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UPPER SILURIAN—LOWER DEVONIAN CHITINOZOA FROM THE SUBSURFACE OF SOUTHEASTERN POLAND

(plates 24-37)

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Abstract. — This paper is a taxonomic and biostratigraphic study of the Chitinozoa from the Upper Silurian-Lower Devonian deposits (Rhenish magnafacies) found in the boreholes from southeastern Poland. The chitinozoans are referred to 46 species of 12 genera. Nineteen species are described as new: *Ancyrochitina aurita*, *A. bullispina*, *A. lemniscata*, *Angochitina longispina*, *Anthochitina radiata*, *Conochitina invenusta*, *Desmochitina spongiloricata*, *Eisenackitina barbatula*, *E. cepicia*, *E. crassa*, *E. cupellata*, *E. fimbriata*, *E. lacrimabilis*, *E. pilosa*, *Gotlandochitina lublinensis*, *Hoegisphaera velata*, *Linochitina longiuscula*, *L. subcylindrica*, and *Margachitina gratiosa*. Their stratigraphic and correlative values are discussed. Chitinozoan frequency and distribution in the sections, as well as associated fossils are considered.

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Key words: Chitinozoa, Silurian, Devonian, biostratigraphy, SE Poland, Radom-Lublin region.

Streszczenie. — Praca jest taksonomicznym i biostratygraficznym studium Chitinozoa z osadów górnego syluru i dolnego dewonu (megafacja reńska) z wierceń południowo-wschodniej Polski. Opisano Chitinozoa należące do 12 rodzajów i 46 gatunków. Wydzielono 19 nowych gatunków: *Ancyrochitina aurita*, *A. bullispina*, *A. lemniscata*, *Angochitina longispina*, *Anthochitina radiata*, *Conochitina invenusta*, *Desmochitina spongiloricata*, *Eisenackitina barbatula*, *E. cepicia*, *E. crassa*, *E. cupellata*, *E. fimbriata*, *E. lacrimabilis*, *E. pilosa*, *Gotlandochitina lublinensis*, *Hoegisphaera velata*, *Linochitina longiuscula*, *L. subcylindrica*, *Margachitina gratiosa*. Przedstawiono uwagi o ich wartości stratygraficznej i korelacyjnej. Omówiono także rozmieszczenie i frekwencję Chitinozoa w profilach wierceń oraz towarzyszący im zespół skamieniałości.
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CONTENTS

INTRODUCTION

This paper presents the results of a taxonomic and biostratigraphic study of the Upper Silurian-Lower Devonian Chitinozoa from the deposits found in the boreholes drilled in the southeastern Poland. The work started in 1973 owing to a co-operation of the Institute of Paleobiology of the Polish Academy of Sciences and the Geological Survey of Poland, Warszawa.

This work is a contribution to the IGCP Project "Ecostratigraphy".

The investigated collection of Chitinozoa is housed in the Institute of Paleobiology of the Polish Academy of Sciences, Warszawa (abbreviated as ZPAL). The cores and the borehole records are stored in the Geological Institute, Warszawa (abbreviated as I. G.)

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MATERIAL

The investigated collections comprise some 21 thousand chitinozoans referred to 46 species of 12 genera; 19 species are described as new. Well preserved chitinozoans were recovered from the Lower Devonian marly biodetrital limestones. The Silurian shales yielded damaged specimens, probably as a result of tectonics. Many specimens of the latter group are preserved as internal moulds (pl. 34: 6). Some deformations and damages resulted from sedimentary and taphonomic processes or are of epigenetic origin; the others are caused by maceration. The absence of some species, e. g. *Anthochitina superba*, *A. radiata*, *Ancyrochitina desmea* etc., in certain samples may actually be the result of poor preservation prohibiting identification of these specimens.

SAMPLING AND PROCESSING

Samples of 500–1000 g were taken from all lithologies present in the investigated cores. Their number and distribution in the boreholes are shown in tables 1–4, 9–12. The Oldred-like facies of the upper Lower Devonian were not sampled.

Approximate 300 g were dissolved in 10–15% acetic, hydrochloric, or formic acid using methods similar to those described by JENKINS (1967) and LAUFELD (1974). In most cases, the residuum was rinsed with water and thereafter, dissolved with 40–70% hydrofluoric acid. Sometimes, a single sample was many times dissolved alternately with hydrochloric and hydrofluoric acids. The residua were finally sifted through a 50 μm sieve in water or decanted. The residues of 1000 g samples were separated by means of water solution of cadmium iodide and potassium iodide (2·3 g/cm³ in specific gravity). The Chitinozoa were then pipetted into marked vessels filled with glycerine and small amounts of phenol or formalin, where they are kept for further study.

Permanent slides were made with glycerine-gelatin. These were used for photomicrography and measurements at magnifications of 100× and 150×. The internal structures were studied in specimens bleached by concentrated hydrochloric acid or concentrated nitric acid with potassium chloride ($KClO_3$), by means of an infra-red microscope MIK-4U4. 2. Thin sections of rocks containing Chitinozoans were also studied.

Those specimens chosen for observation and photography using the SEM were picked from the glycerine, rinsed with water and alcohol, and cleaned of mineral matter with 50% hydrofluoric acid. Some specimens were also cleaned with a brush or ultrasonically. Dry specimens were cemented to SEM specimen stubs using a double-side adhesive tape. Some specimens were broken with sharp steel needles to study the internal structure of the vesicle. Electromicrophotographs were taken on the JEOL — JSM-S1 and JEOL — JSM-2 at 10 kV.

GEOGRAPHICAL AND GEOLOGICAL SETTING

The investigated boreholes Białopole IG 1, Ciepielów IG 1, Siedliska IG 1, Strzelce IG 1 and IG 2 (fig. 1) were drilled in the southern part of the Uplifted East-European Platform and foreland (ŻELICHOWSKI 1974: 78, 113).

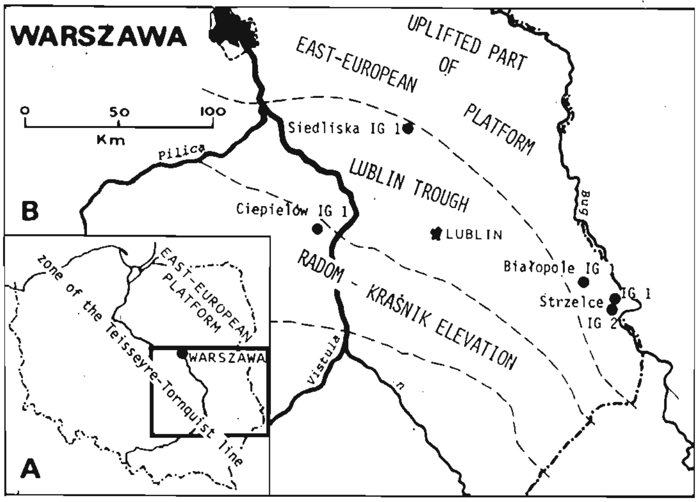


Fig. 1

Location of the investigated boreholes within the regional geological framework (after ŻELICHOWSKI 1975)

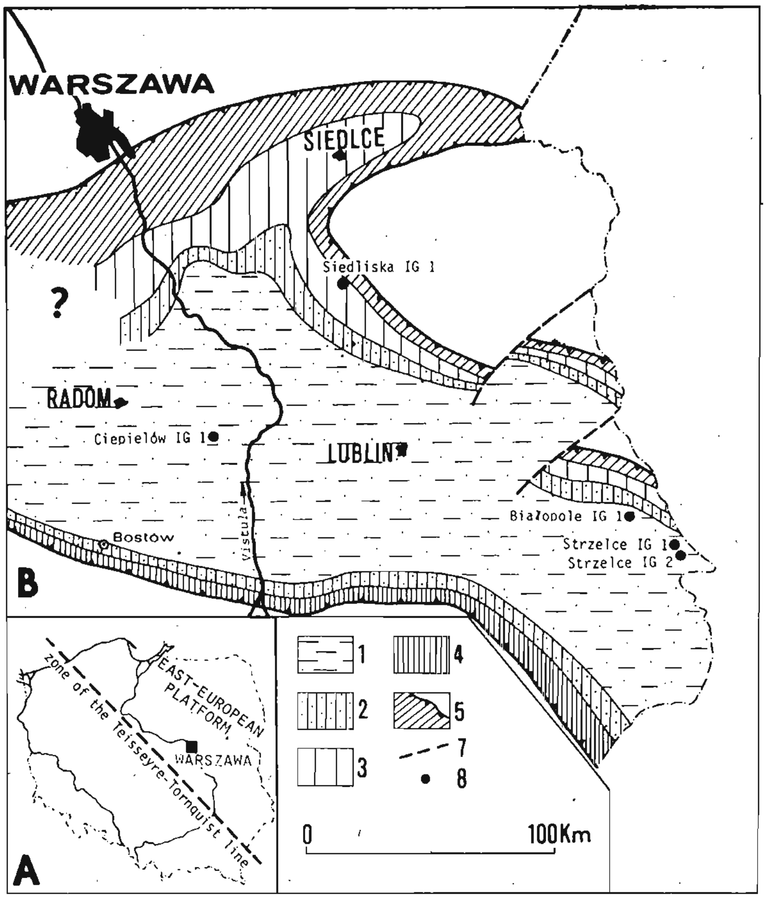


Fig. 2

Geological map (pre-Siegenian) of the southeastern Poland (after TOMCZYK 1974): **1** — Ciepielovian, **2** — Bostovian, **3** — Upper Podlasian, **4** — Podlasian (Upper Rzepin Beds), **5** — Lower Podlasian up to the erosional boundary, **7** — faults, **8** — boreholes

The study of the Paleozoic strata in this area started with boreholes carried on by the Geological Survey of Poland in the fifties. Since that time, through 1970 over a hundred boreholes of moderate depth (ca 3·000 m) were drilled (MIŁACZEWSKI and ŻELICHOWSKI 1970). Data on the geological structure of the area, the Silurian-Devonian stratigraphy, and the history of geological investigation are presented by PAJCHLOWA (1970), TOMCZYK (1970, 1974*b*), MIŁACZEWSKI and ŻELICHOWSKI (1970), and ŻELICHOWSKI (1972, 1974).

Silurian deposits in the investigated area range in age from the Wenlockian across Devonian boundary. They represent the graptolite-shaly facies with siltstones in the upper part of the section. These deposits pass continuously into the Lower Devonian represented by claystones and siltstones intercalated commonly with layers and lenses of limestones enclosing an abundant marine fauna. The siltstones become upwards more and more sandy and comprise commonly layers of fine-grained quartz sandstones; they are often mottled and display commonly mud cracks. This is a typical Oldred facies; it is attributed to the Siegenian to Emsian. Thus, the marine sedimentation persisted in the investigated area continuously all through the Silurian and Lower Devonian. The earliest regression is marked in the Lower Siegenian deposits, while the terrestrial oldred-type sedimentation became prevalent in the Upper Siegenian.

The facies development of the investigated Siluro-Devonian strata appears typical of the Rhenish magna facies; in fact, there are close paleontologic relations to the equivalent formations of the Podolia, Rhineland, Ardennes, Brittany, Iberian Chain and Anti-Atlas (TELLER 1964; TOMCZYKOWA 1975*a*, 1975*b*; TOMCZYKOWA and TOMCZYK 1970; TOMCZYK, PAJCHLOWA and TOMCZYKOWA, 1977; TOMCZYKOWA and TOMCZYK 1978).

Continuous Siluro-Devonian sections were found in four of the investigated boreholes. The equivalent strata are not present in Siedliska IG 1 (fig. 2); hence, only a single sample of Mielnikian age was examined for comparative purposes. The lithology and megafossil biostratigraphy of the investigated boreholes are based on the published and unpublished works by TOMCZYK (1971, 1974*a*, 1976), TOMCZYKOWA (1971, 1974, 1976), MIŁACZEWSKI (1971, 1974, 1976), TOMCZYK, PAJCHLOWA and TOMCZYKOWA (1977), TOMCZYKOWA and TOMCZYK (1978).

Borehole Białopole IG 1 (figs. 1, 2)

Location: Białopole, between Chełm and Hrubieszów; southern part of the Uplifted East-European Platform, Kumów Horst (see also Żelichowski 1972, 1974: 78, fig. 17).

Lithology and core interval could be used for core extent: see Table 9.

Stratigraphy: biostratigraphy given after MIŁACZEWSKI (1971), TOMCZYK (1971), TOMCZYKOWA (1971), and TOMCZYK, PAJCHLOWA and TOMCZYKOWA (1977); graptolite and trilobite identification after TOMCZYK (*l. c.*) and TOMCZYKOWA (*l. c.*), respectively; the tentaculites were studied by HAJŁASZ (1976). For chitinozoan vertical ranges see Table 9. The investigated core fragment ranges between 2092·5 and 1337·0 m in depth, that is from the Ludlovian through Siegenian.

Upper Silurian

Lower Mielnikian (2092·5–2058·0 m)

Graptolites: *Gothograptus nassa*, *Pristiograptus pseudodubius*, *P.* cf. *ladenicensis*, *P.* cf. *dubius*; trilobites: *Odontopleura* cf. *ovata*; cephalopods, bivalves, and crinoids.

Upper Mielnikian (2058·0–2020·0 m)

Graptolites: *Lobograptus scanicus parascanicus*, *Bohemograptus bohemicus*, *Cucullograptus* sp., *C. pazdroi*, *Neodiversograptus beklemishevi*, *Pristiograptus dubius frequens*, *Monoclimacis haupti*, and *Seatograptus chimera*.

Lower part of the Siedlce series (2020·0–1969·5 m)

Graptolites: *Bohemograptus bohemicus*, *Pristiograptus dubius*, *Linograptus* cf. *posthumus*, *Neolobograptus* sp., *Neocucullograptus* cf. *kozlovskii*.

Middle part of the Siedlce series (1969·5–1948·0 m)

Graptolites: *Monoclimacis haupti*.

Upper part of the Siedlce series (1948·0–1830·0 m)

Graptolites: *Monograptus formosus*, *Linograptus posthumus*, *Pristiograptus* cf. *dubius*, *Monograptus ultimus*; bivalves, cephalopods.

Lower Podlasian (1830·0–1706·0 m)

Graptolites: *Pristiograptus* sp., *P.* cf. *samsonowiczi*, *Linograptus* cf. *posthumus*, *Pristiograptus dubius*, *Monoclimacis ultimus*; cephalopods, bivalves.

Upper Podlasian (1706·0–1577·5 m)
Graptolites: *Pristiograptus* sp., *P.* cf. *admirabilis*, *P. transgrediens*; bivalves, crinoids, trilobites, bryozoans, eurypterids, cephalopods, and fish.

Silurian/Devonian boundary

There is no core comprising deposits of the Silurian/Devonian boundary; hence, the boundary was arbitrarily traced basing upon a comparison to the adjacent boreholes Strzelce IG 1 and IG 2.

Lower Devonian

Lower Bostovian (1577·5–1520·0 m)
Trilobites: *Acastava* sp., *Podolites* cf. *rugulosus rhenanus*, *Acastella* sp.; articulate and inarticulate brachiopods, bivalves, tentaculites, ostracodes, cephalopods, and eurypterids.
Upper Bostovian (1520·0–1430·0 m)
Graptolites: *Monograptus microdon* cf. *silesicus*; trilobites: *Acastava patula*, *A.* cf. *roualti*, *Podolites* cf. *rugulosus*; brachiopods, bivalves, tentaculites, cephalopods, bryozoans, crinoids, scolecodonts, and fish.
Lower Ciepielovian (1430·0–1352·5 m)
Trilobites: *Parahomalonotus forbesi*, *Paracryphaeus* sp., *Podolites* sp., *Digonus* cf. *vialai*; brachiopods, bivalves, tentaculites, ostracodes, gastropods, eurypterids, and crinoids.
Upper Ciepielovian (1352·5–1301·0 m)
Trilobites: *Paracryphaeus* sp.; brachiopods, bivalves, bryozoans, tentaculites, crinoids, ostracodes, and fish.

Borehole Ciepielów IG 1 (figs. 1, 2)

Location: Ciepielów by Zwoleń; northwestern part of the Radom-Kraśnik Uplift (see also ŻELICHOWSKI 1972, 1974: 78, fig. 17), in the neighbourhood of Bostów, Holy Cross Mountains (fig. 2), where the proposed hypotype section of the Silurian/Devonian boundary occurs (PAJCHLOWA, TOMCZYKOWA and TOMCZYK 1970).
Lithology and core extent: see Table 10.
Stratigraphy: biostratigraphy given after TOMCZYK (1974*a*), TOMCZYKOWA (1974), TOMCZYK, PAJCHLOWA and TOMCZYKOWA (1977); graptolite and trilobite identifications after TOMCZYK (*l.c.*) and TOMCZYKOWA (*l.c.*), respectively; the tentaculites were studied by HAJŁASZ (1968, 1974) and the ostracodes by NEHRING (1974). For the chitinozoan vertical ranges see Table 10. The investigated core fragment is above considerably tectonized structures; it ranges between 2885·0 and 2213·0 m in depth, that is from the uppermost Silurian through Lower Siegenian.

Uppermost Silurian

Preserved part of the Upper Podlasian (2885·0–2598·3 m) Graptolites: *Monoclimacis ultimus*, *Pristiograptus* sp., *Linograptus posthumus*, *Monograptus angustidens*; bivalves: *Cardiola* sp.; crinoids: *Scyphocrinites* cf. *elegans*.

Lower Devonian

Lower Bostovian (2598·3–2406·0 m)
Graptolites: *Linograptus* sp.; trilobites: *Acastella heberti heberti*, *Acastella* sp.; bivalves, cephalopods, gastropods, tentaculites, and ostracodes.
Upper Bostovian (2406–2305·4 m)
Trilobites: *Acastella* cf. *patula*, *A.* cf. *roualti*, *A.* sp., *Acastoides* sp.; brachiopods, bivalves, tentaculites, eurypterids, and ostracodes.
Lower Ciepielovian (2305·4–2210·3 m)
Trilobites: *Acastoides* sp., *Homalonotus* sp., *Digonus* cf. *vialai*, *D.* sp., *Parahomalonotus* sp., *Pseudocryphaeus* sp.; tentaculites: *Alternatus mirabilis*; brachiopods, bivalves, eurypterids, ostracodes, and fish.

Borehole Strzelce IG 1 (figs. 1, 2)

Location: Strzelce by Hrubieszów; southern part of the Uplifted East-European Platform, Kumów Horst, upthrown side of the Serebryszcze fault (see also ŻELICHOWSKI 1972, 1974: 78, fig. 17).
Lithology and core extent: see Table 11.
Stratigraphy: biostratigraphy given after TOMCZYK (1976), TOMCZYKOWA (1976), TOMCZYK, PAJCHLOWA and TOMCZYKOWA (1977); graptolite and trilobite identifications are after TOMCZYK (*l. c.*) and TOMCZYKOWA (*l. c.*), respectively. For, the chitinozoan vertical ranges see Table 11. The investigated core fragment ranges between 1545·1 and 1260·0 m in depth, that is from the Upper Podlasian (uppermost Silurian) through Upper Ciepielovian (Siegenian, Lower Devonian).

Uppermost Silurian

Upper Podlasian (1545·1–1424·0 m)
Graptolites: *Pristiograptus transgrediens*, *Linograptus* sp., *L.* cf. *posthumus*, *Pristiograptus* cf. *dubius*; bivalves, crinoids: *Scyphocrynites* cf. *elegans*; trilobites: *Acastella* sp.

Silurian/Devonian boundary

There is no core comprising deposits of the Silurian/Devonian boundary; hence, the boundary was traced basing upon a comparison to the adjacent borehole Strzelce IG 2.

Lower Devonian

Lower Bostovian (1424·0–1387·0 m)

Trilobites: *Podolites rugulosus rhenanus, Acastava* sp.; brachiopods, bivalves, cephalopods, trilobites, and crinoids.

Upper Bostovian (1387·0–1355·5 m)

Trilobites: *Acastoides* sp., *Acastava patula*; brachiopods, bivalves, tentaculites, ostracodes, cephalopods, and crinoids.

Lower Ciepielovian (1355·5–1287·5 m)

Trilobites: *Acastoides* sp., *Pseudocryphaeus* sp.; brachiopods, bivalves, tentaculites, crinoids, eurypterids, ostracodes, and fish.

Upper Ciepielovian (1287·5–1256·5 m); no core.

Borehole Strzelce IG 2 (figs. 1, 2)

Location: Strzelce by Hrubieszów; southern part of the Uplifted East-European Platform, Kumów Horst, (see also ŻELICHOWSKI 1972, 1974: 78, fig. 17).

Lithology and core extent: see Table 12.

Stratigraphy: biostratigraphy given after TOMCZYK (1976), URBANEK (*in* TOMCZYK *l. c.*), TOMCZYKOWA (1976), TOMCZYK, PAJCHLOWA and TOMCZYKOWA (1977); graptolite and trilobite identifications after TOMCZYK (*l. c.*) and TOMCZYKOWA (*l. c.*), respectively. For the chitinozoans vertical ranges see Table 12. The investigated core fragment ranges between 1978·8 and 1592·0 m in depth, that is from the upper part of the Siedlce series (uppermost Silurian) through Upper Ciepielovian (Lower Devonian).

Uppermost Silurian

Upper part of the Siedlce series (1978·8–1890·0 m)

Graptolites: *Monograptus* ex. gr. *formosus, Monoclimacis ultimus, M.* cf. *ultimus, Linograptus posthumus, Pristiograptus dubius, P. dubius* cf. *tumescens, P. dubius frequens*; brachiopods, bivalves, cephalopods, eurypterids, and crinoids.

Lower Podlasian (1890·0-1855·0 m)

Graptolites: *Monoclimacis ultimus, Linograptus* cf. *posthumus, Pristiograptus dubius*; bivalves, cephalopods.

Upper Podlasian (1855·0–1732·5 m)

Graptolites: *Monograptus angustidens, Pristiograptus* cf. *transgrediens, Linograptus* sp., *L.* cf. *posthumus*; trilobites: *Acastella* sp.; crinoids: *Scyphocrinites* cf. *elegans*; brachiopods, bivalves, tentaculites, cephalopods, ostracodes, and crinoids.

Silurian/Devonian boundary

The boundary was traced above the strata with graptolites *Monograptus angustidens* and below the strata with trilobites *Acastella elsana*.

Lower Devonian

Lower Bostovian (1732·5–1700·0 m)

Graptolites: *Monograptus* cf. *uniformis, M. microdon* cf. *silesicus, Linograptus* sp.; trilobites: *Acastella elsana, A. tiro, Podolites rugulosus rhenanus, Acastava* sp.; brachiopods, bivalves, gastropods, tentaculites, and crinoids.

Upper Bostovian (1700·0–1678·0 m)

Trilobites: *Acastava patula, Podolites rugulosus rhenanus, Acastoides* sp.; brachiopods, bivalves, cephalopods, tentaculites, crinoids, and fish.

Lower Ciepielovian (1678·0–1604·5 m)

Trilobites: *Parahomalonotus forbesi, Trimerus novus, Digonus elegans, Pseudocryphaeus* sp.; brachiopods, bivalves, bryozoans, cephalopods, ostracodes, eurypterids, tentaculites, and fish.

Upper Ciepielovian (1604·5–1573·5 m)

Brachiopods, bivalves, tentaculites, bryozoans, eurypterids, ostracodes, crinoids, and fish.

DISTRIBUTION OF CHITINOZOA AND ASSOCIATED BIOTA

The distribution of chitinozoans in the four boreholes investigated is shown in tables 1–4. The relationships of the chitinozoan abundance per 100 g sample to lithology are presented in tables 5–8. These tables also include the percentages of particular chitinozoan genera, and amounts of other organic microfossils extracted from the samples. There is a high variability of chitinozoan distribution (tables 1–12). Samples lacking Chitinozoa occur in a close neighbourhood of samples very rich in these microfossils, while the lithology remains constant or undergoes only a slight change.

The phenomenon of sudden changes in chitinozoan frequency in a section may result from several factors, the most important of which are: (i) chitinozoan resedimentation or digestion by deposits feeders; This author found under SEM that chitinozoan vesicles are commonly

Table 1

Distribution of Chitinozoa species in samples from the borehole Białopole IG 1 (excluding those samples without any Chitinozoa)

MIELNIKIAN							YET NOT ERECTED						PODLASIAN							BOSTOVIAN						CIEPIELO-VIAN					
2089.8	2035.9	2035.6	2034.8	2034.7	2034.2	2034.1	1994	1993.1	1990	1989.1	1907	1896	1732	1726.5	1672.8	1671.4	1671.3	1670.1	1646	1520	1519	1518	1463	1462	1459	1412	1411	1404	1403	1337	
																							3	3		8			12	14	*Ancyrochitina* cf. *ancyrea*
																														3	*Ancyrochitina bullispina*
																									5	26			17	26	*Ancyrochitina* aff. *desmea*
																				4							2		9	12	*Ancyrochitina* aff. *primitiva*
					1		62																								*Ancyrochitina* cf. *primitiva*
																														8	*Ancyrochitina tomentosa*
7													1		6		22		9	12	5	2		2	14		3	2		37	*Ancyrochitina* sp.
																										3	1				*Angochitina echinata*
																														1	*Angochitina longispina*
4		3	18	20			3													8											*Angochitina* sp.
																											5			51	*Anthochitina superba*
																											2			3	*Anthochitina radiata*
							4																								*Conochitina* cf. *latifrons*
							2																								*Conochitina* cf. *intermedia*
							2	10		8	1																				*Conochitina* sp.
																														5	*Eisenackitina cepicia*
																					4										*Eisenackitina cupellata*
																				4						2	4			1	*Eisenackitina lacrimabilis*
													12		56																*Eisenackitina oviformis*
																							1	6			9			61	*Eisenackitina pilosa*
														1		16	20	4	16	3		28									*Eisenackitina* cf. *urna*
							12																								*Eisenackitina* sp.
																											2				*Gotlandochitina lublinensis*
																														12	*Hoegisphaera glabra*
																									9	28	7			11	*Hoegisphaera* sp.
											2			95					100												*Linochitina* cf. *cingulata*
																		3													*Linochitina longiuscula*
																							3		5	3					*Linochitina subcylindrica*
5	10	18	14	37	40	3	5		1				26				7					5	16								*Linochitina* sp.
																										12	28		50	4	*Margachitina gratiosa*
																							45	3	8	22	5				*Sphaerochitina sphaerocephala*
																							5	7	6	16	4				*Urochitina simplex*

perforated by unidentified microorganisms to a variable extent. The morphology and variability of perforations appears identical to those described by LAUFELD (1974); (ii) post-burial and late diagenetic destruction of chitinozoan vesicles; Vesicles post-mortem transformed to a variable extent were observed under SEM; (iii) the original absence of Chitinozoa controlled by a temporary change in environmental conditions unreflected in lithology. Many authors noticed this characteristic mode of occurrence of the Chitinozoa and compared it to the water-bloom phenomenon (CRAMER 1970, URBAN and NEWPORT 1973, LAUFELD 1974).

As demonstrated by the sections investigated, the chitinozoan abundance does often not display any correlation to the species diversity (tables 1–12). In monotonous graptolite shales with very common *Tasmanites* and acritarch *Leiosphaeridium*, peaks in chitinozoan abundance occur in monospecific samples, which agress with LAUFELD'S (1975) observations and ideas.

Table 2

Distribution of Chitinozoa species in samples from the borehole Ciepielów IG 1 (excluding those samples without any Chitinozoa)

		Ancyrochitina ancyrea	*Ancyrochitina* cf. *ancyrea*	*Ancyrochitina cornigera*	*Ancyrochitina lemniscata*	*Ancyrochitina* aff. *primitiva*	*Ancyrochitina* cf. *primitiva*	*Ancyrochitina tomentosa*	*Ancyrochitina* sp.	*Angochitina* cf. *longicollis*	*Angochitina* sp.	*Conochitina* sp.	*Eisenackitina lacrimabilis*	*Eisenackitina pilosa*	*Eisenackitina* cf. *urna*	*Eisenackitina* sp.	*Hoegisphaera* sp.	*Linochitina* cf. *cingulata*	*Margachitina gratiosa*	*Sphaerochitina sphaerocephala*	*Urochitina simplex*
CIEPIELOVIAN	2216													1							
	2217													1							
	2218												2								
	2235												13								
	2241.5												6								
	2266												1								
	2268												400						1		
	2269								4				76								
	2272												4								
	2274										9		5								
	2275												2	1							
	2277						9		11				62								
	2278								4				4							3	
	2280		4	5			14												6		
	2282		23																		
	2287																			6	27
	2290												9						4		
	2293																			160	
	2305																			70	30
BOSTOVIAN	2307												1							50	20
	2317								2											69	50
	2323	1																		21	10
	23235							3												35	27
	2325																			500	2
	2361									2										500	8
	2371																			5	
	2410	17					8		33												
	2430					11															
	2490	19				16	2										22				
	2520	4				27			24							20					
	2540								7							40	30			5	
	2569																			2	
	2580					12											20			50	
	2590															150	100				
PODLASIAN	2606															75					
	2625								20							40					
	2636				4				5							150					
	2645				60				80							5					
	2655				18				42							110	10				
	2661				11				39							180	100				
	2671				3				19							70		18			
	2683	3			9				6		12							38			
	2722											4			2						
	2762											5						24			
	2780											3									
	2785														10						

Those deposits comprise large amounts of *Ancyrochitina* (often, as the only chitinozoan genus) regarded as planktic because of the vesicle structure (CHAIFFETZ 1972, LAUFELD 1967, 1974, WOOD 1974). Similarly, specimens of the genus *Linochitina* occur frequently and abundantly in the Silurian graptolite shales, forming chains composed each of several vesicles linked closely together.

These observations fit well to the generally accepted view (e. g. BERRY 1977) of graptolite shales as accumulated in deep-water environments upon continental or platform slopes, and on shelf or platform margins.

Both the lithology and fauna (cephalopods, bivalves, lingulids, crinoids, fish, and conodonts) of the investigated graptolite shales indicate that these are, in part, deposits of the IV (limy terrigenous muds) and V (terrigenous muds) macrofacies zones as recognized by NESTOR and EINASTO (1977) in the Silurian Paleo-Baltic basin. The latter basin was situated north to the investigated depositional basin. Both the basins made part of a pericontinental sea encircling the degraded Fennosarmatian continent. The sea was widely connected with the Proto-Tethys Ocean of the Hercynnian Geosyncline (NESTOR and EINASTO *l. c.*, TOMCZYKOWA and TOMCZYK 1978, TOMCZYKOWA 1975*b*). Its IV and V lithofacies zones were situated (NESTOR and EINASTO *l. c.*) upon the continental slope and transitional between real shelf and the hemipelagic (-batial). Their more precise comparison to the present-day continental slope sediments (KUENEN 1950, DAVIS 1977) requires detailed analyses and large petrographic studies in the investigated area.

Table 3

Distribution of Chitinozoa species in samples from the borehole Strzelce IG 1 (excluding those samples without any Chitinozoa)

PODLASIAN																					BOSTOVIAN					CIEPIELOVIAN				
1534	1523.5	1519	1516	1514.5	1511.2	1510.8	1508	1502.5	1502	1501	1500.1	1496.8	1494.5	1493.5	1492.5	1492	1491.5	1490.5	1468	1459	1405	1371	1370	1368	1367	1298	1296	1295.5	1263	
						1								5								2								*Ancyrochitina ancyrea*
																			50	23				5	1	2	2			*Ancyrochitina* cf. *ancyrea*
																	4													*Ancyrochitina bullispina*
																			8	12					1		1			*Ancyrochitina* aff. *desmea*
												6							8											*Ancyrochitina lemniscata*
																													5	*Ancyrochitina* aff. *primitiva*
2						2		17				29	2	9			5		60											*Ancyrochitina* cf. *primitiva*
119		31	2	4	200	9	8	120	8		1	69		54	5	3	62		520	35	2		3			4	8	3	10	*Ancyrochitina* sp.
													6	6																*Angochitina* cf. *crassispina*
																										3	39	6		*Anthochitina superba*
																								1	1					*Eisenackitina lacrimabilis*
							5	7				22	30	7		4														*Eisenackitina oviformis*
																										30	15	2		*Eisenackitina pilosa*
						14	48	57	12	4	11	92	4	38	2		28		31	5										*Eisenackitina* cf. *urna*
																2	22	2	12											*Eisenackitina* sp.
																								1						*Gotlandochitina lublinensis*
																								53						*Hoegisphaera glabra*
																			600	800					4					*Hoegisphaera* sp.
8					80														39											*Linochitina subcylindrica*
																			17											*Linochitina* sp. A
4	200												4	15		3	6		80											*Linochitina* sp.
																										3	11	6		*Margachitina gratiosa*
	300																						3							*Sphaerochitina sphaerocephala*
																								3	7					*Urochitina simplex*

The most abundant and diverse chitinozoan assemblages derived form the siltstones and marls (pl. 36: 1–9; pl. 37: 1–3), and often biodetrital limestones (pl. 36: 10; 37: 4) of the Lower Ciepielovian. Some samples comprise, indeed, a few to a dozen or so chitinozoan species. Then, one may claim that in the Radom—Lublin region, the optimum living (or preservation)

Table 4

Distribution of Chitinozoa species in samples from the borehole Strzelce IG 2 (excluding those samples without any Chitinozoa)

YET NOT ERECTED	1976	1975	1945	1926	1915	1913	1896.7	1893	1891
Ancyrochitina ancyrea									
Ancyrochitina cf. ancyrea									
Ancyrochitina aurita									
Ancyrochitina cf. aurita									
Ancyrochitina bullispina									
Ancyrochitina cornigera									
Ancyrochitina aff. desmea									
Ancyrochitina lemniscata									
Ancyrochitina aff. primitiva									
Ancyrochitina cf. primitiva									
Ancyrochitina tomentosa									
Ancyrochitina sp.			2	5	13				4
Angochitina cf. crassispina									
Angochitina echinata									
Angochitina filosa									
Angochitina cf. longicollis									
Angochitina longispina									
Angochitina sp.									
Anthochitina superba									
Anthochitina radiata									
Conochitina invenusta									
Desmochitina spongiloricata									
Desmochitina sp.									
Eisenackitina barbatula									
Eisenackitina cepicia									
Eisenackitina crassa									
Eisenackitina cupellata									
Eisenackitina fimbriata									
Eisenackitina lacrimabilis									
Eisenackitina pilosa									
Eisenackitina cf. urna	170	2	71	2	2		6		27
Eisenackitina sp.								50	
Gotlandochitina lublinensis									
Hoegisphaera glabra									
Hoegisphaera cf. glabra									
Hoegisphaera velata									
Hoegisphaera sp.									
Linochitina cf. cingulata					29				
Linochitina longiuscula									
Linochitina serrata									
Linochitina subcylindrica									
Linochitina sp. A									
Linochitina sp. B									
Linochitina sp.	1400		3			12	4	5	
Margachitina gratiosa									
Sphaerochitina sphaerocephala									
Urochitina simplex									

PODLASIAN	1886	1872	1860	1849.5	1845	1833	1831	1819	1817.5	1816	1805	1804	1773	1757	1754.5	1753	1751	1749	1747	1743	1741	1739	1737	1736	1735
Ancyrochitina ancyrea			21	14									62	17	45	11					42		92	4	
Ancyrochitina cf. ancyrea															150								4		
Ancyrochitina aurita																									
Ancyrochitina cf. aurita																									
Ancyrochitina bullispina																									
Ancyrochitina cornigera																									
Ancyrochitina aff. desmea				4									29			4	13		3				4		
Ancyrochitina lemniscata													4									5			
Ancyrochitina aff. primitiva						6					5					3		3					35	12	
Ancyrochitina cf. primitiva											6		25									600	12	3	20
Ancyrochitina tomentosa																									
Ancyrochitina sp.						400	3		30	12			41			22	23		5	1					
Angochitina cf. crassispina																									
Angochitina echinata	14																								
Angochitina filosa																									
Angochitina cf. longicollis																									
Angochitina longispina																									
Angochitina sp.																									
Anthochitina superba																									
Anthochitina radiata																									
Conochitina invenusta																									
Desmochitina spongiloricata																									
Desmochitina sp.																									
Eisenackitina barbatula																									
Eisenackitina cepicia																									
Eisenackitina crassa																									
Eisenackitina cupellata																									
Eisenackitina fimbriata																									
Eisenackitina lacrimabilis																									
Eisenackitina pilosa																									
Eisenackitina cf. urna	5	34	8	23		5		1	54	7	7	5	80	67	102	18		110	150	130	450	10	2	46	55
Eisenackitina sp.				95																		6			
Gotlandochitina lublinensis																									
Hoegisphaera glabra																									
Hoegisphaera cf. glabra																									
Hoegisphaera velata																									
Hoegisphaera sp.															250	220	200								
Linochitina cf. cingulata			34			300	1		1	5		1	48					20		350	300		25	11	42
Linochitina longiuscula																							6		
Linochitina serrata										9															1
Linochitina subcylindrica																					100	50			20
Linochitina sp. A																									
Linochitina sp. B																									
Linochitina sp.		14																	29					11	
Margachitina gratiosa																									
Sphaerochitina sphaerocephala																									
Urochitina simplex																									

BOSTOVIAN	1732	1712	1708	1706	1704	1702	1701	1695	1687	1684	1681
Ancyrochitina ancyrea						2					
Ancyrochitina cf. ancyrea						1		2		4	
Ancyrochitina aurita											
Ancyrochitina cf. aurita											
Ancyrochitina bullispina											
Ancyrochitina cornigera						1					
Ancyrochitina aff. desmea						4					
Ancyrochitina lemniscata											
Ancyrochitina aff. primitiva											
Ancyrochitina cf. primitiva								5			
Ancyrochitina tomentosa						5		4		5	
Ancyrochitina sp.						30	8	6			2
Angochitina cf. crassispina				67	30	2					
Angochitina echinata				15	5					2	
Angochitina filosa			2		2	3		4			
Angochitina cf. longicollis	28		1			2					
Angochitina longispina								2			
Angochitina sp.											
Anthochitina superba								1			
Anthochitina radiata											
Conochitina invenusta						21					
Desmochitina spongiloricata	7										
Desmochitina sp.											
Eisenackitina barbatula											
Eisenackitina cepicia											
Eisenackitina crassa											
Eisenackitina cupellata						43	154	90			
Eisenackitina fimbriata											
Eisenackitina lacrimabilis											
Eisenackitina pilosa											
Eisenackitina cf. urna											
Eisenackitina sp.											
Gotlandochitina lublinensis								11			
Hoegisphaera glabra	5										
Hoegisphaera cf. glabra	9		1	80	21	14		2		3	1
Hoegisphaera velata	3					3					
Hoegisphaera sp.											
Linochitina cf. cingulata								5	1	1	
Linochitina longiuscula						18					
Linochitina serrata											
Linochitina subcylindrica	4			6	5				2	1	
Linochitina sp. A											
Linochitina sp. B				3							
Linochitina sp.											
Margachitina gratiosa											
Sphaerochitina sphaerocephala			25								
Urochitina simplex						1					

CIEPIELOVIAN	1669	1667	1651	1648	1629	1613	1611	1609	1608	1607	1606	1605	1600	1592
Ancyrochitina ancyrea														
Ancyrochitina cf. ancyrea		7	23		2		2					2	1	
Ancyrochitina aurita					1	3						5		
Ancyrochitina cf. aurita		1				2				1				
Ancyrochitina bullispina						2								
Ancyrochitina cornigera														
Ancyrochitina aff. desmea		2	10	9		11	2	2	15	6	2	13		2
Ancyrochitina lemniscata														
Ancyrochitina aff. primitiva		2	22	2		1						7		
Ancyrochitina cf. primitiva														
Ancyrochitina tomentosa										1				1
Ancyrochitina sp.	3	27	3	3		52		12	10	18			3	
Angochitina cf. crassispina					2									
Angochitina echinata		18												
Angochitina filosa					10									
Angochitina cf. longicollis														
Angochitina longispina														
Angochitina sp.														1
Anthochitina superba			30	6		5	2	6		12	2	1	5	8
Anthochitina radiata			2							2			4	2
Conochitina invenusta														
Desmochitina spongiloricata														
Desmochitina sp.				4										
Eisenackitina barbatula					3									
Eisenackitina cepicia			6	1		2		3				1		
Eisenackitina crassa					26									
Eisenackitina cupellata														
Eisenackitina fimbriata				1			2					1		
Eisenackitina lacrimabilis				400	32				11		2			
Eisenackitina pilosa			140		400	2	3	7		2	20	6	5	186
Eisenackitina cf. urna														
Eisenackitina sp.														
Gotlandochitina lublinensis			1	3										
Hoegisphaera glabra			3	3										9
Hoegisphaera cf. glabra		17			12				6			18		
Hoegisphaera velata				16	3				1			2		
Hoegisphaera sp.		3												
Linochitina cf. cingulata	12			3	25									
Linochitina longiuscula					66									
Linochitina serrata					4				2					
Linochitina subcylindrica	10	3		5	11									
Linochitina sp. A				3	9									
Linochitina sp. B					41									
Linochitina sp.														3
Margachitina gratiosa			17	12			4		71	21		1	22	4
Sphaerochitina sphaerocephala		7												
Urochitina simplex		41												

conditions for the Chitinozoa were in the Lower Ciepielovian. Both the abundant fossil assemblage (*Tasmanites*, *Leiosphaeridia*, scolecodonts, bryozoans, bivalves, brachiopods, cephalopods, ostracodes, trilobites, eurypterids, graptolites, fish, and conodonts) associated with the Chitinozoa (tables 5–8) and the basin paleogeography and facies development (TOMCZYK *et al.* 1977; TOMCZYKOWA and TOMCZYK 1978) indicate that the environmental optimum or near-optimum conditions for Chitinozoa existed in a shallow marine basin with a rich, mostly benthic fauna.

Table 5

Relationship of frequency distribution of the Chitinozoa and other microfossils to sample lithology of the borehole Białopole IG 1

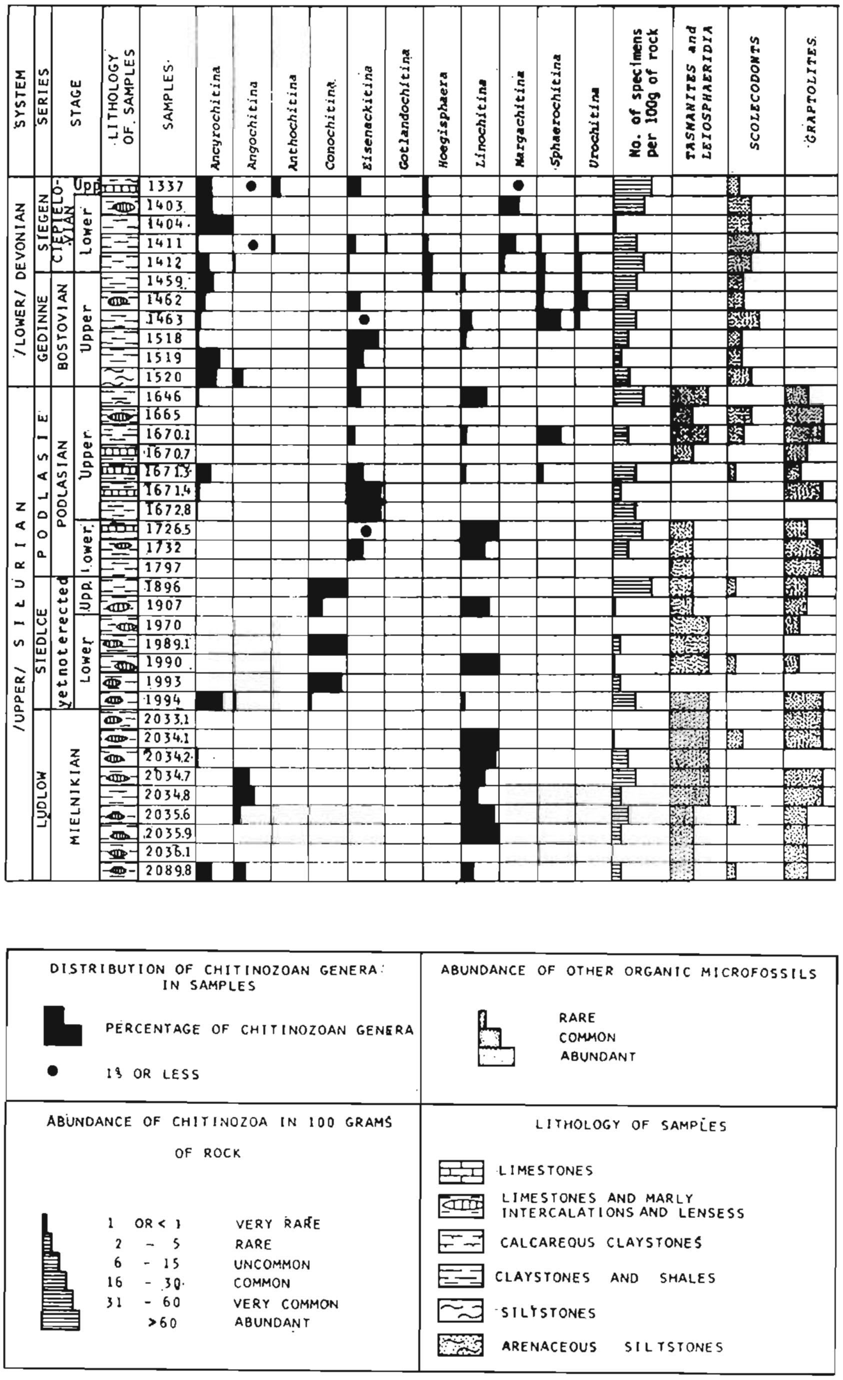
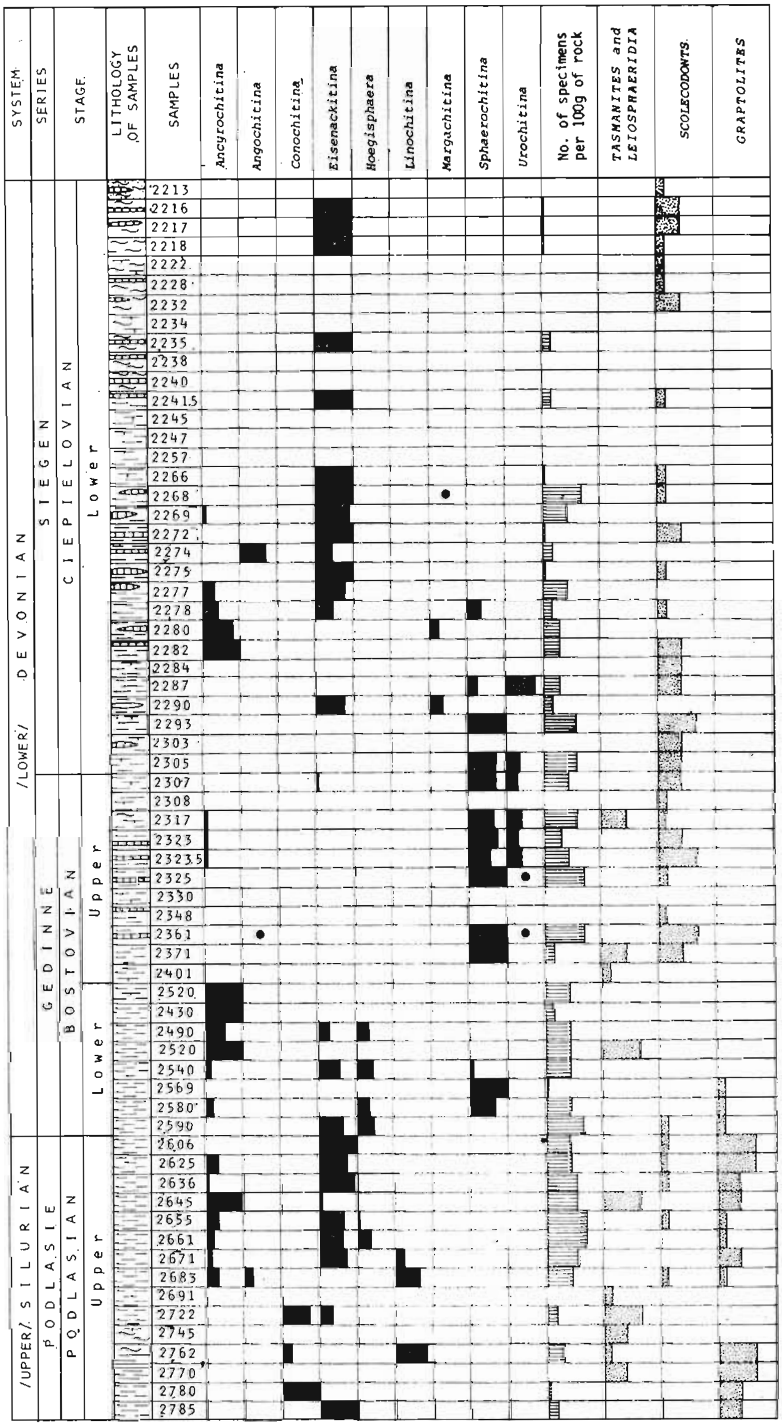


Table 6

Relationship of frequency distribution of the Chitinozoa and other microfossils to sample lithology of the borehole Ciepielów IG 1 (for detailed explanations see Table 5)

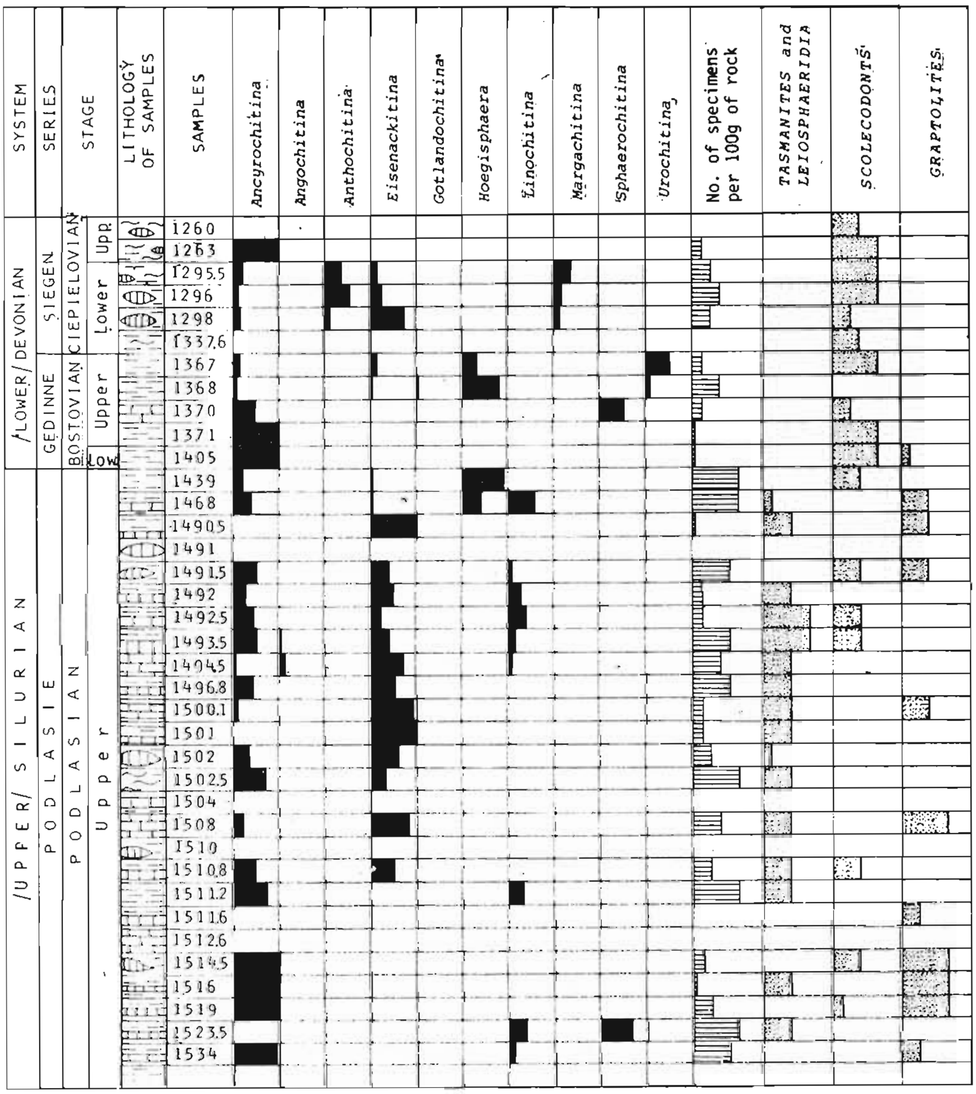


The Lower Ciepielovian lithology and fauna suggest that these are deposits of the III (limy biodetrital muds) and IV macrofacies zones of the Silurian Paleo-Baltic basin, marked in the paleomorphology by the shelf margin and open shelf (NESTOR and EINASTO 1977). In the Lower Ciepielovian marly siltstones, coquinites occur only as lenses and thin (1–15 cm thick) layers which could be formed by valves received temporarily from the adjacent shallower zone.

A comparison to the Silurian Chitinozoa distribution in Gotland (cf. LAUFELD 1974) does also confirm the above opinion and permits a conclusion that the shoreline was far away (up to a few hundred kilometers) from the investigated area of the deceasing Lower Devonian marine basin of the southeastern Poland (fig. 2) when the environmental conditions were near the optimum living conditions for Chitinozoa.

Table 7

Relationship of frequency distribution of the Chitinozoa and other microfossils to sample lithology of the borehole Strzelce IG 1 (for detailed explanations see Table 5)



Both the chitinozoan abundance and diversity decrease rapidly in the Upper Ciepielovian siltstones and limestones; actually, the Chitinozoa disappear soon. Neither Chitinozoa, nor any other fossils built up of organic matter were found in the sandy, oldred-like siltstones (Emsian?) overlying the Ciepielovian rocks. This was probably not caused by the decrease in basin depth, as the Chitinozoa have already been reported even from sediments interpreted as deposited in shallow ponds situated landwards to upper tidal flats (CHAIFFETZ *et al.* 1977); one may rather claim that the main causes were: a decrease in salinity, considerable increase in terrigenous influx, and constant oxidation of organic matter in the shallow-water bioturbated deposits.

Table 8

Relationship of frequency distribution of the Chitinozoa and other microfossils to sample lithology of the borehole Strzelce IG 2 (for detailed explanation see Table 5)

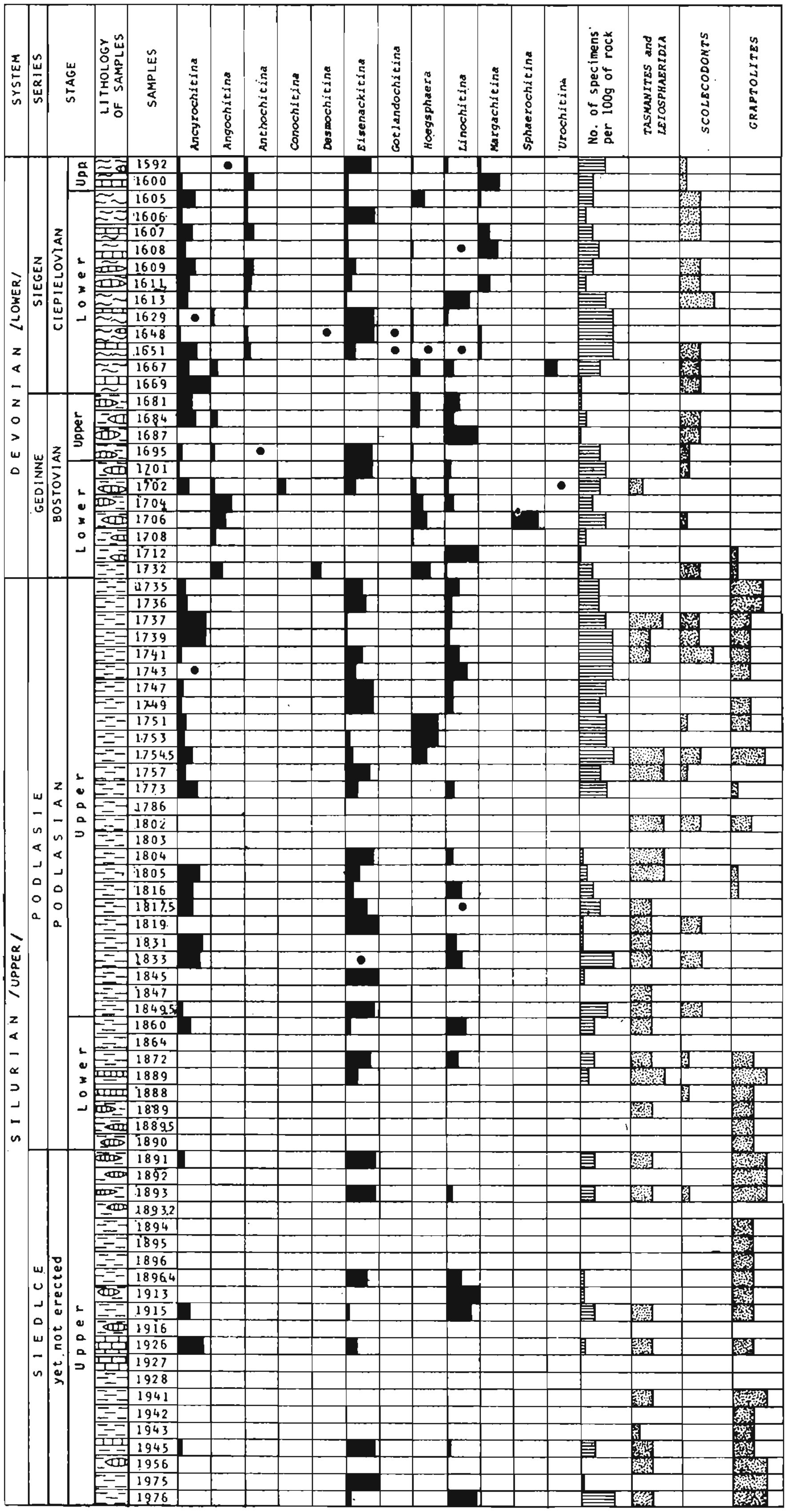
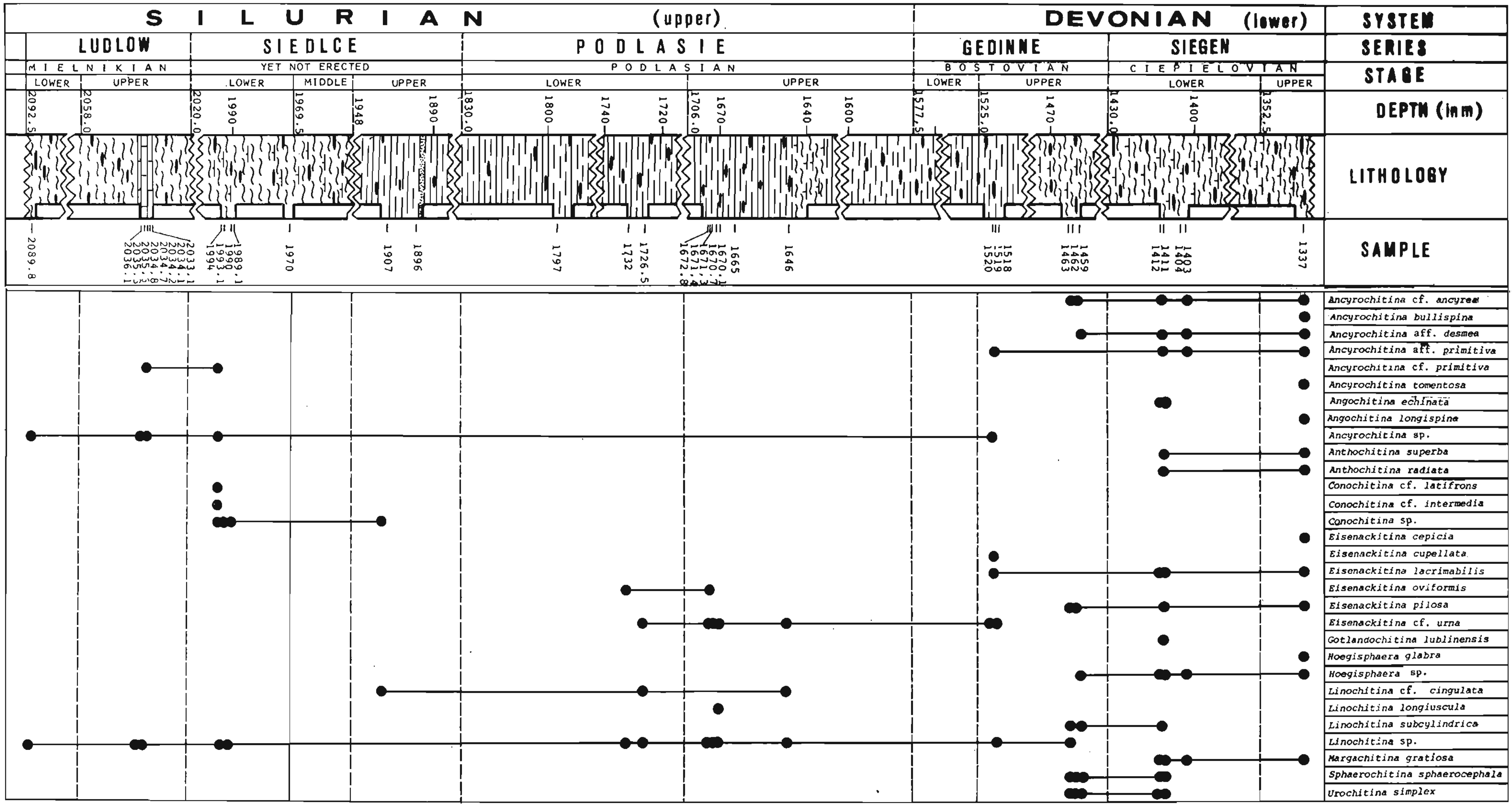


Table 9

Range of more important chitinozoan species and sample distribution in the borehole Białopole IG 1; lithology and stratigraphy after TOMCZYK (1971), TOMCZYKOWA (1971), and TOMCZYK *et al.* (1977), (for explanation see Table 10)



REMARKS ON CORRELATIVE VALUE OF THE CHITINOZOA

The value of Chitinozoa-based correlation of the investigated borehole sections is restricted by the scarcity of taxonomic studies of the Silurian-Devonian Chitinozoa; furthermore, the core profiles are discontinuous. Therefore, the vertical ranges are presented for the investigated chitinozoan species in particular boreholes (tables 9–12). A more precise estimation of the stratigraphic-correlative value of the investigated material will be possible after examining the Chitinozoa from the type and hypotype sections (the Barrandien and Podolia) of the Silurian/Devonian boundary. In part, a correlation of the investigated Chitinozoa with the graptolite- and trilobite-based stratigraphy (table 13) is already possible due to the biostratigraphic studies on the investigated boreholes (TOMCZYK 1971, 1974*a*, 1976; TOMCZYKOWA 1971, 1974, 1975*a*, 1975*b*, 1976).

The Mielnikian (Ludlovian) deposits comprise scarce *Ancyrochitina* cf. *primitiva*, the species *A. primitiva* being reported from the Llanvirnian through Ludlovian of Gotland (LAUFELD 1974) and from the Paadla Stage (Ludlovian) of Estonia (MÄNNIL 1970). LAUFELD (1970) recorded the species in the Wenlockian Restevo Beds (TSEGELNJUK 1974; NIKIFOROVA and PREDTECHENSKY 1972) of the Podolia. In Radom—Lublin region, *A.* cf. *primitiva* displays a wide stratigraphic range (Mielnikian through Upper Bostovian) and hence, its stratigraphic value is poor.

The lower part of the Siedlce series comprises three *Conochitina* species; they cannot be precisely identified because of the poor preservation state. These are: *C.* cf. *intermedia*, *C.* cf. *latifrons*, and *C.* sp., the latter species present all over the Siedlce series. The species *C. intermedia* occurs in Gotland and Estonia (LAUFELD 1974, MÄNNIL 1970) in equivalents of the Whitcliffian strata (MARTINSSON 1967; KALIO 1970, 1977) which are regarded as equivalent to the upper part of the Siedlce series (TOMCZYKOWA and WITWICKA 1974). *C. latifrons* occurs in the Klinteberg and Hemse Beds, Gotland, and in the Paadla Stage, Estonia, regarded as equivalents of the strata of the lowermost Whitcliffian or just underlying this stage (MARTINSSON 1967, KALIO 1970).

Eisenackitina cf. *urna* appears in the upper part of the Siedlce series. The species *E. urna* has insofar not been redefined after SEM observations, while its world-wide records range from the Silurian through Lower Devonian (CRAMER 1967, OBUT 1973). *Linochitina* cf. *cingulata* does also make its appearance in the Siedlce series, persisting up to the Lower Ciepielovian.

The species *Eisenackitina oviformis* makes its appearance in the Podlasian. It is indicative of the stage and its regional equivalents outside the southeastern Poland. In fact, it occurs in the Sundre Beds, Gotland (LAUFELD 1974), regarded as equivalent to the upper part of the Siedlce series and lowermost Podlasian (TOMCZYKOWA and WITWICKA 1974); in the borehole Łeba 1, it co-occurs with the graptolites indicative of the Upper Podlasian and lowermost Pridolian (EISENACK 1972*a*).

The new species *Ancyrochitina lemniscata* sp. n. occurs exclusively in the Podlasian. *Ancyrochitina ancyrea* and *Angochitina echinata* make their appearance in the Podlasian but their stratigraphic range is wide, as they occur also in the younger deposits. Moreover, *A. ancyrea* was recorded in the Wenlockian to Ludlovian of Gotland (LAUFELD 1974). In the Balto-Scandian area *A. ancyrea (sensu lato)* appears in the latest Ashgilian (LAUFELD 1971, GRAHN 1978) and *A. echinata* was recorded in strata (LAUFELD *l. c.*, EISENACK 1972*a*) regarded as equivalent to the Lower or Upper Podlasian (TOMCZYKOWA and WITWICKA 1974).

The following species make their appearance in the Upper Podlasian: *Ancyrochitina bullispina* sp. n., *A.* aff. *desmea*, *A.* aff. *primitiva*, *Angochitina* cf. *crassispina*, *Linochitina longiuscula* sp. n., *L. serrata*, *L. subcylindrica* sp. n., *L.* sp. A, *L.* sp. B, and *Sphaerochitina sphaerocephala*. However, the stratigraphic value of all these species is poor as they occur also in the Lower Devonian; furthermore, some of them occur also in the older deposits outside the Radom—Lublin region.

Table 10

Range of more important chitinozoan species and sample distribution in the borehole Ciepielów IG 1; lithology and stratigraphy after TOMCZYK (1974), TOMCZYKOWA (1974), and TOMCZYK *et al.* (1977)

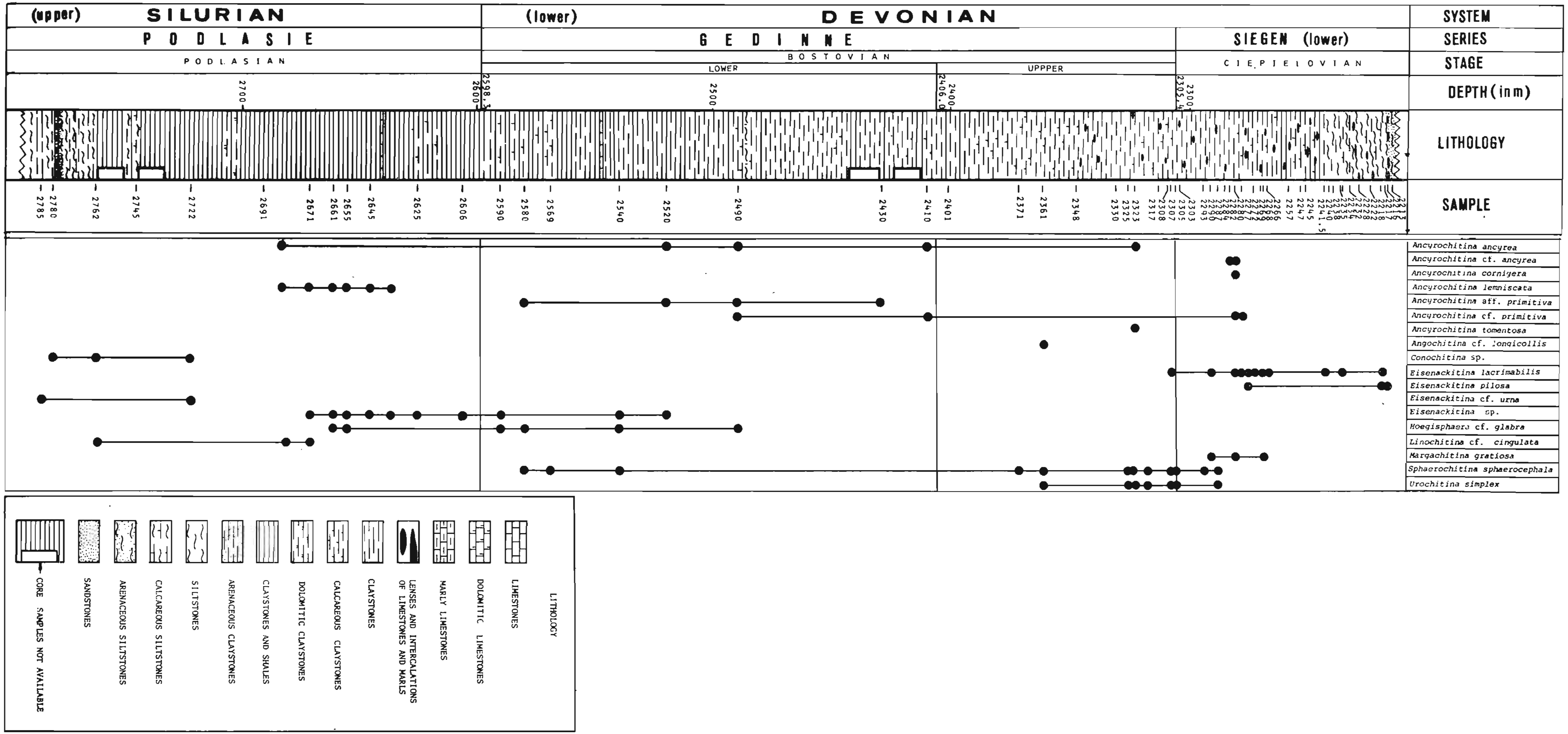
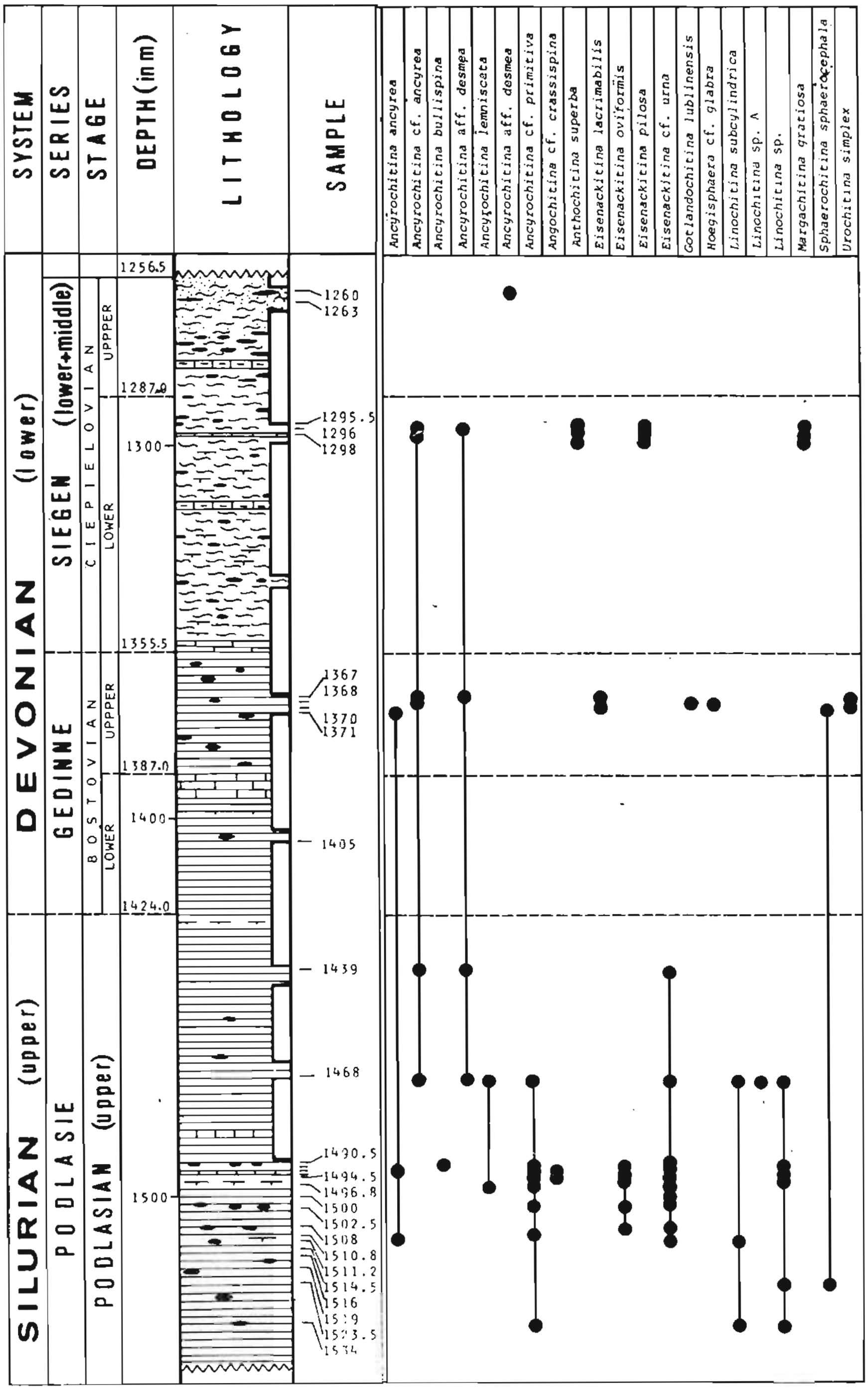


Table 11

Range of more important chitinozoan species and sample distribution in the borehole Strzelce IG 1; lithology and stratigraphy after TOMCZYK (1976), TOMCZYKOWA (1976), and TOMCZYK *et al.* (1977); for explanation see table 10



Aside of the above-mentioned species, *Hoegisphaera glabra* and *Ancyrochitina cornigera* appear also in the Bostovian (Gedinnian); both the species were insofar recorded exclusively in the Devonian (URBAN and NEWPORT 1973, LEGAULT 1973*a*), often in the Emsian or Givetian. The presence of *Urochitina simplex*, *Hoegisphaera glabra*, and *Ancyrochitina cornigera* stresses the Devonian nature of the Bostovian and Ciepielovian chitinozoan assemblages. At the same time, the mainly Silurian species *Ancyrochitina* cf. *primitiva* and *Angochitina* cf. *longicollis* disappear in the Bostovian. *Conochitina invenusta* sp. n. occurs exclusively in the Lower Bostovian.

The species *Ancyrochitina tomentosa*, *Angochitina filosa*, *Hoegisphaera glabra*, and *H. velata* sp. n. make their appearance in the Lower Bostovian; however, the latter species persists also higher in the section. *Ancyrochitina* cf. *longicollis* and *Eisenackitina cupellata* sp. n. occur only in the Bostovian. *Angochitina longispina* sp. n. was recorded exclusively in the Upper Bostovian. The appearance of *Gotlandochitina lublinensis* sp. n. and the mass occurrence of *Eisenackitina pilosa* sp. n., *E. lacrimabilis* sp. n., and *Anthochitina superba* are characteristic of the Upper Bostovian; *A. superba* wad insofar reported only from the erratic boulders of the *Beyrichia* Limestone and the Gedinnian Borshchov Beds of the Podolia.

Many chitinozoan species persist up to the Ciepielovian (Siegenian). However, there are also species making their appearance in and restricted to the Lower Ciepielovian; those are: *Ancyrochitina aurita* sp. n., *A.* cf. *aurita* sp. n., *Eisenackitina barbatula* sp. n., *E. crassa* sp. n., and *E. fimbriata* sp. n. The following species occur all over the Ciepielovian: *Anthochitina radiata* sp. n., *Eisenackitina cepicia* sp. n., and *Margachitina gratiosa* sp. n.

In the Lower Ciepielovian many species disappeared which were characteristic for the underlaying Silurian deposits. These are: *Angochitina echinata*, *A. filosa*, *Sphaerochitina sphaerocephala*, all the species of *Linochitina*, *Ancyrochitina cornigera*, *Eisenackitina lacrimabilis* sp. n., *Gotlandochitina lublinensis* sp. n., and *Urochitina simplex.*

The occurrence of the chitinozoan genera *Anthochitina* and *Margachitina* in the Lower Devonian of Radom—Lublin region assures that a correlation will be allowed of the investigated sections with the hypotype Silurian-Devonian section of the Podolia, as related taxa were recorded in the latter area although not described precisely (OBUT 1973). Announced or already initiated world-wide investigations of the Siluro-Devonian Chitinozoa shall also soon permit a correlation with the type section (Barrandian) of the Silurian/Devonian boundary as well as with many topotypes (LAUFELD 1977). The occurrence of the Lower Devonian species *Ancyrochitina cornigera*, *Hoegisphaera glabra*, *Urochitina simplex*, and *Eisenackitina urna* in the investigated deposits gives promise to permit a correlation of the Polish sections with far-away sections of the South and North Americas and Mediterranean (North Africa and Spain).

The high stratigraphic-correlative value of the Chitinozoa consists in their occurrence not only in the graptolite-shaly facies but also in shallow-water epicontinental, near reef, and even lagoon facies. Therefore, the Chitinozoa may be expected to provide an important tool for correlation of the zones based on such excellent guide fossils as the graptolites with those based on the trilobites, ostracodes, or brachiopods.

SYSTEMATIC PALEONTOLOGY

GENERAL REMARKS

The taxonomic descriptions follow the rules of the International Code of Zoological Nomenclature, as recommended arbitrarily by the Subcommission on Chitinozoa at a symposium held by the International Committee of the Microflora of the Paleozoic (CIMP) in 1974 at Visby, Gotland. Actually, chitinozoan taxonomy does not reflect true phylogenetic relationships. Furthermore, taxonomic value attributed to particular morphologic elements varies among paleontologists, which results in a number of different divisions of the Chitinozoa into supra-generic units (van OYEN and CALANDRA 1963; CRAMER 1964; JANSONIUS 1964, 1967, 1970; TAUGOURDEAU 1966; TAPPAN 1966; COMBAZ *et al.* 1967; EISENACK 1968, 1972; and others).

Table 12

Range of more important chitinozoan species and sample distribution in the borehole Strzelce IG 2; lithology and stratigraphy after TOMCZYK (1976), TOMCZYKOWA (1976), and TOMCZYK *et al.* (1977). For explanation see table 10

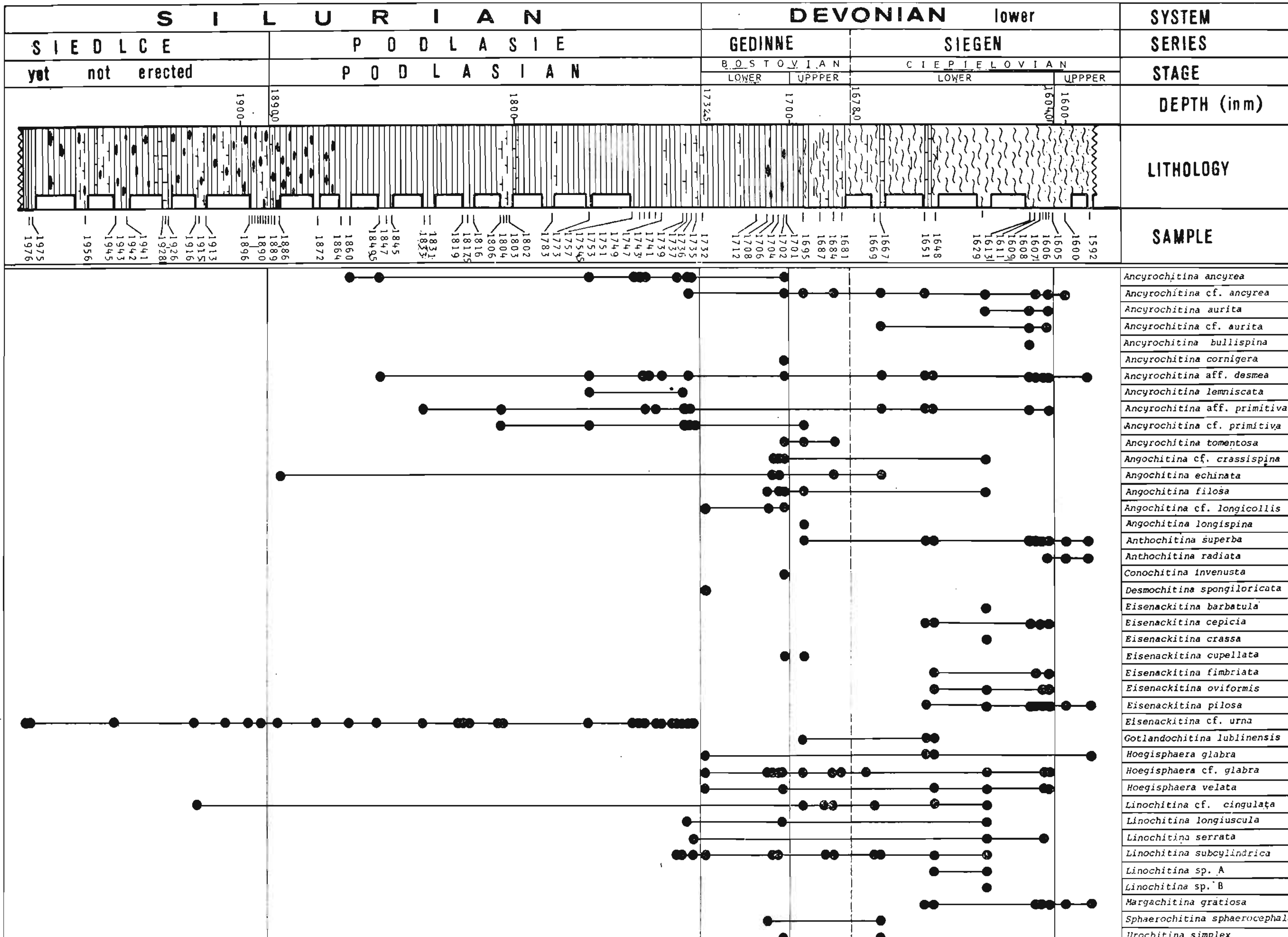


Table 13

Biostratigraphic division of the Upper Silurian and Lower Devonian of Poland (after TOMCZYK *et al.* 1977, modified)

SYSTEM	SERIES	STAGE		GRAPTOLITE ZONES AND GUIDE TRILOBITES	CHITINOZOAN OCCURRENCE
DEVONIAN (Lower)	EMS			OLD — RED	
	SIEGEN	CIEPIELOVIAN	Upper	Brachiopods Bivalves Bryozoans Tentaculitids, etc.	*Anthochitina radiata* *Eisenackitina cepicia* *Margachitina gratiosa* *Eisenackitina fimbriata* *Eisenackitina barbatula* *Eisenackitina crassa* *Ancyrochitina aurita*
			Lower	*Parahomalonotus angusticostatus* *Trimerus novus* *Acastella rouaulti* - *Parahomalonotus forbesi*	
	GEDINNE	BOSTOVIAN	Upper	*Digonus vialai* - *D. bostoviensis* *Podolites rugulosus*	*Angochitina longispina* *Eisenackitina cupellata* *Desmochitina spongiloricata* *Conochitina invenusta*
			Lower	*Acastella elsana* - *A. tiro*	
SILURIAN (Upper)	PODLASIE	PODLASIAN	Upper	*Monograptus angustidens* *Pristiograptus transgerdiens* *Monograptus boucekí* - *M. perneri*	*Ancyrochitina lemniscata* *Eisenackitina oviformis*
			Lower	*Pristiograptus samsonowiczi* *Monograptus ultimus* - *Pristiograptus bugensius*	
	SIEDLCE	Yet not erected	Upper	*Monograptus formosus*	*Conochitina* sp. *Conochitina* cf. *intermedia* *Conochitina* cf. *latifrons*
			Middle	*Monoclimacis tomczyki*	
			Lower	*Neocucullograptus kozlowskii* *Bohemograptus bohemicus*	
	LUDLOW	MIELNIKIAN	Upper	*Saetograptus leintwardinensis* *Lobograptus progenitor*	*Ancyrochitina* cf. *primitiva* *Linochitina* sp.
			Lower	*Neodiversograptus nilssoni* *Gothograptus nassa*	

Recent scanning electron-microscope studies dealt with but a few species do not allow the reevaluation of previous taxonomic criteria and schemes. Therefore, an alphabetical arrangement of the genera and species irrespective of any suprageneric taxa appears as the most reasonable approach for the moment. In fact, this is the way the recent SEM taxonomic studies have been arranged (URBAN 1972; URBAN and NEWPORT 1973; LAUFELD 1974; NEVILL 1974). In the present study, the systematic descriptions are arranged alphabetically.

TERMINOLOGY

The morphological terms used in the present study are for the most part those recommended by the CIMP (COMBAZ *et al.* 1967) or introduced subsequently by CRAMER (1967), JANSONIUS (1970), JENKINS (1970), EISENACK (1968, 1972), and LAUFELD (1974).

Below, the explanations and schematic drawings (fig. 3) are given for those morphological terms introduced or re-interpreted by the author.

Aboral: the part of the vesicle where the base and basal scar occur; the aperture occurs at the opposite side of the vesicle.

Aboral pole: synonymous to the base and basal pole; relevant especially to the vesicles lacking sharply marked basal edge.

Aboral scar: synonymous to the basal scar.

Aperture: the main opening of the vesicle with its center situated on the longitudinal axis of the vesicle; it occurs adorally, located at a collar, neck, lip, or chamber; it may be straight or variously shaped, smooth or rough, or fringed.

Appendices: singular processes at the basal edge; they may be simple or branched.

Auricles: fenestrate or lacy membrane elements situated at the neck at planes passing through the longitudinal axis of the vesicle (new term, proposed herein).

Basal callus: thickened portion of the vesicle wall at the center of the base; it is usually in the form of a cone-like rise above the external surface of the base, or a circular boss around the basal scar.

Basal edge: more or less distinctly bent portion of the vesicle wall forming an edge separating the base and the chamber flank; often, it bears appendices, carina, or other ornamentation elements.

Basal margin: synonymous to the basal edge,

Basal pore: opening at the center of the basal scar (new term, proposed herein).

Basal process: singular process at the center of the base forming a „tuft" of equal-rank fibriform branches.

Basal rings: concentric folds or striae on the external surface of the base around the basal scar (new term, proposed herein).

Basal scar: hollow (usually circular) at the surface at the center of the base, or at the basal callus. It is a reflection of previously existing connection between the interiors of subadjacent chambers; it comprises a more or less overgrown basal pore.

Base: the portion of the vesicle wall situated aborally to the basal edge, and sometimes on the same plane, transversally to the longitudinal axis.

Body: synonymous to the chamber.

Carina: circular membrane extending distally at the basal edge.

Chain: a number of the vesicles linked longitudinally one with another.

Chamber: the portion of the vesicle situated aborally to the flexure; when the latter is lacking, the chamber occurs aborally to either the collar, lip, or aperture.

Collar: the end of the vesicle expanding orally; it is part of the oral tube and extends from the neck or chamber (in neckless forms) to the aperture.

Distal: distant from the longitudinal axis of the vesicle.

Fenestrate: naturally perforate membrane, carina, collar, etc.

Fenestration: natural formation and spatial distribution of the openings (new term, proposed herein).

Flange: aborally stretched plug or internal margin of the operculum; it is sometimes in the form of a skirt-like membrane.

Flank: the portion of the vesicle wall extending between the basal edge and either the shoulder flexure, or collar.

Lip: swelling around the aperture of the neckless and collarless vesicles. Lips occur in some species of the genera *Hoegisphaera*, *Margachitina*, *Pterochitina*, and *Desmochitina*.

Longitudinal axis: geometrical axis linking the centers of the aperture and base; it makes also the axis or radial symmetry of the vesicle.

Neck: the portion of the vesicle extending between the collar or aperture (in collarless forms) and the flexure.

Neck processes: processes resembling in shape but smaller-sized than the appendices; thery are situated on the neck (usually in the middle) where they often form a verticil (new term, proposed herein).

Operculum: disc closing the vesicle and situated usually within the aperture or somewhat below it; its thickness may equal or slightly exceed the thickness of the vesicle wall.

Oral: the end of the vesicle where the operculum and aperture occur.

Oral scar: circular boss with a pit or pore at its center, situated at the external surface of the operculum; it is a reflection of previously existing connection with the superadjacent vesicle (new term, proposed herein).

Ornamentation: larger external-morphological elements of the vesicle, such as the appendices, processes, auricles, spines, etc. The ornamentation does not include the surface sculpture.

Proximal: close to the longitudinal axis of the vesicle.

Perforation: various openings and channels penetrating disorderly the vesicle, operculum, and/or vesicle ornamentation elements; they are not related to the very nature of the Chitinozoa themselves but result from activities of some unknown microorganisms or from mechanical damage (e. g. caused by pyrite or dolomite crystals).

Plug: thick cylindrical element closing the vesicle, situated within the neck, usually oral to the flexure; its structure is either spongy or multilayered with the layers concentrical or transversal relative to the longitudinal axis. A flange may occur at both the lower and upper margins of the plug.

Prosome: synonymous to the plug.

Sculpture: morphology of the vesicle surface; it is to be seen at the external and internal surfaces, operculum, and large ornamentation elements. In the present study, it will be referred to as laevigate, granulate, verrucate, reticulate, rugate, or spongy.

Verticil: processes or spines clustered at a single plane perpendicular to the longitudinal axis of the vesicle (new term, proposed herein).

Abbreviations used (cf. fig. 3A, B, C)

L	— total lenght of the vesicle
C	— length of the chamber
N	— minimum width of the neck
A	— width (diameter) of the aperture
W	— maximum width (diameter) of the vesicle
ap	— appendices
pr	— processes
n+pr	— joint width (diameter) of the neck and length of the neck processes
W+ap	— joint width (diameter) of the vesicle and length of the appendices
lpr	— length of the processes
lap	— length of the appendices
bs	— basal scar
bp	— basal processus
l+bp	— joint length of the vesicle and the basal processus
lvelum	— length of the velum
Wcarina	— diameter of the carina and base
lspine	— length of the spines

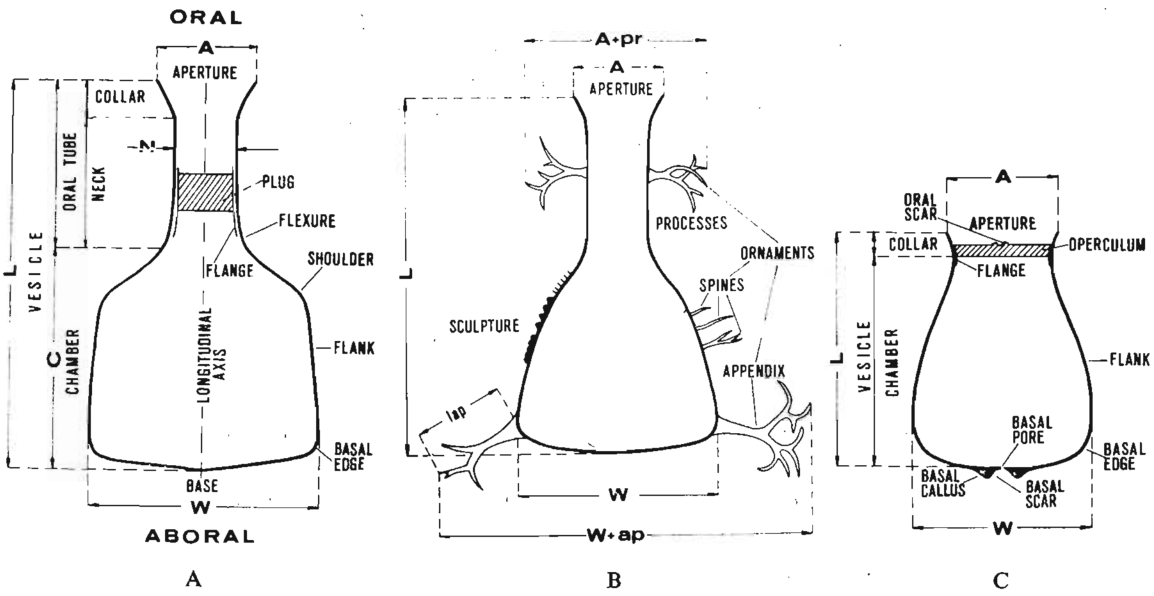


Fig. 3

A, B, C. Morphological terms and measurement symbols used for the Chitinozoa description

Genus *Ancyrochitina* EISENACK, 1955

Type species: *Conochitina ancyrea* EISENACK, 1931.

Remarks. — For revised diagnosis and discussion see LAUFELD (1974).

Ancyrochitina ancyrea (EISENACK, 1931)
(pl. 24: 1)

1974. *Ancyrochitina ancyrea* (EISENACK); LAUFELD: 38, figs. 4–5 *(cum syn.)*.
1977. *Ancyrochitina ancyrea* (EISENACK); EISENACK: 29, figs. 3–5.

Material. — Ca 400 specimens.
Dimensions (in μm):

	L	C	W	N	A	W+ap
Range	119–152	51–76	61–81	21–25	25–42	102–105
Mode	136	59	61	23	30	

Description. — The vesicle is cylindro-conical. The flexure is gentle. There is no shoulder. The neck expands gradually towards the aperture, attaining at least half the length of the vesicle. The aperture is smooth, straight of finely fringed. The neck is smooth but its proximal part (more than one third in lenght) is sometimes covered with short simple spines. The base is convex or flat. The basal edge is wide and bears 8–10 appendices. The appendices are hollow, moderately long, straight, bifurcate or rarely trifurcate. The vesicle surface is laevigate or granulate.

Remarks. — Following LAUFELD (1974), the range of *A. ancyrea* is here restricted to that defined originally by EISENACK (1931). Then, any forms displaying more complex or irregularly branched appendices are not included here; some neotypes designated subsequently by EISENACK (1964, pl. 24: 4) are also left outside the range of the species. The investigated specimens resemble most closely those making part of the youngest assemblage (derived from the Hemse Beds) recognized in the Silurian of Gotland by LAUFELD (*l. c.*, fig. 5: E–F).

Occurrence. — *A. ancyrea s. l.* is cosmopolitan in Upper Ordovician through Devonian sediments. The species, restricted to its original range, occurs most commonly in the Silurian of the western margin of the Eastern-European Platform (LAUFELD *l. c.*). Gotland: Visby Beds, Högklint Beds, and Hemse Beds (Wenlockian-Ludlovian). Poland: Radom—Lublin region; Podlasian through Bostovian (uppermost Silurian through Lower Devonian).

Ancyrochitina cf. *ancyrea* (EISENACK, 1931)

(pl. 25: 7, pl. 36: 1)

Material. — 350 poorly preserved specimens with the appendices partly broken off.

Remarks.— Any more precise identification is impossible because of the poor preservation of the vesicles. In some cases, the distribution of appendices and the occurrence of a constriction in the middle of a specimen may indicate that one deals with specimen composed of two (?) underdeveloped and unseparated vesicles (pl. 25: 7). Both the number of appendices and their furcate distal ends (pl. 25: 7*b*) suggest that the investigated specimens resemble very closely or even are conspecific with *A. ancyrea*. However, their dimensions differ from those typical of the species. The „sculpture" at the surface of the specimen shown in pl. 35: 7b is actually an artifact: these are remains after a mineral residue attached originally to the specimen, taken off with a brush by the author.

Occurrence. — Poland: Radom—Lublin region; uppermost Podlasian to Upper Ciepielovian (Upper Silurian to Lower Devonian).

Ancyrochitina aurita sp. n.

(pl. 24: 10, pl. 26: 10)

Holotype: ZPAL Ch. II/2S76; pl. 26: 10.
Type stratum: Lower Ciepielovian, Lower Devonian (sample taken at 1629 m in depth).
Type locality: borehole Strzelce IG 2, Radom-Lublin region.
Derivation of the name: Lat. *aurita* — eared, after the specific neck processes.

Diagnosis. — Cylindro-conical vesicle with both the appendices and auricles lacy.

Material. — 9 poorly preserved specimens.

Dimensions (in μm):

	L	C	W	W+ap	A	N	N+pr
Holotype	139	59	68		33	24	
Range	136–169	59–64	68–76	up to 119	27–38	19–27	up to 72
Mode	144	59	68		34	25	

Description. — The vesicle is cylindro-conical. The chamber passes gently into the neck. The flexure is distinct. There is no shoulder. The oral tube makes up two thirds of the vesicle length. The neck ends with a short but distinct collar. The collar margin is straight or fringed. The base is convex, separated from the flank with a wide basal edge usually bearing 6 appendices. The appendices are lacy and hollow with their cavities separated from the interior of the chamber (pl.24: 10*b*); they are wide at the base but their ends are short and sharp. The neck bears 4–6 lacy auricles. The bars and auricle fragments are solid (pl. 26: 10*b*, *c*). The vesicle surface is laevigate.

Remarks. — *A. aurita* resembles in both the shape and dimensions *A. primitiva*; in fact, they can be easily misidentified (especially under a light microscope), since the ornamentation elements of *A. aurita* can be easily broken off leaving hardly any scars at the vesicle surface. The auricles vary in shape on a single specimen.

The Silurian specimens recognized by LAUFELD (1974, fig. 13C, D) for *A.* cf. *primitiva* display the neck processes resembling auricles made of a fenestrate membrane, while their appendices lack any openings and appear typical of true *A. primitiva.*

Some Silurian Chitinozoa attributed to the genus *Gotlandochitina* related closely to *Ancyrochitina* do also show a tendency to form auricles (LAUFELD *l. c.*, figs. 48, 51).

Occurrence. — Poland: Radom—Lublin region; Lower Ciepielovian (Lower Devonian).

Ancyrochitina aff. *aurita* sp. n.

(pl. 24: 9)

Material. — 4 damaged specimens.

Description. — The vesicle shape and dimensions are as in *A. aurita.* The difference is in the structure of the appendices and auricles. In the investigated specimens, the neck processes are in the form of longitudinal crests extending over the neck and flexure. They are formed by a membrane more solid proximally than distally (pl. 24: 9b). The appendices are also lacy. They are flat and situated at a plane parallel to the longitudinal axis of the vesicle, just as the auricles are. Thus, they lack any interior cavities. Their proximal parts are short and wide, whereas the distal ends are sharp. There are approximately 12 appendices at the basal edge. The vesicle surface is laevigate.

Occurrence. — Poland: Radom—Lublin region; Lower Ciepielovian, Lower Devonian).

Ancyrochitina bullispina sp. n.

(pl. 25: 15)

1966. *Ancyrochitina* sp.; TAUGOURDEAU: pl. 3: 65–66.
1968. *Ancyrochitina diabolo* (EISENACK); EISENACK: 173, pl. 29: 9–10.

Holotype: ZPAL Ch. II/4S38; pl. 25: 15.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1613 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *bullae* — bubble, spina — spine, after the characteristic shape of the appendices.

Diagnosis. — Vesicle shape typical of the genus (EISENACK 1955, JANSONIUS 1970); short, hollow appendices with bulbous bases at the basal edge.

Material. — 9 specimens.

Dimensions (in μm):

	L	C	W	N	A	W+ap
Holotype	161	76	76	25	42	144
Range	161–169	76–85	76–102	25	42	144

Description. — The vesicle is cylindro-conical. The chamber width often exceeds or equals the height. The base of the chamber is slightly convex and passes into the broadly rounded basal edge. There are 6–8 appendices with bulbous bases at the basal edge. The appendices rapidly taper distally to form short and sharp spines. They are hollow but the cavities are separated from the chamber interior. The basal edge passes into the flank. The flank is short and gives way to the flexure; the latter makes up a gentle boundary between the chamber and the neck. There is no shoulder. The oral tube is almost cylindrical and expands slightly towards the aperture; it comprises a little more than half the length of the vesicle. The collar is usually hardly distinguishable. The vesicle surface is laevigate. The illustrated specimen (pl. 25: 15) displays but two appendices, while the others have been broken off. In fact, the appendices can be easily broken off just near the basal edge, leaving hardly any scars.

Remarks. — The only congeneric species resembling *A. bullispina* is *A. diabolus* (EISENACK) recorded from Upper Silurian erratic boulders of Baltic origin (EISENACK 1937: 223). The difference consists in the shorter chamber of the species investigated and in the shape of the appendices.

Occurrence. — Erratic boulders of Baltic origin: *Beyrichia* Limestone regarded as equivalent to the Middle Podlasian (TOMCZYKOWA and WITWICKA 1974). North Africa: Sahara (Siluro-Devonian). Poland: Radom—Lublin region; Upper Podlasian to Upper Ciepielovian (Upper Silurian to Lower Devonian).

Ancyrochitina cornigera COLLINSON and SCOTT, 1958
(pl. 24: 6)

1973. *Ancyrochitina cornigera* COLLINSON and SCOTT; URBAN and NEWPORT: 240, pl. 1: 1–5 *(cum syn.)*.

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

	L	C	W	N	A	W+ap
Range	112–152	59–76	76	24	34	81–95

Description. — The vesicle shape is typical of the species. The neck is short and ends with an expanding collar. Both the flexure and basal edge are distinct. There is no shoulder. The appendices (usually 8 in number) are fairly short, wide at the base, and sharply ended. The vesicle surface is laevigate.

Remarks. — The Polish specimens contrast to those recorded from the Cedar Valley Formation (URBAN 1972; URBAN and NEWPORT 1973) by having appendices ranging in number from 4 to 12. The Lower Silurian Brazilian specimens attributed to *A. cornigera* and *A. megastyla* COLLINSON and SCOTT by DA COSTA (1971: 218, fig. 4, 220, fig. 8) can not be compared because of their poor preservation.

Occurrence. — North America (USA): Iowa, Solon Mbr. and Rapid Mbr. of the Cedar Valley Fm. (upper Middle Devonian). Poland: Radom—Lublin region; Lower Bostovian to Lower Ciepielovian (Lower Devonian).

Ancyrochitina aff. *desmea* EISENACK, 1964
(pl. 24: 7–8)

Material. — 230 specimens.
Dimensions (in μm):

	L	C	W	N	A	W+ap	N+pr
Range	119–152	59–84	59–76	21–24	34–42	102–135	59
Mode	144	76	72	21	34	135	

Description. — The chamber shows a convex base, wide basal edge, and gentle flexure. There are 6–8 appendices of circular or oval cross-section situated at the basal edge. They are moderately long (35–40 μm) and tri- or tetrafurcate. The neck is almost cylindrical. It expands slightly towards the aperture as a rule, passing gradually into the collar. The aperture margin is straight or finely fringed. The oral tube makes up half the length of the vesicle or even more. There are 4–6 fairly short, singular or bifurcate or trifurcate neck processes in the middle of the neck or a little more closely to the aperture.

Remarks. — The investigated specimens fall within the range of broadly meant *A. desmea* EISENACK, 1954. They are, however, incompatible with the species diagnosis as restricted by LAUFELD (1974). The difference is in their less branched appendices and simpler neck processes. According to LAUFELD (*l. c.*), *A. desmea* appears as a good guide fossil for the Hemse Beds and Hemse Marl (Ludlovian) in Gotland.

Occurrence. — Poland: Radom—Lublin region; Podlasian to Upper Ciepielovian (Lower Devonian).

Ancyrochitina lemniscata sp. n.
(pl. 25: 5, 6, 10)

Holotype: ZPAL Ch. II/14S6; pl. 25: 5.
Type horizon: Podlasian, uppermost Silurian (sample taken at 2645 m in depth).
Type locality: borehole Ciepielów IG 1, Radom—Lublin region.
Derivation of the name: Lat. *lemniscata* — trimmed with ribbons, after the long, tape-like appendices.

Diagnosis. — Cylindro-conical vesicle with long neck and long and wide appendices extending aborally.

Material. — 128 poorly preserved, flattened specimens, often with the appendices broken off.

Dimensions (in μm):

	L	C	W	N	A	lap
Holotype	164	80	94	44	56	85

Description. — The cylindro-conical vesicle is large but with relatively small chamber (the chamber length is less than one third of the total length of the vesicle). The chamber base is convex or almost flat. There are 7–8 appendices at the distinct basal edge. They are wide at the base (31 μm), tape-like, very long (85 μm). They are hollow with the cavities separated from the interior of the chamber. They extend aborally; however, their ends are often inclined laterally and upwards. There is a plug within the neck. The external surface of the vesicle is laevigate.

Remarks. — The species resembles *A. gundersinda* CRAMER from the Middle Siegenian of the northwestern Spain (CRAMER 1964) but it differs from the latter in its small-sized vesicle and the shape of the appendices.

Occurrence. — Poland: Radom—Lublin region; Podlasian (uppermost Silurian).

Ancyrochitina aff. *primitiva* EISENACK, 1964
(pl. 25: 1–4)

Material. — Ca 196 specimens.

Dimensions (in μm):

	L	C	W	N	A	W+ap
Range	119–144	51–68	68	24–25	25–27	102–135

Description. — The vesicle is cylindro-conical. The chamber length attains one third to second of the total length of the vesicle. The flexure is gentle. There is no shoulder. The neck is cylindrical or slightly expanding towards the aperture. It ends with a collar. There are no neck processes. The base is slightly convex or flat. It passes into the wide basal edge bearing 5–7 appendices variable in length. The appendices are simple, with somewhat widened bases and the medial parts extending aborally. Their ends may incline orally. The external surface of the vesicle is laevigate.

Remarks. — The investigated specimens differ from true *A. primitiva* EISENACK from the Slite Marl (Wenlockian), Gotland, by their longer appendices extending aborally. They resemble *Ancyrochitina* sp. reported by WRIGHT (1976, fig. 6) from the Middle Devonian Columbus Limestone, Ohio (USA).

Occurrence. — Poland: Radom—Lublin region; Upper Podlasian to Upper Ciepielovian (uppermost Silurian to Lower Devonian).

Ancyrochitina cf. *primitiva* EISENACK, 1964
(pl. 24: 4)

Material. — Ca 1000 poorly preserved specimens.
Dimensions (in μm):

	L	C	W	N	A
Range	169–175	72–78	62–74	23–25	29–34
Mode	175	77	62	23	29

Remarks. — The size and shape of the vesicles are typical of the species *A. primitiva.* However, more precise identification of the examined specimens is impossible because of their poor preservation. The appendices show relatively wide bases resembling some specimens of *A. pachyderma* (see LAUFELD 1974: 45, fig. 10) and *A.* cf. *primitiva* (see LAUFELD *l. c.*, fig. 15).

Occurrence. — Poland: Radom—Lublin region; Mielnikian to Lower Ciepielovian (Upper Silurian to Lower Devonian).

Ancyrochitina tomentosa TAUGOURDEAU and JEKHOWSKY, 1960
(pl. 24: 5)

1968. *Ancyrochitina tomentosa* T. J.; EISENACK: 172, pl. 27: 16–25, pl. 29: 8 *(cum syn.)*.
?1973*a*. *Ancyrochitina tomentosa* TAUGOURDEAU and De JEKHOWSKY; LEGAULT: 22, pl. 3: 11.

Material. — 27 specimens.

Remarks. — The investigated specimens differ from those attributed to *A.* aff. *desmea* by their more flattened laterally and shorter appendices. They have not been measured because of their poor preservation and presence of unremovable mineral patches.

Occurrence. — North Africa: Sahara (Middle Devonian). Erratic boulders of Baltic origin: *Beyrychia* Limestone regarded as equivalent to the Middle Podlasian (TOMCZYKOWA and WITWICKA 1974). Poland: Radom—Lublin region; Lower Bostovian to Upper Ciepielovian (Lower Devonian).

?*Ancyrochitina* sp.
(pl. 25: 14)

Material. — 1 specimen; borehole Strzelce IG 2, depth of 1704 m; Lower Bostovian (Lower Devonian).

Description. — The vesicle is cono-ovoidal. The neck is short and indistinct. The aperture is simple and wide. The base is very convex. There are 6 solid appendices oval in cross section situated at the wide basal edge. The external surface of the vesicle is granulate.

Remarks. — The investigated specimen resembles very closely *Ancyrochitina* sp. recorded by EISENACK (1972*b*, pl. 34: 33) in the *Beyrychia* Limestone, erratic boulders of Baltic origin, regarded as equivalent to the Middle Podlasian (TOMCZYKOWA and WITWICKA 1974). The vesicle shape (pl. 25: 14) may indicate that it represents an aberrant form of a co-occurring species of the genus *Ancyrochitina.*

The occurrence of specimens hardly identifiable because of their vesicle shape rather than poor preservation (URBAN 1972: 24, *Margachitina*? sp.) shows that aberrant chitinozoans do actually occur much more commonly than it was previously assumed (CRAMER and DIEZ, 1970, 1974).

Genus *Angochitina* EISENACK, 1931 (emend. EISENACK, 1968)

Type species: Angochitina echinata EISENACK, 1931

Angochitina cf. *crassispina* EISENACK, 1964
(pl. 27: 1-5, 10, fig. 4*b*)

Material. — Ca 120 poorly preserved specimens.
Dimensions (in μm):

	L	C	W	S	A
Range	170–212	85–110	55–85	17-38	25–42
Mode	178	102	69	25	34

Description. — The vesicle is cylindro-spheroidal. The chamber length attains half the length of the vesicle or even more. The neck passes gently into the chamber through the very elongate flexure. The oral tube ends with a distinct, widened collar. The aperture is often finely fringed. The entire surface of the vesicle is covered with irregularly and rather sparsely distributed, massive spines. Among the spines, the surface is laevigate. There is a plug within the neck, discernible under an infra-red microscope.

Remarks. — No specimens were found with completely preserved spines. Most spines have been broken off near the surface of the vesicle (pl. 27: 6*b*). There are no cavities within the spines. One may claim that the spines have been secondarily filled; in fact, the appendices (pl. 25: 2*b*) and even the whole vesicles (pl. 34: 4) were found secondarily filled in other species.

Discussion. — LAUFELD (1974: 53) claimed a short stratigraphic range for *A. crassispina* and reported its occurrence in the Hemse Beds to Eke Beds (Lower Ludlovian) in Gotland. Nevertheless, EISENACK (1964: 333, 335) recorded the species also in the Sundre Beds (uppermost Ludlovian) eqivalent partly to the lowermost Podlasian of Poland (TOMCZYKOWA and WITWICKA 1974).

Occurrence. — Poland: Radom—Lublin region; Upper Podlasian to Upper Ciepielovian (Lower Devonian).

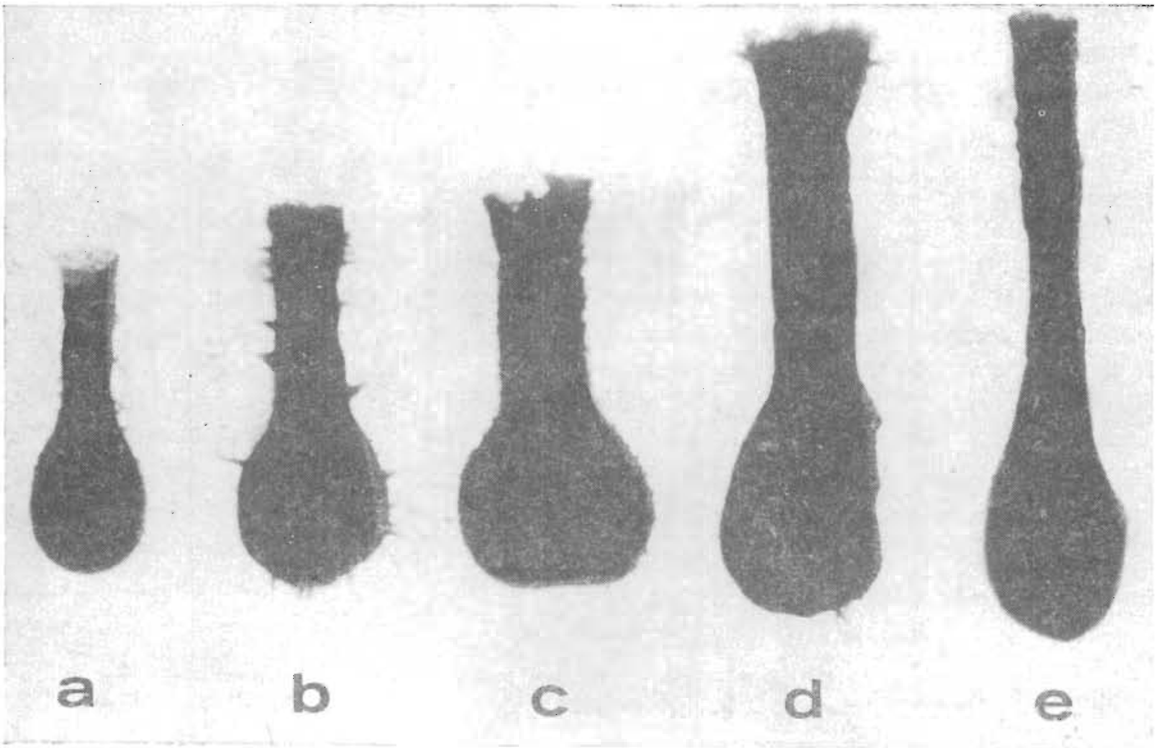


Fig. 4
Silhouettes of vesicles of *Ancyrochitina filosa* EISENACK (a), *A.* cf. *crassispina* EISENACK (b), *A. echinata* EISENACK (c), *A.* cf. *longicollis* EISENACK (d, e); photographs under a light microscope

Angochitina echinata Eisenack, 1931
(pl. 25: 11–13, fig. 4*c*)

1972*a*. *Angochitina echinata* Eisenack; Eisenack: 71, pl. 17: 1–14.
1974. *Angochitina echinata* Eisenack; Laufeld: 53, figs 16, 17 *(cum syn.)*.

Material. — 60 specimens.
Dimensions (in μm):

	L	C	W	N	A
Range	144–203	68–85	76–85	25–42	42–59
Mode	195	85	85	34	51

Description. — The vesicle is cylindro-spheroidal. The chamber length attains at most the length of the vesicle. The neck expands slightly towards the aperture. It ends with a collar which may be rolled outwards. The surface of the vesicle is entirely covered with irregularly spaced, fine, thin spines. Among the spines, the surface of the vesicle is granulate.

Remarks. — The slightly flattened base reflects probably a damage rather than the original shape. The investigated specimens are highly variable in length of the oral tube, just as the specimens from Gotland (Laufeld 1974) and the borehole Łeba 1 (Eisenack 1972*a*) are. In a single vesicle, all the spines are almost equal in size. They are somewhat less densely spaced than in the specimens from Gotland.

Occurrence. — Gotland: Hemse Beds to Sundre Beds (Ludlovian). Poland: Pomerania, borehole Łeba 1 (Upper Podlasian, *P. transgrediens* Zone); Radom—Lublin region; Podlasian to Lower Ciepielovian (Lower Devonian).

Angochitina filosa Eisenack, 1955
(pl. 25: 8, fig. 4*a*)

1967. *Angochitina filosa* Eisenack; Cramer: 110, pl. 4: 98, 99, 101 *(cum syn.)*.

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

	L	C	W	N	A
Range	161–203	68–102	44–76	19–38	34–44

Description. — The vesicle is cylindro-spheroidal. It is covered with sparse, long, hair-like, usually simple spines. The chamber is ovoidal or spheroidal. The chamber base is strongly convex. The chamber length makes commonly up less than half the vesicle in length. Among the spines, the vesicle surface is laevigate.

Occurrence. — Erratic boulders of Baltic origin: *Beyrychia* Limestone regarded as equivalent to the Middle Podlasian, uppermost Silurian (Tomczykowa and Witwicka 1974). Spain: upper part of the Formigoso Fm. and lower part of the San Pedro Fm. (Wenlockian to Ludlovian). Poland: Radom—Lublin region; Bostovian to Lower Ciepielovian (Lower Devonian).

Angochitina cf. *longicollis* Eisenack, 1959
(pl. 27: 8–9, fig. 4*d, e*)

Material. — 33 specimens; Radom—Lublin region; Bostovian (Lower Devonian).
Dimensions (in μm):

	L	C	W	N	A
Range	186–278	76–93	59–76	24–41	34–44
Mode	212	85	68	27	42

Remarks. — The shape of the vesicle is identical to that of the type specimens. However, the preservation state of the investigated specimens makes impossible any more precise comparison to true *A. longicollis*.

One may suppose that the Chitinozoa of a similar preservation state reported from the Silurian and Devonian of North Africa, Spain, and the USA and attributed to *Sphaerochitina longicollis* do also actually represent *A. longicollis* but with completely destroyed spines.

Angochitina longispina sp. n.
(pl. 25: 9)

Holotype: ZPAL Ch. II/4S14; pl. 25: 9.
Type horizon: Upper Devonian, Lower Devonian (sample taken at 1695 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *longus* — long, *spina* — spine, after the specific ornamentation.

Diagnosis. — Cylindro-spheroidal vesicle with neck and flank covered with thin spines; spine length equal to or exceeding the neck width.

Material. — 3 specimens.

Dimensions (in μm):

	L	C	W	N	A	lspines
Holotype	111	56	62	29	35	28–35

Description. — The chamber is almost spherical. It attains at least half the length of the vesicle. The flexure is gentle. Neither shoulder, nor basal edge are distinguishable. The chamber is covered with irregularly distributed, simple or furcate, relatively long and thin spines (pl. 25: 9*b*); the spine length is almost constant in a single specimen. The base and flexure are free from spines. The cylindrical neck ends with a small collar. Its adapertural part (two thirds in length) is covered with spines. The neck spines are shorter than those at the chamber and form something like a verticil in a place. There is a plug within the neck above the flexure, discernible under an infra-red microscope.

Remarks. — The observed species appears quite different from the related species *A. devonica* EISENACK and *A. spinosa* (EISENACK) well illustrated by the use of SEM technique by URBAN (1972), LAUFELD (1974), and WOOD (1974). In fact, its spines are longer and thinner; they are also somewhat undulate and therefore, resemble most closely the spines of the Devonian specimens attributed to *A.* cf. *spinosa* by URBAN (1972: pl. 11, pl. 1: 2, 3). Furthermore, the above mentioned relatives of *A. longispina* display spines at the base and flexure, as well. The Devonian specimens *A. devonica* from the Eifel Synclinorium (W. Germany) described by PILCHER (1971) are not comparable because of their poor preservation.

Occurrence. — Poland: Radom—Lublin region; Upper Bostovian to Upper Ciepielovian (Lower Devonian).

?*Angochitina* sp.
(pl. 27: 7)

Material. — 1 specimen; borehole Strzelce IG 2, Radom—Lublin region, depth 1708 m; Lower Bostovian (Lower Devonian).

Description. — The vesicle is deformed. Its well developed chamber passes into the neck expanding orally up to the chamber width. The vesicle is entirely covered with spines. This is probably an aberrant form resembling those occurring commonly in various species of the genus *Ancyrochitina*.

Remarks. — Aberrant vesicles are hardly identifiable. The Middle Devonian specimens from the Cedar Valley Fm., Iowa, USA, were attributed by URBAN (1972, pl. 3: 9–12) to *Margachitina*? sp.; however, their shape and spiny ornamentation indicate that these are aberrant (unseparated) vesicles of the genus *Angochitina*.

Genus *Anthochitina* EISENACK, 1971

Type species: Anthochitina superba EISENACK, 1971

Anthochitina superba EISENACK, 1971
(pl. 26: 1–5, 7–9, fig. 5)

1971. *Anthochitina superba* EISENACK; EISENACK: 452–454, figs. 1–15.
1973. *Clathrochitina mitcovensis* OBUT; OBUT: pl. 11: 9.

Material. — 190 specimens.
Dimensions (in μm):

	L	C	W	N	A	W carina
Range	178–288	51–85	76–102	25–38	51–68	135–212
Mode	220	85	85	34	51	

Description. — The vesicle is cylindro-conical. The flexure makes a gentle boundary between the chamber and the neck. There is no shoulder. The oral tube attains half the length of the vesicle or more. It ends with a distinct collar expanding orally. The aperture margin is straight and smooth. The chamber length equals usually the maximum diameter. The base is flat or slightly convex, distinctly separated from the flank by a sharp basal edge bearing a wide carine. The carina is more or less spongy in structure; it may also be fenestrate with openings of variable size. Its development is highly variable (fig. 5). The carina margin can be smooth

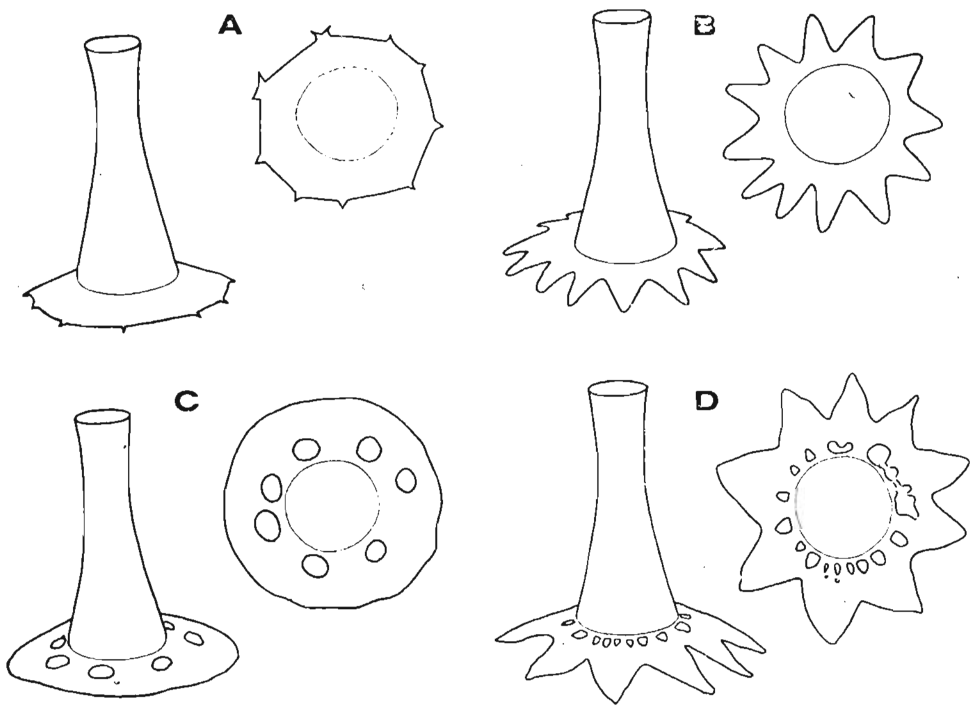


Fig. 5
Diagrammatic drawings of vesicles of *Anthochitina superba* EISENACK in lateral and aboral views, showing the variability in carina development

or covered with short spines. In contrast to the carina itself, the marginal spines are very compact in structure and opaque under a light microscope. The spines may be either simple or coupled fork-like even in a single specimen. The margin of the carina may also form a more or less distinct multipetal star. The external surface of the vesicle is most commonly laevigate but sometimes granulate. The vesicle wall is unilayered (pl. 26: 1*b*). There is a plug within the neck orally to the flexure, discernible under an infra-red microscope. In most cases, the chamber is filled with a mineral matter opaque under transmitted light.

Remarks. — The observed specimens resemble very closely the Upper Silurian forms described by EISENACK (1971) from the *Beyrichia* Limestone; only a few specimens are larger. However, they resemble the Lower Devonian forms from the Podolia (OBUT 1973) in that they are less transparent under a transmitted light and probably more compact than those from the *Beyrichia* Limestone.

Occurrence. — Erratic boulders of Baltic origin: *Beyrichia* Limestone equivalent probably to the Middle Podlasian (TOMCZYKOWA and WITWICKA 1974). Podolia: Goroshevo, Mitkov Beds; Borshchov horizon (lowermost Devonian). Poland: Radom—Lublin region; Upper Bostovian to Ciepielovian (Lower Devonian).

Anthochitina radiata sp. n.
(pl. 26: 6, fig. 6)

Holotype: ZPAL Ch. II/4S3; pl. 26: 6.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1629 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *radiata* — radiate, after the specific outline of the vesicle in aboral view.

Diagnosis. — Cylindro-conical vesicle with carina situated at radial processes at the basal edge.

Material. — 15 specimens.

Dimensions (in μm):

	L	C	W	N	A
Holotype	187	75	79	30	44
Range	187–191	75–77	79–83	30–33	44–46

Description. — The shape and size of the vesicle are identical to those of *A. superba* EISENACK. Under transmitted light, the investigated specimens resemble in aboral view a spoke wheel with the vesicle base at the center and the spongy membrane of the carina at the periphery. The radial processes are solid in structure. Their proximal parts may, however, display little hollows gaping sometimes outwards (pl. 26: 6*c*). There is a plug within the neck, discernible under an infra-red microscope. In most specimens, the chamber is filled with a mineral matter

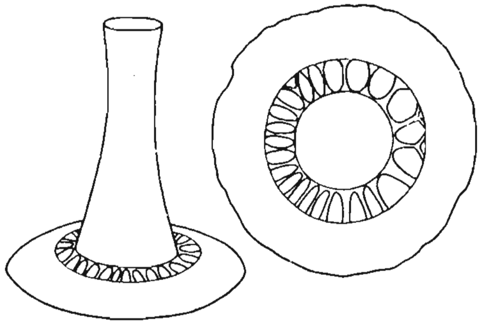


Fig. 6

Diagrammatic drawing of a vesicle or *Anthochitina radiata* sp. n. in lateral and aboral views (presumably pyrite). The external surface of the vesicle is laevigate. The mound-like pseudosculpture at the surface of some specimens is but a deformation caused by the mineral fill.

Remarks. — *A. radiata* sp. n. differs from *A. superba* EISENACK in the shape of the caraina.

Occurrence. — Poland: Radom—Lublin region; Ciepielovian (Lower Devonian).

Genus *Conochitina* EISENACK, 1931

Type species: *Conochitina claviformis* EISENACK, 1931

Remarks. — In the present study, the genus *Conochitina* is conceived according to the emendation by JANSONIUS (1964: 912) and LAUFELD (1974: 57).

Conochitina invenusta sp. n.

(pl. 27: 18)

Holotype: ZPAL Ch. II/4S1; pl. 27: 18.
Type horizon: Lower Bostovian, Lower Devonian (sample taken at 1702 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *invenusta* — unbeauty, after the poor preservation state of the type material.

Diagnosis — Short conical vesicle with flat base and large basal scar; the external surface of vesicle verrucate, especially at the basal edge where small and low spines with multiramose roots may appear.

Material. — 21 mostly damaged specimens.

Dimensions (in μm):

	L	W	A	bs
Holotype	152	117	55	28
Range	148–157	117	50–56	28

Description. — The vesicle shows straight and flat sides. The basal edge is broadly rounded. The base is flat or slightly concave, with wide and hollow basal scar. There are numerous concentric lines within the scar. There is no shoulder, nor flexure. The collar is indistinct; it is recognizable only due to a slight oral expansion of the vesicle and disappearance of the sculpture. No operculum is preserved in any of the specimens observed.

Remarks. — The shape of the vesicle, the sculpture, and the basal scar development make this species different from all others described.

Occurrence. — Known only from the type horizon and locality.

Conochitina cf. *intermedia* EISENACK, 1955

(pl. 27: 15)

Material. — 8 specimens, strongly damaged but not deformed.

Dimensions (in μm):

	L	W	A
Range	160–178	102–104	60–62

Description. — The vesicle is conical with straight sides. It ends with a distinct collar expanding orally. The base is flat, separated from the flanks with a sharp basal edge. The investigated vesicles are so damaged that neither their external sculpture, nor basal elements are recognizable. All the vesicles are filled with a mineral matter (presumably pyrite) and hence, undeformed. Some specimens are a little longer than the holotype (173 μm).

Discussion. — The species *C. intermedia* was erected by EISENACK (1955) for the specimens derived from the *Beyrichia* Limestone, erratic boulders of Baltic origin, equivalent probably to the Middle Podlasian (TOMCZYKOWA and WITWICKA 1974). Some specimens corresponding exactly to the original diagnosis were recorded by LAUFELD (1974) in the Hamra Beds and Sundre Beds (Ludlovian), Gotland, and characterized and illustrated with SEM-photographs. MÄNNIL (1970) reported the species (without giving any illustration or description) from the Middle Paadla to Upper Kuresaare Stages (Ludlovian), Estonia.

Occurrence. — Poland: Radom—Lublin region; lower part of the Siedlce series (uppermost Silurian).

Conochitina cf. *latifrons* EISENACK, 1964

(pl. 27: 19–20)

Material. — 19 poorly preserved specimens.

Dimensions (in μm):

	L	W	N	A
Range	289–313	98–107	63–67	77–83

Description. — The vesicle is subconical. The flexure is long and indistinct. The flank is slightly convex or flat, with a specific depression just near the basal edge. The basal edge is rounded. The base is flat or slightly convex. The vesicle surface is verrucate, especially at the basal edge. The sculpture disappears near the aperture.

Remarks. — The investigated specimens are somewhat larger than those from Gotland. Despite their poor preservation, the vesicle shape typical of the species *C. latifrons* can be recognized. However, one may suppose that such a shape of the vesicles may also be due to the base being pressed inwards.

Discussion. — The species *C. latifrons* was recorded in the uppermost part of the Klinteberg Marl and the lower part of the Hemse Beds (Wenlockian to Ludlovian), Gotland (LAUFELD 1974); and in the Lower Paadla (Ludlovian), Estonia (MÄNNIL 1970).

Occurrence. — Poland: Radom—Lublin region; lower part of the Siedlce series (Upper Silurian).

Conochitina sp.

(pl. 27: 16–17)

Material. — 23 specimens; Radom—Lublin region; Siedlce series (Upper Silurian).

Dimensions (in μm):

	L	W	N	A
Range	290–300	107–112	77	75–77

Description. — The subcylindrical vesicle is large and resembles in shape the species *C. tuba*. The flexure and shoulder are more or less indistinct. The basal edge is broadly rounded. The base is more or less convex, with a wide and flat basal callus. The vesicle surface is verrucate. The aperture is smooth or finely fringed. It is located on an indistinct collar.

Genus *Desmochitina* EISENACK, 1931 (emend. EISENACK, 1968)

Type species: Desmochitina nodosa EISENACK, 1931

Desmochitina spongiloricata sp. n.
(pl. 35: 8, 9)

Holotype: ZPAL Ch. II/4S13: pl. 35: 8.
Type horizon: Lower Bostovian, Lower Devonian (sample taken at 1732 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *spongia* — spongy, *loricata* — armored, after the spongy layer covering the vesicle wall.

Diagnosis. — Discoidal vesicle with aperture diameter attaining one sixth of the vesicle width; operculum flat and thin; vesicle wall bilayered, with the internal layer homogeneous, and the external one spongy in structure.

Material. — 7 poorly preserved and flattened specimens.

Dimensions (in μm):

	L	W	A
Holotype	47	106	27
Range	up to 51	106–127	19–27

Description. — The thick and spongy external layer covers the wall of the vesicle and obscures the vesicle shape. The vesicle is much longer than wide. A single preserved operculum is flat and thin, without any oral scar. The spongy structure of the external layer is obscured in flattened specimens (pl. 35: 9). The internal layer is commonly exposed near the aperture. No chains were observed.

Remarks. — The thick spongy layer makes *D. spongiloricata* different from its congeners with a similar discoidal vesicle.

Occurrence. — Known only from the type horizon and locality.

Desmochitina sp.
(pl. 35: 7)

Material. — 4 specimens; borehole Strzelce IG 2, depth 1600 m; Upper Ciepielovian (Lower Devonian).

Description. — The vesicle is discoidal. Its base is connected directly with the operculum of an subadjacent vesicle. The operculum is thin and somewhat convex. The vesicle surface is laevigate.

Remarks. — Any more precise identification is impossible because of the poor state of preservation. The morphology and size of the investigated vesicles and their co-occurrence with *Margachitina gratiosa* may indicate that these are aberrant forms of the latter species. In fact, aberrant forms occur very commonly among the Silurian specimens of *Margachitina margaritana* (Eisenack) in Estonia. One may also claim that the specimens of *Desmochitina* sp. co-occurring with *M. poculum* (Collinson and Schwalb) in the Lower Devonian Bailey Fm., Illinois, USA, do actually represent aberrant forms of the latter species. Then, it would appear that aberrant vesicles occur much more commonly in the genus *Margachitina* than it was previously assumed.

Genus *Eisenackitina* Jansonius, 1964

Type species: *Eisenackitina castor* Jansonius, 1964

Remarks. — Some species with small-sized subcylindrical to conical vesicles are included herein. Their vesicles display a sculpture typical of the genus *Eisenackitina* and a thin operculum within the aperture, They resemble in shape the genus *Conochitina* but the vesicles are much less elongate. The intra-generic variation in vesicle shape was similarly conceived by Eisenack (1972*b*) who attributed to the considered genus such species as *Eisenackitina oelandica* and *E. lagenicula*.

Eisenackitina barbatula sp. n.
(pl. 32: 13)

Holotype: ZPAL Ch. II/4S24; pl. 32: 13.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1629 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *barbatula* — newly bearded, unshaven, after the specific ornamentation.

Diagnosis. — Discoidal vesicle with orthogonal outline; basal edge and shoulder distinct; base flat; aperture straight, situated at an indistinct collar; vesicle covered with short, fairly thick spines, especially at the basal edge.

Material. — 3 specimens.

Dimensions (in μm):

	L	W	A
Holotype	79	136	50
Range	76–83	136–141	50–51

Description. — The vesicle is almost twice as wide as long. The distinct shoulder and sharp basal edge make the vesicle orthogonal in outline. The flank is straight or slightly convex. The base is flat but the nature of the basal scar has not been recognized because of the preservation state of the investigated specimens. Any operculum has not been found but the indistinct collar and simple aperture may indicate that it is flat and thin. The vesicle surface is verrucate. The sculpture disappears towards the aperture and the center of the base. At the basal edge, the verrucae tend to form short, sharp spines.

Remarks. — *E. barbatula* differs from all the insofar known congeners in the proportions and the orthogonal outline of the vesicle.

Occurrence. — Known only from the type horizon and locality.

Eisenackitina cepicia sp. n.
(pl. 28: 10, pl. 29: 1–4)

Holotype: ZPAL Ch. II/2S31; pl. 28: 10.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1600 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *cepicia* — onion-like, after the vesicle shape.

Diagnosis. — Wider than long, conical vesicle with rounded basal edge and concave base with large bowl-like basal scar; lambda-type spines with multiramose roots at the basal edge.

Material. — 18 specimens.

Dimensions (in μm:)

	L	W	A
Holotype	67	122	45
Range	64–91	114–128	45–49

Description. — The vesicle is small-sized. The flexure is long and gentle. The neck is indistinct. The basal edge is broadly rounded. The margin of the basal scar is somewhat thickened and risen above the base to form an indistinct basal callus of 14 μm in diameter. The operculum is flat and thin, situated within the terminal part of the aperture. The spines with multiramose roots cover the basal edge but disappear gradually polewards. The adapertural surface of the vesicle and the central part of the base are covered with finely verrucate sculpture.

Remarks. — *E. cepicia* differs in the vesicle shape from its previously known congeners.

From the Lower Devonian species from the Radom—Lublin region (*E. crassa* sp. n., *E. Fimbriata* sp. n., *E. pilosa* sp. n.) it differs in its wide bowl-like basal scar and the lambda-type spines with multiramose roots.

Occurrence. — Poland: Radom-Lublin region; Ciepielovian (Lower Devonian).

Eisenackitina crassa sp. n.
(pl. 29: 5–7)

Holotype: ZPAL Ch. II/2S114; pl. 29: 5.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1629 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *crassa* — obese, gross, after the vesicle outline.

Diagnosis. — Wider than long, conical vesicle with very short neck, convex side, and broadly rounded basal edge; flat base with small basal callus; vesicle surface covered with dense nodes forming short and thick spines at the basal edge.

Material. — 26 specimens.

Dimensions (in μm):

	L	W	A
Holotype	80	111	42
Range	47–85	76–153	30–59
Mode	85	144	51

Description. — The vesicle is small-sized. The flexure is short. Sometimes, an indistinct shoulder appears. The convex side makes the vesicle swollen in outline. There is an indistinct basal callus of 5–8 μm in diameter at the center of the flat and slightly concave base. The operculum is thin and flat, situated within the aperture. The spines covering the vesicle disappear at the neck and at the center of the base.

Remarks. — *E. crassa* differs in the vesicle shape from its previously known congeners. From the Lower Devonian species from the Radom—Lublin region (*E. cepicia* sp. n., *E. fimbriata* sp. n., *E. pilosa* sp. n.), it differs in its small indistinct basal callus, the swollen outline of the vesicle, and the short and thick spines densely covering the basal edge.

Occurrence. — Known only from the type horizon and locality.

Eisenackitina cupellata sp. n.
(pl. 30: 12, 15, pl. 31: 8–12, fig. 7)

Holotype: ZPAL Ch. II/2S198; pl. 31: 11.
Type horizon: Upper Bostovian, Lower Devonian (sample taken at 1695 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *cupella* — cask, after the vesicle shape.

Diagnosis. — Subcylindrical, long vesicle with straight side and rounded basal edge, without flexure nor shoulder; large basal callus at the center of the convex base; flat operculum within distinct collar.

Material. — Ca 300 specimens.

Dimensions (in μm):

	L	W	A
Holotype	169	98	69
Range	169–246	93–119	63–69
Mode	195	93	66

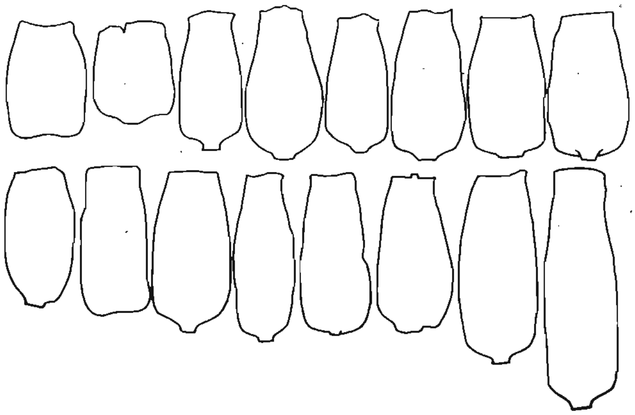


Fig. 7

Shape variation in *Eisenackitina cupellata* sp. n.; all the specimens derived from a single sample (borehole Strzelce IG 2, 1702 m in depth)

Description. — The vesicle is subcylindrical or somewhat conical, highly variable in length. Shorter forms are also more swollened and display an indistinct flexure. Those more elongate are also more cylindrical (with straight side, without flexure nor shoulder), ended with a more or less distinct, straight or folded collar. The shorter a vesicle, the shorter and wider also the basal callus. A long basal callus may also bear at its tip a fragment of the external layer of the operculum of a subadjacent vesicle (pl. 30: 14). The vesicle surface is laevigate.

Remarks. — *E. cupellata* markedly differs from its elongate congeners. The short morphotypes of *E. cupellata* resemble somewhat the Upper Silurian *E. urna* (EISENACK) from the Podolia and Bohemia but they differ in their straight side and the shorter and wider basal callus. The elongate morphotypes resemble *E. elongata* EISENACK from the uppermost Silurian of Bohemia (EISENACK 1972*b*), the difference being in their dimensions, the shape of the vesicle and basal callus, and the lack of shoulder, flexure and vesicle constriction at the oral ending.

Occurrence. — Poland: Radom—Lublin region; Bostovian (Lower Devonian).

Eisenackitina fimbriata sp. n.

(pl. 28: 1)

Holotype: ZPAL Ch. II/2S296; pl. 28: 1.

Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1611 m in depth).

Type locality: borehole Strzelce IG 2, Radom-Lublin region.

Derivation of the name: Lat. *fimbriata* — curly, after the specific ornamentation.

Diagnosis. — Conical vesicle wider than long with broadly rounded basal edge and concave base with shallow basal scar covered with concentric lines; vesicle covered with hollow, irregularly branching spines, the ends of which may grow into the vesicle surface forming closed loops.

Material. — 4 specimens.

Dimensions (in μm):

	L	W	A
Holotype	84	124	54
Range	84–102	114–153	38–59

Description. — The neck is very short. The flexure is long and gentle. There is no shoulder. The operculum is thin, located within the terminal part of the aperture. There are fine spines and verrucae among the long irregular spines covering the surface of the vesicle. The surface of the neck is laevigate.

Remarks. — *E. fimbriata* differs from its previously known congeners in the vesicle outline. From the wide-conical Lower Devonian species *E. cepicia* sp. n., *E. crassa* sp. n., and *E. pilosa* sp. n., from the Radom—Lublin region, it differs in its long, branching, loop-like spines and the basal scar development.

Occurrence. — Known only from the type horizon and locality.

Eisenackitina lacrimabilis sp. n.
(pl. 29: 8–13, pl. 30: 1–10)

Holotype: ZPAL Ch. II/2S46; pl. 29: 8.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1629 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *lacrimabilis* — tear-like, after the vesicle shape.

Diagnosis. — Ovoidal vesicle with slightly convex side, broadly rounded basal edge, and strongly convex base with large basal callus at its center; external surface of the vesicle covered with sharp nodes forming fringed crests.

Material. — Ca 1000 specimens.

Dimensions (in μm):

		L	W	A
Holotype		136	100	48
form A				
	Range	136–169	93–136	42–53
	Mode	161	110	51
form B				
	Range	119–153	110–136	51–61
	Mode	136	119	59
form C				
	Range	123–186	85–136	51–68
	Mode	151	93	55

Description. — The vesicle is highly variable in shape, droplike (form A; pl. 29: 8, 13) to barrel-like (form B; pl. 29: 9–12) and elongate barrel with distinct neck (form C; pl. 30: 1). All the morphotypes co-occur with each other. Sometimes, there is an indistinct flexure and shoulder (forms B and C). There is usually no neck. The collar is more or less distinct; it is either straight, expanding, or rolled outwards (especially in forms B and C). Within the collar, there is a thin operculum with short flange and oral scar. The surface of the neck and collar is laevigate as a rule. The vesicle sculpture is commonly obscured to various extent.

Remarks. — *E. lacrimabilis* resembles the Middle Devonian species *Desmochitina parkea* URBAN and *D. aranea* URBAN from the Cedar Valley Fm., Iowa USA (URBAN 1972) but it differs in its narrower aperture, the more conical shape of the vesicle, and the external sculpture as seen at high magnification. From the Gedinnian species *D. streptococa* OBUT, it differs in the lack of spines and its less spheroidal shape. The strongly convex base with large basal callus at its center and absence of shoulder make the difference from the Silurian (E_2) to Lower Siegenian *Eisenackitina bohemica* EISENACK.

Occurrence. — Poland: Radom—Lublin region; Upper Bostovian to Upper Ciepielovian (Lower Devonian).

Eisenackitina oviformis (EISENACK, 1972)
(pl. 30: 11)

1974. *Eisenackitina oviformis* (EISENACK); LAUFELD: 82, fig. 45 *(cum syn.)*.

Material. — 150 mostly compressed specimens.
Dimensions (in μm):

	L	W	A
Range	110–138	81–120	58–75

Remarks. — The verrucate sculpture with rounded verrucae is preserved even in compressed specimens. Despite the deformation, the vesicle shape with its globose aboral pole appears clearly in some cases. There is a characteristic, shallow and wide (25–33 μm), bowl-like basal scar at the globose base.

Occurrence. — Gotland: Hamra Beds and Sundre Beds (Upper Ludlovian). Poland: Pomerania, borehole Łeba 1 (EISENACK 1972*a*: 83), the interval regarded by TOMCZYKOWA and WITWICKA (1974, fig. 2) as equivalent to the upper part of the Siedlce series (*M. formosus* Zone) to Upper Podlasian (*Nodibeyrichia gedanensis* Zone), uppermost Silurian; Radom—Lublin region; Podlasian (uppermost Silurian).

Eisenackitina pilosa sp. n.
(pl. 28: 2-9)

Holotype: ZPAL Ch. II/2S55; pl. 28: 4.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1651 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *pilosa* — hairy, pily, after the characteristic ornamentation.

Diagnosis. — Conical vesicle wider than long, covered with hair-like, fairly long spines of constant diameter; long flexure passing into a rounded basal edge; slightly concave base with wide basal scar covered with concentric lines.

Material. — Ca 900 specimens.
Dimensions (in μm):

	L	W	A	lspines
Holotype	91	118	50	
Range	76–110	118–153	42–51	up to 25
Mode	102	144	51	

Description. — The neck is short or lacking. The aperture is simple. There is a discoidal thin operculum within the terminal part of the aperture. The basal scar is in the form of a wide and shallow hollow (22 to 28 μm in diameter). The spines are usually simple, straight or undulate. They grow directly at the surface of the vesicle. They show the best development at the basal edge. Among the long spines, the vesicle surface is verrucate.

Remarks. — *E. pilosa* differs in the shape of the vesicle from its previously known taxa. Its long simple spines and very wide basal scar make it different from the Lower Devonian wide-conical species from the Radom—Lublin region (*E. cepicia* sp. n., *E. crassa* sp. n., *E. fimbriata* sp. n.).

Occurrence. — Poland: Radom—Lublin region; Upper Bostovian to Upper Ciepielovian (Lower Devonian).

Eisenackitina cf. *urna* (EISENACK, 1934)
(pl. 31: 1–7)

Material. — Ca 2000 specimens.
Dimensions (in μm):

	L	W	A
Range	153–193	91–123	53–67
Mode	156	104	62

Description. — The vesicle is conical with convex sides and broadly rounded basal edge. The base is convex with fairly large basal callus. The flexure and shoulder are not very distinct. The collar is short and indistinct. The vesicle is variable in length. Long morphotypes resemble somewhat the species *E. cupellata* and, indeed, deformed specimens of both species may be hardly distinguishable under a light microscope. The basal callus is also variable in both its size and shape, depending upon the operculum characteristics of a subadjacent vesicle. The operculum is in the form of a thin disc or very thick, cylindrical plug; the latter type shows usually smaller diameters. A discoidal operculum is attached to the base of an adjacent vesicle by means of the basal callus, while the oral margin does not fuse with the base of adjacent vesicle. A cylindrical operculum, that is a plug, adjoins tightly to the base of the adjacent vesicle, while the oral margin is fused with the adjacent base. Those vesicles with cylindrical opercula form very tight chains composed each of several specimens. The vesicle surface is laevigate.

Remarks. — The investigated specimens resemble most closely the Lower Devonian forms from the Podolia illustrated but never described by OBUT (1973, pl. 14: 6–8, pl. 15: 5–9). In the Podolia, *E. urna* was recorded in the Tajna Beds at the base of the Borshchov horizon, Gedinnian, Lower Devonian, and in the beds with *Monograptus uniformis angustidens* Přibyl, Pridolian, uppermost Silurian.

Occurrence. — Poland: Radom—Lublin region; upper part of the Siedlce series to Bostovian (Upper Silurian to Lower Devonian).

Genus *Gotlandochitina* LAUFELD, 1974

Type species: *Gotlandochitina martinssoni* LAUFELD, 1974

Remarks. — The shape of the vesicle is as in *Sphaerochitina* and *Ancyrochitina* but the ornamentation is arranged in longitudinal rows. The spines and processes are hollow. The type species displays a plug.

Gotlandochitina lublinensis sp. n.
(pl. 24: 2–3)

Holotype: ZPAL Ch. II/4S12; pl. 24: 2.
Type horizon: Upper Bostovian, Lower Devonian (sample taken at 1695 m in depth).
Type locality: borehole Strzelce IG 2, Radom-Lublin region.
Derivation of the name: Lat. *lublinensis* — after the town Lublin situated at the center of the investigated area.

Diagnosis. — Cylindro-spheroidal vesicle with gentle but nevertheless distinct flexure; approximately 8 longitudinal rows of processes and spines situated at the chamber side and in the central part of the neck; spines branching at least twice; external surface of the vesicle finely verrucate.

Material. — 18 specimens.
Dimensions (in μm):

	L	C	W	N	A	W+pr
Range	119–152	59–76	61–68	17–25	25–42	102–135

Description. — The vesicle is cylindro-spheroidal. Neither basal edge, nor shoulder is distinguishable. The flexure is gentle but nevertheless, distinct. The base is convex. The neck is almost cylindrical, slightly expanding towards the aperture, and ended with a collar. The aperture is finely fringed. The chamber is covered with 8 longitudinal rows of processes, each row consisting of but two processes and sometimes also 1–2 spines situated orally to the processes. The processes are branched two or three times. The ends of more aboral processes are inclined aborally, while the other processes display the ends inclined orally. Longitudinal rows of spines occur also in the central part of the neck. Both the processes and spines are hollow. The base and flexure are usually free from ornamentation. Among the spines and processes, the external surface of the vesicle is finely verrucate.

Remarks. — The investigated species differs from *G. villosa* LAUFELD from the Sundre Beds, Gotland, in its more elongate chamber and more branched processes.

Occurrence. — Poland: Radom—Lublin region; Upper Bostovian to Lower Ciepielovian (Lower Devonian).

Genus *Hoegisphaera* STAPLIN, 1961

Type species: *Hoegisphaera glabra* STAPLIN, 1961

Remarks. — The type species had been erected and described after the observations under a light microscope but its diagnosis was subsequently supplemented by URBAN (1972) after the SEM-observations.

Hoegisphaera glabra STAPLIN, 1961

(pl. 32: 12)

1961. *Hoegisphaera glabra* STAPLIN; STAPLIN: 419, pl. 50: 5–7.
1972. *Hoegisphaera glabra* STAPLIN; URBAN: 23, pl. 4: 4–12.
1973. *Hoegisphaera glabra* STAPLIN; URBAN and NEWPORT: 241, pl. 1: 6, 10.
1974. *Hoegisphaera glabra* STAPLIN; WOOD: 135, pl. 8: 1–2.

Material. — 85 specimens.

Description. — The vesicle is variable in shape, discoidal to more or less spheroidal. The operculum diameter equals or exceeds a little half the vesicle width. The aperture is surrounded by an indistinct lip. A similar swelling occurs commonly at the margin of the operculum. Any traces of scars were not found at the operculum or the center of the base. The external surface of the vesicle is laevigate. Both the vesicle wall and the operculum consist of at least two layers, the external layer being much thinner than the internal one. No membrane-formed carina was found at the aboral side of the vesicle, as observed by URBAN (1972).

Remarks. — The absence of any scars may indicate that the vesicles of *H. glabra* did not form chains. The bilayered structure of the vesicle wall was also found by URBAN (*l. c.*), WOOD (1974), and LEGAULT (1973*a*, *b*) in *H.* cf. *glabra.*

Occurrence. — North America: Alberta (Canada), Cooking Lake Mbr. and Duvernay Mbr., Woodbend Fm., Upper Devonian; Iowa (USA), Cedar Valley Fm., Middle Devonian; Ohio (USA), Silica Fm., Middle Devonian. Poland: Radom—Lublin region; Bostovian to Ciepielovian (Lower Devonian).

Hoegisphaera cf. *glabra* STAPLIN, 1961

(pl. 32: 8–11)

Material. — 190 specimens.

Dimensions (in μm):

	L	W	A
Range	51–85	68–85	25–51
Mode	51	76	42

Description. — The vesicle is discoidal or subspherical. The aperture diameter attains at most half the width of the vesicle. The oral margin is surrounded by a distinct lip. The operculum is commonly preserved within the aperture. It is thin, slightly convex; it is located inside the lip and displays a swollen margin. The external surface of the vesicle is laevigate. The vesicle wall is bilayered. The thin external layer may separate from the internal one near the aperture and form an irregular, fringed pseudocollar. Sometimes, the very thin internal layer is also exposed at the operculum surface. The external layer may form fine folds, especially in proximity of the aperture.

Occurrence. — Poland: Radom—Lublin region; Bostovian to Lower Ciepielovian (Lower Devonian).

Hoegisphaera velata sp. n.

(pl. 32: 1–7)

Holotype: ZPAL Ch. II/4S37; pl. 32: 1.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1629 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *velata* — provided with a sail or veil.

Diagnosis. — Subspheroidal vesicle with aperture approximating in diameter half the vesicle width; thin external layer of vesicle wall forms at the oral side a velum extending orally.

Material. — 28 specimens.

Dimensions (in μm):

	L	W	A	lvelum
Holotype	51	70	40	8
Range	51–68	68–76	34–42	4–8·5
Mode	68	76	42	8·5

Description. — The external layer of the vesicle is much thinner than the internal one. It forms radial folds; more or less away from the aperture, it produces also a velum in the form of a pseudocollar. The pseudocollar may result in subcylindrical outline of the vesicle. The operculum is thin and covered with a thin folded layer.

Remarks. — Three vesicles have been found attached laterally and forming an aggregate resembling that described by LEGAULT (1973*b*) in *H.* cf. *glabra.* The specimens with velum displaced to the area of the maximum width of the vesicle resemble somewhat *Pterochitina perivelata* EISENACK. Possibly, the investigated specimens make a transition between the Silurian *P. perivelata* (EISENACK) described by LAUFELD (1974), and the Middle Devonian *H. glabra* provided with a velum (URBAN 1972). This considerable morphological resemblance of representatives of the genera *Hoegisphaera* and *Pterochitina* and their overlapping stratigraphical ranges may support the supposition of LAUFELD (1974: 104) that *Hoegisphaera* is actually a junior synonym of *Pterochitina.*

Occurrence. — Poland: Radom—Lublin region; Bostovian to Lower Ciepielovian (Lower Devonian).

Genus *Linochitina* EISENACK, 1968

Type species: *Conochitina erratica* EISENACK, 1931

Linochitina cf. *cingulata* (EISENACK, 1937)

(pl. 33: 5–6)

Material. — 1500 specimens.

Dimensions (in μm):

	L	W	A
Range	76–110	59–68	30–42
Mode	76	59	42

Remarks. — The investigated specimens display less prominent flexure and shoulder and wider aperture than the Wenlockian specimens from Gotland do (LAUFELD 1974). Moreover, their base is more flat and lacks any distinct basal scar. They resemble most closely the specimen illustrated by LAUFELD (*l. c.*) in fig. 57B. However, this morphological characteristics may be due to the poor preservation of the investigated specimens.

The species *L. cingulata* is cosmopolitan in the Silurian and Devonian but it was but poorly illustrated with light micrographs as a rule. Well illustrated specimens of *L. cingulata* come from the Silurian of Gotland where they occur in the Slite Marl through the top of the Mulde Beds, Wenlockian.

Occurrence. — Poland: Radom—Lublin region; upper part of the Siedlce series to Lower Ciepielovian (Upper Silurian to Lower Devonian).

Linochitina longiuscula sp. n.

(pl. 33: 7–9)

Holotype: ZPAL Ch. II/2S171; pl. 33: 7.
Type horizon: Lower Ciepielovian, Lower Devonian (sample taken at 1648 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *longiuscula* — fairly long.

Diagnosis. — Long conical vesicle with chamber ended with collar; sharp basal edge; convex base with large basal callus; external surface of vesicle granulate (at high magnifications).

Material. — 93 specimens.

Dimensions (in μm):

	L	W	N	A
Holotype	90	40	30	34
Range	87–131	40–55	30–41	33–44

Description. — The vesicles commonly form chains. The widely expanding collar is usually attached to the base of a superadjacent vesicle. There is no neck. There is no cingulum at the basal edge. The operculum is thick discoidal.

Remarks. — *L. longiuscula* is shorter and less slender than *L. erratica* (EISENACK) cosmopolitan in the Upper Silurian. It differs from the excellently illustrated with electromicrographs specimens of the latter species from the Eke Beds (Ludlovian), Gotland (LAUFELD 1974: 100), also in its strongly convex base, the lack of cingulum, and the granulate external surface of the vesicle. The sharp basal edge and granulate sculpture make *L. longiuscula* different from *L. odiosa* LAUFELD from the Slite Marl (Wenlockian), Gotland, as the latter species displays a broadly rounded basal edge and laevigate to very finely granulate external surface of the vesicle.

Occurrence. — Poland: Radom—Lublin region; Upper Podlasian to Lower Ciepielovian (Lower Devonian).

Linochitina serrata (TAUGOURDEAU and JEKHOWSKY, 1960)

(pl. 34: 7)

1960. *Desmochitina cingulata serrata* TAUGOURDEAU and JEKHOWSKY, TAUGOURDEAU and JEKHOWSKY: 1226, pl. 4: 76—77.

Material. — 16 specimens.

Dimensions (in μm):

	L	W	N	A
Range	96–100	59–61	39–41	44–48

Description. — The vesicle is conical. The cingulum is very short. The flexure and shoulder are indistinct. The base is slightly convex and shows concentric lines at the surface. The indistinct neck passes into the wide collar. Growth lines (?) appear sometimes at the collar and neck, revealing the multilayered structure of the vesicle wall (pl. 34: 7*b*). The operculum is thick and flat; it displays a long flange at its internal margin.

Remarks. — The SEM-observations of *L. cingulata* (see LAUFELD 1974) and *L. cingulata serrata* demonstrated differences in the vesicle shape and base morphology between both the forms thus, permitting advancement of the subspecies *L. cingulata serrata* to the species rank. The Lower Silurian Brazilian specimens attributed by DA COSTA (1971) to *Linochitina cingulata serrata* EISENACK are not comparable with the investigated specimens because of their poor preservation.

Occurrence. — North Africa: borehole Geli, Sahara (Silurian). Poland: Radom—Lublin region; Upper Podlasian to Lower Ciepielovian (Upper Silurian to Lower Devonian).

Linochitina subcylindrica sp. n.

(pl. 34: 1–3)

Holotype: ZPAL Ch. II/2S203; pl. 34: 3.
Type horizon: Lower Bostovian, Lower Devonian (sample taken at 1702 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *subcylindrical* — almost cylindrical, after the vesicle shape.

Diagnosis. — Cylindrical or slightly conical vesicle with distinct collar, sharp basal edge, and small cingulum; flat and smooth base with indistinct or unrecognizable basal scar; external surface of vesicle laevigate.

Material. — 360 specimens.

Dimensions (in μm):

	L	W	N	A
Holotype	84	47	30	36
Range	84–93	47–68	29–43	36–51

Description. — The vesicle sides are straight. There is no flexure no shoulder and hence, the neck is unrecognizable. The collar is sometimes wide. The operculum is thick and shows a flange. No chains were found and the basal scar is hardly discernible; then, one may claim that the vesicles are but poorly connected one with another.

Remarks. — The straight side, and the absence of both flexure and shoulder make *L. subcylindrica* different from the cosmopolitan Silurian species *L. cingulata* (EISENACK) and *L. erratica* (EISENACK) as well as from *L. hedei* LAUFELD from the Hamra Beds (Ludlovian), Gotland. In addition to the above characteristics, its convex base and distinct cingulum do also make it different from *L. convexa* LAUFELD from the Eke Beds (Ludlovian) and *L. odiosa* from the Slite Marl (Wenlockian), Gotland (LAUFELD 1974).

Occurrence. — Poland: Radom—Lublin region; Upper Podlasian to Lower Ciepielovian (Lower Devonian).

Linochitina sp. A

(pl. 33: 1–4)

Material. — 30 specimens.

Description. — The vesicle is cylindro-conical or bulbiform. The flexure is gentle but distinct. The shoulder is rather indistinct. The collar is expanding, often with the flanged margin. The base is convex with large basal callus. It is separated from the flank with a sharp basal edge devoid of cingulum. The chains are fairly tight. The vesicles resemble in dimensions *L.* cf.

cingulata and *L. serrata* and, indeed, they are hardly distinguishable under a light microscope. The external surface of the vesicle is granulate.

Occurrence. — Poland: Radom—Lublin region; Upper Podlasian to Lower Ciepielovian (Upper Silurian to Lower Devonian).

Linochitina sp. B
(pl. 33: 10–12)

Material. — 44 specimens.

Description. — The vesicle is conical. There is usually neither flexure, nor shoulder. There is no distinct neck. The chamber ends with a long and wide collar considerably rolled outwards and with a swollen margin. The base is convex with a large basal callus. It is separated from the flank with a sharp basal edge; no cingulum was observed at the edge. The external surface of the vesicle is granulate. The vesicle is rather short or moderately long in size. The vesicles form usually tight chains. Under a light microscope, the species is hard to distinguish from *L.* cf. *cingulata.*

Occurrence. — Poland: Radom—Lublin region; Bostovian to Ciepielovian (Lower Devonian).

?*Linochitina* sp.
(pl. 34: 4–6)

Remarks. — The vesicles form chains considerably damaged by taphonomic processes. The organic matter is strongly metamorphosed. It has filled the vesicles and produced internal moulds. In their dimensions, general outline, and close attachment one to another, they resemble members of the genus *Linochitina.* Possibly, they represent various species of this genus.

Genus *Margachitina* EISENACK, 1968

Type species: *Desmochitina margaritana* EISENACK, 1937

Margachitina gratiosa sp. n.
(pl. 35: 1–6; fig. 8)

Holotype: ZPAL Ch. II/2S18; pl. 35: 2.
Type horizon: Upper Ciepielovian, Lower Devonian (sample taken at 1600 m in depth).
Type locality: borehole Strzelce IG 2, Radom—Lublin region.
Derivation of the name: Lat. *gratiosa* — beauty, popular, after the regularity and grace of the form and the commonness of the species in the Devonian of the Radom—Lublin region.

Diagnosis. — Discoidal vesicle with base extended in the form of weld linking it firmly with operculum of the adjacent vesicle; aperture provided with lip, often located in a hollow; operculum convex, covered with radial rugae disappearing at the junction.

Material. — 197 specimens.

Dimensions (in μm):

	L	W	A
Holotype	47	70	34
Range	47–78	68–93	34–51
Mode	52	76	50

Description. — The vesicle is more or less discoidal, sometimes subspherical. The weld linking the base and operculum of adjacent vesicles is opaque and compact in structure. It is usually 7 μm long and 5–7 μm wide. The aperture is surrounded by a variously shaped lip (fig. 8) and located commonly a little below the surface of the vesicle. The internal margin of the operculum forms a short flange larger in diameter than the aperture; therefore, vesicle chains are hardly disintegrated into singular vesicles. The external surface of the vesicle displays concentric rugae forming light and dark striae under a light microscope. They cross the transversal rugae producing reticulate sculpture of the vesicle surface. The sculpture is best developed in the middle of the vesicle length. The internal surface of the vesicle and operculum is laevigate.

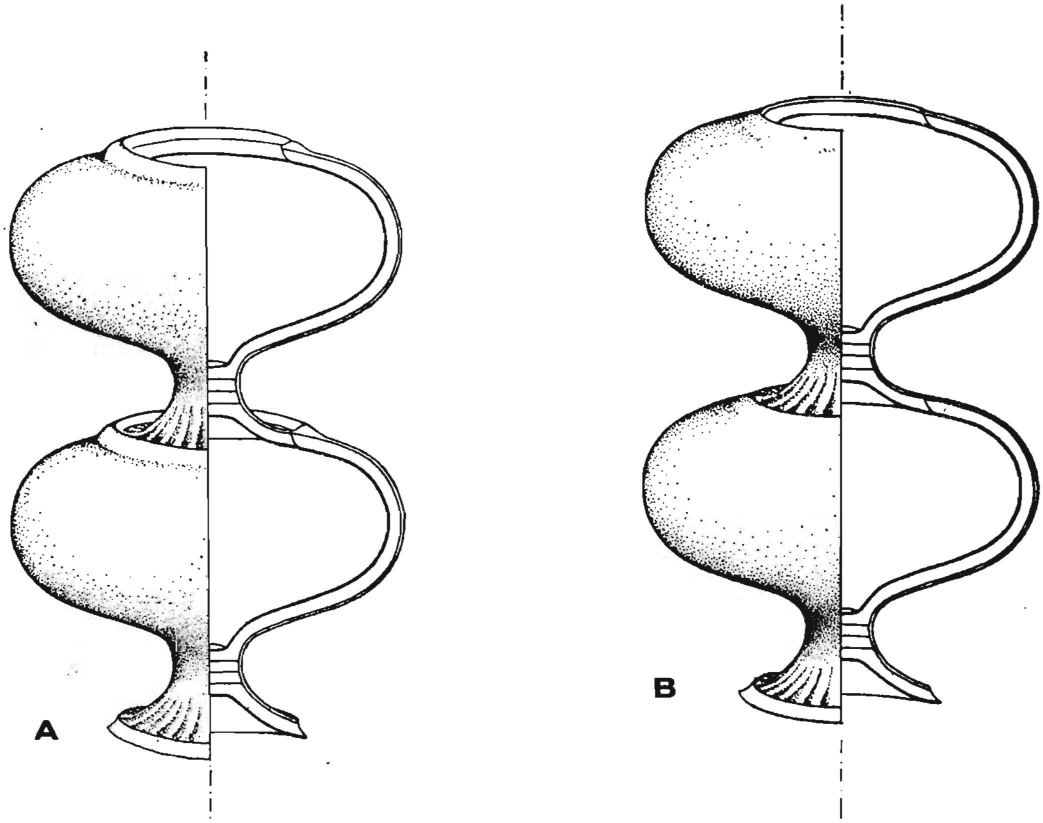


Fig. 8
Diagrammatic drawing of a twin of *Margachitina gratiosa* sp. n. showing the outline external morphology, hypothetic internal structure, and position of the operculum within the aperture. The aperture is surrounded by a indistinct (B) or thickened lip and located a little below the surface of the vesicle (A)

Remarks. — The investigated vesicles resemble in dimensions *Margachitina poculum* (Collinson and Schwalb, 1955) from the Middle Devonian Bailey Fm., boreholes in southern Illinois, USA; however, the latter species displays laevigate external surface of the vesicle. *Margachitina margaritana catenaria* Obut and *Margachitina elliptica* Obut from Goroshevo, Podolia (Mitkov Beds, Borshchov Stage, Lower Devonian) are not comparable with the investigated specimens because of the poor preservation of the specimens illustrated by Obut (1973) and the lack of their description.

Occurrence. — Poland: Radom—Lublin region; Ciepielovian (Lower Devonian).

Genus *Sphaerochitina* Eisenack, 1955

Type species: *Lagenochitina sphaerocephala* Eisenack, 1932

Sphaerochitina sphaerocephala (Eisenack, 1932)

(pl. 27: 10–14, fig. 9)

1972*a*. *Sphaerochitina sphaerocephala* Eisenack; Eisenack: 69, pl. 16: 3–15, (? 1–3, 17–25); pl. 19: 18–26.
1974. *Sphaerochitina sphaerocephala* (Eisenack); Laufeld: 112, fig. 69 (*cum syn.*).
1976. *Sphaerochitina sphaerocephala*; Eisenack: 650, figs. 16–18.

Material. — Ca 2000 specimens.
Dimensions (in μm):

	L	C	W	N	A
Range	147–270	76–93	55–77	19–41	34–44
Mode	190	84	67	27	38

Remarks. — Well preserved vesicles show a globose chamber and cylindrical neck. The sculpture is verrucate with the small nodes fused sometimes into either very low ones, or more distinct, higher and sharp ones. The vesicles are highly variable in shape, as described by EISENACK (1968). One may agree with LAUFELD (1974: 112) that only some of the specimens attributed by EISENACK (1972*a*) to *S. sphaerocephala* do actually belong to the species. However, the state of preservation of specimens derived from claystones and clayey shales (as in the case of most specimens from the borehole Łeba 1 studied by EISENACK and the investigated boreholes of Radom—Lublin region) makes hardly applicable the precise criteria proposed by LAUFELD (1974) to restrict the range of the species *S. sphaerocephala.*

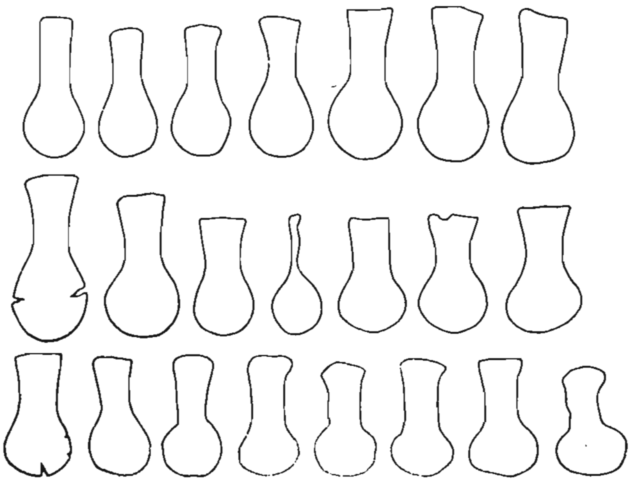


Fig. 9
Shape variation in *Sphaerochitina sphaerocephala* EISENACK; all the specimens derived from a single sample (borehole Ciepielów IG 1, 2305 m in depth)

Occurrence. — Gotland: Hamra Beds and Sundre Beds (Upper Silurian). Poland: Pomerania, borehole Łeba 1 (Middle to Upper Podlasian, Upper Silurian); Radom—Lublin region; Upper Podlasian to Lower Ciepielovian (Lower Devonian).

Genus *Urochitina* TAUGOURDEAU and JEKHOWSKY, 1960

Type species: *Urochitina simplex* TAUGOURDEAU and JEKHOWSKY, 1960

Urochitina simplex TAUGOURDEAU and JEKHOWSKY, 1960

(pl. 34: 8–12, fig. 10, 11)

1960. *Urochitina simplex* TAUGOURDEAU and JEKHOWSKY; TAUGOURDEAU and JEKHOWSKY: 1232, pl. 11: 159.

Material. — 270 specimens.
Dimensions (in μm):

	L	C	W	N	A	L+bp
Range	152–213	68–90	51–85	17–28	25–48	195–257

Description. — The vesicle is cylindro-ovoidal. The chamber is commonly elongate (although sometimes subspherical) and makes up nearly half the length of the vesicle. The base is strongly convex. There is no shoulder. However, the flexure is distinct. It passes into the neck expanding gently towards the aperture. The neck is ended with an orally expanding collar.

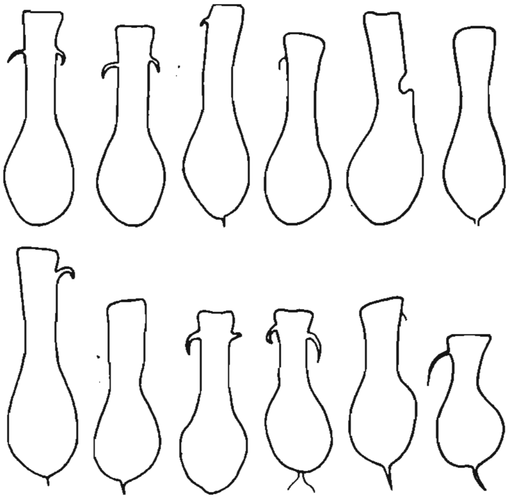


Fig. 10
Shape variation in *Urochitina simplex* TAUGOURDEAU and JEKHOWSKY; all the specimens derived from a single sample (borehole Ciepielów IG 1, 2305 m in depth)

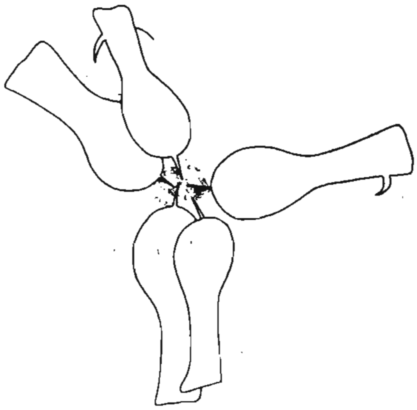


Fig. 11
Diagrammatic drawing of a natural aggregate showing the mode of aggregation

Singular, non-branched, thin, and moderately long (ca 27 μm) spines may occur below the collar. They are usually inclined aborally. Fairly long (up to 35 μm) and thick (3–5 μm) basal processus is situated at the center of the base. It ends with a fibriform-fringed swelling, the fibres being fairly constant in width (0·3 to 0·5 μm). The vesicle surface is laevigate.

Remarks. — The specimens are often attached one to another by means of fibriform processes and form aggregates (WRONA 1980) consisting each of 3–4 radially arranged vesicles (pl. 34: 10; fig. 10). Many specimens are more or less deformed (fig. 9). They may resemble *U. globosa* TAUGOURDEAU and JEKHOWSKY and *U. verrucosa* TAUGOURDEAU and JEKHOWSKY.

Occurrence. — North Africa: Sahara (Upper Siegenian to Emsian, Devonian). Poland: Radom—Lublin region; Lower Bostovian to Lower Ciepielovian (Lower Devonian).

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EXPLANATION OF PLATES 24–37

PLATE 24

Ancyrochitina ancyrea (EISENACK)

1. Specimen in oblique aboral view (ZPAL Ch. II/4S34); the appendices are partly broken off; borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 450.

Gotlandochitina lublinensis sp. n.

2. *a* — Holotype in lateral view (ZPAL Ch. II/4S12); borehole Strzelce IG 2, 1695 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 270.
   b — Detail of its appendice; × 1800.
3. Distorted specimen in oblique lateral view (ZPAL Ch. II/4S11); borehole Strzelce IG 2, 1695 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 270.

Ancyrochitina cf. *primitiva* EISENACK

4. *a* — Specimen in oblique aboral view (ZPAL Ch. II/3S18); borehole Strzelce IG 2, 1695 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 240.
   b — Traces after its broken off appendices; × 600.

Ancyrochitina tomentosa TAUGOURDEAU and JEKHOWSKY

5. *a* — Specimen in lateral view (ZPAL Ch. II/2S192); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 350.
   b — Detail of its soiled appendices; × 900.

Ancyrochitina cornigera COLLINSON and SCOTT

6. *a* — Distorted specimen in oblique aboral view (ZPAL Ch. II/2S101); borehole Ciepielów IG 1, 2280 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 300.
   b — Detail of its appendices; × 1500.

Ancyrochitina aff. *desmea* EISENACK

7. Slightly deformed specimen in oblique lateral view (ZPAL Ch. II/2S47); borehole Strzelce IG 2, 1629 m in depth. Lower Ciepielovian (Siegenian), Lower Devonian; × 425.
8. *a* — Specimen in lateral view (ZPAL Ch. II/2S124); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 375.
   b — Detail of its appendices; × 1000.

Ancyrochitina aff. *aurita* sp. n.

9. *a* — Specimen in lateral view (ZPAL Ch. II/4S 40); the auricles and appendices are partly broken off; borehole Strzelce IG 2, 1605 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
   b — Auricle; note the fenestration type; × 980.
   c — Detail of the auricle; note the connection with the vesicle wall; × 3000.
   d — Detail of the appendices; × 1500.

Ancyrochitina aurita sp. n.

10. *a* — Paratype in oblique aboral view (ZPAL Ch. II/4S 39); the auricles and appendices are partly broken off; borehole Strzelce IG 2, 1605 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
   b — Scars after its broken off appendices; note the vesicle perforation; × 1200.
   c — Detail of the auricle; × 1500.

PLATE 25

Ancyrochitina aff. *primitiva* EISENACK

1. *a* — Distorted specimen in obliqué lateral view (ZPAL Ch. II/2S 253); borehole Strzelce IG 2, 1732 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 325.
   b — Detail of its appendix; note that the appendix is hollow in its proximal part; × 1500.
2. *a* — Vesicle filled up with mineral matter, (ZPAL Ch. II/2S 99); the oral part is flattened; borehole Ciepielów IG 1, 2280 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 350.
   b — Detail of its appendix; note the considerable decomposition of the organic matter of the vesicle; × 1500.
3. Soiled specimen in oblique lateral view (ZPAL Ch. II/2S 252); borehole Strzelce IG 2, 1704 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 300.
4. Slightly flattened and deformed specimen (ZPAL Ch. II/2S 109); borehole Ciepielów IG 1, 2278 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 300.

Ancyrochitina lemniscata sp. n.

5. Holotype (ZPAL Ch. II/14S 6); the specimen is flattened; borehole Ciepielów IG 1, 2645 m in depth, Podlasian, Upper Silurian; × 125.
6. Oral portion of a flattened specimen (ZPAL Ch. II/14S 7); note the prosome pushed out of the aperture; borehole Ciepielów IG 1, 2645 m in depth, Podlasian, Upper Silurian; × 150.
10. Specimen in aboral view (ZPAL Ch. II/14S 1); borehole Ciepielów IG 1, 2645 m in depth, Podlasian, Upper Silurian; × 225.

Ancyrochitina cf. *ancyrea* (EISENACK)

7. *a* — Chain of vesicles in lateral view (ZPAL Ch. II/15S 12); the specimen is flattened; borehole Strzelce IG 2, 1737 m in depth, Podlasian, Upper Silurian; × 100.
   b — Detail of the surface of the vesicles and appendices; × 300.

Angochitina filosa EISENACK

8. Specimen in oblique oral view (ZPAL Ch. II/4S 4); the spines are partly broken off; borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 270.

Angochitina longispina sp. n.

9. *a* — Holotype in oblique aboral view (ZPAL Ch. II/4S 14); borehole Strzelce IG 2, 1695 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 360.
   b — Detail of its appendices; note the pyrite crystals encrusting the external surface of the vesicle; × 1000.

Angochitina echinata EISENACK

11. Slightly soiled and deformed specimen (ZPAL Ch. II/2S 184); borehole Strzelce IG 2, 1667 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 275.
12. Deformed specimen (ZPAL Ch. II/2S 185); borehole Strzelce IG 2, 1667 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 250.
13. *a* — Soiled specimen (ZPAL Ch. II/2S 142); the spines are partly broken off; borehole Strzelce IG 2, 1667 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 350.
    b — Detail of its surface and spines; × 1250.

Ancyrochitina sp.

1. Specimen with the appendices partly broken off (ZPAL Ch. II/2S 251); borehole Strzelce IG 2, 1704 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 600.

Ancyrochitina bulbispina sp. n.

15. *a* — Holotype (ZPAL Ch. II/4S 38); the appendices are partly broken off; borehole Strzelce IG 2, 1613 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
    b — Detail of its appendix; × 1500.
    c — The disrupted appendix; note that it is hollow; × 1800.

PLATE 26

Anthochitina superba EISENACK

1. *a* — Damaged specimen (ZPAL Ch. II/2S 02); the carina is partly broken off; borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 250.
   b — Detail of its vesicle wall disrupted near the aperture; × 1500.
2. Slightly deformed specimen in lateral view (ZPAL Ch. II/2S 42); borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 260.
3. Specimen in aboral view (ZPAL Ch. II/2S 06); note the fenestrate carina and the lack of basal scar; borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 450.
4. *a* — Specimen in oblique aboral view (ZPAL Ch. II/4S 20); note the star-like carina margin; borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 240.
   b — Same specimen in lateral view; the chamber is filled up with mineral matter (presumably pyrite); × 240.
   c — Detail of its carina; × 1800.
6. Specimen in aboral view (ZPAL Ch. II/2S 04); the base is damaged; note the spongy and initial fenestrate nature of the carina; borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 350.
7. *a* — Specimen in oral view (ZPAL Ch. II/2S 80); borehole Strzelce IG 2, 1611 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 325.
   b — Detail of its carina; × 5000.
8. *a* — Specimen in aboral view (ZPAL Ch. II/3S 63); the carina is partly broken off; borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 270.
   b — Detail of its carina; × 1800.
9. Specimen in oblique aboral view (ZPAL Ch. II/2S 48); the carina is deeply cut into separate petals; borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 400.

Anthochitina radiata sp. n.

6. *a* — Holotype (ZPAL Ch. II/4S 3); the specimen is damaged; borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 270.
   b — Fragment of its crushed carina and base; note the broken vesicle wall; × 600.
   c — Detail of the radius; note that it is hollow in its proximal part; × 1800.

Ancyrochitina aurita sp. n.

10. *a* — Holotype in oblique lateral view (ZPAL Ch. II/2S 76); the appendices are broken off; borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 350.
b — Detail of its auricle; note the solid structure of the elements in cross section; × 2000.
c — The auricles in lateral view; × 2250.

Ancyrochitina sp.

11. *a* — Slightly deformed twin (ZPAL Ch. II/2S 51); the appendices are partly broken off; borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 325.
b — Oral part of the vesicle; note the considerable decomposition of the organic matter of the vesicle; × 2000.

PLATE 27

Angochitina cf. *crassispina* EISENACK

1. *a* — Specimen in lateral view (ZPAL Ch. II/2S 215); the spines are partly broken off; borehole Strzelce IG 2, 1706 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 350.
b — Partly broken spines at the side of the chamber; × 1250.
2. Distorted specimen in lateral view (ZPAL Ch. II/2S 223); borehole Strzelce IG 2, 1706 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 325.
3. *a* — Deformed specimen in lateral view (ZPAL Ch. II/2S 222); the spines are partly broken off; borehole Strzelce IG 2, 1706 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 325.
b — Detail of its neck; × 1500.
4. *a* — Slightly deformed specimen in lateral view (ZPAL Ch. II/2S 218); the spines are partly broken off; borehole Strzelce IG 2, 1706 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 325.
b — Detail of ornamentation at its neck; × 1200.
5. Distorted specimen in lateral view (ZPAL Ch. II/4S 2); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 270.
6. *a* — Deformed specimen in lateral view (ZPAL Ch. II/2S 226); the spines are partly broken off; borehole Strzelce IG 2, 1706 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 325.
b — Fragment of the surface of its vesicle; note that the spine is not hollow; × 3500.

Angochitina sp.

7. Damaged specimen of an aberrant vesicle in oblique lateral view (ZPAL Ch. II/4S 19); borehole Strzelce IG 2, 1708 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 180.

Angochitina cf. *longicollis* EISENACK

8. Slightly deformed specimen in lateral view (ZPAL Ch. II/2S 224); the spines are broken off; borehole Strzelce IG 2, 1706 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 225.
9. Damaged specimen (ZPAL Ch. II/2S 178); note the considerable decomposition of the organic matter of the vesicle in its oral part; borehole Strzelce IG 2, 1648 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 225.

Sphaerochitina sphaerocephala EISENACK

10. *a* — Specimen with deformed oral part in lateral view (ZPAL Ch. II/2S 258); borehole Ciepielów IG 1, 2305 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 275.
b — Fragment of the external surface of its chamber with partly preserved ornamentation; × 900.
c — Fragment of the external surface of the neck and flexure with partly preserved ornamentation; × 1500.

11. Strongly flattened specimen in lateral view (ZPAL Ch. II/2S 259); borehole Ciepielów IG 1, 2305 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 375.
12. Damaged specimen in oblique lateral view (ZPAL Ch. II/4S 17); borehole Strzelce IG 2, 1767 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
13. Twin in lateral view (ZPAL Ch. II/15 S 22); the vesicles are incompletely developed, flattened, and deformed; borehole Białopole IG 1, 1463 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 150.
14. Specimen with flattened neck (ZPAL Ch. II/15S 21); borehole Białopole IG 1, 1463 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 225.

Conochitina cf. *intermedia* EISENACK

15. Internal mould with remains of the vesicle wall in oblique aboral view (ZPAL Ch. II/15S 2); borehole Białopole IG 1, 1994 m in depth, lower part of the Siedlce series (stages yet not erected), Upper Silurian; × 225.

Conochitina sp.

16. *a* — Specimen with damaged oral part in oblique oral view (ZPAL Ch. II/15S 25); the vesicle surface is encrusted with grained pyritic clusters; borehole Siedliska IG 1, 2382 m in depth, lower part of the Siedlce series (stages yet not erected), Upper Silurian; × 300.
    b — Detail of the pyrite encrustation; × 3000.
17. Damaged specimen in oblique aboral view (ZPAL Ch. II/15S 8); borehole Siedliska IG 1, 2382 m in depth, lower part of the Siedlce series (stages yet not erected), Upper Silurian; × 125.

Conochitina invenusta sp. n.

18. *a* — Holotype in oblique aboral view (ZPAL Ch. II/4S 1); the specimen is damaged; borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 270.
    b — Detail of the sculpture at its basal edge; × 1800.

Conochitina cf. *latifrons* EISENACK

19. Specimen in oblique aboral view (ZPAL Ch. II/15 S 16); borehole Siedliska IG 1, 2382 m in depth, lower part of the Siedlce series (stages yet not erected), Upper Silurian; × 150.
20. Specimen in lateral view (ZPAL Ch. II/15S 17); borehole Siedliska IG 1, 2382 m in depth, lower part of the Siedlce series (stages yet not erected), Upper Silurian; × 150.

PLATE 28

Eisenackitina fimbriata sp. n.

1. *a* — Holotype in lateral view (ZPAL Ch. II/2S 96); the spines are partly damaged; borehole Strzelce IG 2, 1611 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 350.
   b — Fragment of its lateral surface; note the disrupted hollow spine; × 2000.

Eisenackitina pilosa sp. n.

2. Specimen in oblique oral view (ZPAL Ch. II/4S 26); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepeliovian (Siegenian), Lower Devonian; × 270.
3. *a* — Specimen in oblique aboral view (ZPAL Ch. II/4S 28); the spines are completely broken off; borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
   b — Its aperture and operculum; note the oral scar; × 900.

4. *a* — Holotype (ZPAL Ch. II/2S 55); the spines are partly broken off; borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 400.
   b — Its basal scar; × 1500.
5. Considerably damaged specimen (ZPAL Ch. II/2S 56); borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 400.
6. *a* — Specimen in oblique lateral view (ZPAL Ch. II/2S 24); the ornamentation is damaged; borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 350.
   b — Detail of its surface; note the spine (?); × 2500.
7. Fragment of a specimen in oral view (ZPAL Ch. II/2S 57); note the aperture with operculum inside; borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 1000.
8. Fragment of lateral surface of a specimen (ZPAL Ch. II/2S 127); note the perforation of the vesicle wall; borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 1500.
9. *a* — Fragment of a broken specimen in aboral view (ZPAL Ch. II/2S 33); note the internal surface of the vesicle wall; borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 450.
   b — Detail of the fracture surface of the vesicle wall; × 5000.

Eisenackitina cepicia sp. n.

10. *a* — Holotype in oblique aboral view (ZPAL Ch. II/2S 31); borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 375.
    b — Ornamentation at its basal edge; × 1000.
    c — Detail of the ornamentation; × 2500.
    d — The basal scar; × 3000.

PLATE 29

Eisenackitina cepicia sp. n.

1. Deformed and broken specimen (ZPAL Ch. II 2S 34); the ornamentation is damaged; borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 450.
2. *a* — Soiled specimen in oblique aboral view (ZPAL Ch. II/2S 54); borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 425.
   b — Its basal scar; × 2500.
3. Soiled specimen in oblique oral view (ZPAL Ch. II/2S 59); note the operculum within the aperture; borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 400.
4. Soiled specimen in oblique lateral view (ZPAL Ch. II/2S 61); the ornamentation is damaged; borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 600.

Eisenackitina crassa sp. n.

5. *a* — Holotype in oblique lateral view (ZPAL Ch. II/2S 114); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 425.
   b — Ornamentation at its basal edge; × 1000.
6. *a* — Specimen in oral view (ZPAL Ch. II/2S 115); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 375.
   b — Ornamentation of the vesicle near the aperture; note the operculum deep inside the aperture; × 1000.
7. *a* — Detail of the center of the base of a specimen (ZPAL Ch. II/2S 26); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 500.
   b — The basal scar and basal pore; × 5000.

Eisenackitina lacrimabilis sp. n.

8. *a* — Holotype in oblique aboral view (ZPAL Ch. II/2S 46); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 350.
   b — Its basal callus; × 1500.

9. *a* — Slightly deformed specimen in lateral view (ZPAL Ch. II/4S 35); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
   b — Its base and basal callus, slightly soiled; × 360.
   c — The aperture with operculum inside; × 900.
10. *a* — Soiled specimen in lateral view (ZPAL Ch. II/4S 21); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 270.
   b — Its base and basal callus; note the perforation caused by undetermined microorganisms; × 360.
   c — The basal callus and basal scar; × 1800.
11. Damaged specimen in lateral view (ZPAL Ch. II/2S 113); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 375.
12. Damaged and soiled specimen in oblique oral view (ZPAL Ch. II/4S 27); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
13. Slightly soiled specimen in oblique lateral view (ZPAL Ch. II/2S 112); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 325.

PLATE 30

Eisenackitina lacrimabilis sp. n.

1. Distorted specimen in lateral view (ZPAL Ch. II/2S 149); borehole Strzelce IG 2, 1608 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 300.
2. Crashed specimen in oblique lateral view (ZPAL Ch. II/2S 173); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 325.
3. Fragment of vesicle surface near the basal edge (ZPAL Ch. II/2S 5); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 1500.
4. Disrupted specimen in lateral view (ZPAL Ch. II/2S 11); note the mineral matter filling up the aboral part of the vesicle interior; borehole Strzelce IG 2, 1608 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 650.
5. Base of a specimen (ZPAL Ch. II/2S 148); note the basal callus, scar, and pore; borehole Strzelce IG 2, 1608 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 1000.
6. Basal callus and basal scar of a specimen (ZPAL Ch. II/2S 108); borehole Ciepielów IG 1, 2268·6 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 1500.
7. Disrupted oral part of a vesicle (ZPAL Ch. II/4S 25); note the operculum situated below the aperture; borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 900.
8. Fracture surface of a chamber wall (ZPAL Ch. II/1S 1); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 3000.
9. Disrupted oral part of a vesicle (ZPAL Ch. II/2S 9); the specimen lacks operculum; note the laevigate internal surface of the vesicle wall; borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 1000.
10. Specimen fragment in oral view (ZPAL Ch. II/2S 156); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 1000.

Eisenackitina oviformis (EISENACK)

11. *a* — Deformed specimen in oblique lateral view (ZPAL Ch. II/15S 4); borehole Białopole IG 1, 1732 m in depth, Lower Podlasian, Upper Silurian; × 300.
   b — Its basal scar in oblique aboral view; × 1000.

Eisenackitina cupellata sp. n.

12. *a* — Deformed specimen in oblique lateral view (ZPAL Ch. II/4S 30); note several perforations of the vesicle wall; borehole Strzelce IG 2, 1695 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 270.
   b — Oral part of the vesicle; × 1200.
   c — Detail of the perforation; × 6000.

13. *a* — Distorted specimen in oblique lateral view (ZPAL Ch. II/2S 194); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 350.
    b — Aboral part of the vesicle in lateral view; × 800.
    c — Its mineral fill; × 2000.
14. Central part of the base of a specimen (ZPAL Ch. II/3S 14); note the basal callus; borehole Strzelce IG 2, 1701 m in depth, Lower Bostovian (Gedinnian); Lower Devonian; × 1200.
15. Basal part of a broken specimen (ZPAL Ch. II/2S 201); note the cross sections through the vesicle wall and basal callus; borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 1750.

PLATE 31

Eisenackitina cf. *urna* (EISENACK)

1. *a* — Vesicle chain in lateral view (ZPAL Ch. II/14S 13); borehole Strzelce IG 2, 1439 m in depth, Upper Podlasian, Upper Silurian; × 100.
   b — Detail of the connection between the vesicles; × 300.
2. *a* — Fragment of a chain of deformed vesicles (ZPAL Ch. II/15S 18); note the underdevelopment of the vesicles; borehole Strzelce IG 2, 1773 m in depth, Upper Podlasian, Upper Silurian; × 100.
   b — Marginal vesicle in the chain; × 300.
3. Marginal fragment of a vesicle chain (ZPAL Ch. II/15S 19); borehole Strzelce IG 2, 1773 m in depth, Upper Podlasian, Upper Silurian; × 100.
4. *a* — Deformed and stretched twin (ZPAL Ch. II/15 S 13); borehole Strzelce IG 2, 1849·5 m in depth, Lower Podlasian, Upper Silurian; × 175.
   b — Detail of the connection between the vesicles; note the operculum pushed partly out of the aperture; × 500.
   c — Basal part of the vesicle attached to the operculum of the adjacent vesicle; × 500.
5. *a* — Distorted specimen in oblique lateral view (ZPAL Ch. II/15S 14); note the operculum pressed out of the aperture; borehole Strzelce IG 2, 1849·5 m in depth, Lower Podlasian, Upper Silurian; × 200.
   b — Its basal scar; × 1000.
6. *a* — Fragment of a broken vesicle in inside view (ZPAL Ch. II/14S 16); borehole Strzelce IG 2, 1893 m in depth, uppermost part of the Siedlce series (any stages are not defined as yet), Lower Silurian; × 300.
   b — Detail of the internal surface of its collar and aperture; note the flange broken off the perculum and fused closely with the vesicle wall; × 1000.
   c — Fracture surface of the vesicle wall; × 3000.
7. *a* — Two marginal vesicles of a chain in lateral view (ZPAL Ch. II/14S 3); both the specimens are slightly flattened; borehole Ciepielów IG 1, 2661 m in depth, Upper Podlasian, Upper Silurian; × 150.
   b — Detail of the connection between the vesicles; × 750.

Eisenackitina cupellata sp. n.

8. Damaged specimen in oblique lateral view (ZPAL Ch. II/2S 191); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 275.
9. *a* — Slightly deformed specimen in oblique aboral view (ZPAL Ch. II/2S 200); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 300.
   b — Its basal callus; × 1000.
10. Damaged specimen in lateral view (ZPAL Ch. II/3S 187); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 200.
11. Holotype in oblique oral view (ZPAL Ch. II/3S 15); borehole Strzelce IG 2, 1701 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 290.
12. Specimen in lateral view (ZPAL Ch. II/2S 188); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 300.

PLATE 32

Hoegisphaera velata sp. n.

1. *a* — Holotype in oral view (ZPAL Ch. II/4S 37); borehole Strzelce IG 2, 1605 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
   b — Same specimen in lateral view, fused laterally with a fragment of the adjacent vesicle; × 360.
2. Damaged specimen in lateral view (ZPAL Ch. II/2S 158); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 700.
3. Specimen in oblique oral view (ZPAL Ch. II/2S 195); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 650.
4. Damaged specimen in oral view (ZPAL Ch. II/4S 42); borehole Strzelce IG 2, 1605 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 600.
5. Paratype in oblique lateral view (ZPAL Ch. II/4S 41); borehole Strzelce IG 2, 1605 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 600.
6. Specimen in oblique oral view (ZPAL Ch. II/2S 163); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 700.
7. Specimen in oblique oral view (ZPAL Ch. II/2S 162); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 700.

Hoegisphaera cf. *glabra* Staplin

8. Specimen filled with mineral matter in oblique oral view; (ZPAL Ch. II/2S 129); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 750.
9. Damaged specimen filled with mineral matter in oral view (ZPAL Ch. II/2S 137); borehole Strzelce IG 2, 1732 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 750.
10. Soiled specimen in oral view (ZPAL Ch. II/2S 143); borehole Strzelce IG 2, 1667 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 650.
11. Slightly deformed specimen in aboral view (ZPAL Ch. II/2S 154); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 700.

Hoegisphaera glabra Staplin

12. *a* — Slightly damaged specimen in oblique oral view (ZPAL Ch. II/1S 2); note the perforation of the vesicle wall and the operculum; borehole Strzelce IG 2, 1605 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 650.
    b — Detail of its lips and operculum; × 2500.
    c — Perforation of the operculum; × 10000.

Eisenackina barbatula sp. n.

13. *a* — Holotype in oblique oral view (ZPAL Ch. II/4S 24); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
    b — Same specimen in lateral view; × 360.

PLATE 33

Linochitina sp. A

1. *a* — Twin in oblique oral view (ZPAL Ch. II/4S 22); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 270.
   b — Its operculum in oblique lateral view; × 600.
   c — The operculum in aboral view; × 1200.

2. Specimen in lateral view (ZPAL Ch. II/2S 117); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 500.
3. *a* — Twin in lateral view (ZPAL Ch. II/2S 110); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 225.
   b — Detail of the connection between the vesicles; note the growth lines at the collar; × 900.
4. *a* — Chain fragment composed of three damaged vesicles in lateral view (ZPAL Ch. II/2S 179); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 200.
   b — One of the vesicles in lateral view; × 500.
   c — Detail of the connection between the vesicles; × 800.

Linochitina cf. *cingulata* (EISENACK)

5. Specimen in lateral view (ZPAL Ch. II/2S 71); borehole Strzelce IG 2, 1669 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 550.
6. *a* — Slightly deformed specimen in oblique aboral view (ZPAL Ch. II/2S 74); borehole Strzelce IG 2, 1669 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 650.
   b — Fragment of its base; × 1750.

Linochitina longiuscula sp. n.

7. *a* — Holotype: the central vesicle in the chain (ZPAL Ch. II/2S 171); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 175.
   b — Same specimen in lateral view; × 400.
8. *a* — Chain of five vesicles (ZPAL Ch. II/2S 111); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 110.
   b — Detail of the connection between the vesicles; × 1000.
9. *a* — Chain of the damaged vesicles (ZPAL Ch. II/2S 82); borehole Strzelce IG 2, 1669 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 175.
   b — Detail of the connection between the vesicles; × 1000.

Linochitina sp. B

10. Twin (ZPAL Ch. II/2S 181); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 300.
11. *a* — Chain of five vesicles (ZPAL Ch. II/2S 182); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 175.
    b — Its fragment; × 650.
12. *a* — Chain of three damaged vesicles (ZPAL Ch. II/2S 119); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 200.
    b — One of the vesicles in lateral view; × 500.
    c — Detail of the connection between the vesicles; × 800.
    d — Basal part of one of the vesicles; note the basal edge, base, and basal callus; × 850.

PLATE 34

Linochitina subcylindrica sp. n.

1. Specimen in oblique aboral view (ZPAL Ch. II/4S 15); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 450.
2. Vesicle fused with the operculum of the adjacent vesicle (ZPAL Ch. II/4S 8); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 270.
3. Holotype in lateral view (ZPAL Ch. II/2S 203); borehole Strzelce IG 2, 1702 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 500.

Linochitina sp.

4. Internal mould of a vesicle (ZPAL Ch. II/2S 38); borehole Białopole IG 1, 2034·2 m in depth, Upper Mielnikian (Ludlovian), Upper Silurian; × 650.
5. Twin (ZPAL Ch. II/2S 40); both the vesicles are damaged; borehole Białopole IG 1, 2034·2 m in depth, Upper Mielnikian (Ludlovian), Upper Silurian; × 200.
6. *a* — Twin (ZPAL Ch. II/2S 36); note the considerable decomposition of the organic matter; borehole Białopole IG 1, 2034·3 m in depth, Upper Mielnikian (Ludlovian), Upper Silurian; × 275.
   b — Fragment of one of the vesicles; × 2500.

Linochitina serrata TAUGOURDEAU and JEKHOWSKY

7. *a* — Twin in oblique aboral view (ZPAL Ch. II/4S 9); borehole Strzelce IG 2, 1629 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 270.
   b — Detail of the connection between the vesicles; note the growth lines at the collar; × 1200
   c — The operculum fused with the base of the adjacent vesicle; note the wide flange; × 900.

Urochitina simplex TAUGOURDEAU and JEKHOWSKY

8. Damaged specimen filled with mineral matter (ZPAL Ch. II/14S 15); borehole Ciepielów IG 1, 2305 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 225.
9. Damaged specimen filled with mineral matter (ZPAL Ch. II/15S 23); borehole Białopole IG 1, 1412 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 300.
10. *a* — Three flattened vesicles interconnected by their basal processes (ZPAL Ch. II/14S 11); borehole Ciepielów IG 1, 2305 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 100.
    c — The basal processus; × 3000.
11. Damaged specimen in oblique oral view (ZPAL Ch. II/4S 33); borehole Strzelce IG 2, 1651 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 360.
12. *a* — Deformed specimen (ZPAL Ch. II/14S 14): note the basal processus and fibrous remains after the aggregation; borehole Ciepielów IG 1, 2305 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 150.
    b — Its processus and fibrous remains after the aggregation; × 750.

PLATE 35

Margachitina gratiosa sp. n.

1. *a* — Chain of four vesicles in oblique oral view (ZPAL Ch. II/2S 22); borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 225.
   b — Detail of the connection between the vesicles; × 1300.
2. *a* — Chain fragment of six vesicles (ZPAL Ch. II/2S 18); borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 150.
   b — Holotype of the vesicles in oblique oral view; × 700.
   c — Operculum within the aperture of a broken vesicle in inside view; × 1100.
3. *a* — Specimen in oblique oral view (ZPAL Ch. II/4S 29); borehole Strzelce IG 2, 1608 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 600.
   b — Same specimen in lateral view; × 600.
4. *a* — Specimen in oblique oral view (ZPAL Ch. II/2S 18); borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 700.
   b — Lip of the vesicle; note the perforation and mineral fill of the vesicle; × 1750.
   c — The operculum; × 1750.
5. *a* — Oral part of a specimen in oral view (ZPAL Ch. II/2S 16); borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 600.
   b — Detail of its operculum; × 1500.
6. Operculum in aboral (inside) view (ZPAL Ch. II/2S 19); borehole Strzelce IG 2, 1600 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 750.

Desmochitina sp.

7. Chain fragment of two vesicles (ZPAL Ch. II/2S 11); borehole Strzelce IG 2, 1648 m in depth, Lower Ciepielovian (Siegenian), Lower Devonian; × 600.

Desmochitina spongiloricata sp. n.

8. *a* — Holotype in oblique oral view (ZPAL Ch. II/4S 13); borehole Strzelce IG 2, 1732 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 450.
   b — Detail of its surface; × 1800.
9. *a* — Deformed specimen in oral view (ZPAL Ch. II/2S 138); borehole Strzelce IG 2, 1732 m in depth, Lower Bostovian (Gedinnian), Lower Devonian; × 420.
   b — Detail of its surface; note the mineral patches and damage of the original sculpture; × 1500.

PLATE 36

Ancyrochitina cf. *ancyrea* EISENACK

1. Aboral part of vesicle in thin section (ZPAL Ch. II/C32E1); borehole Ciepielów IG 1, 2323 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 140.

Urochitina cf. *simplex* TAUGOURDEAU and JEKHOWSKY

2–3. Two specimens in thin section (ZPAL Ch. II/C32E2, 3); borehole Ciepielów IG 1, 2323 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 140.

Angochitina sp.

4. Specimen in thin section (ZPAL Ch. II/C32E4); borehole Ciepielów IG 1, 2323 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 140.

?*Sphaerochitina* sp.

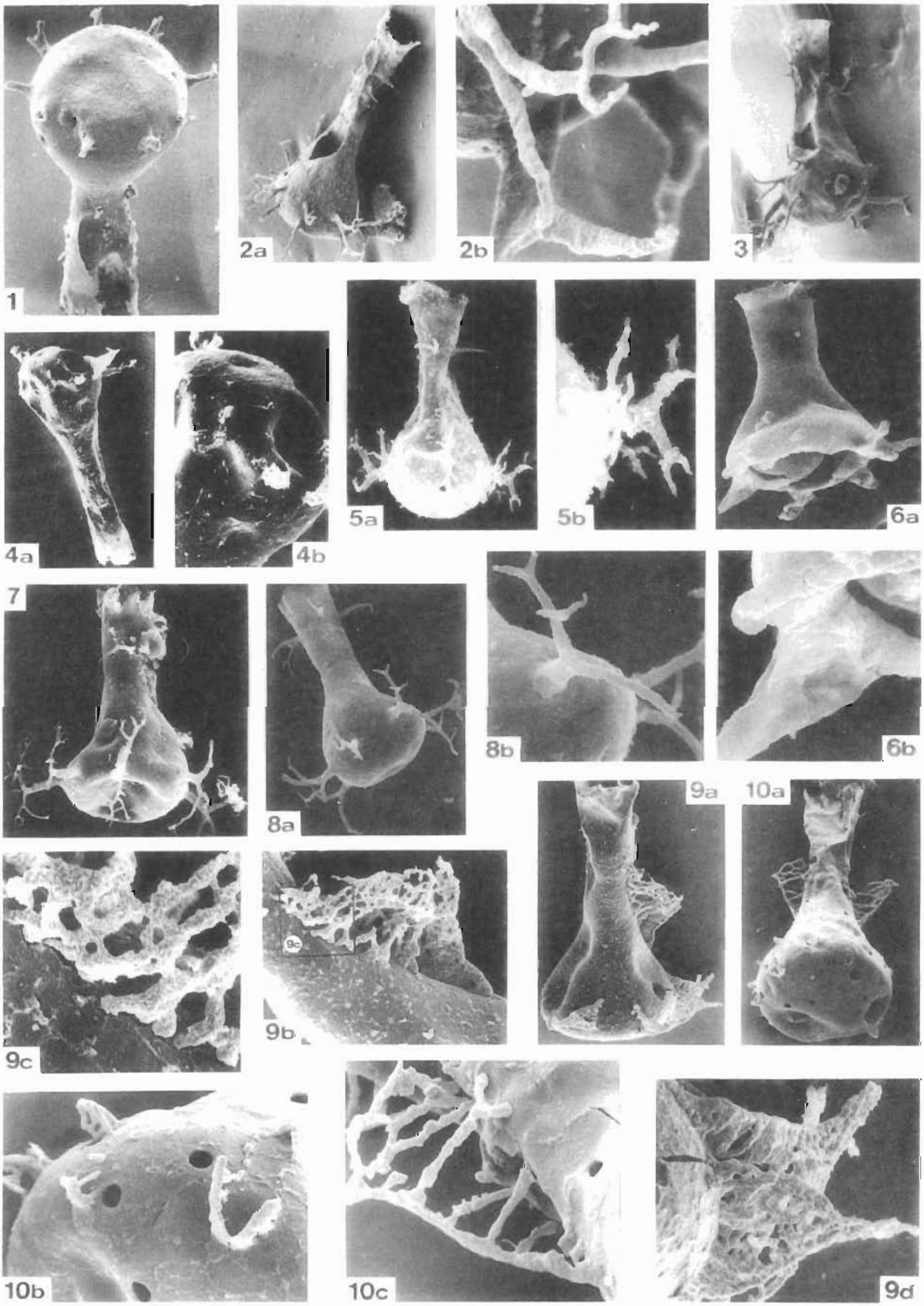
5. Specimen (ZPAL Ch. II/C32E5) in thin section; borehole Ciepielów IG 1, 2323 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 140.

Urochitina cf. *simplex* TAUGOURDEAU and JEKHOWSKY

6–8. Three fragments of a natural aggregation of vesicles (ZPAL Ch. II/C32E6, 7, 8); borehole Ciepielów IG 1, 2323 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 140.
9. Chitinozoan-bearing calcareous shale, thin section (ZPAL Ch. II/C32E); borehole Ciepielów IG 1, 2323 m in depth, Upper Bostovian (Gedinnian), Lower Devonian; × 10.
10. Chitinozoan-bearing biodetrital marly limestone, thin section (ZPAL Ch. II/C21); borehole Ciepielów IG 1, 2235·8 m in depth, (Lower?) Ciepielovian (Siegenian), Lower Devonian; × 10.

PLATE 37

1–3. Chitinozoan-bearing calcareous shale; same thin section as in plate 36:9; × 20.
4. Chitinozoan-bearing biodetrital marly limestone; thin section (ZPAL Ch. II/BP1); borehole Białopole IG 1, 1337 m in depth, Upper Ciepielovian (Siegenian), Lower Devonian; × 10.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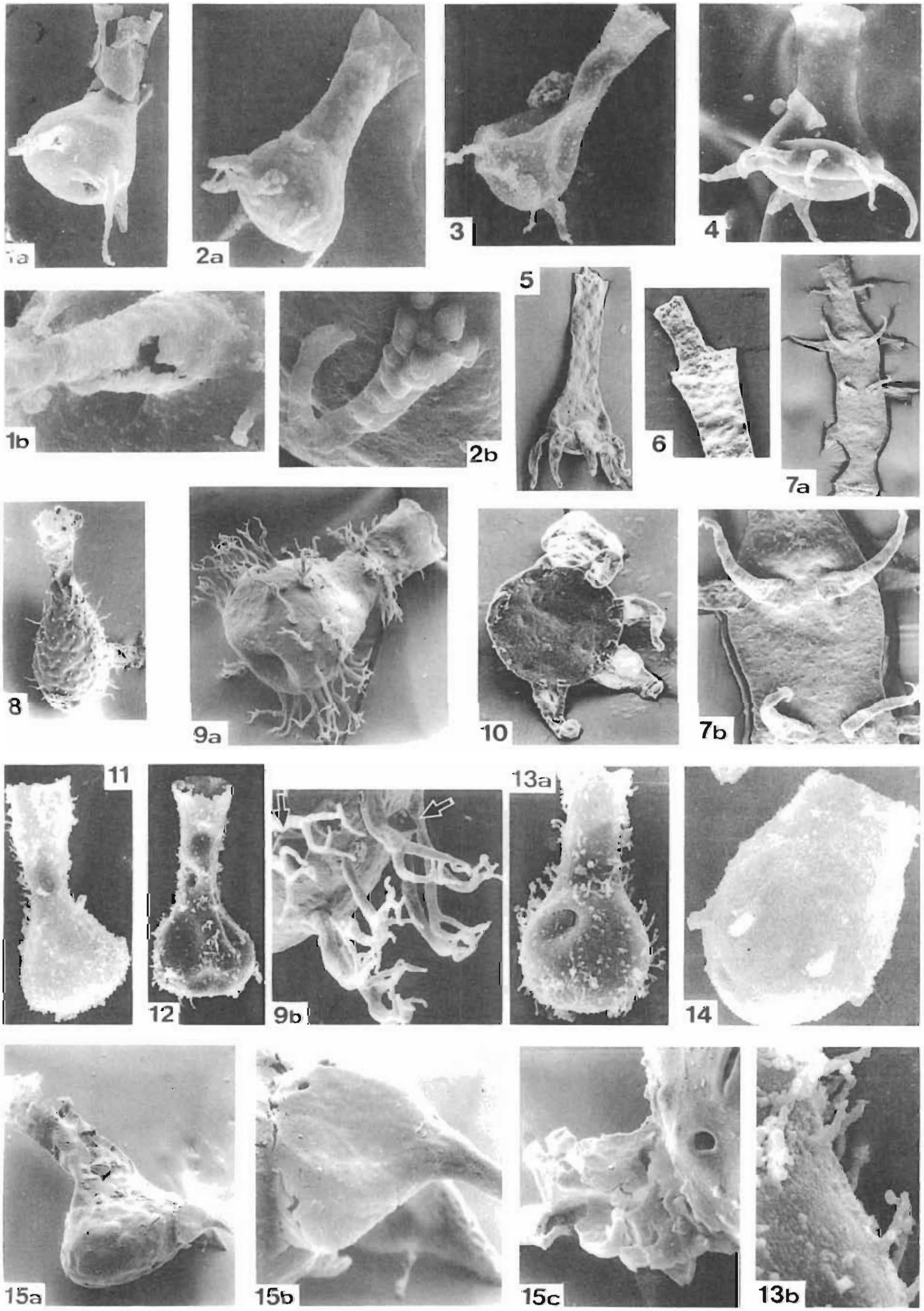
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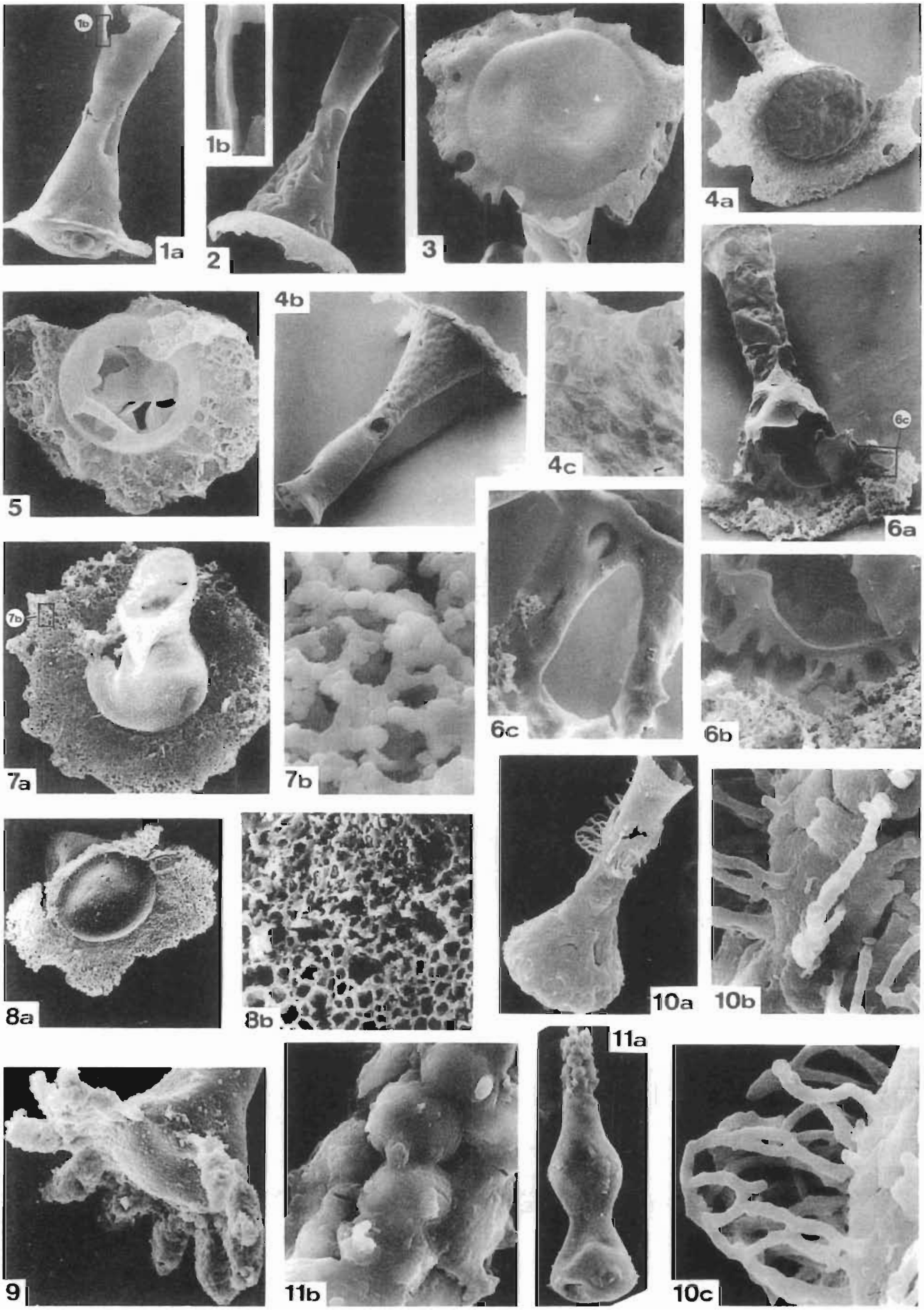
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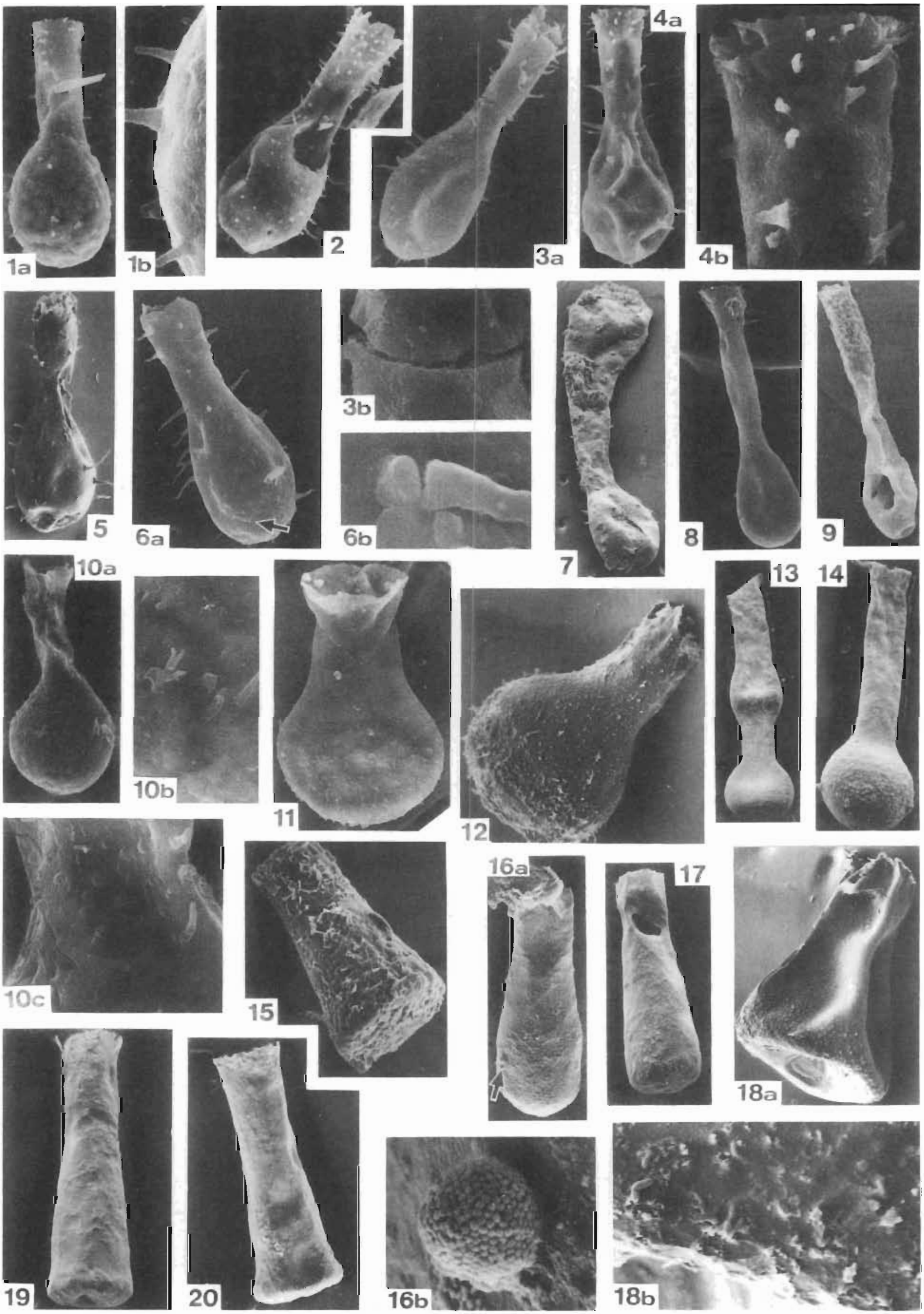
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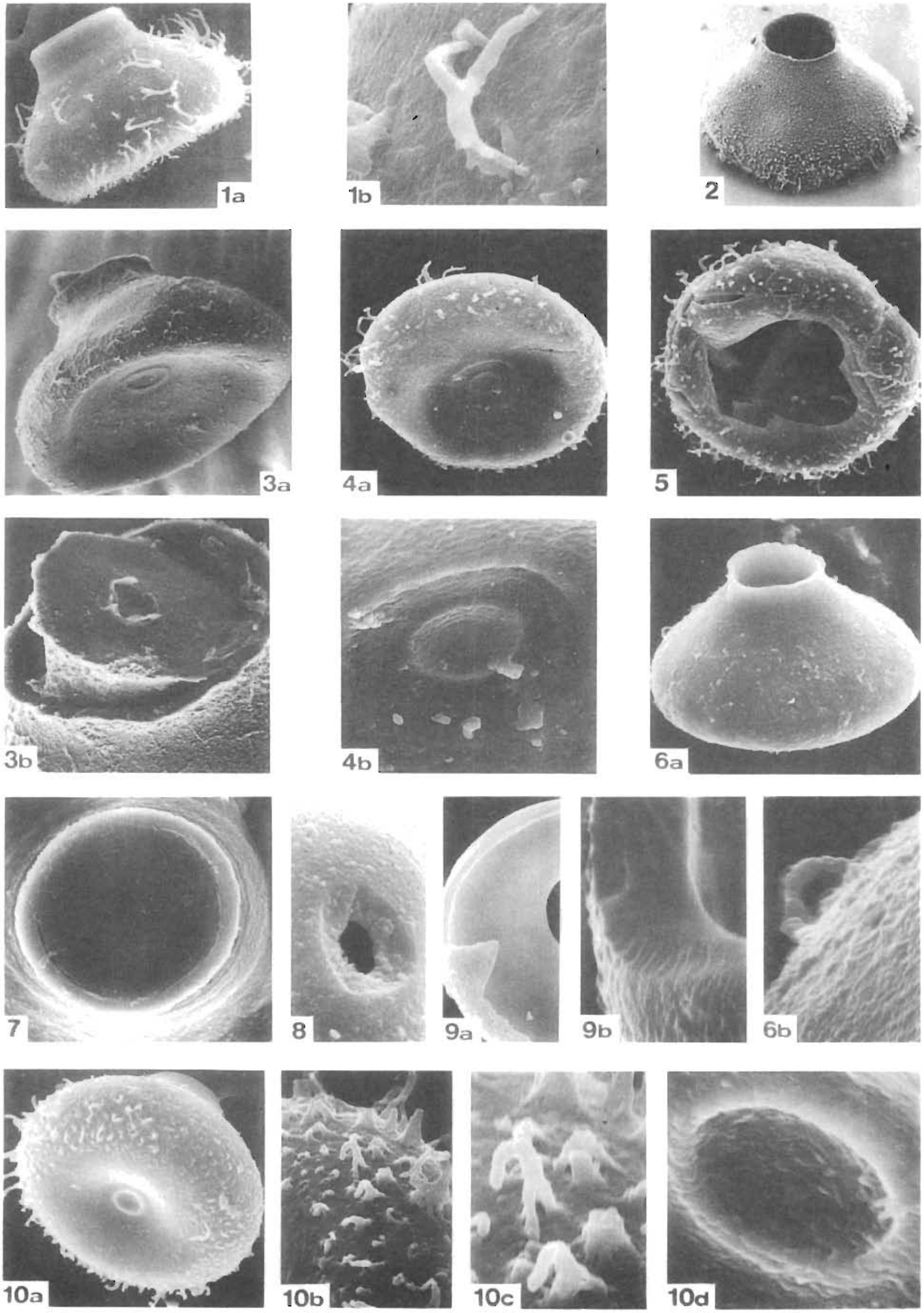
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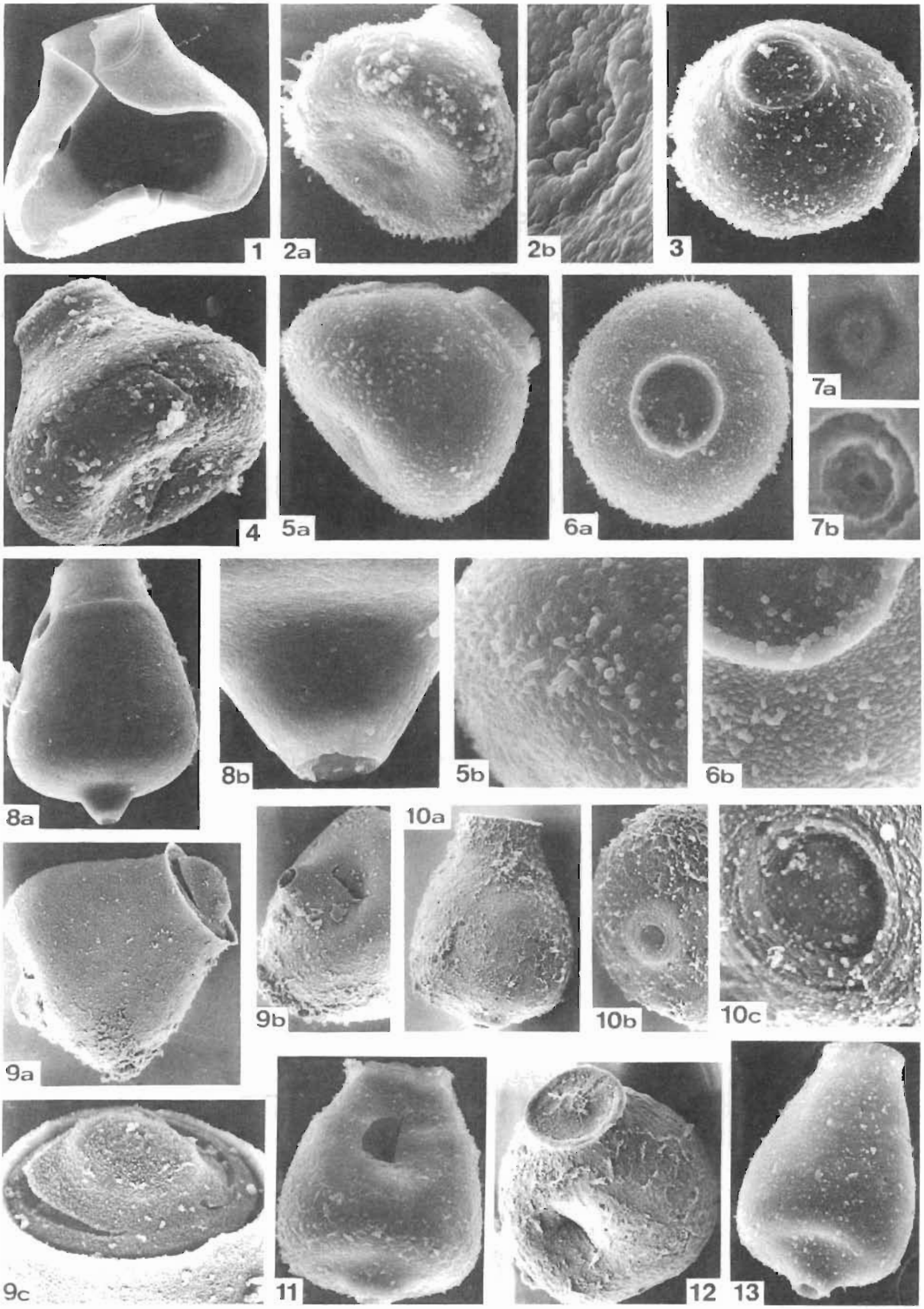
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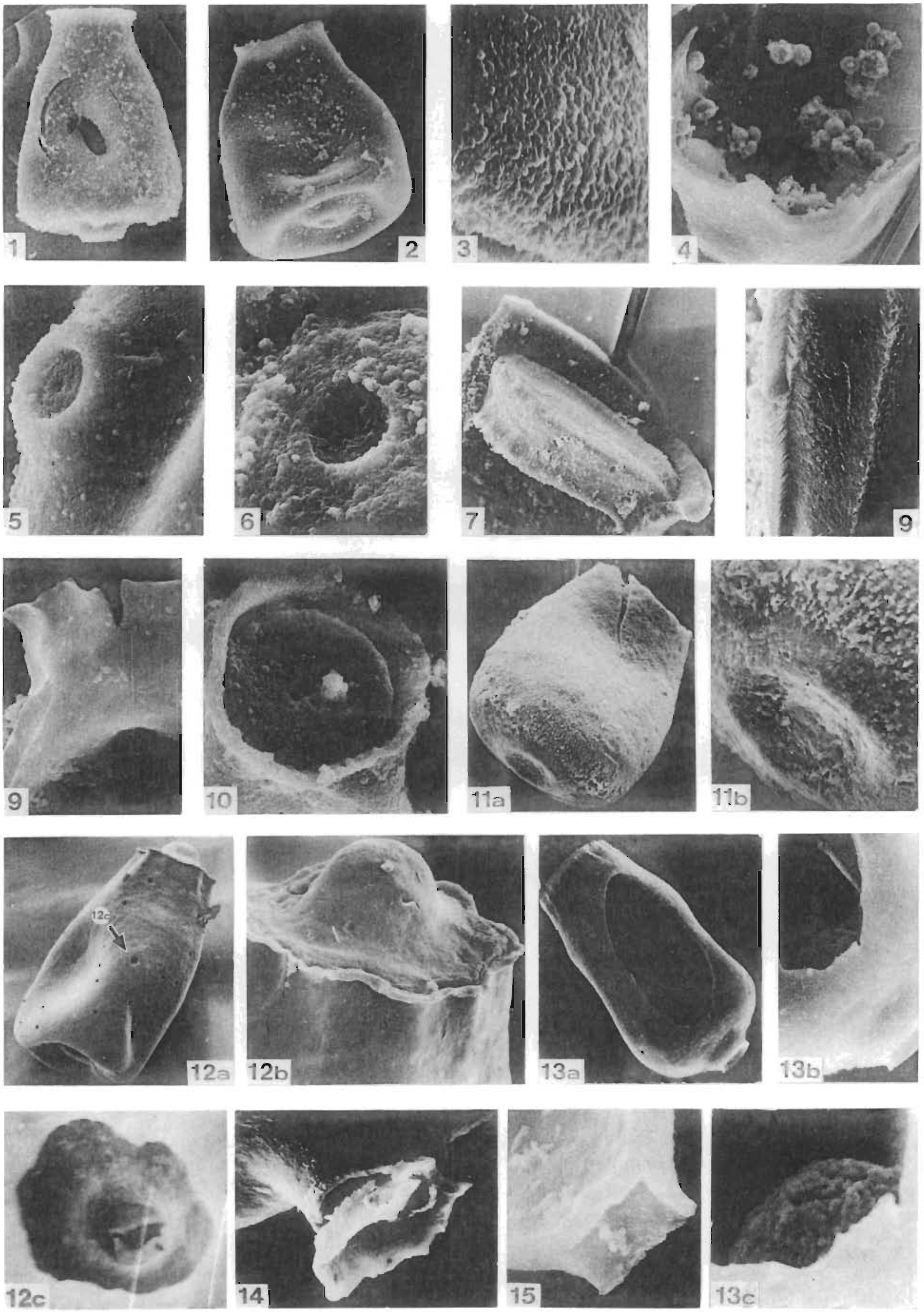
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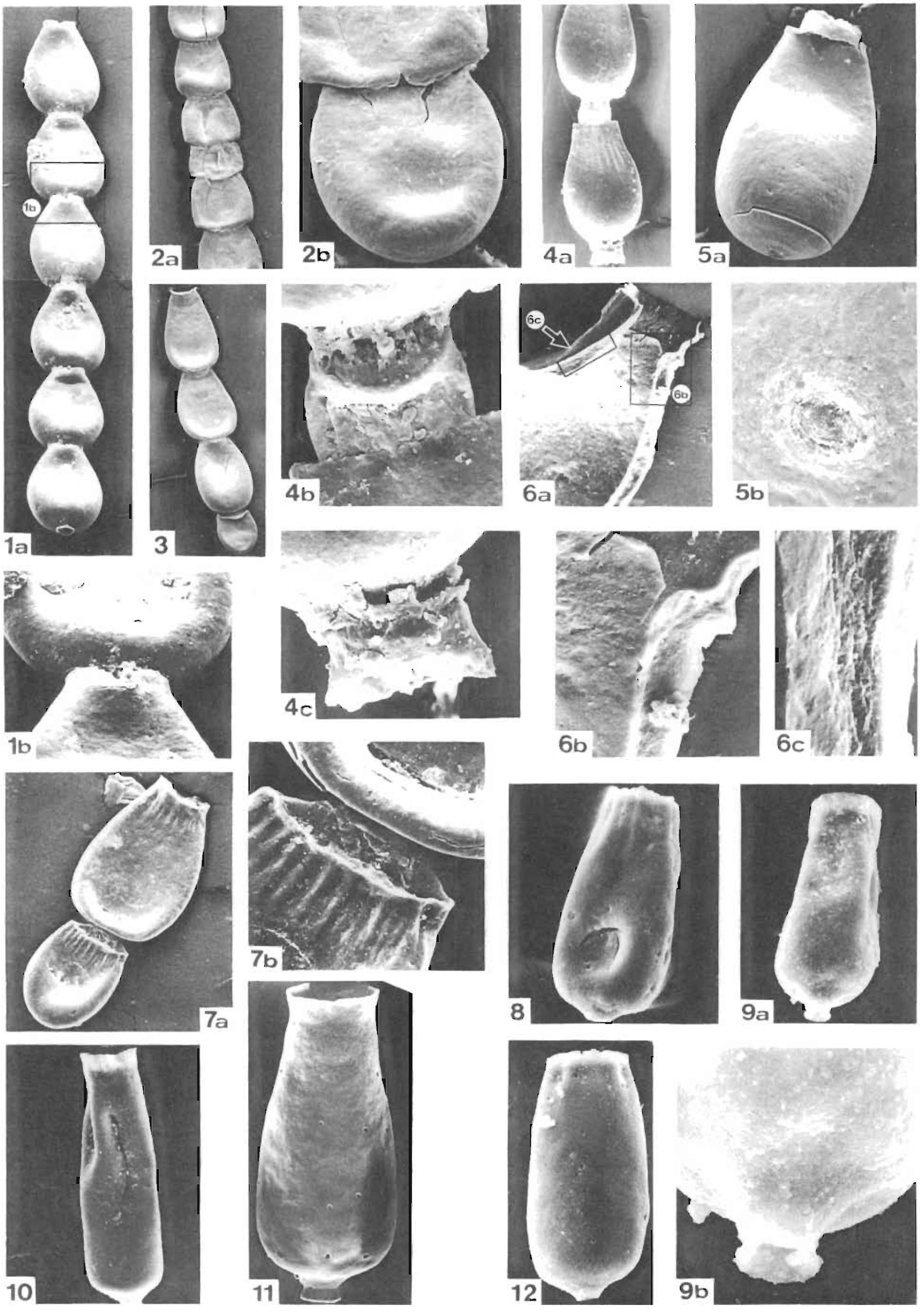
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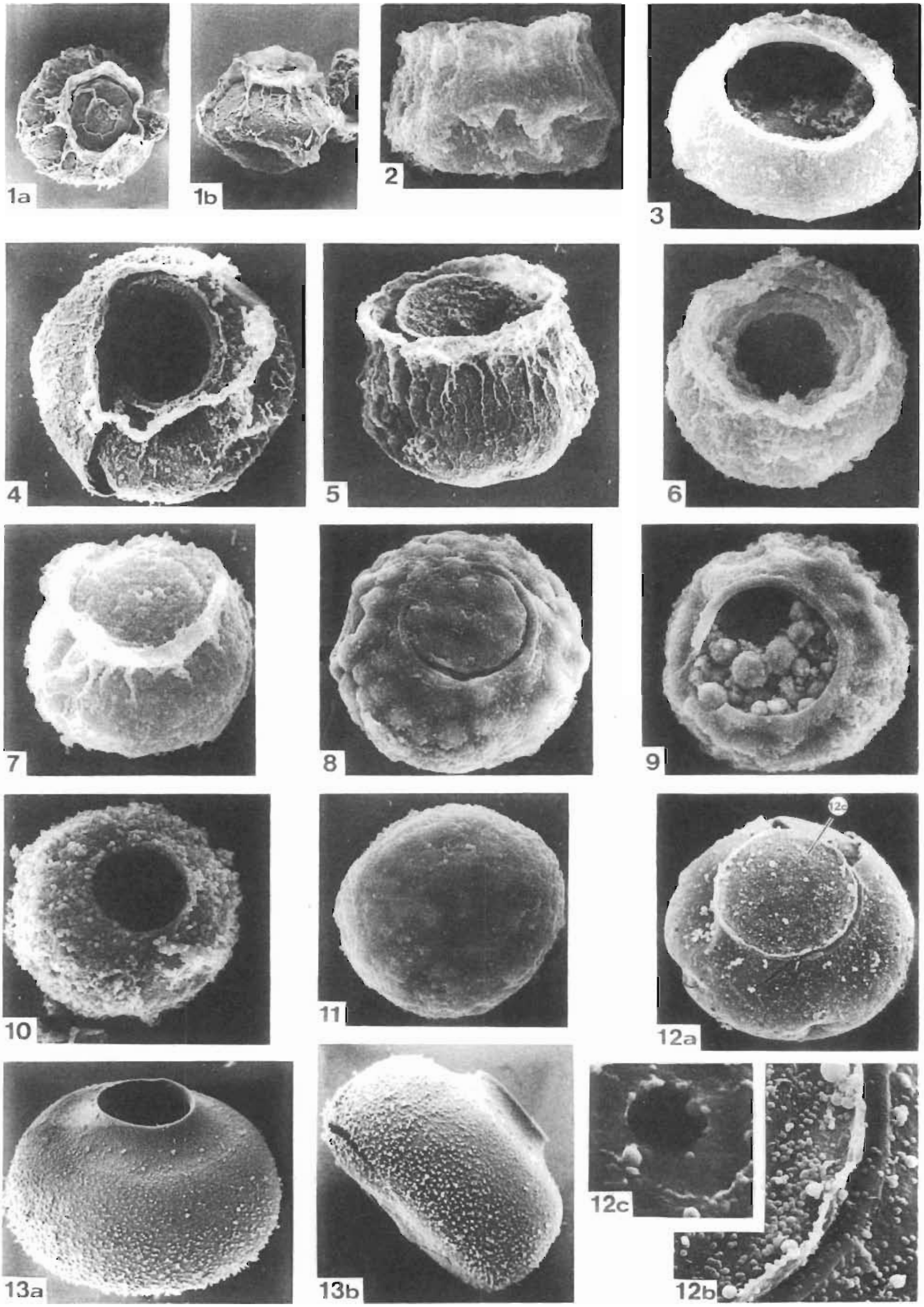
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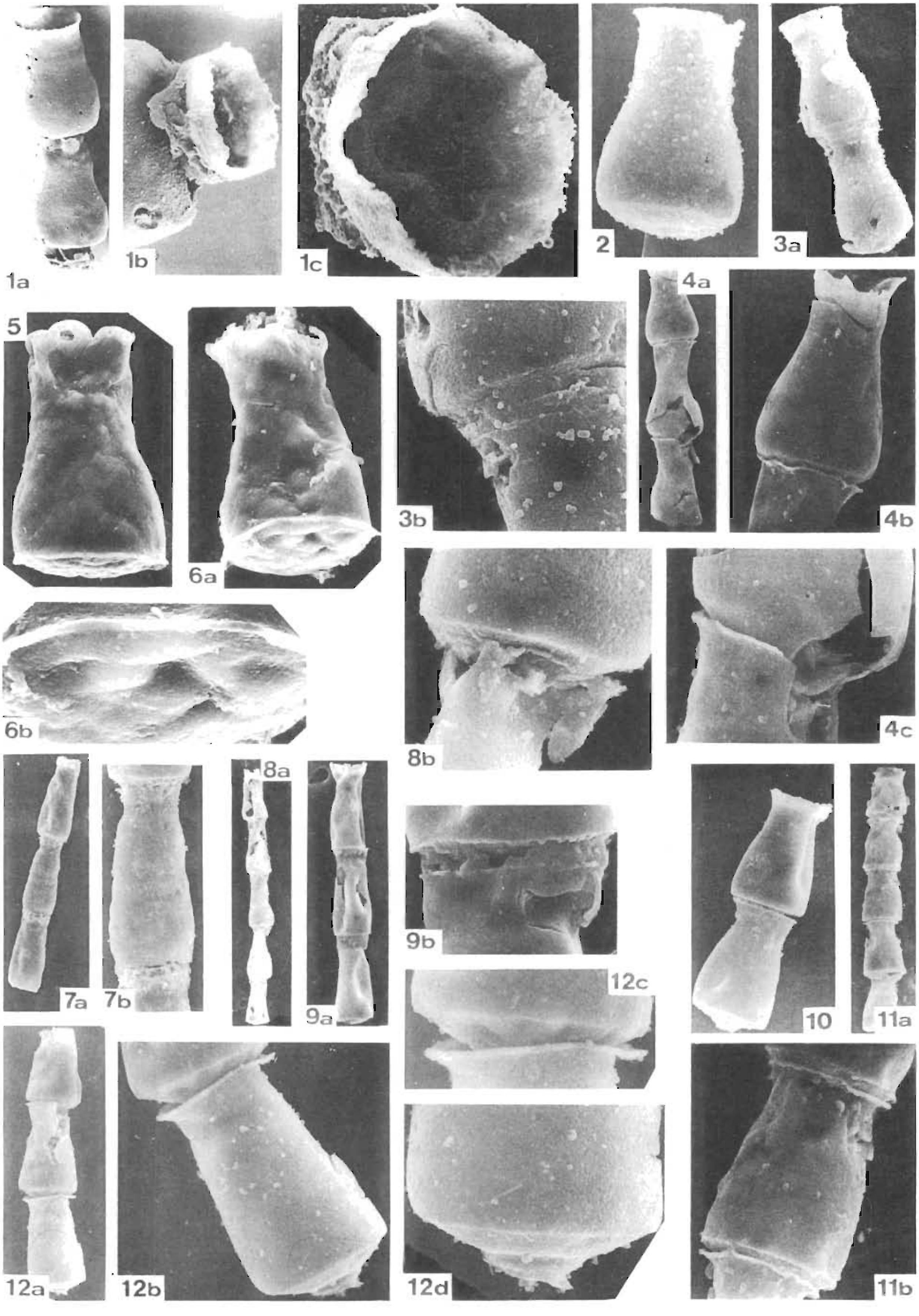
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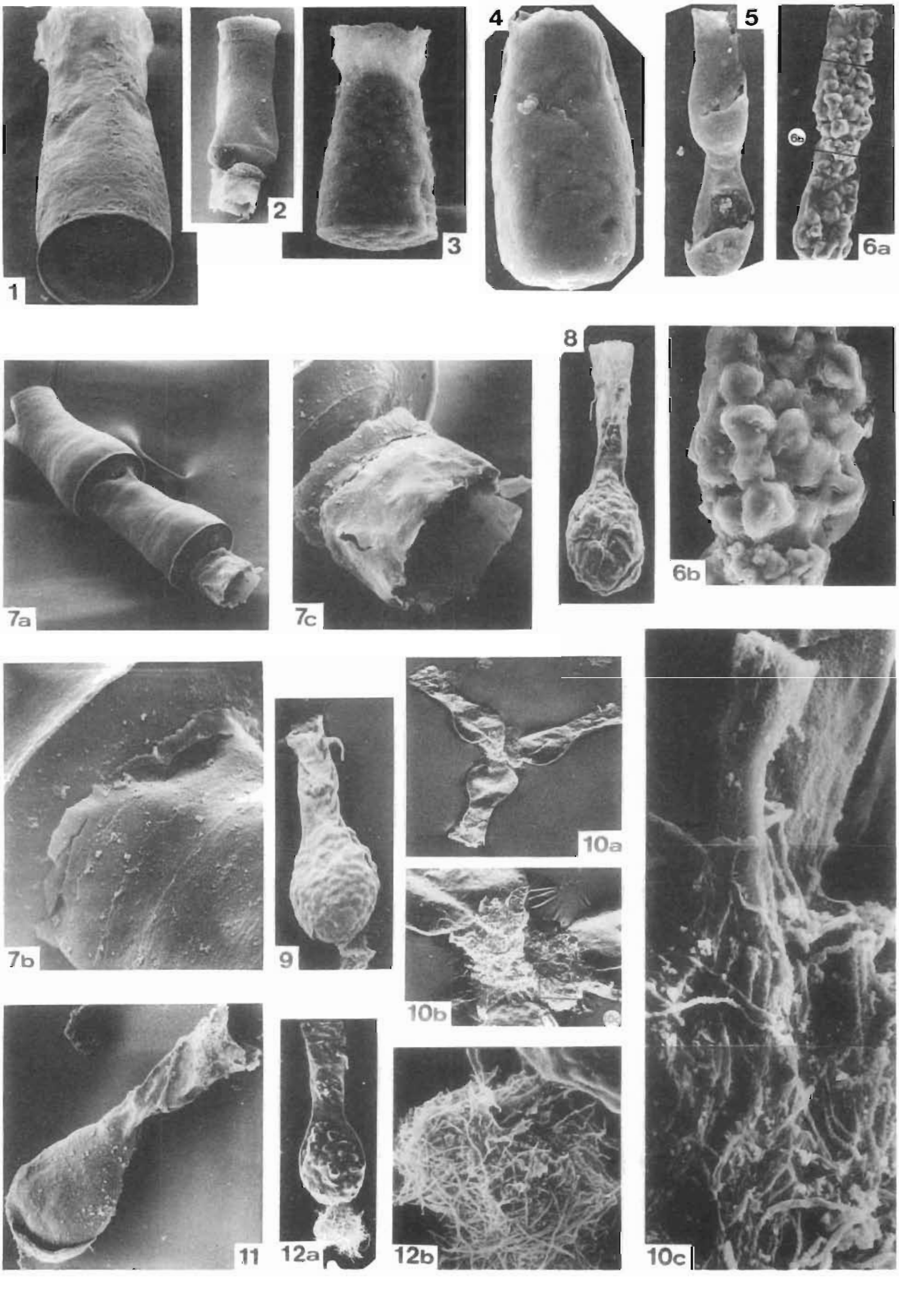
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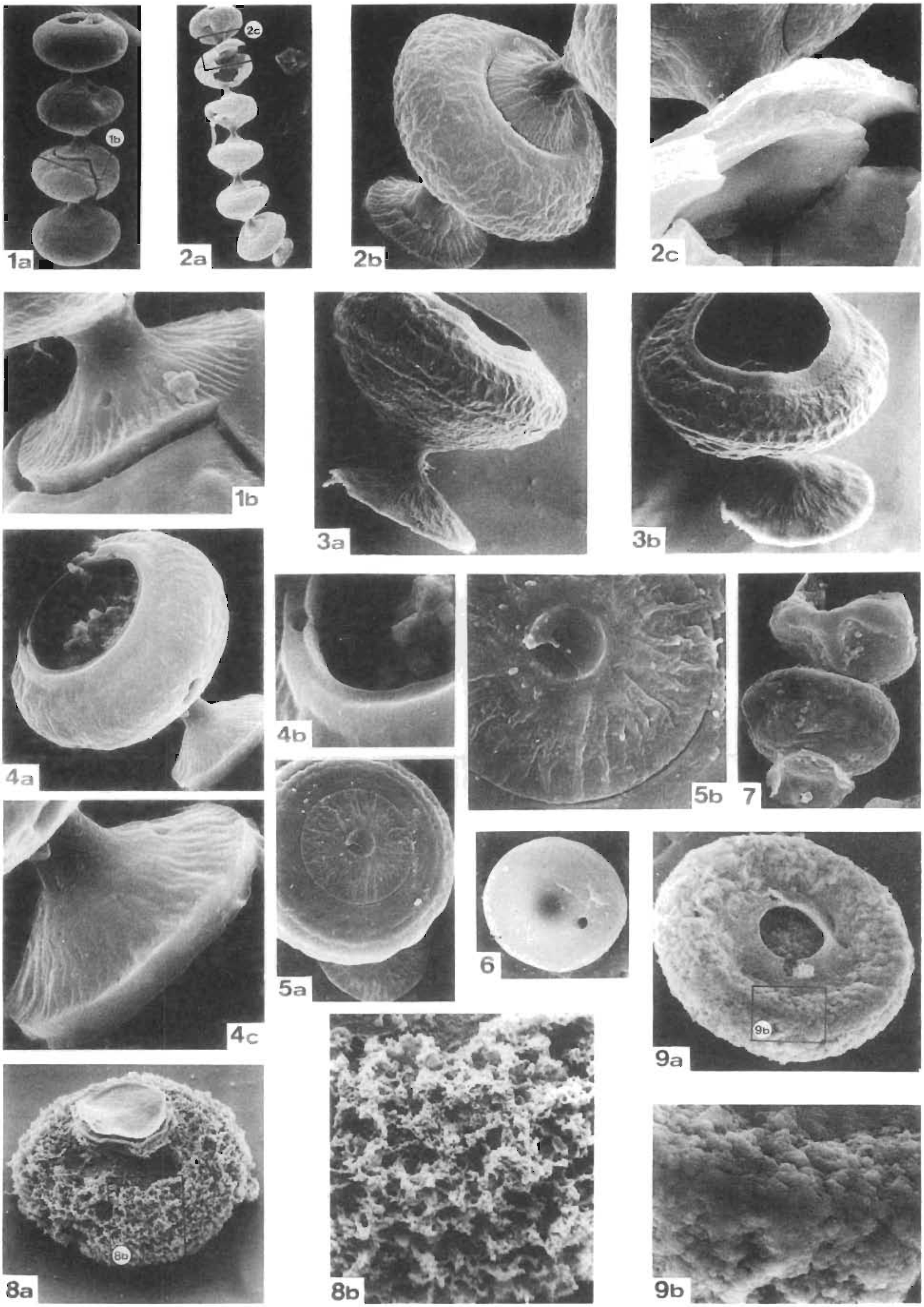
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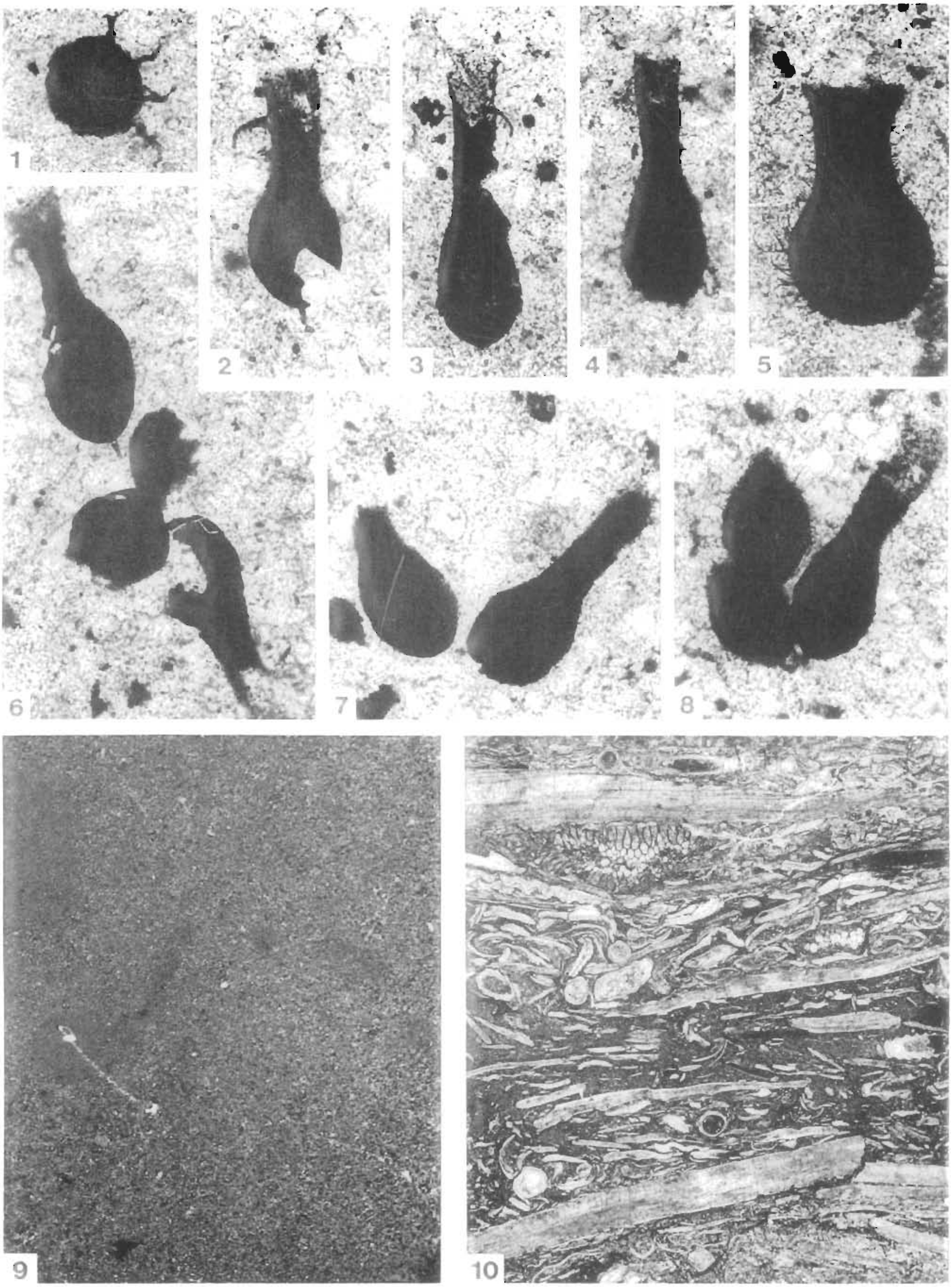
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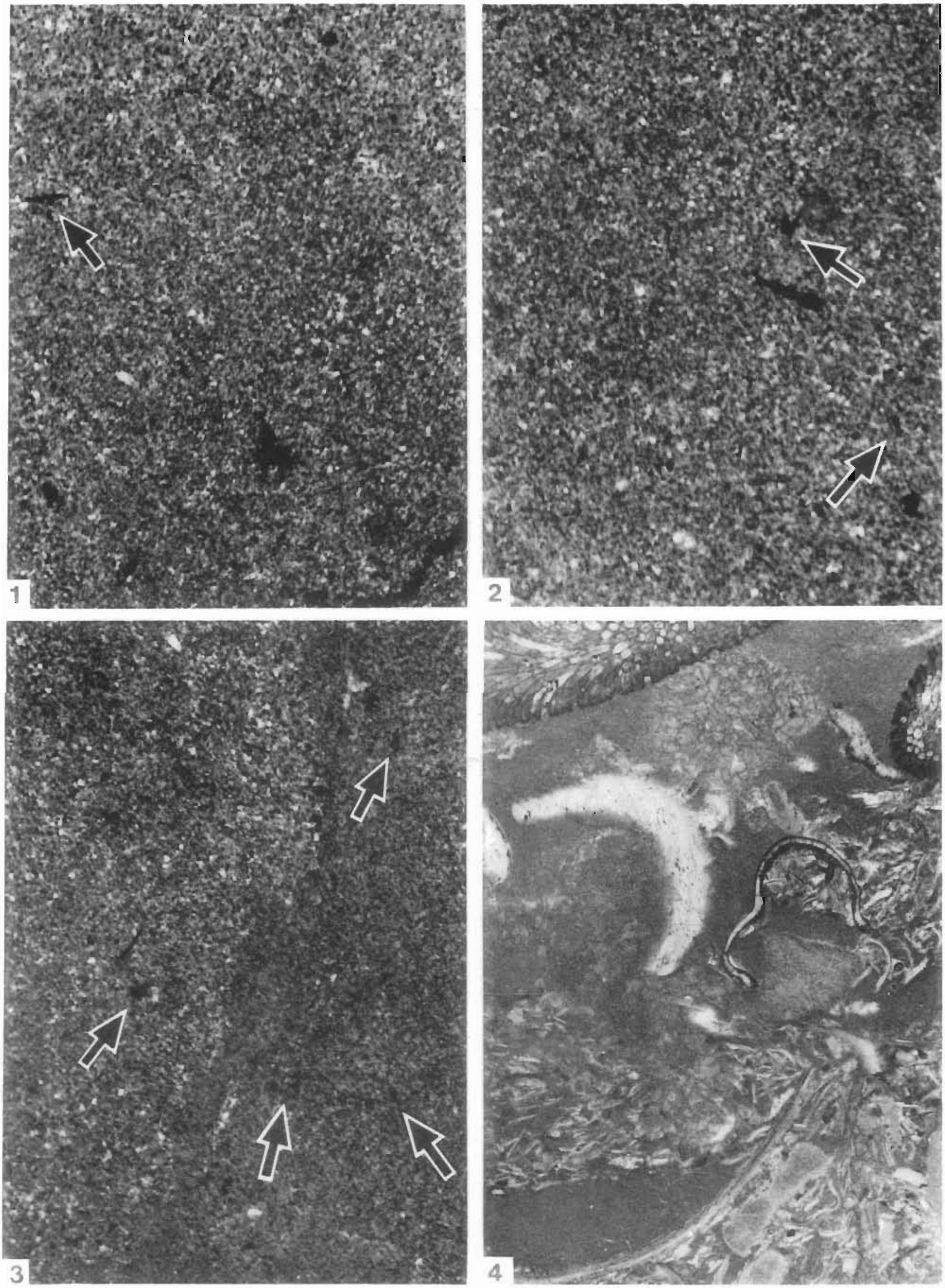
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