and *Globotruncanita subspinosa* (PESSAGNO). KUHRY (1970) stated after examination of the type material of *Globotruncanita elevata* (BROTZEN) that the differences between *Globotruncanita elevata* (BROTZEN) and *Globotruncanita andori* (DE KLASZ) as given by the creator of the latter species do not exist and are the result of the simplified illustration given by BROTZEN (1934). Including *Globotruncanita stuartiformis* (DALBIEZ) and *Globotruncanita subspinosa* (PESSAGNO) in the synonymy of *Globotruncanita elevata* (BROTZEN), KUHRY (1970) argued that they are linked by a continuous series of transitional forms and represent one species.

I agree with CARON (1972) that "any planktic foraminiferal species is linked to others by transitional forms, whenever sufficiently rich and well-preserved assemblages are examined". As was evidenced by CARON (1972), the distinct morphological differences in the test structure and their different stratigraphical range enable us to treat them as 3 different species.

In Central Poland *Globotruncanita elevata* (BROTZEN) was found in the chalk from the uppermost Lower Maastrichtian. Possessing a flat to slightly concave spiral side with an elevation in the centre, the highly convex umbilical side and a characteristic large angle between the spiral and umbilical sides in the ultimate chamber, it possesses all the diagnostic features typical of that species.

Occurrence. — USA, Mexico: Campanian-Maastrichtian; Papua New Guinea: Upper Santonian; Israel: Lower Campanian; Libya: Campanian-Lower Maastrichtian; South Africa: Campanian-Lower Maastrichtian; Bulgaria: Campanian; Central Poland (Chotcza): Lower Maastrichtian.

Subfamily **Rugoglobigerininae** SUBBOTINA, 1953

Genus *Rugoglobigerina* BRÖNNIMANN, 1952

Rugoglobigerina hexacamerata BRÖNNIMANN, 1952

(pl. 22: 6, 7)

1952. *Rugoglobigerina reicheli hexacamerata* BRÖNNIMANN; BRÖNNIMANN, 23–25, pl. 2: 10–12, fig. 8: a–m.
1967. *Rugoglobigerina hexacamerata* BRÖNNIMANN; PESSAGNO, 364–365, pl. 74: 4, pl. 91: 5–7.
1971. *Rugoglobigerina hexacamerata* BRÖNNIMANN; EL-NAGGAR, 485–486, pl. 9: 1–3, 5–12, pl. 10: 1–2.
1972. *Rugoglobigerina hexacamerata* BRÖNNIMANN, BARR, 28–29, pl. 9: 6a–c.
1973. *Rugoglobigerina hexacamerata* BRÖNNIMANN; OWEN, 63, pl. 20: 4–6.

Material. — 4 specimens.

Dimensions (in mm):

	L	W	T
ZPAL FXXIII/194	0·24	0·20	0·10

Description. — Test low trochospiral, spiral side slightly convex with weakly depressed central part, umbilical side planiform; equatorial periphery circular, lobate; axial periphery rounded: test comprises 3 to 3½ whorls: chambers spherical; final whorl consisting of 6 cham-

bers increasing slowly in size as added, ultimate chamber very often smaller than penultimate one; wall covered by meridionally arranged rugosities except terminal 2 or 3 chambers which are commonly smooth: spiral sutures depressed, radial; umbilical sutures radial to slightly curved; umbilicus small, deep; primary aperture umbilical; spiral system of tegilla.

Remarks. — *R. hexacamerata* somewhat resembles *Rugoglobigerina pennyi* BRÖNNIMANN but differs from it in being smaller, less trochospiral and spiroconvex, much narrower in apertural view and in having less well developed rugosities on 2–3 terminal chambers.

Occurrence. — Trinidad: Upper Maastrichtian; USA (Texas, Arkansas): Middle-Upper Maastrichtian; Mexico: Upper Maastrichtian; Papua New Guinea: Lower Maastrichtian; Egypt: Middle-Upper Maastrichtian; Libya: Upper Maastrichtian; Austria (Tirol): Uppermost Maastrichtian; Central Poland (Boiska, Kazimierz): Maastrichtian.

Rugoglobigerina macrocephala BRÖNNIMANN, 1952

(pl. 22: 12, 15, 16)

1952. *Rugoglobigerina macrocephala macrocephala* BRÖNNIMANN; BRÖNNIMANN, 25–27, pl. 2: 1–0, fig. 9: a–s.
1961. *Rugoglobigerina macrocephala macrocephala* BRÖNNIMANN; CORMINBOEUF, 117, 118, pl. 2: 3a–c.
1961. *Rugoglobigerina macrocephala ornata* BRÖNNIMANN; CORMINBOEUF, 118, pl. 2: 4a–c.
non 1962. *Rugoglobigerina macrocephala macrocephala* BRÖNNIMANN; HERM, 58, pl. 3: 1.
1972. *Rugoglobigerina macrocephala* BRÖNNIMANN; GOVINDAN, 174, pl. 3: 4–6, 19–21.
1973. *Rugoglobigerina macrocephala* BRÖNNIMANN; SMITH and PESSAGNO, 56–57, pl. 23: 1–3, 7–10 (here additional synonymy).
non 1973. *Rugoglobigerina macrocephala* BRÖNNIMANN; OWEN, 63, pl. 20: 7–9.
non 1974. *Rugoglobigerina macrocephala* BRÖNNIMANN; VAPTZAROVA, 46, pl. 4: 4, 5, 6.
1975. *Rugoglobigerina macrocephala* BRÖNNIMANN; STAPLETON, pl. 2: 8a–c.
non 1977. *Rugoglobigerina macrocephala* BRÖNNIMANN; HAMAM and HAYNES, 56, pl. 2: 7–8.

Material. — 6 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/196	0·34	0·20	0·20

Description. — Test very low trochospiral, consisting of 3 to 3½ whorls; equatorial periphery lobate, axial periphery broadly rounded; chambers globular, subspherical; final whorl consisting of 3–4 chambers increasing rapidly in size as added; ultimate chamber constitutes almost a half of whorl and occupies a position opposing other chambers of the whorl; sutures depressed, radial; wall covered by meridionally arranged rugosities; umbilicus rather small; primary aperture interiomarginal, umbilical; tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — It is probable that *R. macrocephala* descends from *R. rugosa* (PLUMMER); transitional individuals have been observed. Four-chambered specimens were often included in *Rugoglobigerina macrocephala* (e. g., OWEN, 1973, pl. 20: 7–9, VAPTZAROVA 1974, pl. 4: 4, 5, 6, HAMAM and HAYNES 1977, pl. 2: 7–8) but as their successive chambers do not increase in size so sharply, they lack a trilobate equatorial periphery and the ultimate chamber is not placed in opposition to other chambers, they should be instead included in *Rugoglobigerina rugosa* (PLUMMER).

Occurrence. — Trinidad: Maastrichtian; USA (Arkansas, Texas), Mexico: Middle-Upper Maastrichtian; India: Middle-Upper Maastrichtian; South Africa: Middle-Upper Maastrichtian; Egypt: Maastrichtian; Central Poland (Kazimierz, Bochotnica): Upper Maastrichtian.

Rugoglobigerina milamensis SMITH and PESSAGNO, 1973
(pl. 22: 1, 5, 9)

part. 1962. *Rugoglobigerina rugosa* (PLUMMER); BERGGREN, 71–75, pl. 11: 3a–5a–b, *non* pl. 11: 1a–b, 2, 4a–c, *non* fig. 8.
part. 1964. *Rugoglobigerina rugosa* (PLUMMER); OLSSON, 173, pl. 7: 3a–c, 4a–c, *non* pl. 7: 2a–c, 5a–c.
part. 1966. *Rugoglobigerina rotundata* BRONNIMANN; DOUGLAS, and SLITER, 116, pl. 1: 5a–c, *non* pl. 1: 6a–c.
1973. *Rugoglobigerina milamensis* SMITH and PESSAGNO; SMITH and PESSAGNO, 56, 57, pl. 24: 4–7.
1974. *Rugoglobigerina rugosa* (PLUMMER); VAPTZAROVA, 44, 45, pl. 3: 19–21, 22–24.
1975. *Rugoglobigerina rugosa* (PLUMMER); STAPLETON, pl. 2: 7a–c.

Material. — 11 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/188	0·36	0·33	0·24

Description. — Test high trochospiral, consisting of 2 to 3 whorls; equatorial periphery subcircular, lobate; chambers spherical to subspherical, slightly elongated axially in apertural view; final whorl consisting of 5 to 6 chambers increasing only slightly in size as added; ultimate chamber slightly offset umbilically; sutures radial, depressed; wall strongly ornamented with costellae but ornamentation not clearly developed in a meridional pattern; ornament on ultimate chamber weaker than on preceding chambers; umbilicus large, deep; primary aperture umbilical; tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — The specimens described are richly ornamented, but the ornamentation is not so clearly developed in a meridional pattern as that observed in the holotype. In Polish specimens chambers of the final whorl are less elongated axially than in the holotype.

R. milamensis differs from *Rugoglobigerina pennyi* BRÖNNIMANN in having a higher spiral side and chambers not so strongly elongated axially in apertural and adapertural views. The specimens figured by BERGGREN (1962, pl. 11: 3a–c, 5a–c), OLSSON (1964, pl. 7: 3a–c, 4a–c), VAPTZAROVA (1974, pl. 3: 19–21, 22–24) and STAPLETON (1975, pl. 2: 7a–c) as *R. rugosa* belong to *R. milamensis* because those specimens appear to be strongly trochospiral and spiroconvex and possess chambers elongated axially in apertural view. The specimen figured by DOUGLAS and SLITER (1966, pl. 1: 5a–c) as *Rugoglobigerina rotundata* BRÖNNIMANN is strongly spiroconvex and its chambers are not elongated axially and is therefore included here in *R. milamensis*.

Occurrence. — USA (New Jersey, California, Texas, Arkansas): Maastrichtian; South Africa: Maastrichtian; Bulgaria: Upper Campanian-Lower Maastrichtian; Denmark: Maastrichtian; Central Poland (Solec, Kłudzie, Boiska, Kazimierz, Bochotnica): Maastrichtian.

Rugoglobigerina pennyi BRÖNNIMANN, 1952
(pl. 22: 10, 11, pl. 12: 6)

1952. *Rugoglobigerina rugosa pennyi* BRÖNNIMANN; BRÖNNIMANN, 34, pl. 4: 1–3, fig. 14a–c, d–f, g–i.
1962. *Rugoglobigerina pennyi*; BERGGREN, 75, pl. 12: 1a–c, 2a–c, 3a–c.
part. 1966. *Rugoglobigerina rotundata* BRÖNNIMANN and BROWN; DOUGLAS and SLITER, 116, pl. 1: 6a–c, *non* pl. 1: 5a–c.
part. 1971. *Rugoglobigerina* (*R.*) *pennyi* BRÖNNIMANN; EL-NAGGAR, 488–489, pl. 8: 1, *non* pl. 8: 2, pl. 9: 4, 13, 15, 16, *non* pl. 9: 14; pl. 17: 12, *non* pl. 6: 19, *non* pl. 11: 1–10.
1972. *Rugoglobigerina pennyi* BRÖNNIMANN; GOVINDAN, 174, pl. 3: 7–9.
part. 1972. *Rugoglobigerina pennyi* BRÖNNIMANN; HANZLIKOVA, 114, 115, pl. 33: 2, *non* pl. 33: 1, 3.
1973. *Rugoglobigerina pennyi* BRÖNNIMANN; SMITH and PESSAGNO, 57, pl. 24: 1–3.
1974. *Rugoglobigerina pennyi* BRÖNNIMANN; VAPTZAROVA, 47, pl. 4: 7, 8, 9.
1977. *Rugoglobigerina pennyi* BRÖNNIMANN; RODRIGUEZ, 88–89, pl. 5: 1–3.

Material. — 7 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/191	0·34	0·32	0·20

Description. — Test low trochospiral, consisting of $2^1/_2$ to 3 whorls; equatorial periphery lobate; chambers spherical; final whorl consisting of 6 chambers increasing gently in size as added; wall covered by meridionally arranged rugosities; sutures depressed, radial; umbilicus broad, deep; primary aperture interiomarginal, umbilical; tegilla broken in material examined.

Remarks. — The specimens illustrated as *Rugoglobigerina rotundata* BRÖNNIMANN by DOUGLAS and SLITER (1966, pl. 1: 6a–c) does not possess characteristic axially elongated chambers in apertural and adapertural views; the low trochospiral test and globular chambers successively increasing in size only gradually enable us to include this specimen in *R. pennyi*.

Occurrence. — Trinidad: Upper Maastrichtian; USA (Texas; Arkansas), Mexico: Middle-Upper Maastrichtian; India: Middle-Upper Maastrichtian; Egypt: Maastrichtian; Bulgaria: Upper Maastrichtian; Czechoslovakia (Moravia): Maastrichtian; Central Poland (Kłudzie, Boiska, Kazimierz): Maastrichtian.

Rugoglobigerina rotundata BRÖNNIMANN, 1952
(pl. 22: 13, 14)

1952. *Rugoglobigerina rotundata* BRÖNNIMANN; BRÖNNIMANN, 34–36, pl. 4: 7–9, fig. 15a–c, d–f, 16a–c.
non 1966. *Rugoglobigerina rotundata* BRÖNNIMANN; DOUGLAS and SLITER, 116, pl. 1: 5a–c, 6a–c.
1972. *Rugoglobigerina rotundata* BRÖNNIMANN; HANZLIKOVA, 115, pl. 33: 8, 9.
1972. *Rugoglobigerina pustulata* BRÖNNIMANN; HANZLIKOVA, 115, pl. 33: 7.
1972. *Rugoglobigerina rotundata* BRÖNNIMANN; BARR, 30, pl. 10: 3a–c.
1973. *Rugoglobigerina rotundata* BRÖNNIMANN; SMITH and PESSAGNO, 58, pl. 24: 8–11 (here additional synonymy).
1974. *Rugoglobigerina rotundata* BRÖNNIMANN; VAPTZAROVA, 46–47, pl. 3: 25–28.
1974. *Rugoglobigerina pustulata* BRÖNNIMANN; VAPTZAROVA, 45, 46, pl. 4: 1, 2, 3.
1977. *Rugoglobigerina rotundata* BRÖNNIMANN; SLITER, 543, pl. 11: 1–3.

Material. — 8 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/203	0·35	0·33	0·21

Description. — Test low trochospiral; equatorial periphery lobate, axial periphery rounded; final whorl consisting of 5–6 chambers increasing gradually in size as added, distinctly elongated axially in apertural and abapertural views; wall covered by meridionally arranged rugosities; umbilicus small, deep; primary aperture interiomarginal, umbilical; tegilla with infralaminal and intralaminal accessory apertures.

Remarks. — The species discussed differs from *R. milamensis* SMITH and PESSAGNO in having the chambers more elongated axially in apertural and adapertural views and in being very low trochospiral.

Occurrence. — Southern Atlantic Ocean: Lower Campanian-Lower Maastrichtian; Trinidad: Upper Maastrichtian; USA (Texas, Arkansas, California), Mexico: Upper Maastrichtian; Egypt: Middle-Upper Maastrichtian; Libya: Upper Maastrichtian; Bulgaria: Upper Maastrichtian; Austria (Tirol): Upper Maastrichtian; Czechoslovakia (Moravia): Maastrichtian; Central Poland (Kazimierz): Upper Maastrichtian.

Rugoglobigerina rugosa (PLUMMER, 1926)
(pl. 22: 2, 3, 4, 8)

1926. *Globigerina rugosa* PLUMMER; PLUMMER, 38–39, pl. 2: 10a–d (*fide* ELLIS and MESSINA, Catalogue Foram.).
1952. *Rugoglobigerina rugosa rugosa* (PLUMMER); BRÖNNIMANN, 28–33, fig. 11a–i, 12a–i, 13a–i.
1969. *Rugoglobigerina rugosa* (PLUMMER); DOUGLAS, 175–176, pl. 6: 1–2.
1970. *Rugoglobigerina rugosa* (PLUMMER); TODD, 152, pl. 6: 1.
1972. *Rugoglobigerina rugosa* (PLUMMER); GOVINDAN, 173–174, pl. 3: 1–3, 13–18.

1972. *Rugoglobigerina rugosa* (PLUMMER); HANZLIKOVA, 116, pl. 23: 5, 6.
1973. *Rugoglobigerina rugosa* (PLUMMER); SMITH and PESSAGNO, 58–60, pl. 25: 1–4 (here additional synonymy).
1974. *Rugoglobigerina macrocephala* BRÖNNIMANN; VAPTZAROVA, 46, pl. 4: 4, 5, 6.
non 1974. *Rugoglobigerina rugosa* (PLUMMER); VAPTZAROVA, 44, 45, pl. 3: 19–21, 22–24.
non 1975. *Rugoglobigerina rugosa* (PLUMMER); STAPLETON, pl. 2: 7a–c.
1977. *Rugoglobigerina rugosa* (PLUMMER); RODRIGUEZ, 82–86, pl. 4: 5–7.
1977. *Rugoglobigerina rugosa* (PLUMMER); HAMAM and HAYNES, pl. 2: 12.
1977. *Rugoglobigerina macrocephala* BRÖNNIMANN; HAMAM and HAYNES, 56, pl. 2: 7–8.

Material. — 68 specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/199	0·34	0·28	0·20

Description. — Test trochospiral, biconvex, of moderately convex spiral side, consisting of 2½ whorls; equatorial periphery lobate, axial periphery broadly rounded; chambers globular, hemispherical; final whorl consisting of 4–5 chambers, increasing sharply in size as added; wall covered by meridionally arranged rugosities, variable degree of ornamentation; spiral sutures distinctly depressed, slightly curved; umbilical sutures distinctly depressed, radial; umbilicus large, deep; primary aperture umbilical; tegilla with intralaminal and infralaminal accessory apertures.

Remarks. — *R. rugosa* is a very common species appear in the Upper Campanian and has been recorded many times in the literature. However, the forms with 4–4½ chambers in the final whorl were often erroneously determined as *Rugoglobigerina macrocephala* BRÖNNIMANN (e. g., VAPTZAROVA 1974, pl. 4: 4–7, HAMAM and HAYNES 1977). *Rugoglobigerina rugosa* (PLUMMER) with 4 chambers in the final whorl differs from *Rugoglobigerina macrocephala* BRÖNNIMANN in having the chambers less sharply increasing in size as added and in that the ultimate chamber does not constitute half of the total test size.

Forms with a high spiral side were often included in *R. rugosa* but at present they are included in *Rugoglobigerina milamensis* SMITH and PESSAGNO (e. g., VAPTZAROVA 1974, pl. 3: 19–21, 22–24; STAPLETON 1975, pl. 2: 7a–c).

Occurrence. — USA (Texas, Arkansas), Mexico: Campanian, Maastrichtian; India: Upper Campanian-Maastrichtian; Papua New Guinea: Maastrichtian; Trinidad, South Africa: Upper Maastrichtian; Jordan: Maastrichtian; Spain, Bulgaria, Czechoslovakia (Moravia); Maastrichtian; Central Poland (Dziurków, Solec, Kłudzie, Boiska, Lucimia, Kazimierz, Bochotnica): Upper Campanian-Maastrichtian.

Family **Abathomphalidae** PESSAGNO, 1967
Genus *Abathomphalus* BOLLI, LOEBLICH and TAPPAN, 1957
Abathomphalus? *hilli* (PESSAGNO, 1967)
(pl. 23: 10, 11, 12)

part. 1966. *Globotruncana linneiana* (d'ORBIGNY); DOUGLAS and SLITER, 112, pl. 5: 7, *non* pl. 5: 6, 8, *non* pl. 4: 4, 6, 9.
1967. *Globotruncana hilli* PESSAGNO; PESSAGNO, 343, 344, pl. 64: 9–14, 21–23, pl. 94: 1, pl. 97: 7.
1969. *Globotruncana hilli* PESSAGNO; DOUGLAS, 180, pl. 7: 7, 8.

Material. — 16 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/214	0·39	0·35	0·13
ZPAL FXXIII/215	0·44	0·40	0·14

Description. — Test low trochospiral, consisting of 2½ to 3 whorls; periphery truncated by widely spaced, weakly developed double keel; chambers petaloid on spiral side, subrectan-

gular on umbilical side; final whorl consisting of 5 chambers; spiral sutures curved, slightly raised; umbilical sutures depressed, slightly curved; wall pustulose; umbilicus shallow, broad; primary aperture extraumbilical-umbilical; techo with infralaminal accessory apertures.

Remarks. — PESSAGNO (1967) in designating *Globotruncana hilli* stated that in this species the umbilicus is covered by a tegilla with infralaminal and intralaminal accessory apertures. However, his figures of the holotype and paratypes show that these additional structures are destroyed. In the material from the Vistula River profile several specimens with apertural apparatus were found, but it is not a tegilla with infralaminal and intralaminal accessory apertures but rather a techo with an infralaminal accessory aperture. On this evidence this species should be included in *Abathomphalus* rather than in *Globotruncana*.

Occurrence. — USA (Texas, Arkansas, California): Upper Campanian-Lower Maastrichtian; Mexico: Upper Campanian-Lower Maastrichtian; Central Poland (Dorotka, Chotcza): Upper Campanian-Lower Maastrichtian.

Abathomphalus? cf. *subornatus* (GANDOLFI, 1955)
(pl. 23: 7, 8, 9)

Material. — 8 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/211	0·21	0·17	0·10
ZPAL FXXIII/212	0·21	0·16	0·11

Description. — Test low trochospiral with slightly concave initial whorls on spiral side; chambers almost spherical, truncated by weakly developed double keel; final whorl consisting of 4 chambers increasing rapidly in size as added; sutures depressed, initially slightly curved, later straight; wall intensively ornamented by nodules of various sizes; primary aperture umbilical; techo with infralaminal accessory apertures.

Remarks. — Some specimens possess well preserved accessory structures: a techo with infralaminal apertures. On this evidence I included the specimens described in *Abathomphalus*?. *A.*? cf. *subornatus* differs from the holotype in a less sharp and more regular increase in size of chambers of the final whorl and in being considerably smaller.

Occurrence. — Central Poland (Dorotka): Upper Campanian.

Genus *Globotruncanella* REISS, 1957
Globotruncanella petaloides (GANDOLFI, 1955)
(pl. 23: 1, 2, 3)

1955. *Rugoglobigerina petaloidea petaloidea* GANDOLFI; GANDOLFI, 52, pl. 3: 13.
1962. *Rugoglobigerina petaloidea* GANDOLFI; HERM, 59, pl. 2: 5.
1966. *Globotruncanella petaloidea* (GANDOLFI); DOUGLAS and SLITER, 113, pl. 1: 11.
1967. *Globotruncanella petaloidea* (GANDOLFI); PESSAGNO, 374–375, pl. 82: 6–8, 9.
1968. *Globotruncana petaloidea* (GANDOLFI); SLITER, 105, pl. 18: 1.
1969. *Globotruncanella petaloidea* (GANDOLFI); DOUGLAS, 190–192, pl. 7: 2.
1970. *Globotruncanella petaloidea* (GANDOLFI); TODD, 153–154, pl. 5: 9.
1972. *Globotruncanella petaloidea* (GANDOLFI); GOVINDAN, 180–181, pl. 5: 7.
1973. *Globotruncanella petaloidea* (GANDOLFI); SMITH and PESSAGNO, 61–62, pl. 27: 1–3, 4–6.
1973. *Globotruncanella petaloidea* (GANDOLFI); OWEN, 62, pl. 20: 1–3.

Material. — 4 well preserved specimens.
Dimensions (in mm):

	L	W	T
ZPAL FXXIII/205	0·26	0·21	0·11
ZPAL FXXIII/206	0·29	0·25	0·12

Description. — Test low trochospiral, flattened, umbilical side slightly concave; peripheral margin strongly lobulate, axial periphery arched; chambers subglobular with a distinct flattening along the axial periphery; final whorl consisting of 4 to 4½ whorls; sutures depressed, radial to slightly curved; wall finely pustulose; umbilicus small, rather deep; primary aperture interiomarginal, extraumbilical-umbilical, with a prominent apertural flap extending over a portion of umbilicus.

Remarks. — *G. petaloidea* is very similar to *G. havanensis* (VOORWIJK), differing from the latter mainly in having a lower arc-shaped test in side view and in having more inflated chambers on both sides.

Occurrence. — South Africa, Columbia: Upper Maastrichtian; USA (California, Texas), Mexico: Maastrichtian; USA (New Jersey): Upper Campanian-Maastrichtian; India: Campanian-Upper Maastrichtian; Papua New Guinea: Lower Maastrichtian; Denmark: Upper Maastrichtian; Austria (Tirol): Upper Maastrichtian; Central Poland (Jarentowskie Pole, Chotcza, Kazimierz, Bochotnica): Maastrichtian.

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EXPLANATION OF THE PLATES 1—23

PLATE 1

1. *Guembelitria harrisi* TAPPAN. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/1.
2–6. *Guembelitria cenomana* (KELLER). Kazimierz, Upper Maastrichtian. ZPAL FXXIII/2, 3, 4.
7–8. *Guembelitria cretacea* CUSHMAN. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/5, 6.
9–10. *Guembelitriella* sp. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/7, 8.

PLATE 2

1. *Pseudoguembelina* sp. Dobre, Upper Maastrichtian. ZPAL FXXIII/240.
2, 4, 5, 7, 13. *Heterohelix striata* (Ehrenberg) Kazimierz, Upper Maastrichtian. ZPAL FXXIII/9, 10, 11, 12, 13.
3, 8. *Heterohelix moremani* (CUSHMAN). Dobre, Upper Maastrichtian. ZPAL FXXIII/16, 17.
6. *Heterohelix ultimatumida* (WHITE). Kazimierz, Upper Maastrichtian. ZPAL FXXIII/15.
9–10. *Heterohelix planata* (CUSHMAN). Kazimierz, Upper Maastrichtian. ZPAL FXXIII/24, 25.
11–12, 14. *Heterohelix globulosa* (EHRENBERG). Lucimia, Upper Maastrichtian. ZPAL FXXIII/18, 19, 14.

PLATE 3

1, 3, 6, 7. *Chiloguembelina praecursor* sp. n. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/36 — holotype (6), ZPAL FXXIII/34, 35, 37– paratypes (1, 3, 7).
2, 4, 11, 12. *Heterohelix ventilabrelliformis* (van der SLUIS). Kazimierz, Upper Maastrichtian. ZPAL FXXIII/30, 31, 32, 33.
5, 9. *Heterohelix navarroensis* LOEBLICH. Męćmierz, Upper Maastrichtian. ZPAL FXXIII/28, 29.
8. *Heterohelix pulchra* (BROTZEN). Józefów, Upper Campanian. ZPAL FXXIII/38.
10. *Heterohelix reussi* (CUSHMAN). Słupia Nadbrzeżna. Upper Turonian. ZPAL FXXIII/39.
13–14. *Heterohelix planata* (CUSHMAN). Chotcza, Lower Maastrichtian. ZPAL FXXIII/26, 27.

PLATE 4

1–9. *Heterohelix vistulaensis* sp. n. Męćmierz, Upper Maastrichtian. ZPAL FXXIII/42 — holotype (2), ZPAL FXXIII/41, 43, 44, 45, 46, 47, 48, 49 — paratypes (1, 3–9).

PLATE 5

1–3. *Planoglobulina carseyae* (PLUMMER). Kazimierz, Upper Maastrichtian. ZPAL FXXIII/52, 53, 54.
4. *Planoglobulina brazoensis* MARTIN. Chotcza, Lower Maastrichtian. ZPAL FXXIII/55.
5. *Planoglobulina acervulinoides* (EGGER). Chotcza, Lower Maastrichtian. ZPAL FXXIII/56.
6–7. *Heterohelix globulosa* (EHRENBERG). Lucimia, Upper Maastrichtian. ZPAL FXXIII/20, 21.
8–9. *Heterohelix striata* (EHRENBERG). Lucimia, Upper Maastrichtian. ZPAL FXXIII/22, 23.

PLATE 6

1–2. *Pseudotextularia* cf. *elegans* (RZEHAK). Chotcza, Lower Maastrichtian. ZPAL FXXIII/59.
3–4. *Pseudotextularia* sp. Wesołówka 44, Lower Campanian. ZPAL FXXIII/60, 61.
5. *Planoglobulina carseyae* (PLUMMER). Chotcza, Lower Maastrichtian. ZPAL FXXIII/59.
6. *Pseudotextularia deformis* (KIKOINE). Chotcza, Lower Maastrichtian. ZPAL FXXIII/58.
7. *Racemiguembelina powelli* SMITH and PESSAGNO. Chotcza, Lower Maastrichtian. ZPAL FXXIII/57.

PLATE 7

1–2. *Globigerinelloides volutus* (WHITE). Chotcza, Lower Maastrichtian. ZPAL FXXIII/62, 63.
3–4. *Globigerinelloides caseyi* (BOLLI, LOEBLICH and TAPPAN). Jakubowice, Cenomanian. ZPAL FXXIII/64, 65.
5, 6, 9. *Globigerinelloides bentonensis* (MORROW). Wesołówka 43, Upper Santonian. ZPAL FXXIII/66, 67, 68.
7. *Globigerinelloides yaucoensis* (PESSAGNO). Kazimierz, Upper Maastrichtian. ZPAL FXXIII/69.
8, 14. *Globigerinelloides prairiehillensis* PESSAGNO. Lucimia, Upper Maastrichtian. ZPAL FXXIII/70, 71.
10–11. *Heterohelix* cf. *punctulata* (CUSHMAN). Lucimia, Upper Maastrichtian. ZPAL FXXIII/217, 218.
12. *Heterohelix globulosa* (EHRENBERG). Lucimia, Upper Maastrichtian. ZPAL FXXIII/71.
13. *Heterohelix reussi* (CUSHMAN). Słupia Nadbrzeżna, Upper Turonian. ZPAL FXXIII/40.

PLATE 8

1–4. *Globigerinelloides prairiehillensis* PESSAGNO. Kazimierz, Chotcza, Maastrichtian. ZPAL FXXIII/72, 73, 74, 75,
5–11. *Globigerinelloides multispinus* (LALICKER). Lucimia, Chotcza, Maastrichtian. ZPAL FXXIII/76, 77, 78, 79, 80, 81, 82.

PLATE 9

1. *Hedbergella portsdownensis* (WILLIAMS-MITCHELL). Wesołówka 40, Lower Santonian. ZPAL FXXIII/83.
2–4. *Hedbergella crassa* (BOLLI). Chotcza, Lower Maastrichtian. ZPAL FXXIII/84, 85, 86.
5–7. *Hedbergella brittonensis* LOEBLICH and TAPPAN. Wesołówka 38, Lower Santonian. ZPAL FXXIII/87, 88, 89.
8–10. *Hedbergella bornholmensis* DOUGLAS and RANKIN. Dorotka, Upper Campanian. ZPAL FXXIII/90, 91, 92.

PLATE 10

1. *Hedbergella delrioensis* (CARSEY). Jakubowice, Cenomanian. ZPAL FXXIII/94.
2. *Hedbergella angolae* CARON. Jakubowice, Cenomanian. ZPAL FXXIII/95.
3. *Hedbergella* cf. *caspia* (VASSILENKO). Jakubowice, Cenomanian. ZPAL FXXIII/96.
4. *Hedbergella brittonensis* LOEBLICH and TAPPAN. Słupia Nadbrzeżna, Upper Turonian. ZPAL FXXIII/93.

5–6. *Hedbergella planispira* (TAPPAN). Kaliszany, Upper Campanian. ZPAL FXXIII/97, 98.

7–8. *Hedbergella simplicissima* (MAGNÉ and SIGAL). Karsy, Lower Turonian. ZPAL FXXIII/99, 100.

PLATE 11

1–4. *Rotalipora cushmani* (MORROW). Jakubowice, Upper Cenomanian. ZPAL FXXIII/101, 102, 103, 104.

PLATE 12

1. *Dicarinella biconvexa biconvexa* (SAMUEL and SALAJ). Karsy, Lower Turonian. ZPAL FXXIII/109.
2. *Dicarinella biconvexa gigantea* (SAMUEL and SALAJ). Karsy, Lower Turonian. ZPAL FXXIII/110.
3. *Praeglobotruncana hilalensis* BARR. Piotrowice, Lower Turonian. ZPAL FXXIII/111.
4. *Dicarinella* sp. Karsy, Lower Turonian. ZPAL FXXIII/112.
5. *Hedbergella* sp. Karsy, Lower Turonian. ZPAL FXXIII/113.
6. *Rugoglobigerina pennyi* BRÖNNIMANN. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/191.

PLATE 13

1–3. *Dicarinella longoriai* sp. n. Karsy, Lower Turonian. ZPAL FXXIII/114 — holotype (1), ZPAL FXXIII/115, 116 — paratypes (2, 3).

4–6. *Praeglobotruncana delrioensis* (PLUMMER). Karsy, Lower Turonian. ZPAL FXXIII/117, 118, 119.

7–9. *Praeglobotruncana stephani* (GANDOLFI). Karsy, Lower Turonian. ZPAL FXXIII/120, 121, 122.

10–12. *Dicarinella imbricata* (MORNOD). Karsy, Lower Turonian. ZPAL FXXIII/123, 124, 125.

PLATE 14

1. *Marginotruncana longilocula* (GANDOLFI). Wesołówka 38, Lower Santonian. ZPAL FXXIII/127.
2. *Marginotruncana pseudolinneiana* PESSAGNO. Wesołówka 43, Upper Santonian. ZPAL FXXIII/128.

3–5. *Marginotruncana paraconcavata* PORTHAULT. Wesołówka 39, Lower Santonian ZPAL FXXIII/130, 219, 220.

6. *Marginotruncana* cf. *renzi* (GANDOLFI). Wesołówka 32, Coniacian. ZPAL FXXIII/225.

PLATE 15

1. *Marginotruncana caronae* sp. n. Słupia Nadbrzeżna, Upper Turonian. ZPAL FXXIII/132 — holotype (1 *a*), ZPAL FXXIII/227, 228 — paratypes (1 *b*, 1 *c*).
2. *Dicarinella* cf. *concavata* (BROTZEN). Wesołówka 43, Upper Santonian. ZPAL FXXIII/133.
3. *Marginotruncana sinuosa* PORTHAULT. Wesołówka 39, Lower Santonian. ZPAL FXXIII/136.
4. *Marginotruncana* sp. Kolonia Słupia Nadbrzeżna, Upper Turonian. ZPAL FXXIII/135.

PLATE 16

1–2. *Marginotruncana coronata* (BOLLI). Wesołówka 40, Lower Santonian. ZPALFXXIII/105, 106.
3. *Globotruncana churchi* MARTIN. Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/107.
4. *Globotruncana arca* (CUSHMAN). Ciszyca Górna, Upper Campanian. ZPAL FXXIII/108.

PLATE 17

1–3. *Globotruncana plummerae* (GANDOLFI). Dorotka, Upper Campanian. ZPAL FXXIII/146, 147, 148.
4. *Marginotruncana* sp.$_1$ Wesołówka 32, Coniacian. ZPAL FXXIII/149, 222, 223.
5. *Marginotruncana marginata* (REUSS). Wesołówka 41, Upper Santonian. ZPAL FXXIII/150.
6–8. *Globotruncana bulloides* VOGLER. Sulejów, Upper Campanian. ZPAL FXXIII/151, 152, 153.

PLATE 18

1. *Globotruncana ventricosa* (WHITE). Ciszyca Górna, Upper Campanian. ZPAL FXXIII/134.
2–4. *Globotruncana* sp. Ciszyca Górna, Upper Campanian. ZPAL FXXIII/137, 138, 139.
5–7. *Globotruncana fornicata* PLUMMER. Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/140, 141, 142.
8–10. *Globotruncana* sp.$_1$. Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/143, 144, 145.

PLATE 19

1–3. *Globotruncana linneiana* (d'ORBIGNY). Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/154, 155, 156.
4–6. *Globotruncana lapparenti* BROTZEN. Dorotka, Upper Campanian. ZPAL FXXIII/157, 158, 159.
7–9. *Globotruncana obliqua* HERM. Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/160, 161, 162.
10–12. *Globotruncana* sp.$_2$. Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/131.

PLATE 20

1, 5, 9–12. *Globotruncana pozaryskae* sp. n. Ciszyca Górna, Upper Campanian. ZPAL FXXIII/174 — holotype (1), ZPAL FXXIII/175, 176, 177, 178, 179 — paratypes (5, 9–12).
2–4. *Globotruncanita elevata* (BROTZEN). Chotcza, Lower Maastrichtian. ZPAL FXXIII/171, 172, 173.
6–8. *Globotruncana pessagnoi* LONGORIA. Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/168, 169, 170.
13. *Globotruncana patelliformis* (GANDOLFI). Chotcza, Lower Maastrichtian. ZPAL FXXIII/165.
14–15. *Globotruncana nothi* (BRÖNNIMANN and BROWN). Ciszyca Kolonia, Upper Campanian. ZPAL FXXIII/166, 167.

PLATE 21

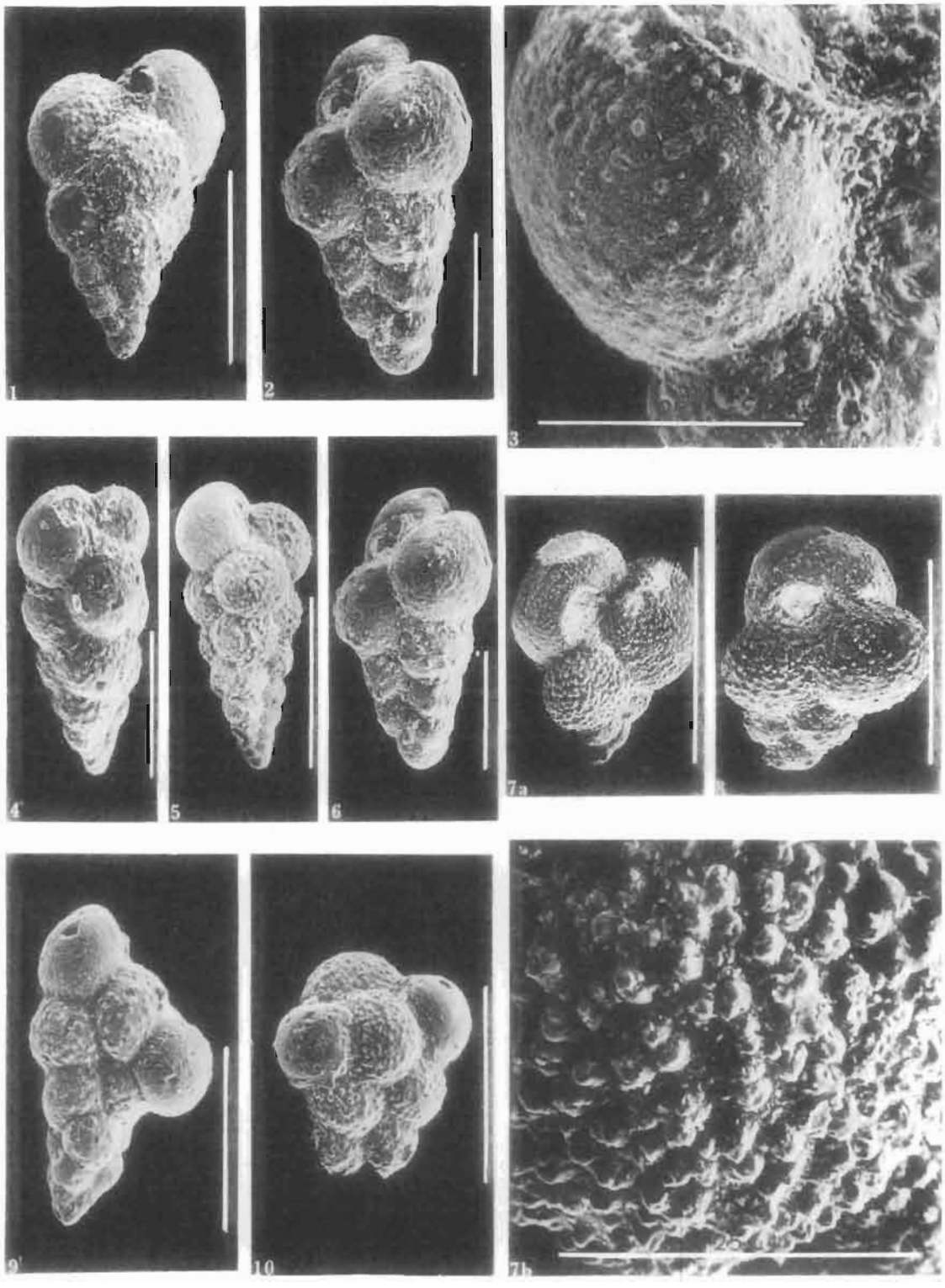
1–3. *Archaeoglobigerina blowi* PESSAGNO. Wesołówka 39, Lower Santonian. ZPAL FXIIIX/180.
4. *Heterohelix vistulaensis* sp. n. Męćmierz, Upper Maastrichtian. ZPAL FXXIII/221 — paratype.
5–7. *Archaeoglobigerina cretacea* (d'ORBIGNY). Wesołówka 39, Lower Santonian. ZPAL FXXIII/181, 182, 183,
8–10. *Helvetoglobotruncana helvetica* (BOLLI). Karsy, Lower Turonian. ZPAL FXXIII/184.
11–13. *Archaeoglobigerina bosquensis* PESSAGNO. Wesołówka 39, Lower Santonian. ZPAL FXXIII/185, 186, 187.

PLATE 22

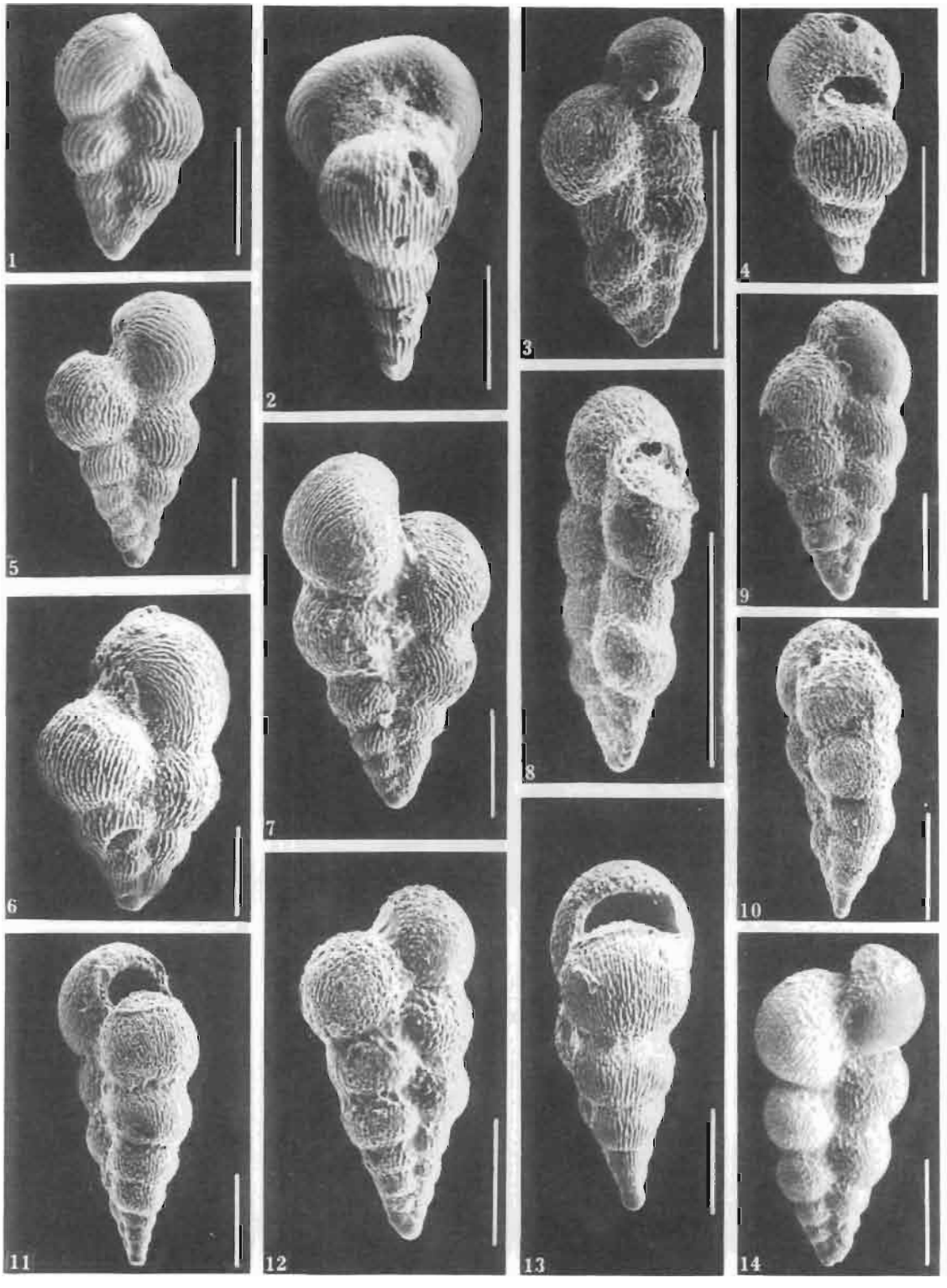
1, 5, 9. *Rugoglobigerina milamensis* SMITH and PESSAGNO. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/188, 189, 190.
2–4, 8. *Rugoglobigerina rugosa* (PLUMMER). Kazimierz, Upper Maastrichtian. ZPAL FXXIII/199, 200, 201, 202.
6–7. *Rugoglobigerina hexacamerata* BRÖNNIMANN. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/194, 195.
10–11. *Rugoglobigerina pennyi* BRÖNNIMANN. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/191, 192.
12, 15–16. *Rugoglobigerina macrocephala* BRÖNNIMANN. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/196, 197, 198.
13–14. *Rugoglobigerina rotundata* BRÖNNIMANN. Kazimierz, Upper Maastrichtian. ZPAL FXXIII/203, 204.

PLATE 23

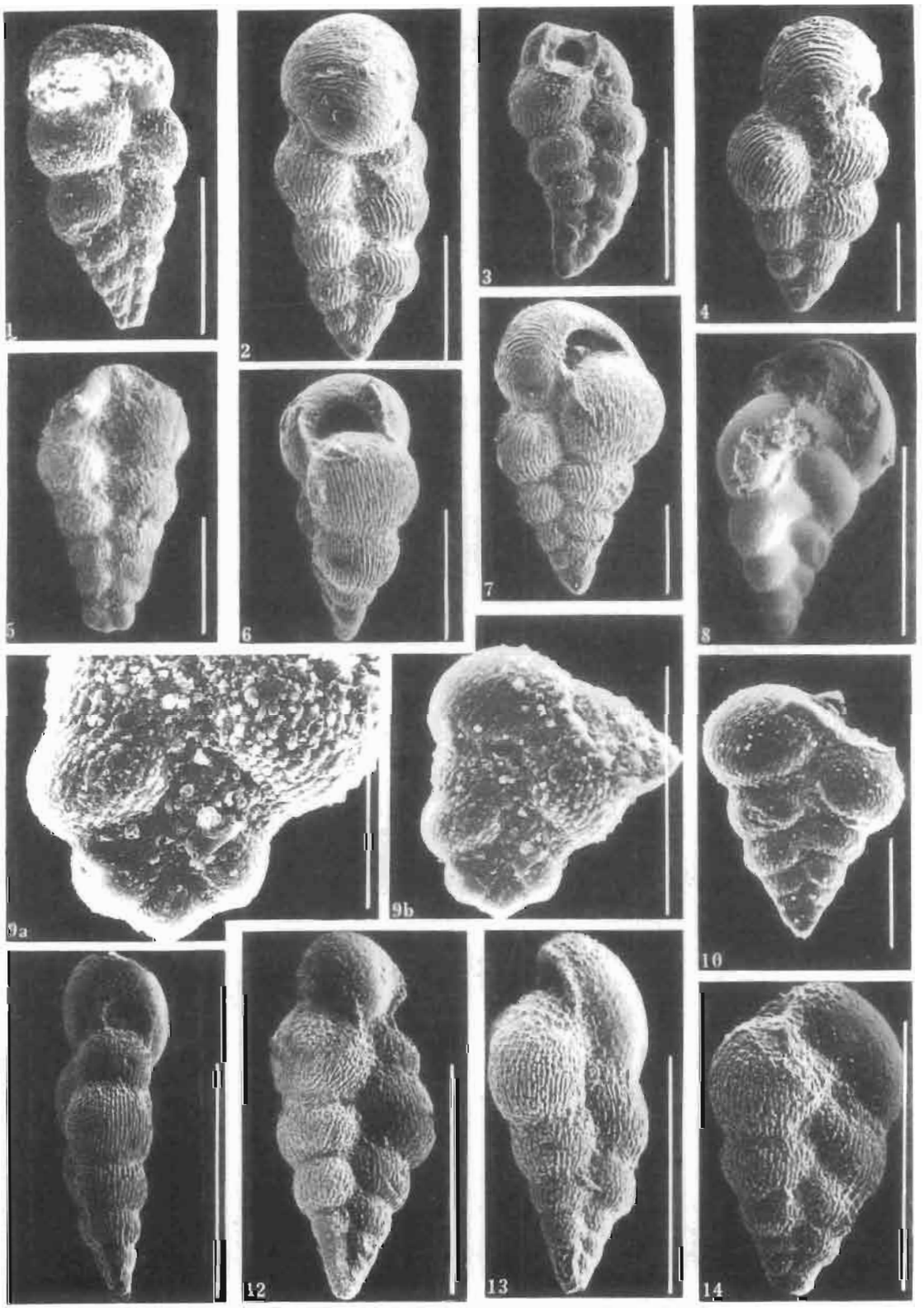
1–3. *Globotruncanella petaloidea* (GANDOLFI). Chotcza, Lower Maastrichtian. ZPAL FXXIII/205, 206, 207.
4–6. *Whiteinella baltica* DOUGLAS and RANKIN. Wesołówka 39, Lower Santonian. ZPAL FXXIII/208, 209, 210.
7–9. *Abathomphalus*? *subornatus* (GANDOLFI). Dorotka, Upper Campanian. ZPAL FXXIII/211, 212, 213.
10–12. *Abathomphalus*? *hilli* (PESSAGNO). Chotcza, Lower Maastrichtian. ZPAL FXXIII/214, 215, 216.



D. PERYT: PLANKTIC FORAMINIFERA ZONATION OF POLISH UPPER CRETACEOUS



D. Peryt: Planktic Foraminifera zonation of Polish Upper Cretaceous



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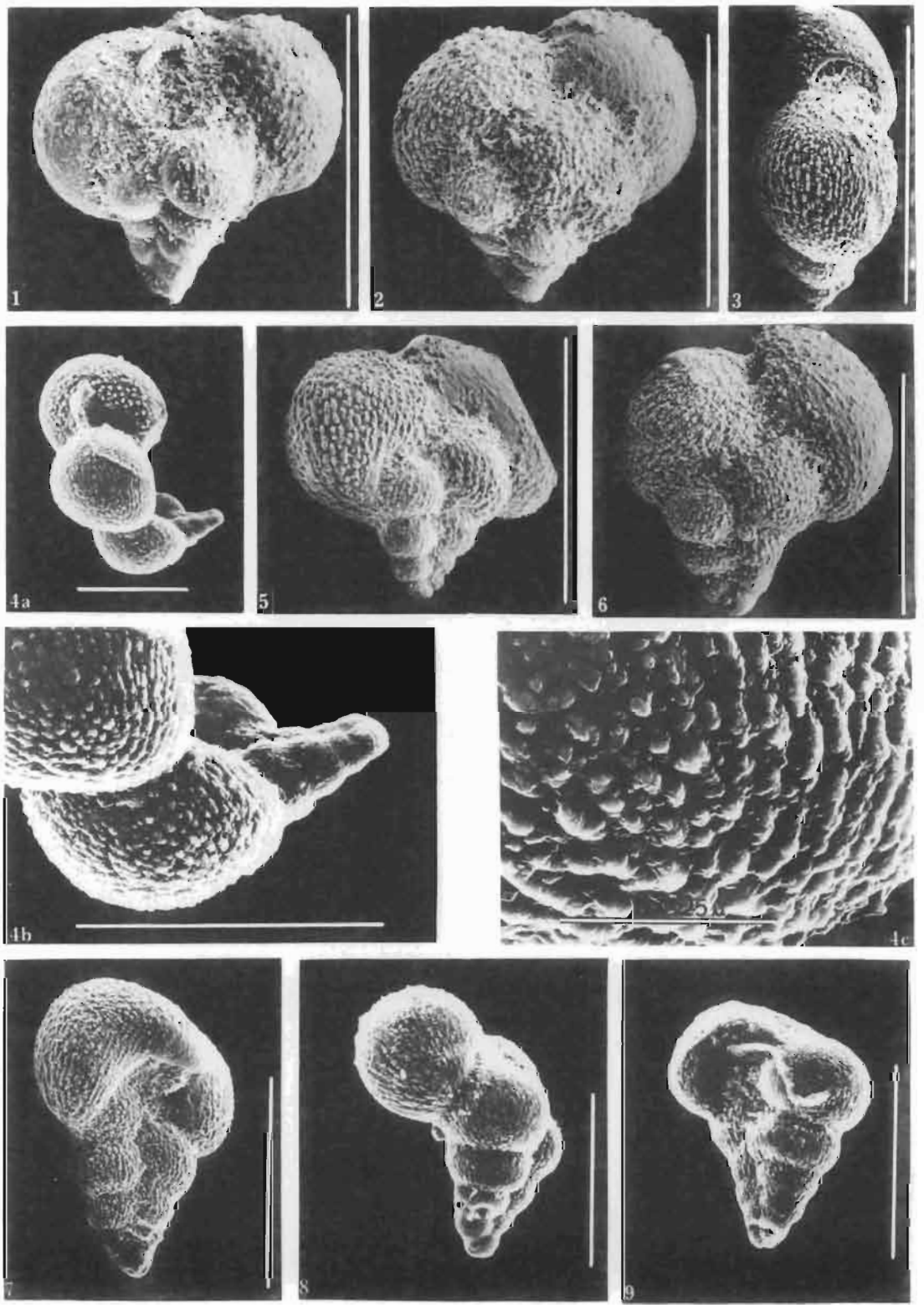

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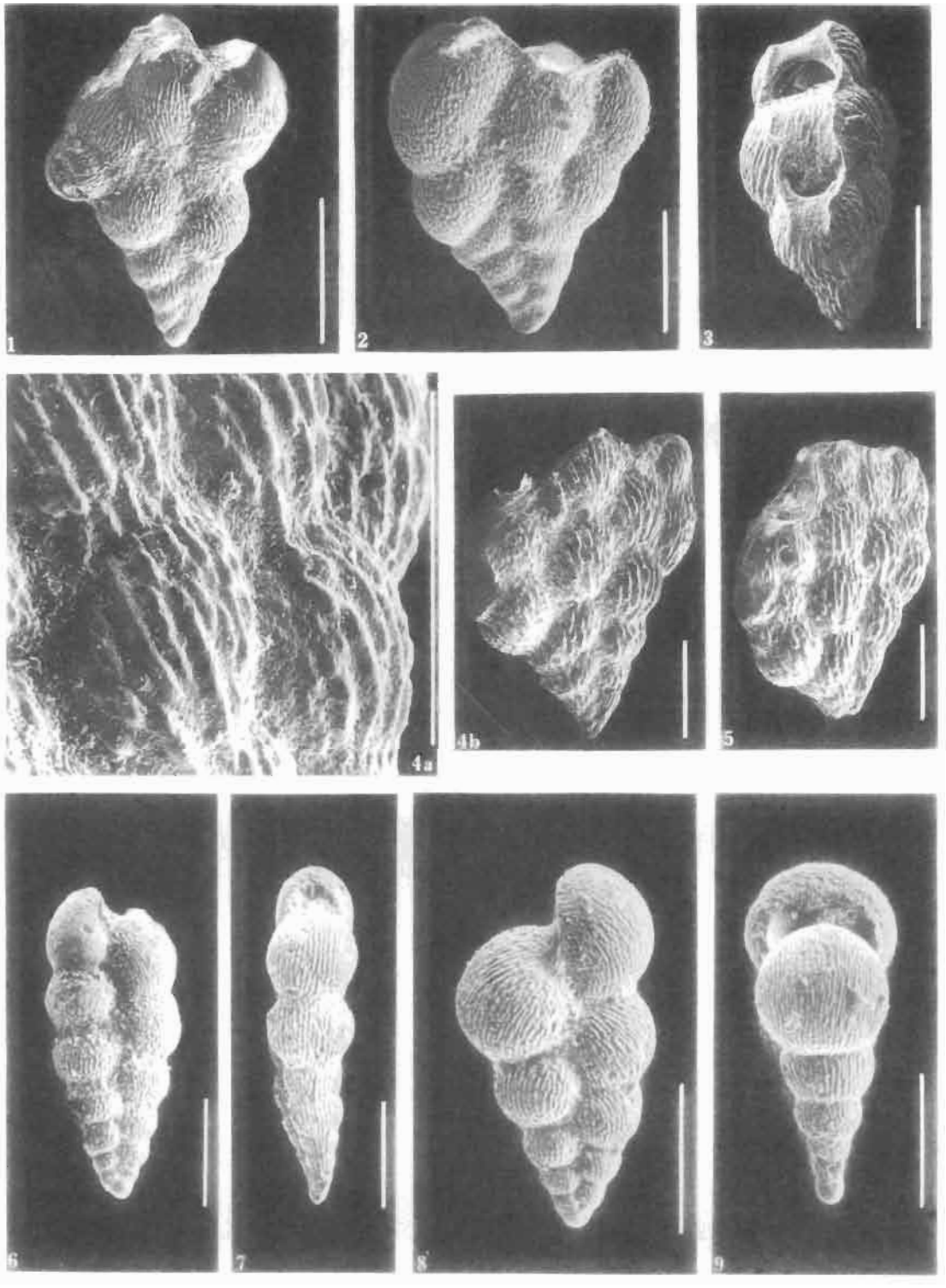

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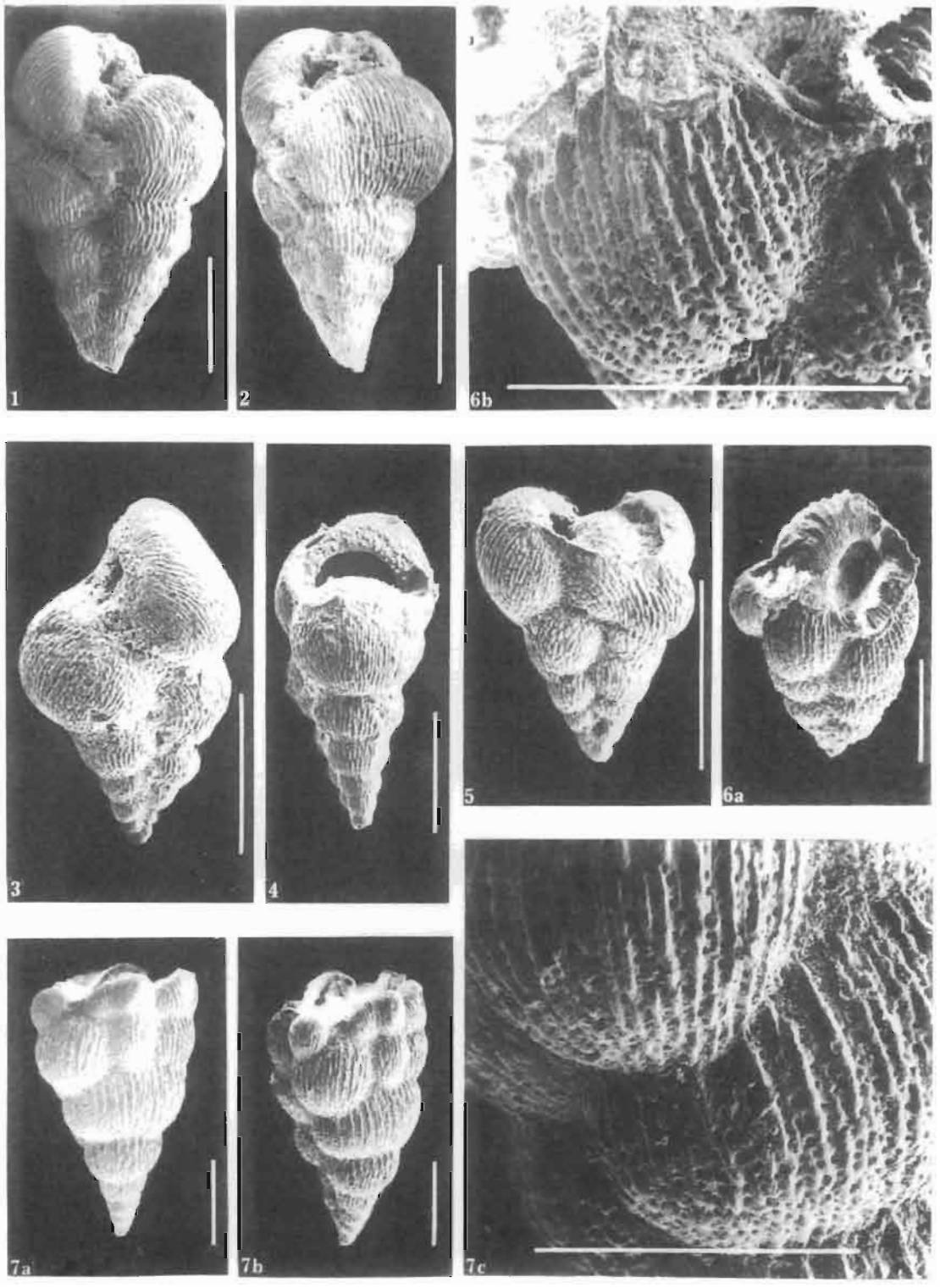

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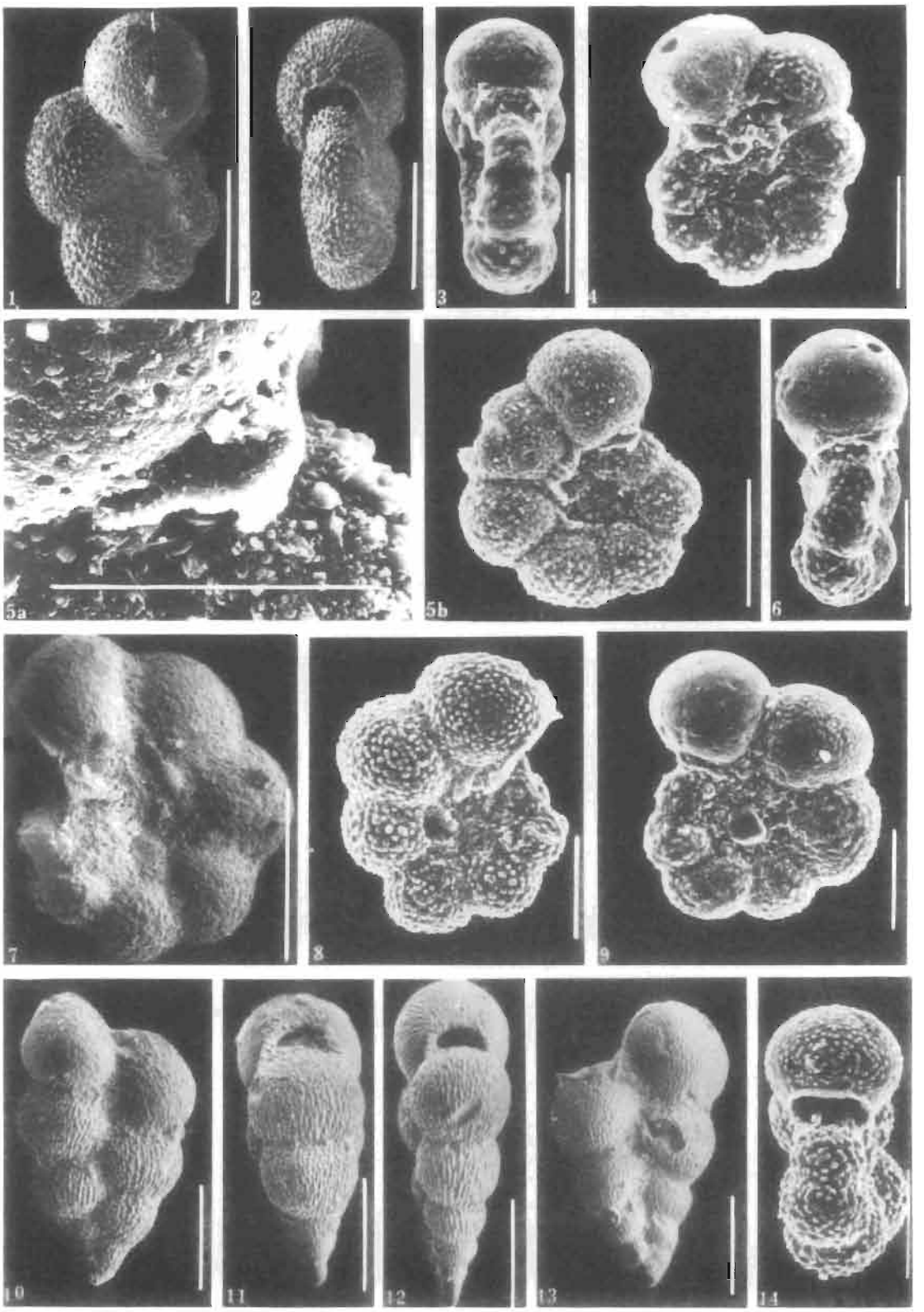
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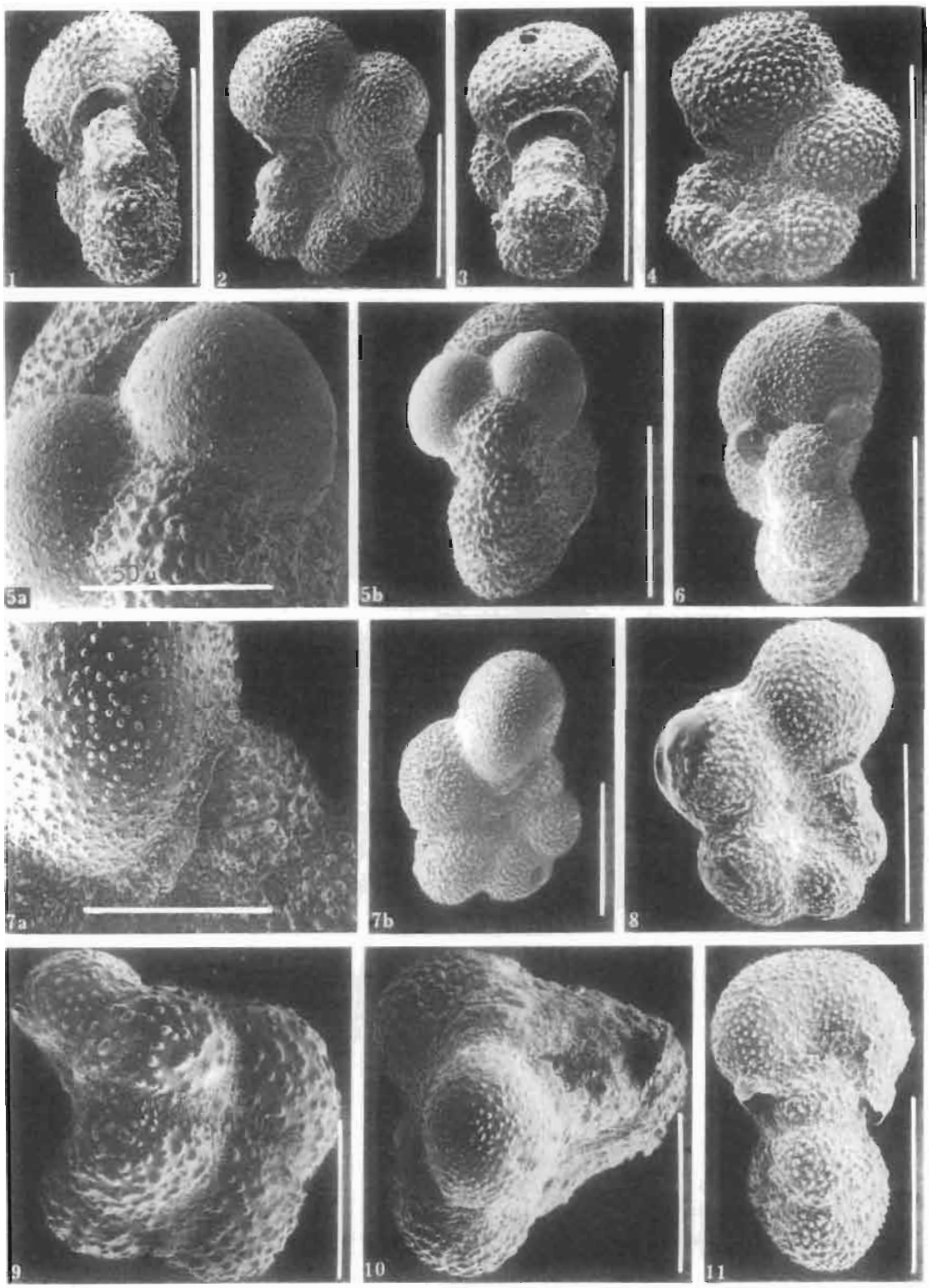

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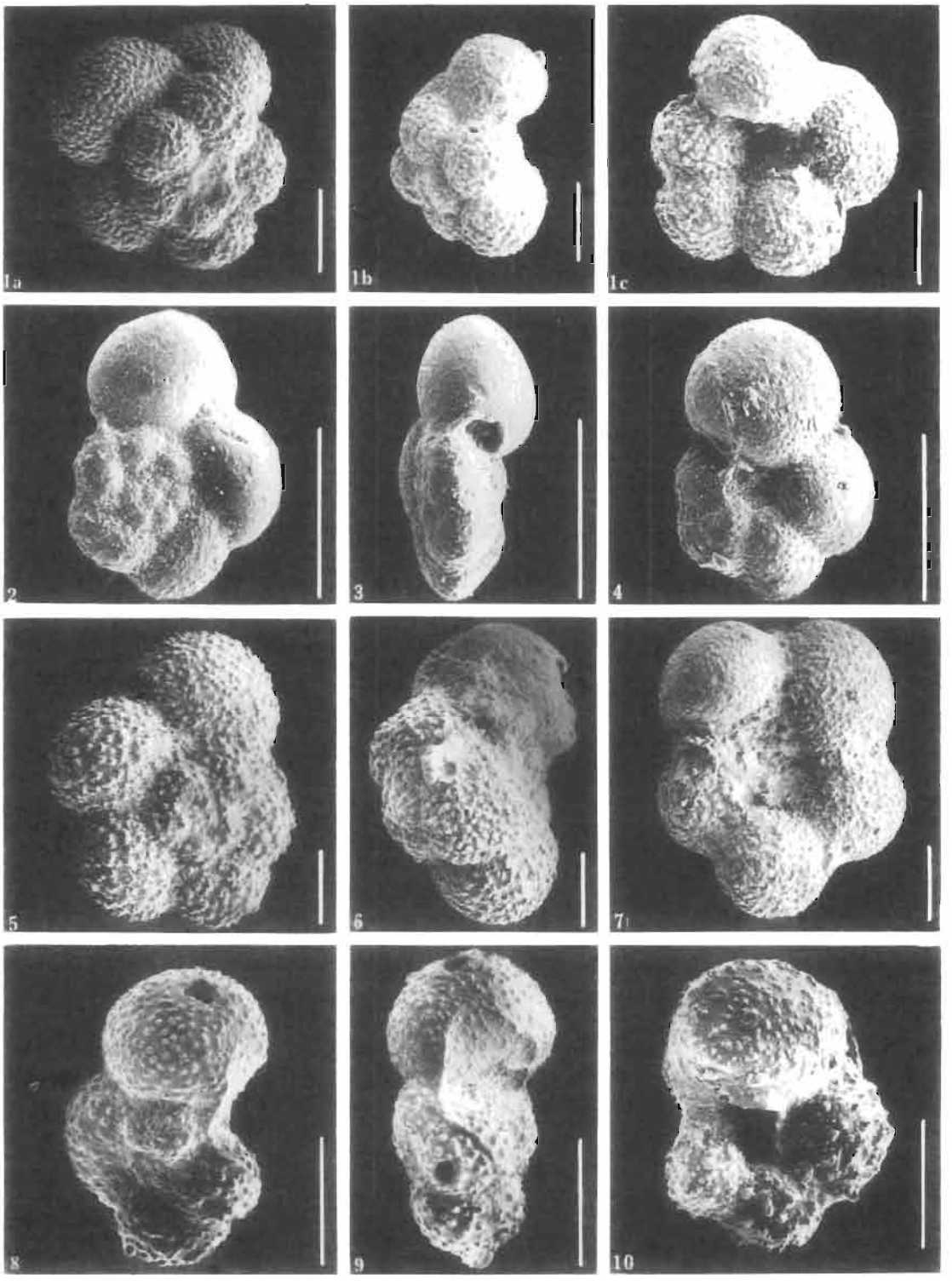
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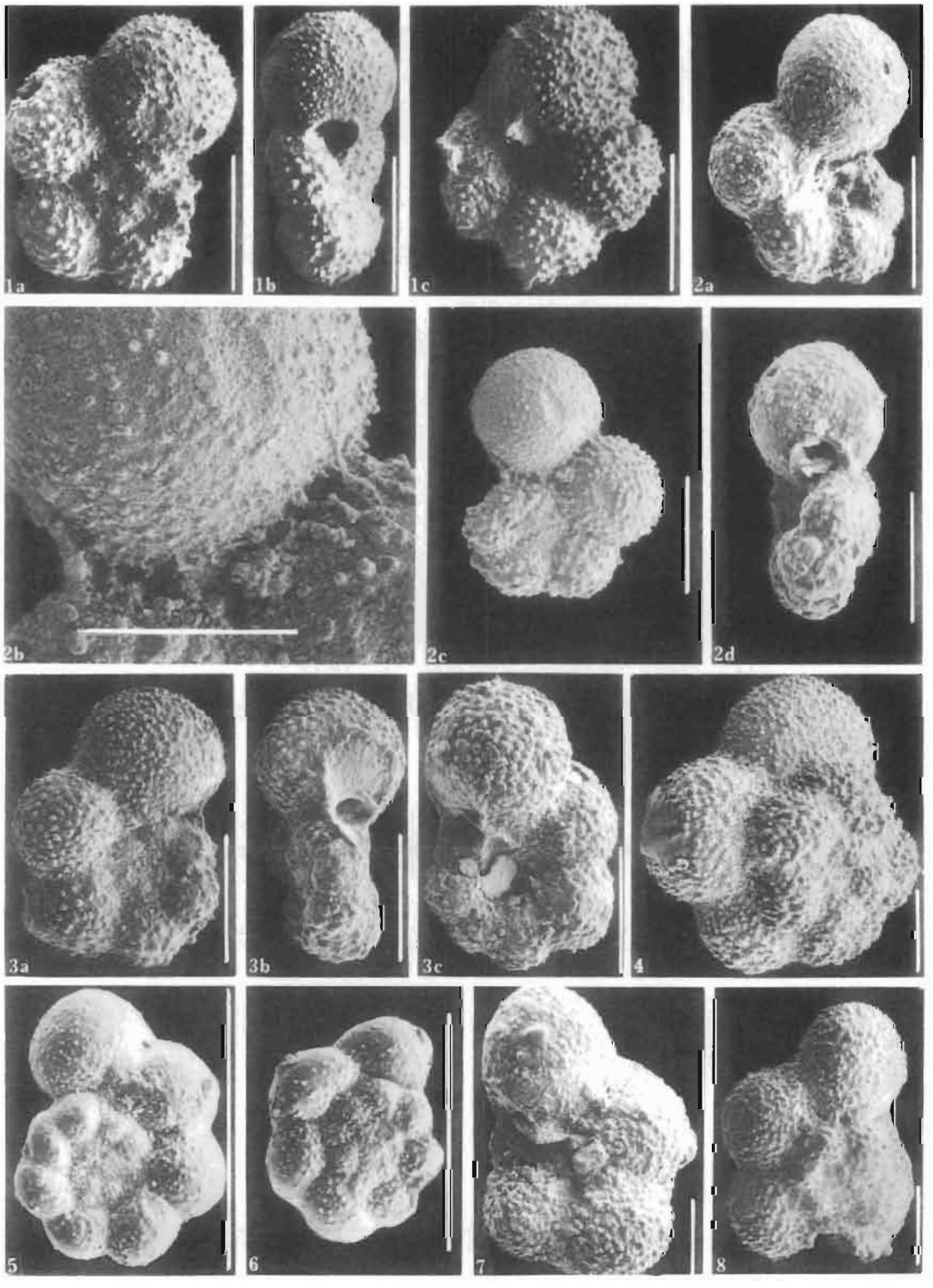

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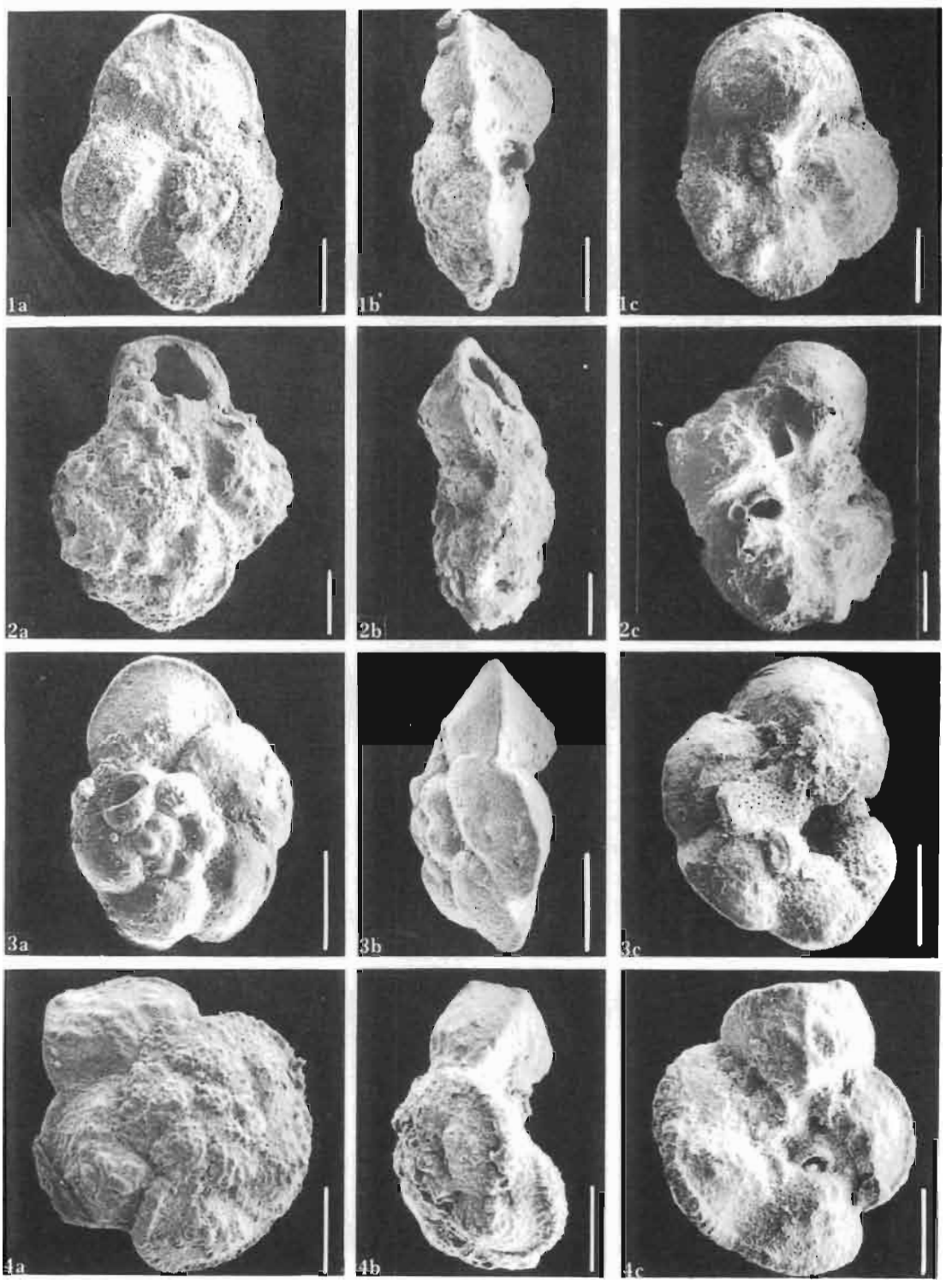

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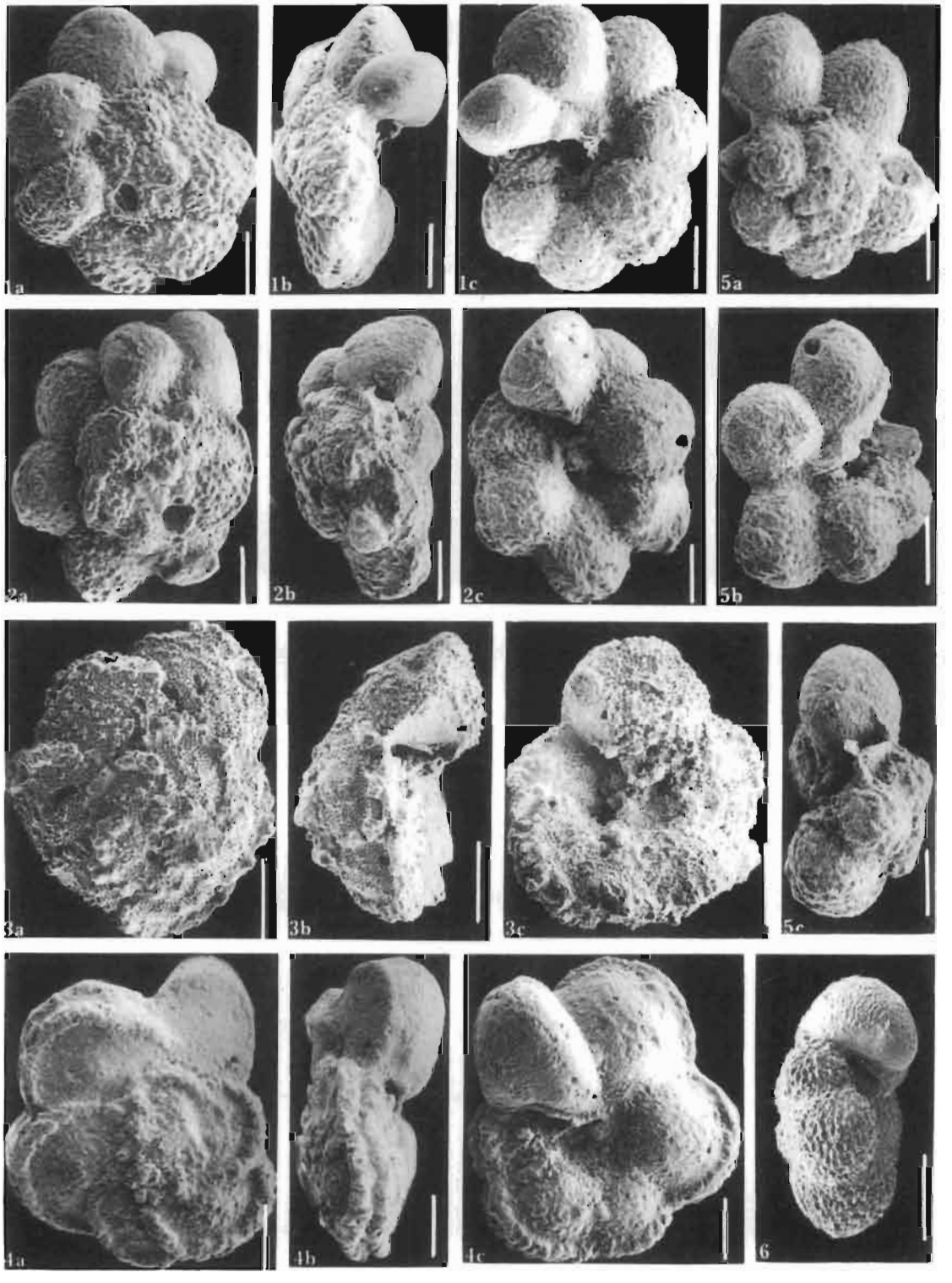

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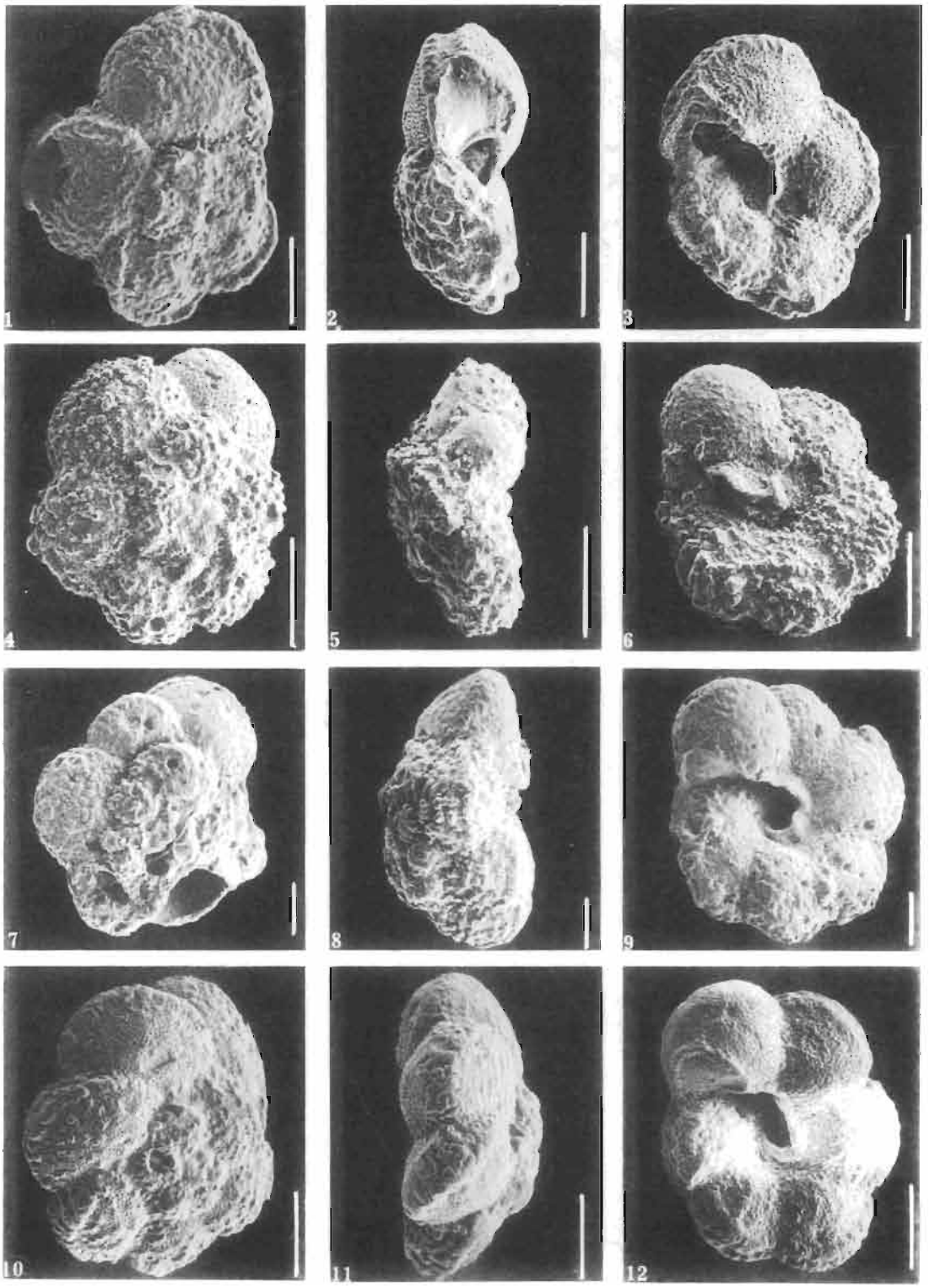
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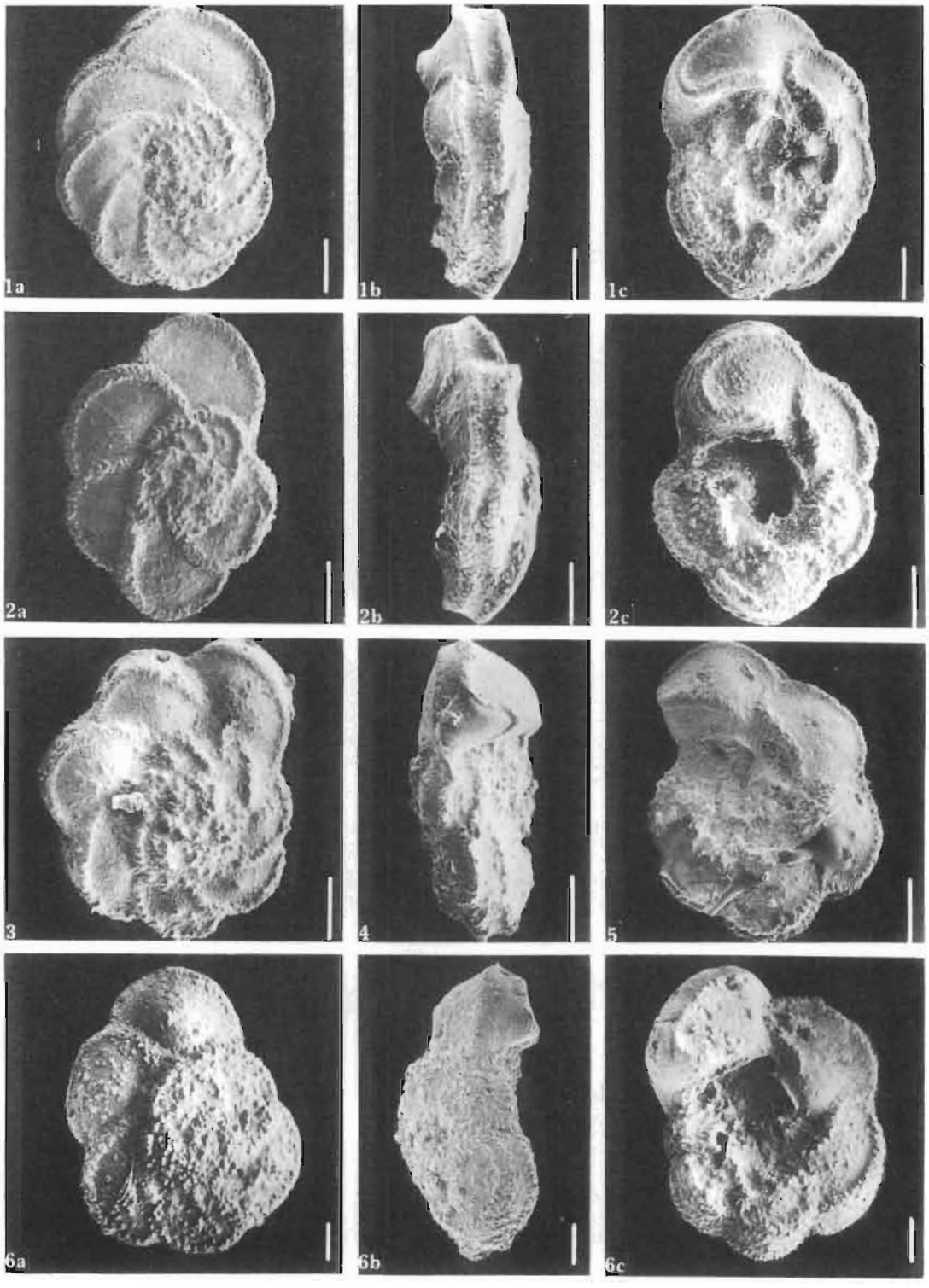

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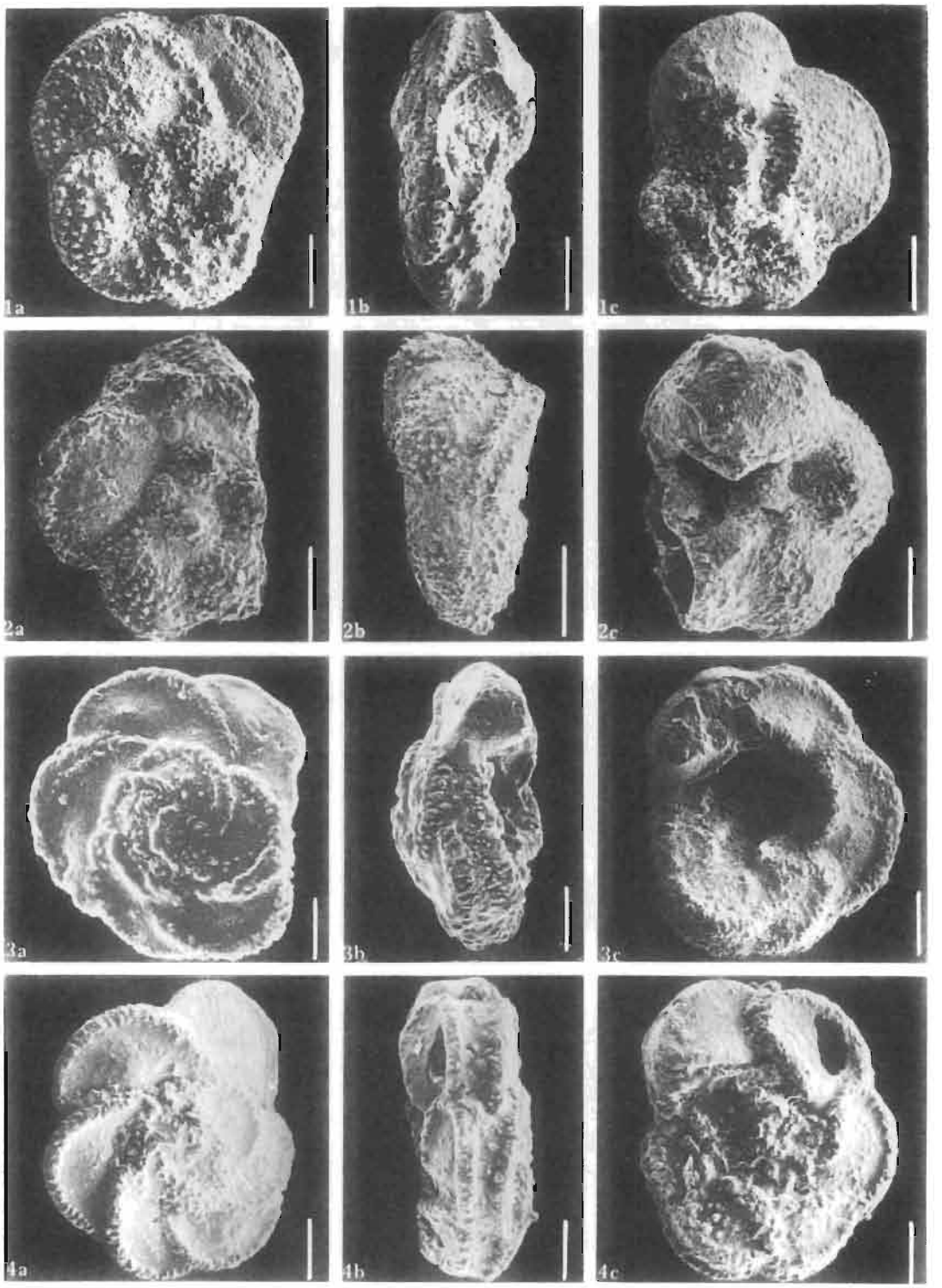

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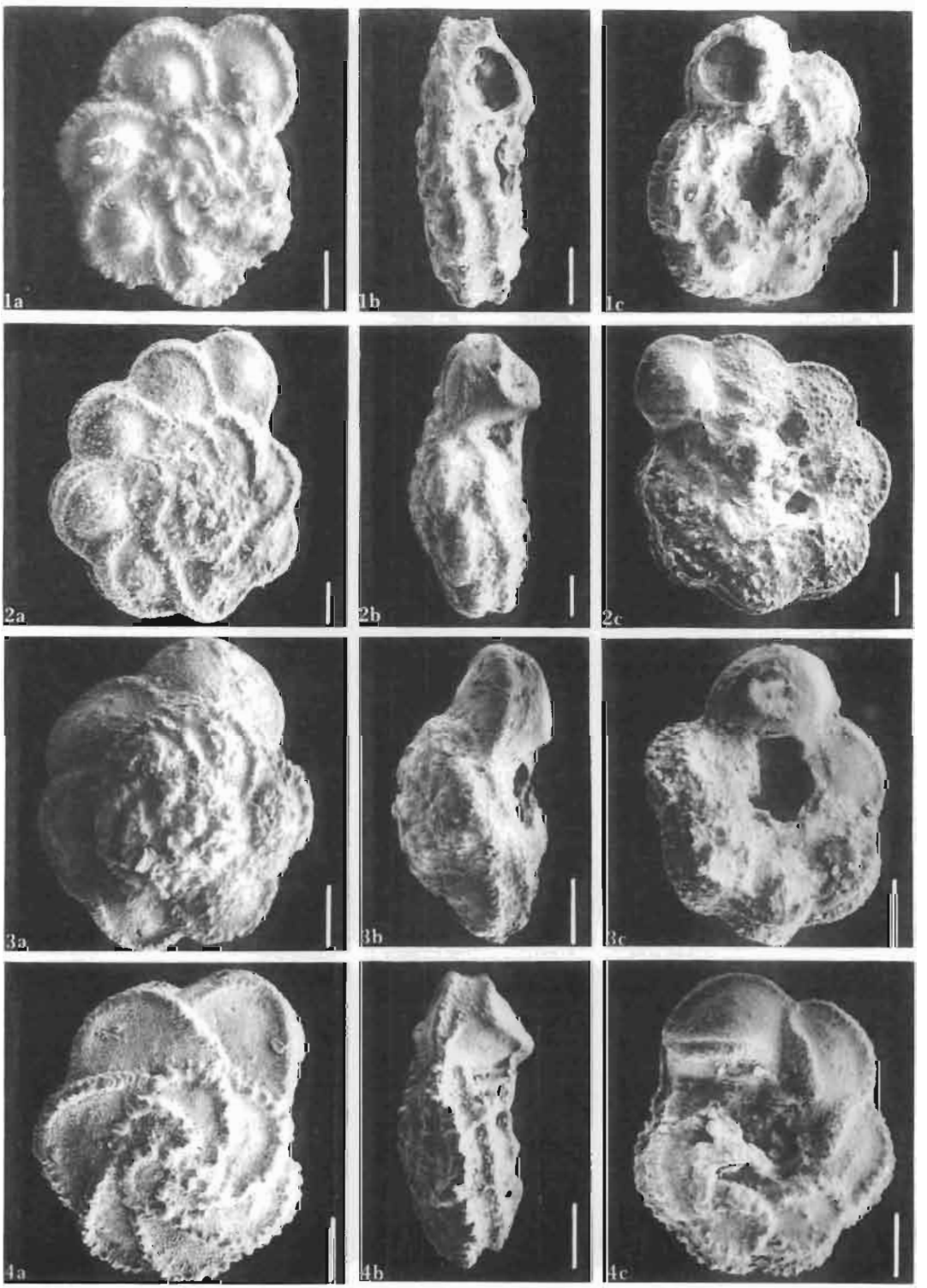

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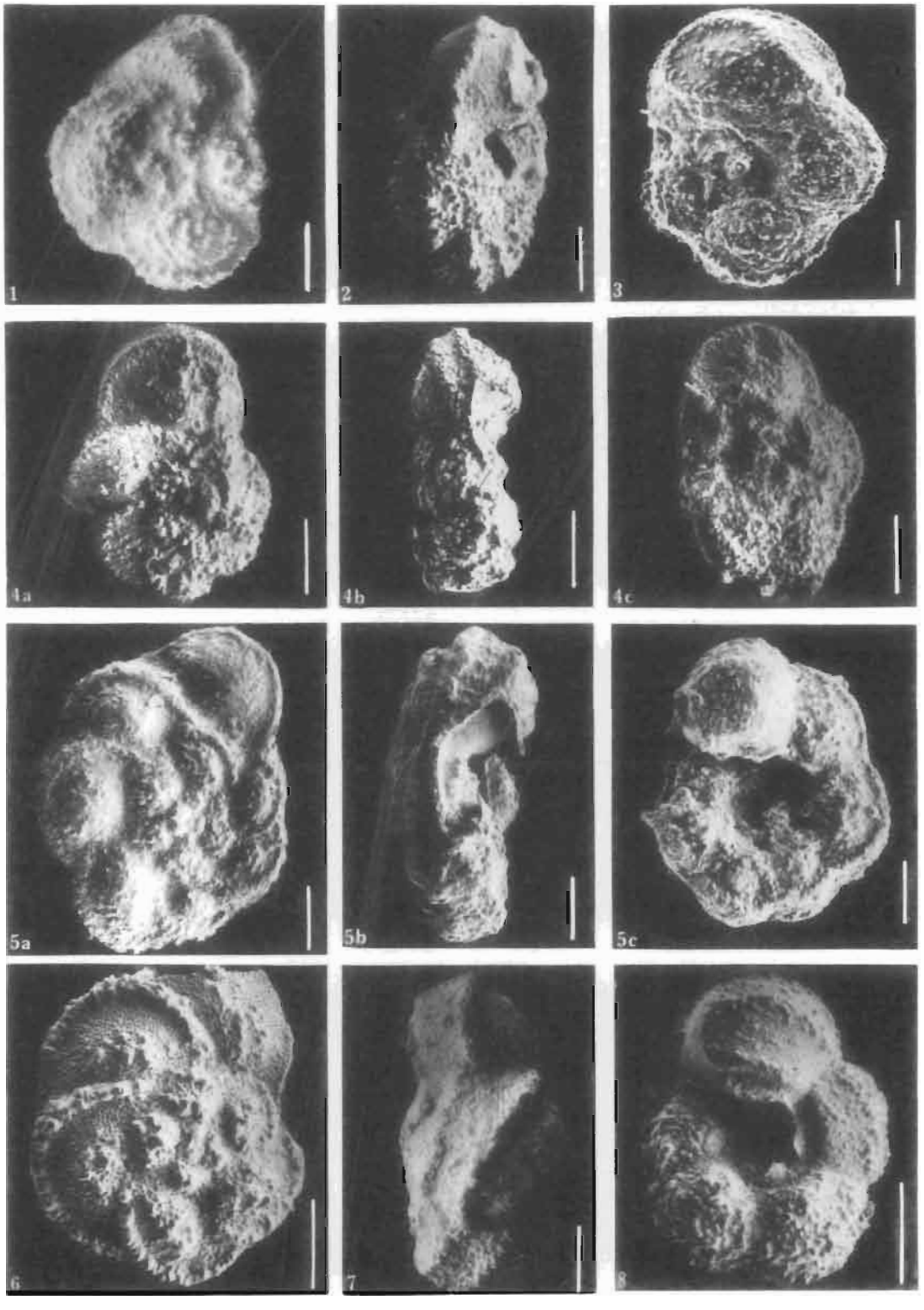

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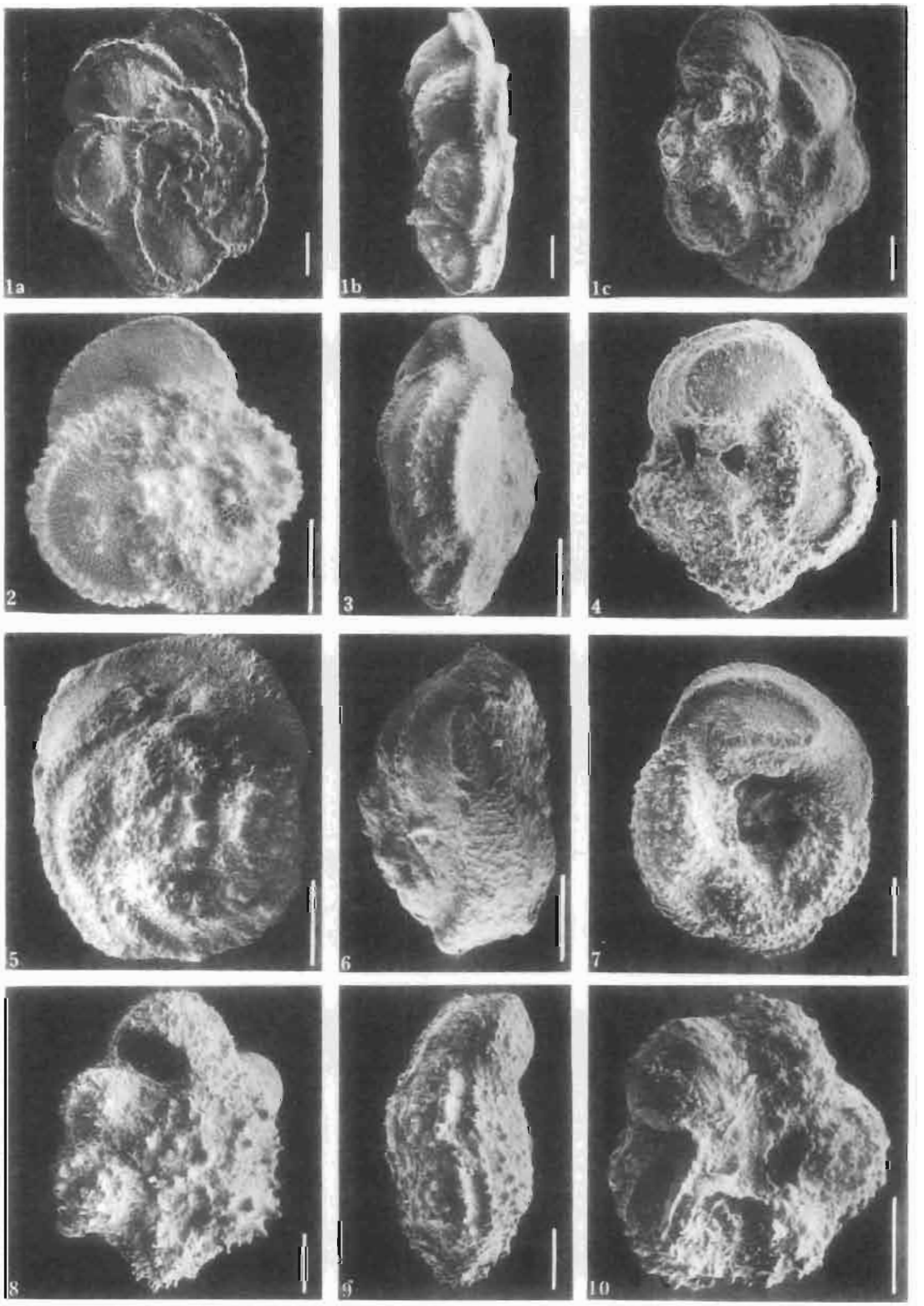
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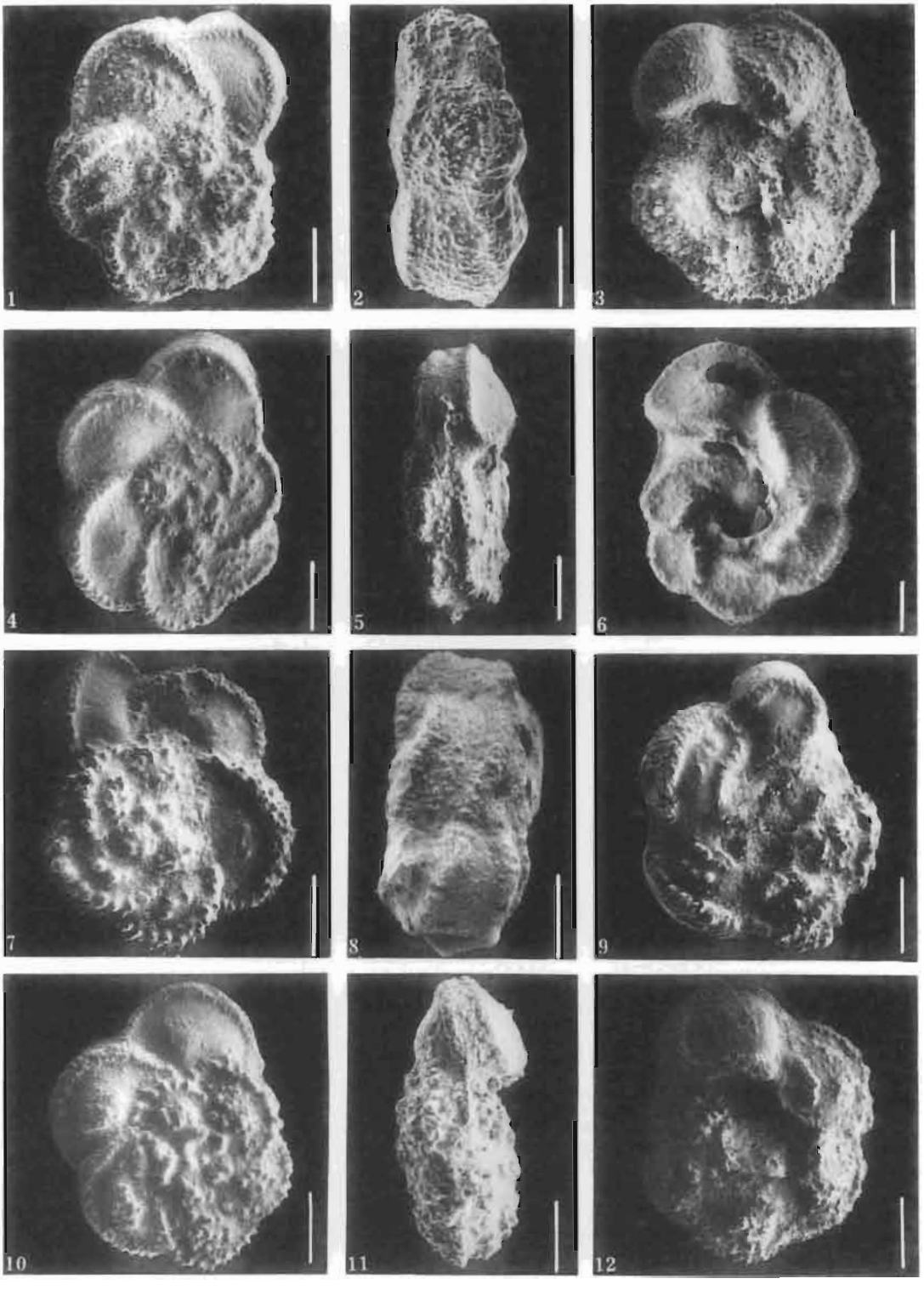

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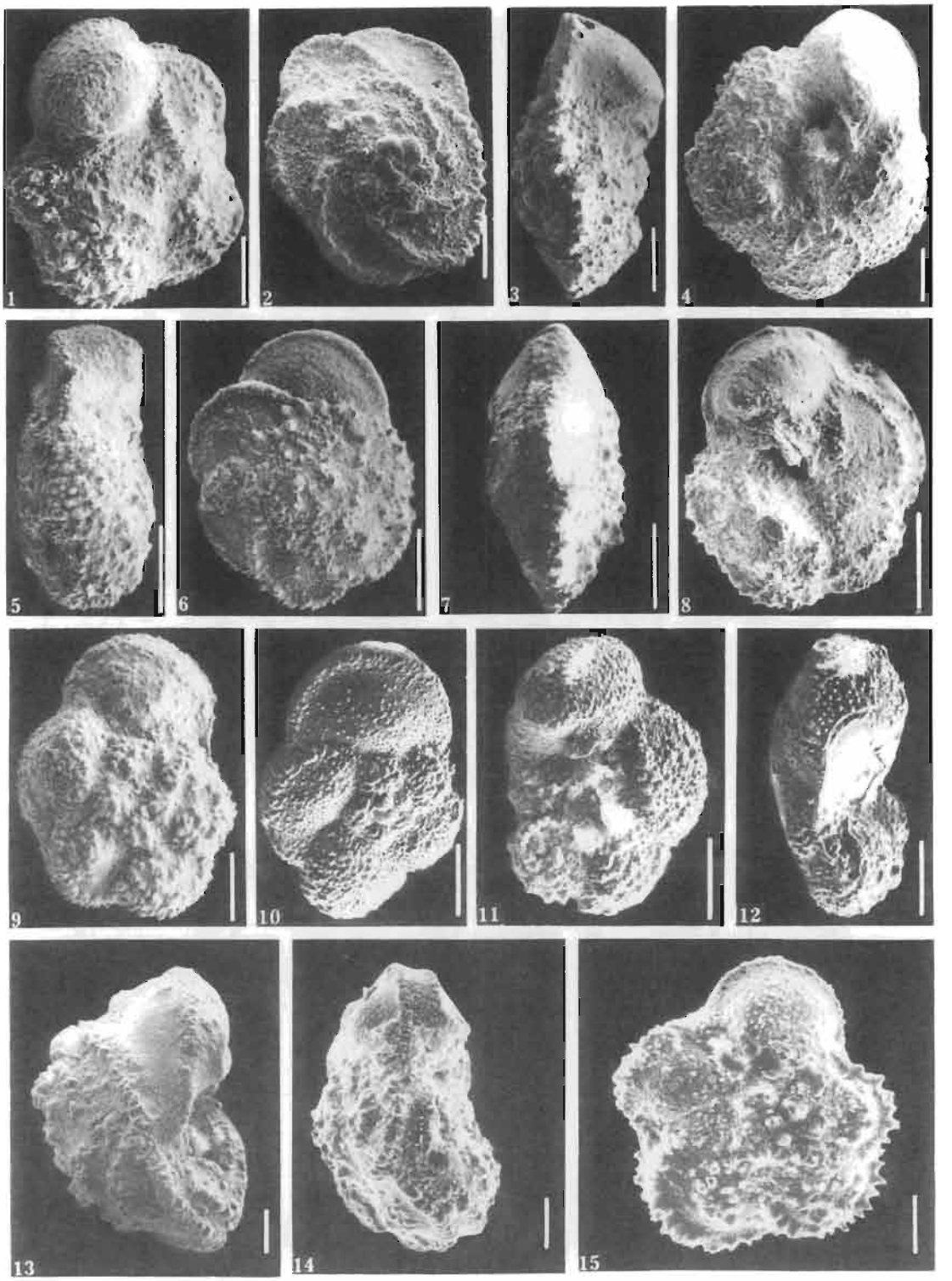

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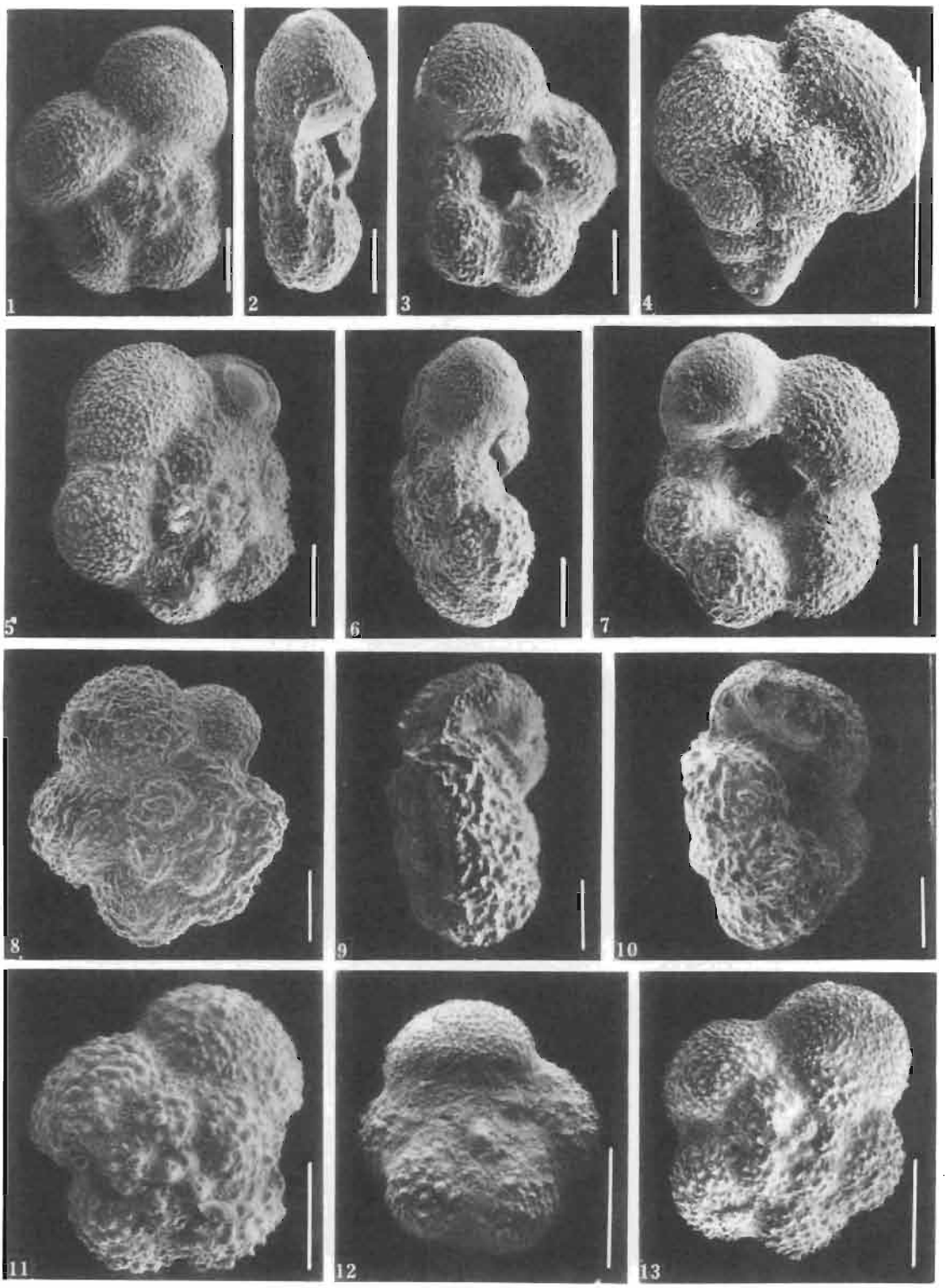

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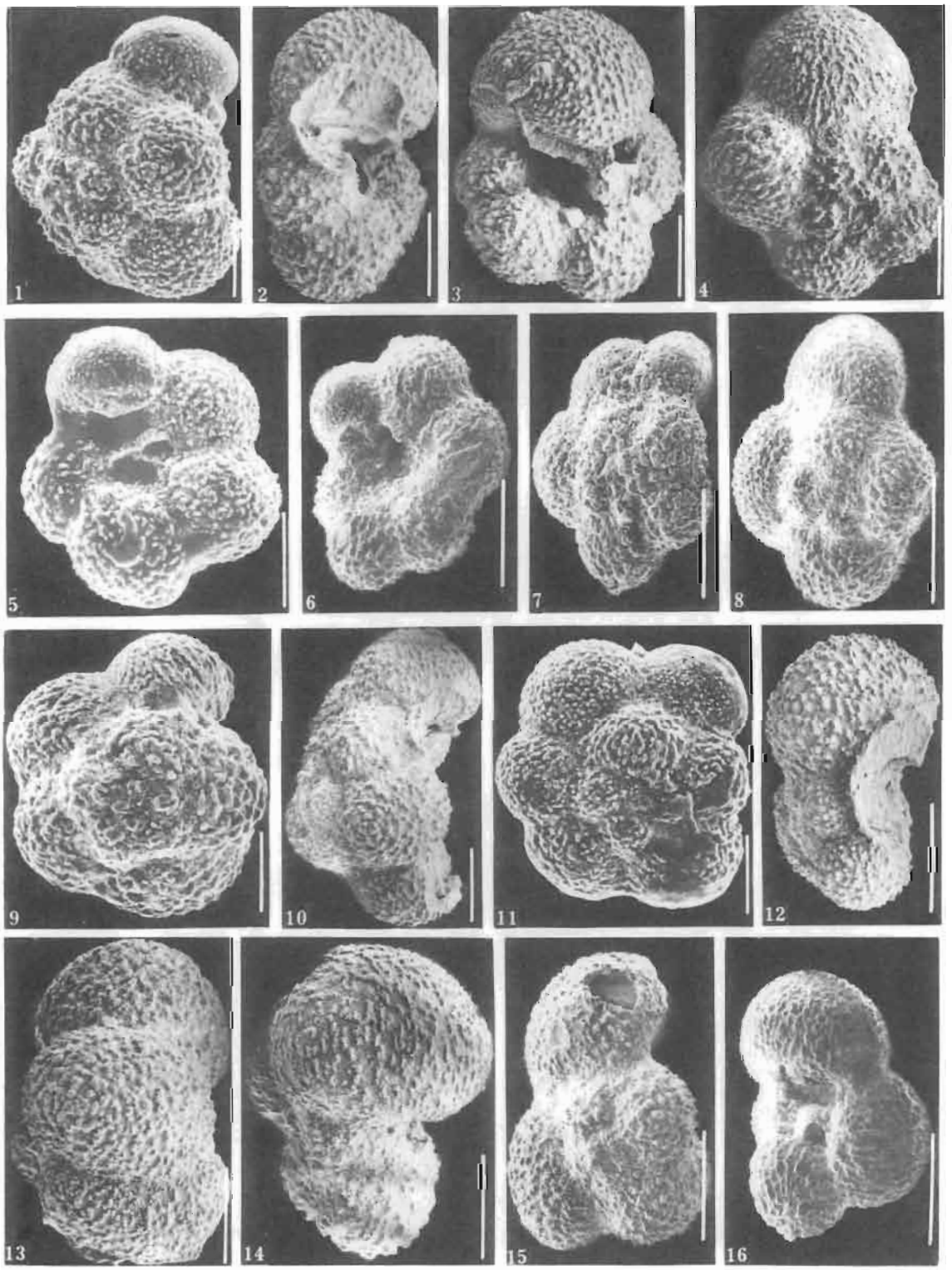

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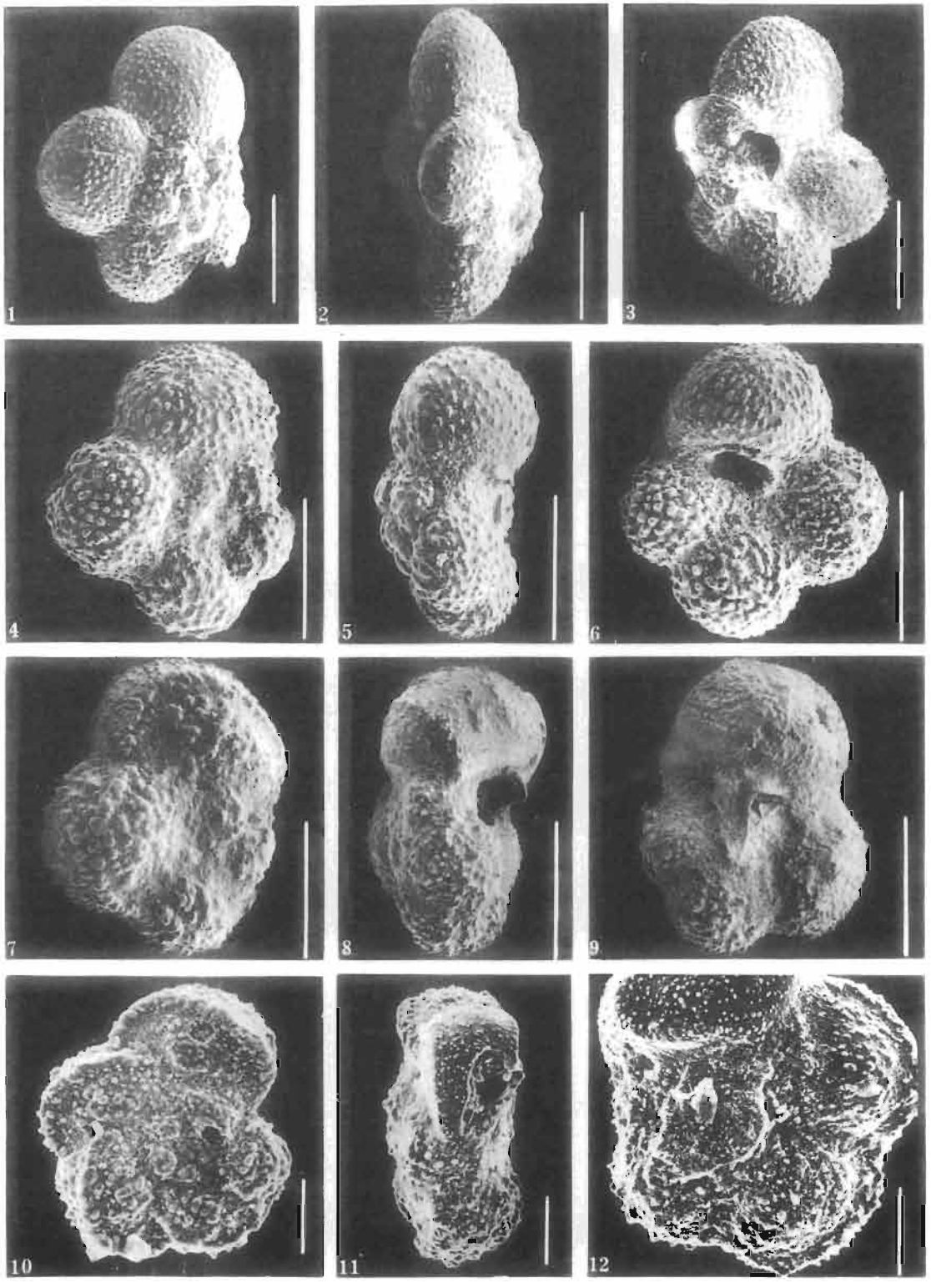

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