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OSTRACODS FROM THE PURBECKIAN OF CENTRAL POLAND

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The recent stratigraphical and paleontological research in the Jurassic/Cretaceous boundary sequence in central Poland confirmed a validity of the hitherto accepted local ostracod zonation. Six ostracod zones have been compared with the zones distinguished in England, France and Germany. From 51 ostracod species and subspecies recorded in the sequence of superposing marine-brackish and brackish-fresh-water sediments the author describes the following new species and subspecies: *Limnocythere biverrucosa, Timiriasevia polonica, Cypridea aleksandrowiensis, C. wandae, C. binodosa polonica, C. dunkeri spinosa, C. granulosa polonica, C. lata polonica, C. obliqua polonica, C. prealta iuvencula* and *C. tumescens granulosa.*
K e y w o r d s: Ostracoda, Purbeckian, Poland.
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INTRODUCTION

Investigations enabling stratigraphical division of the uppermost Jurassic and the lowest Cretaceous of central Poland have been carried out by Dąbrowska (1959, 1964), Bielecka and Sztejn (1966), Bielecka (1975), Marek (1967, 1988), Marek *et al.* (1971), Marek *et al.* (1989) and Mamczar (1986). Ostracods were seldom taken into account in researches. A large collection of the fossils at the disposal of the author makes it possible to fill the gap. Recent micropaleontological research enabled us to complete a list of hitherto known ostracod taxa. The research confirm the validity of the earlier division of the Polish Purbeckian into six local ostracod zones (zones F—A, see Bielecka and Sztejn 1966). The sediments examined contain many species in common with the western Europe as well as species and subspecies unknown so far (table 1).

In central Poland, the Jurassic/Cretaceous boundary sequence is developed in the Purbeckian facies in the form of marine-brackish and brackish-fresh water sediments. The sequence is fully developed in the Kujawy region and all local ostracod zones can be found in the area. The present paper has resulted from the examination of 385 microfauna

samples coming from 19 selected bore holes (fig. 1). Table 2 shows synthetic ranges of the microfauna in question. Lithological sequence and microfaunal content of the Kujawy Purbeckian sediments are well represented

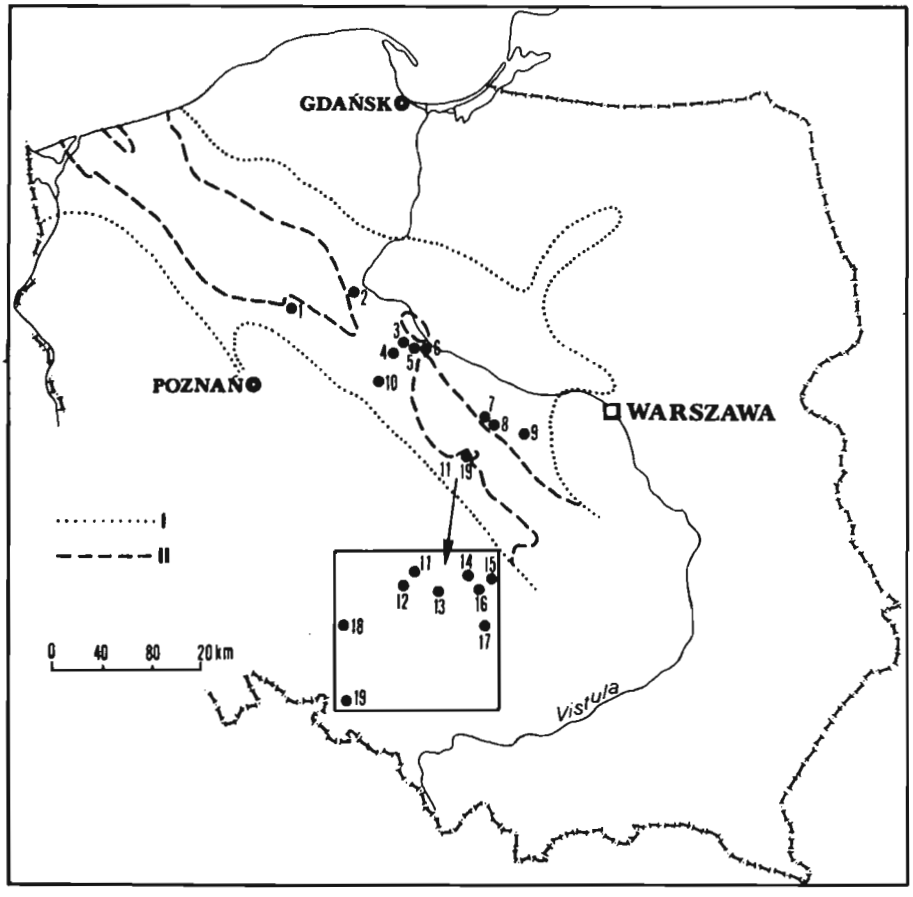

Fig. 1. Purbeckian and Berriasian sediments in the Polish Lowlands (after Marek 1988, slightly modified). *I* primary range of the sediments, *II* post-Upper Cretaceous erosion range of the sediments; *1* Kcynia IG 2, *2* Wałownica, *3* Kajetanowo TK 19, *4* Szczebłotowo (255), *5* 3E Wieniec-Zdrój, *6* Przyruda TK 7, *7* Żychlin IG 1, *8* Bedlno TW 9, *9* Łowicz IG 1, *10* Pagórki IG 1, *11* Śladków T 74, *12* Skotniki T 84, *13* Wypychów T 76, *14* Konarzew KT 31, *15* Mąkolice KT 38, *16* Kwilno KT 35, *17* Zagłoba 1, *18* Piaskowice T 82, *19* Aleksandrów KT/1.

in the following bore-holes: Kcynia IG 2, Szczebłowo (255), Pagórki IG 1 and Mąkolice KT 38 (figs. 2, 3).

The examined Purbeckian sediments abound in microfauna, especially ostracods, while foraminifera are scarce. They are associated with bivalve and fish remnants (vertebrae, otholites, teeth) as well as single skeletal elements of sponges. Among the plant elements, charophytan oogonia are particularly numerous.

The preservation state of the ostracods studied is in general good or very good. To facilitate the observation of ornamentation details on glittering carapace surfaces, the author warmed the specimens which

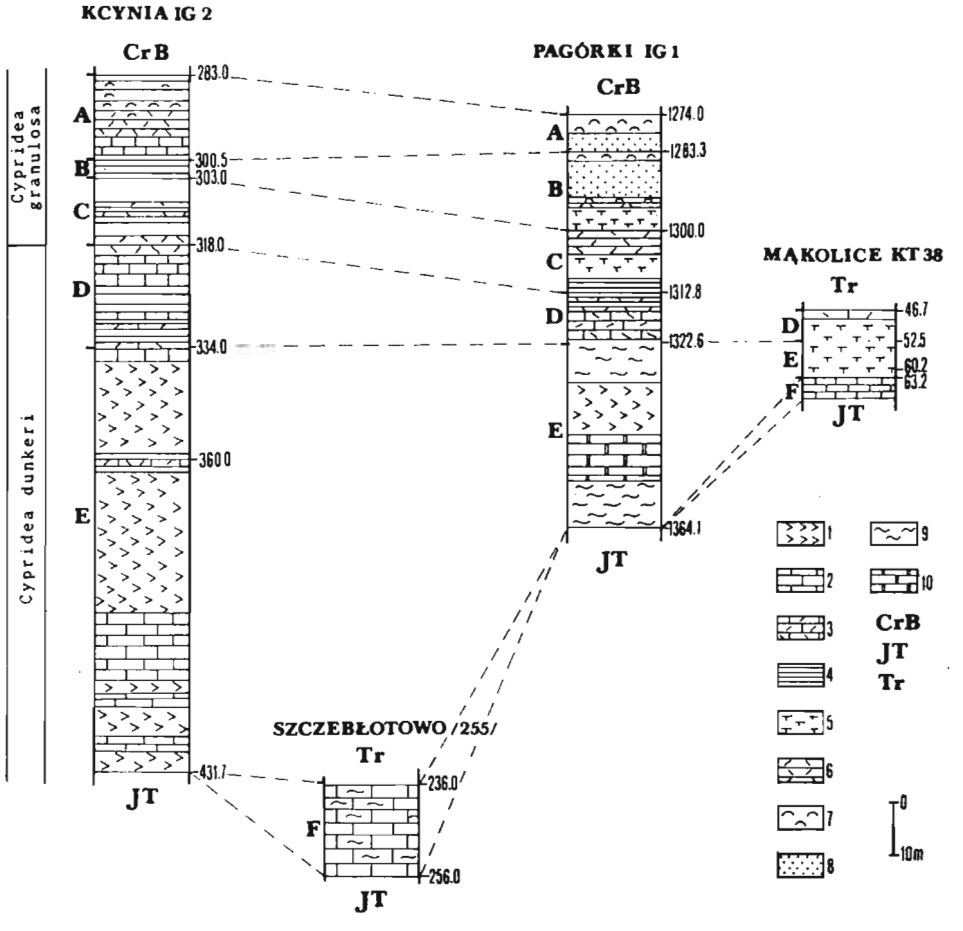

Fig. 2. Purbeckian deposits from selected boreholes in the Kujawy area. Stratigraphic zonation (*F*—*A*) after Bielecka and Sztejn 1966. Lithology: Kcynia IG 2 — after Dembowska 1964, Marek 1967; Pagórki IG 1 — after unpublished data (S. Marek: PIG Archives), Mąkolice KT 38 — after unpublished data (S. Marek: PIG Archives), Szczebłotowo (255) — after unpublished data (J. Znosko, W. Pożaryski: PIG Archives). Legend: *1* gypsum, *2* limestone, *3* marly limestone, *4* claystone, *5* marl, *6* marly shales, *7* lumachelles, *8* sandstone, *9* siltstone, *10* dolomitic limestone; *CrB* Berriasian, *JT* Tithonian, *Tr* Tertiary. See also fig. 3.

caused that the surfaces became lustreless and ornamentation better exposed. In some species (*Pachycytheridea compacta* Wolburg, *Galliaecythereidea postsinuata* Wolburg), thanks to good preservational state of carapaces, it was possible to observe pore canals with preserved sieve-like outlets (pl. 2: 6b, pl. 6: 4b).

The collection of ostracods examined is housed at the Museum of the State Geological Survey in Warsaw (abbreviated as MUZ. PIG).

Acknowledgements. — I wish to thank prof. dr. S. Marek for his help in solving geological problems as well as J. Modrzejewska and M. Pawlik (the State Geological Survey) for making the photos of the microfauna.

CHARACTERISTICS OF THE MICROFAUNA

The Purbeckian sediments at Kujawy formed in a relic basin with varying, abnormal salinity (Marek *et al.* 1989).

The examined deposits contain abundant ostracods which belong to three superfamilies: Cytheracea, Darwinulacea and Cypridacea. Cytheraceans are particularly well represented (12 genera), while cypridaceans and darwinulaceans are represented by few genera (5 and 1 respectively, compare table 1).

Table 1

A list of microfauna typical of the Purbeckian in Central Poland (Kujawy)

OSTRACODA:	
Cytheracea	
Dicrorygma (*Orthorygma*) aff. *groenwalli* Christian.	pl. 4: 8
Fabanella ansata (Jones)	pl. 5: 1
F. boloniensis (Jones)	pl. 4: 3
Galliaecytheridea elegans (Sharpova)	pl. 2: 5
G. postsinuata Wolburg	pl. 2: 6
Klieana alata Martin	pl. 2: 1
K. kujaviana Bielecka et Sztejn	pl. 2: 2—4
Limnocythere biverrucosa sp.n.	pl. 3: 5, 6
Macrodentina (*Dictyocythere*) aff. *mediostricta transfuga* Malz	pl. 4: 5
M. (*Macrodentina*) *maculata* Malz	pl. 4: 4
Nodophthalmocythere kcyniensis Biel. et Sztejn	pl. 3: 3, 4
Pachycytheridea compacta (Wolburg)	pl. 6: 4
Protocytheropteron brodiei (Jones)	pl. 4: 9
Schuleridea sp.	pl. 4: 10
Theriosynoecum forbesi forbesi (Jones)	pl. 4: 7
Timiriasevia polonica sp.n.	pl. 3: 8, 9
Darwinulacea	
Darwinula leguminella (Forbes)	pl. 4: 1
D. oblonga (Roemer)	pl. 4: 2
Cypridacea	
Cypridea aleksandrowiensis sp.n.	pl. 6: 1, 2
C. binodosa binodosa Martin	pl. 6: 5, 6

C. binodosa polonica subsp. n.	pl. 6: 7, 8
C. dunkeri carinata Martin	pl. 7: 8
C. dunkeri dunkeri Jones	pl. 7: 4
C. dunkeri inversa Martin	pl. 6: 3
C. dunkeri sowerbyi Martin	pl. 7: 5, 6
C. dunkeri spinosa subsp. n.	pl. 8: 2
C. granulosa polonica subsp. n.	pl. 5: 5, 6
C. lata polonica subsp. n.	pl. 5: 3, 4
C. obliqua polonica subsp. n.	pl. 5: 7, 8
C. peltoides peltoides Anderson	pl. 8: 1
C. posticalis Jones	pl. 7: 1
C. primaeva Anderson	pl. 2: 7
C. praealta iuvencula subsp. n.	pl. 8: 5, 6
C. praealta praealta Bielecka	pl. 8: 4
C. tumescens acrobeles Anderson	pl. 8: 3
C. tumescens granulosa subsp. n.	pl. 8: 7, 8
C. tumescens praecursor Oertli	pl. 7: 7
C. wandae sp. n.	pl. 7: 2, 3
Damonella ellipsoidea (Wolburg)	pl. 3: 2
D. pygmaea (Anderson)	pl. 3: 1
Mantelliana purbeckensis (Forbes)	pl. 5: 2
Rhinocypris jurassica (Martin)	pl. 4: 6
Scabriculocypris trapezoides Anderson	pl. 3: 7

FORAMINIFERA:

Ammobaculites kcyniensis Sztejn	pl. 1: 2
A. pseudospirale gracilis (Lacroix)	pl. 1: 3
Ammobaculites sp.	pl. 1: 8
Eoguttulina liassica (Strickland)	pl. 1: 5
Haplophragmoides sp.	pl. 1: 7
Saccamina placenta (Grzybowski)	pl. 1: 1
Spirillina infima (Strickland)	pl. 1: 6
Verneuilinoides inaequalis Bartenstein et Brand	pl. 1: 4

The representation of taxa is not uniform. Valves of some species, e.g. *Klieana alata Martin, Rhinocypris jurassica* (Martin), *Cypridea praealata praealata* Bielecka and C. *alata polonica* subsp. n., occur in thousands, while specimens of other species, e.g. *Macrodentina (M.) maculata* Malz, *M. (Dictyocythere)* aff. *mediostricta transfuga* Malz, *Procytheropteron brodiei* (Jones), are rare. The largest group is composed of species represented by several hundred specimens, i.e. *Limnocythere biverrucosa* sp.n., *Nadophthalmocythere kcyniensis* Bielecka et Sztejn, *Cypridea peltoides peltoides* Anderson, *C. tumescens acrobeles* Anderson, *Klieana kujaviana* Bielecka et Sztejn.

Almost all of the genera found in central Poland are also known from south-east England (Anderson 1985) and many from Germany (Martin 1940, Wolburg 1969) and France (Colin and Oertli 1985, Colin 1988). In the English Purbeckian, Anderson *et al.* (1967) and Anderson (1971, 1985) distinguished ostracod assemblages of three ecologically differing

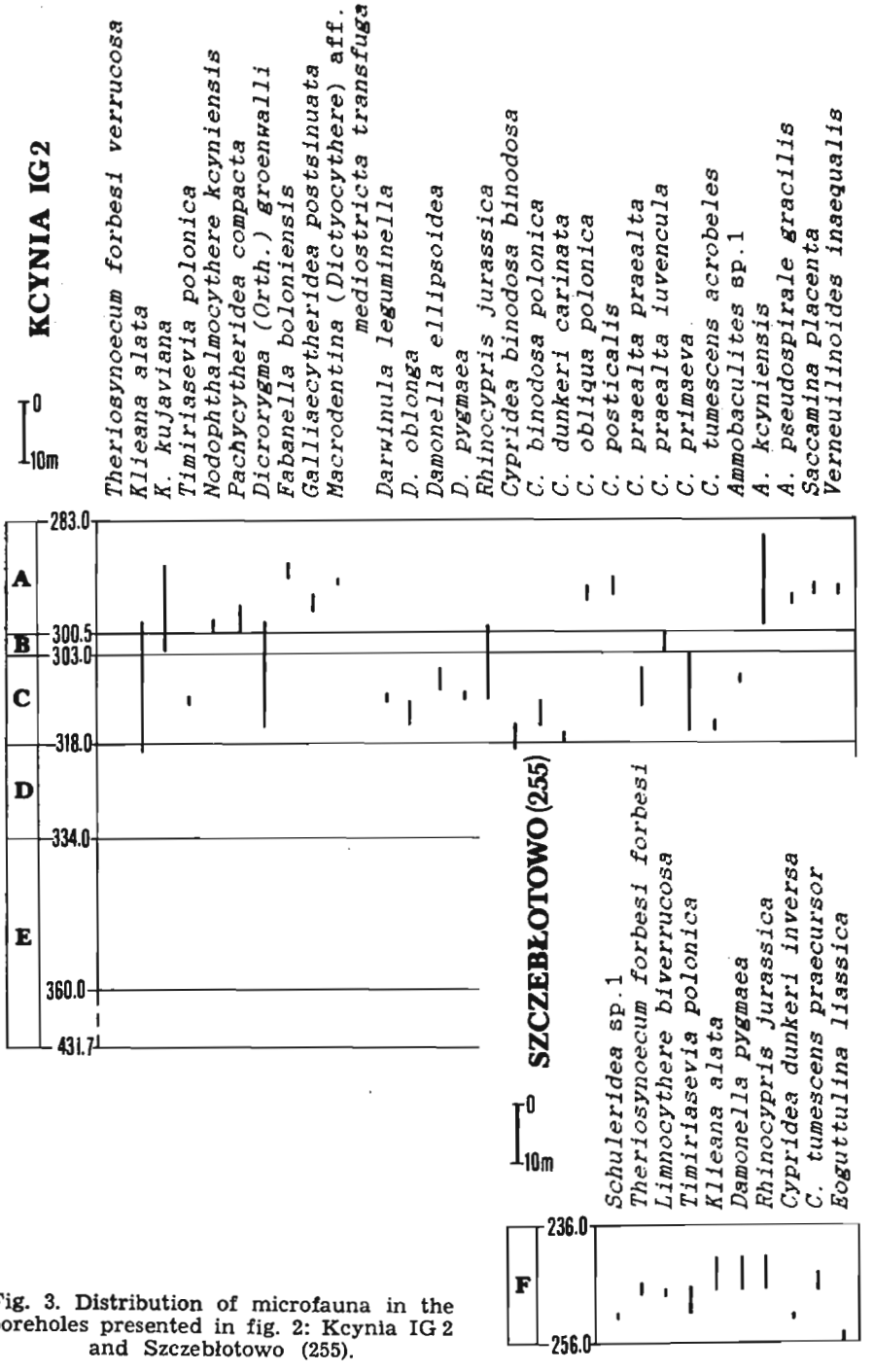

Fig. 3. Distribution of microfauna in the boreholes presented in fig. 2: Kcynia IG 2 and Szczebłotowo (255).

phases: C, S and E, the differences having been caused by the salinity changes. The phase C assemblage, in which *Cypridea* species dominate, developed in low salinity conditions, close to the brackish ones. The phase S assemblage, composed of the remaining Purbeckian ostracod taxa, developed in low or only periodically normal salinity conditions. The phase E assemblage, in which *Fabanella* species are most frequent, occurred in hipersaline environment (Anderson *l.c.*). In Poland, Purbeckian ostracod fauna groups into assemblages (fig. 4) which correspond to those of Anderson's ecologic phases C and S as well as that approximating to the phase E. The mutual relationships of the assemblages in question observed in the Kujawy section (fig. 4) are as follows:

Zone F. — The Purbeckian sedimentation started at the marine environment changing termporarily into more or less fresh water conditions, with ostracod fauna of the phases S and C. Marine and brackish ostracods of the genera *Schuleridea, Galliaecythereidea, Macrodentina*

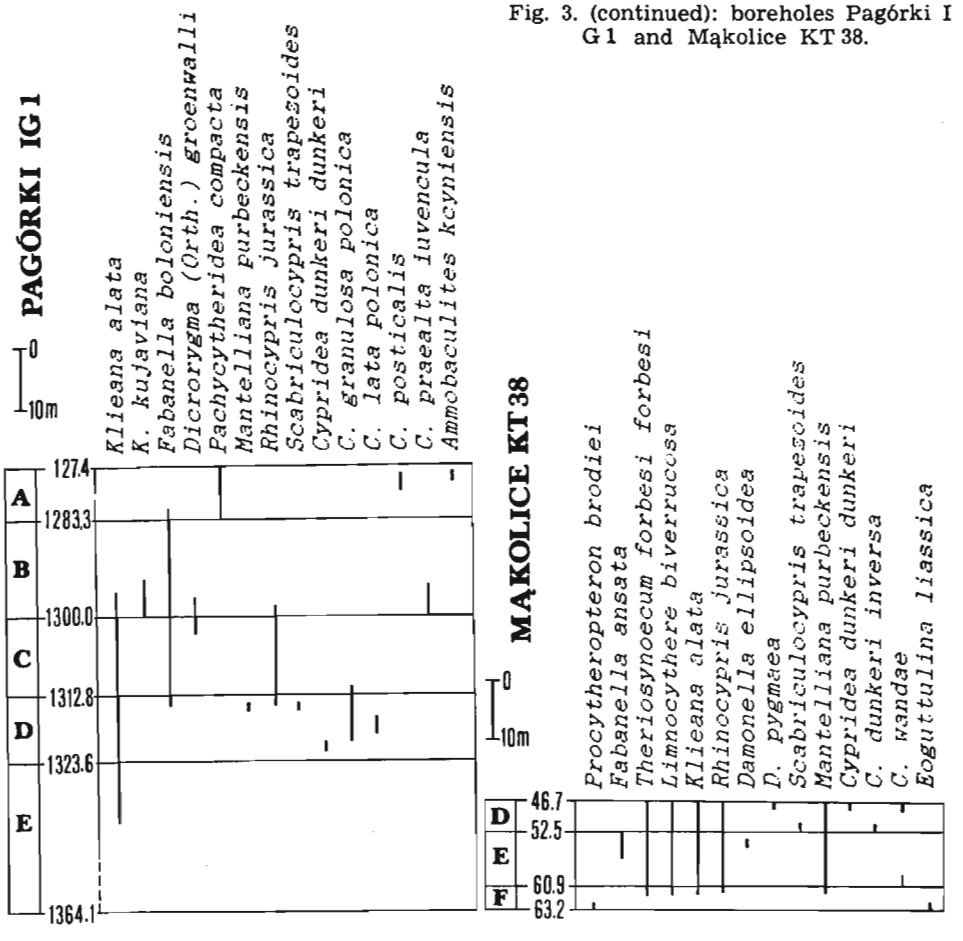

Fig. 3. (continued): boreholes Pagórki I G 1 and Mąkolice KT 38.

and *Procytheropteron* are associated with marine foraminifera (*Spirillina infima* (Strickland) and *Eoguttulina liassica* (Strickland)). Ostracods typical of the phase S are as follows: *Fabanella ansata* (Jones), *Limnocythere biverrucosa* sp.n., *Theriosynoecum forbesi forbesi* (Jones) and others.

Phase C is represented by *Cypridea species.*

Zone E. — In samples from the central parts of the basin, there were found abundant marine ostracods of the phase S (among others, *Fabanella, Limnocythere, Theriosynoecum, Dicrorygma*) associated with scarce foraminifera (*Eoguttulina liassica*). From the central part, there are known sediments of the hypersaline environment: gypsum and anhydrite, interbedded with limestone and claystone intercalations. One of the beds yielded scarce and damaged specimens of *Theriosynoecum forbesii verrucosa* (Jones) which, thanks to its position among evaporates, can be regarded as a fauna equivalent of that of the hypersaline phase E (fig. 4). Gradual freshening of the basin at the zone E can be inferred from a well documented increase of ostracod taxa of the phase C (especially abundant *Cypridea*) and a decrease of those of the phase S.

Zone D. — The share of the ostracods of the phase S is small, while ostracods of the phase C are observed in mass occurrences. Marine fauna is lacking which indicates freshwater conditions.

Zones C and B. — Ostracods of the phase C were replaced by taxa typical of the phase S. This shows that salinity slightly increased and the basin changed into brackish — fresh-water. At the zone C, there are known scarce foraminifera (*Ammobaculites*) at the central part of the basin.

Zone A. — Ostracods of the phase S as well as forminifera indicate salinity increase and reestablishment of the marine — brackish conditions. Alternation of layers with ostracods of phases C and S which are observed in the boreholes (figs. 2, 3) recorded variations of salinity.

The foraminifera mentioned are represented by six genera (table 1) of the group having agglutinated tests: *Ammobaculites, Haplophragmoides, Saccammina, Verneuilinoides, Spirillina* and *Eoguttulina.* The genus *Ammobaculites* is particularly important as indicative of the salinity between 18 and 38‰. (Kileny and Allen 1968, Neale 1984). In Kujawy region it cooccurs with *Cypridea praealta praealta* and *C. primaeva.* This would suggest that the mentioned ostracods could belong to a rather euryhaline group. Such a tolerance is not exceptional, e.g. Anderson (1971) pointed to another species relatively highly resistant to salinity changes, *C. delicatula* Anderson. Species of *Ammobaculites* are known to cooccur with ostracods of the genus *Klieana* as well. There are diverse opinions as concerns the resistance of *Klieana* to salinity changes. Anderson (1971) maintained that those ostracods tolerated a rather high salinity and cooccurred with *Paranotacythere*, which, according to Brenner (1976) is

indicative of the salinity of about 30‰. In Poland, *Klieana* occurs not only with foraminifera but also with ostracods of the genera: *Cypridea, Theriosynoecum, Rhinocypris, Scabriculocypris* and *Limnocythere.* According to Oertli (1963), Neale (1984) and Colin (1988) ostracods of those

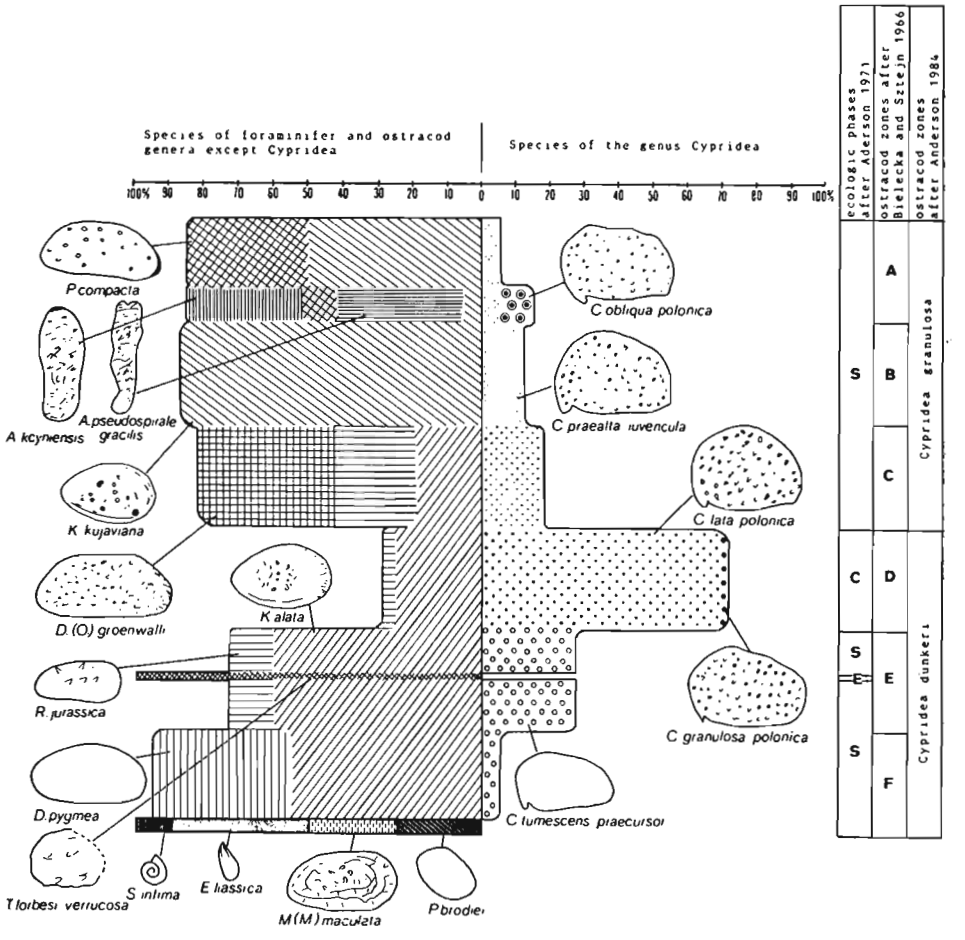

Fig. 4. Occurrence of the ostracods in Purbeckian faunistic cycles in Kujawy.

genera populated limnic or brackish basins, i.e. lived at salinity ranging from 0 to 18‰, of NaCl. It may be therefore assumed that *Klieana*, similarly as *Mantelliana* and *Damonella* (Anderson 1985) were highly tolerant to salinity changes.

POLISH PURBECKIAN OSTRACOD ZONATION IN COMPARISON WITH THAT IN THE WEST OF EUROPE

Micropaleontological studies allow us to correlate the Polish Purbeckian (zones F—A) with the English Lulworth Formation (Morter 1984). This is (table 2) the lower and partly the middle Purbeckian, i.e. Cy-

Table 2

Distribution of microfauna in Late Jurassic/Early Cretaceous deposits of Central Poland (Kujawy). Stratigraphic zonation after Bielecka and Sztejn (1966), Anderson (1985) and Marek *et al.* (1989)

Volgian					Ria-zan	Marek 1989
mid.	upper					
Cypridea dunkeri			Cypridea granulosa			Anderson 1985
F	E	D	C	B	A	Bielecka and Sztejn 1966
						Macrodentina (M.) maculata Malz
						Galliacytheridea elegans (Sharpova)
						Schuleridea sp. 1
						Procytheropteron brodiei (Jones)
						Spirillina infima (Strickland)
	–					*Eoguttulina liassica* (Strickland)
						Fabanella ansata (Jones)
	–					*Theriosynoecum forbesi verrucosa* (Jones)
						T. forbesi forbesi (Jones)
						Limnocythere biverrucosa sp.n
						Cypridea dunkeri inversa Martin
						Timiriasevia polonica sp n
						Cypridea tumescens praecursor Oertli
						Mantelliana purbeckensis (Forbes)
						Cypridea primaeva Anderson
						C. peltoides peltoides Anderson
						Damonella pygmaea (Anderson)
						Klieana alata Martin
						Rhinocypris jurassica (Martin)
						Fabanella boloniensis (Jones)
						Cypridea sowerbyi Martin
						C lata polonica sp n
						C wandae sp.n
						Damonella ellipsoidea (Wolburg)
						Darwinula leguminella (Forbes)
						D. oblonga (Roemer)
						Dicrorygma (Orthorygma) groenwalli Christ.
						Scabriculocypris trapezoides Anderson
						Cypridea binodosa binodosa Martin
						C. granulosa polonica subsp n
						C dunkeri dunkeri Jones
						C dunkeri carinata Martin
						C praealta praealta Bielecka
						C binodosa polonica subsp n
						C tumescens granulosa subsp n
						C tumescens acrobeles Anderson
			–			*Ammobaculites* sp 1
						Cypridea aleksandrowiensis sp n
						C dunkeri spinosa subsp n
						C praealta iuvencula subsp n
						Klieana kujaviana Bielecka et Sztejn
						Nodophthalmocythere kcyniensis Bielecka et Sztejn
					–	*Cypridea obliqua polonica* subsp n
					–	*C posticalis* Jones
						Galliaecytheridea postsinuata Wolburg
					–	*Macrodentina (Dictyocythere)* aff *mediostricta transfuga* Malz
						Pachycytheridea compacta (Wolburg)
					–	*Ammobaculites pseudospirale gracilis* (Lacroix)
					–	*A kcyniensis* Sztejn
					–	*Haplophragmoides* sp 1
					–	*Saccamina placenta* (Grzybowski)
					–	*Verneuilinoides inaequalis* Bartenstein et Brand

pridea dunkeri and Cypridea granulosa zones (Anderson 1985), respectively. The Polish ostracod zones F, E and D, and the English Cypridea dunkeri zone have the following species in common: *C. dunkeri inversa* Martin, *C. peltoides peltoides* Anderson and *Fabanella ansata* (Jones). From the zone E, at the centre of the basin (Bedlno TW9 borehole) only one sample has been found to contain typical marine microfauna, i.e. scarce specimens of *Eoguttulina liassica* (Strickland).

The zones C, B and A correspond to the lower part of the English Cypridea granulosa zone, as it is evidenced by the following common ostracods: *Darwinula oblonga* (Roemer), *Damonella leguminella* (Forbes), *Cypridea tumescens praecursor* Oertli and *C. dunkeri dunkeri* Jones. For correlation of the zone A particularly important is *Cypridea posticalis* Jones, which is known in the German Serpulitian as well as in the lower part of the English Cinder layers, in the Durlston faunistic cycle.

In paleoecological aspect, the Polish Purbeckian seems to correspond well to the environmental characteristics of the English Purbeckian, as assemblages of some Anderson's ecologic phases were well developed in Kujawy region. The ostracod faunas from the zones C and B contain ca. 50% and 67% of species characteristic of the S phase, while that of the zone A has as much as 80%. For comparison, in the English Cypridea granulosa zone, the percentage varies from 16% to about 63%, whereas in Cinder Beds it can be as high as 93%. In general, in Kujawy basin, ostracods of the phase S prevail on those of the phase C.

The microfauna makes the Polish Purbeckian comparable with the border sediments of the German Jurassic/Cretaceous boundary. The sediments examined (zones F—A) correspond to those of Muender Mergel and Serpulitian of North Germany (Marek 1984, Hoedemacker 1987). The zones F—D correlate with the upper part of Muender Mergel both formations having in common *Macrodentina (M.) maculata* Malz, *Fabanella ansata* (Jones) and *C. dunkeri inversa* Martin. The zones C—A have been compared with the Serpulitian as the following ostracods are common for the two formations: *C. posticalis* Jones, *C. tumescens acrobeles* Anderson and *Macrodentina (Dicticytheridea)* aff. *mediostricta transfuga* Malz.

The ostracod zones F, E and D from Kujawy may be also compared with the lower Purbeckian of France, i.e. the Cypridea dunkeri zone on the Island of Orelon and in the neighbourhood of Pontarlier in the French Jura Mts (Colin and Oertli 1985). Common ostracods are as follows: *C. dunkeri inversa* Martin, *Theriosynoecum forbesii forbesii* (Jones), *Fabanella boloniensis* (Jones) and *F. ansata* (Jones). Similarly, the zones C—A can be correlated with the middle Purbeckian in the Paris Basin. The common ostracods are: *C. dunkeri carinata* Martin, *C. binodosa binodosa* Martin and *C. tumescens acrobeles* Anderson.

A species typical of North Germany, France and south-west England, *Cypridea granulosa granulosa* (Sowerby), lacks in the Polish Purbeckian. Instead, ostracods classified as *C. granulosa polonica* subsp. n. are present, being similar in shape to the former but devoid of granulation.

DESCRIPTIONS

Systematics according to Hartmann and Puri 1974.

Abbreviations: C — carapace, RV — right valve, LV — left valve, a — adult specimen.

Family **Limnocytheridea** Klie, 1938
Genus *Limnocythere* Brady, 1868
Limnocythere biverrucosa sp.n.
(pl. 3: 5—6)

1969. *Bisulcocypris verrucosa* (Jones); Bielecka and Sztejn *in* Marek, Bielecka and Sztejn: 571, pl. 1: 5.

1971. *Bisulcocypris verrucosa* (Jones); Bielecka and Sztejn in Marek, Bielecka and Sztejn: 320, fig. 3.

Holotype: carapace MUZ PIG 2092/90/O; pl. 3: 6.

Type horizon: Middle Volgian, the upper part of zone F.

Type locality: Łowicz IG 2, depth 615. 0m.

Derivation of the name. — Lat. *verruca* — wart, because of two warts present on the sides of the carapace.

Diagnosis. — Carapace subrectangular in lateral outline, left valve overlaps the right one along the entire free margin; on the lateral side of the valve, in the posterior half, two distinct tubercles.

Material. — 150 carapaces from the boreholes Łowicz IGl depth 615.00 m; Mąkolice KT38 depth 60.80 m, 60.40 m, 50.80 m; Szczebłotowo (255) depth 246.00 m, 244.30 m.

Dimensions (mm):

	Paratypes						Holotype
	male			female			
	a C						
MUZ PIG	2093/O	2094/O	2095/O	2096/O	2097/O	2098/O	2092/O
length	0.64	0.63	0.63	0.61	0.64	0.64	0.63
height	0.34	0.32	0.36	0.36	0.37	0.36	0.36
width	0.36	0.36	0.32	0.41	0.41	0.41	0.39

Description. — Carapace subrectangular in lateral outline, distinctly inflated, widest at mid-length. Dorsal margin straight, the ventral one slightly concave; the anterior end rounded, the posterior one slightly narrowed; left valve overlaps the free margin of the right one; sulcus shallow, wide, at about mid-length of the

carapace; immediately behind the sulcus two distinct tubercles: one at the dorsal, another at the ventral margin. Lateral surface distinctly reticulated; meshes well visible, elongated, getting smaller towards the front and the back of the carapace; numerous, small pits on the lateral surface.

Variability concerns the outline of ventral margin, which can be slightly concave to almost straight and the surface of tubercles which are smooth or reticulated. Apart from one distinct sulcus, another, very shallow is occasionally present.

Occurrence. — Poland (Kujawy): the upper part of the middle Volgian — the upper Volgian, the upper part of zone F and zones E and D.

Family uncertain

Genus *Timiriasevia* Mandelstam, 1947

Timiriasevia polonica sp.n.

(pl. 3: 8, 9)

Holotype: carapace MUZ PIG 2164/90/O; pl. 3: 9.

Type horizon: middle Volgian, the upper part of the zone F.

Type locality: Szczebłotowo (255) borehole, depth 246.0 m.

Derivation of the name: coming from Poland.

Diagnosis. — Carapace bean-like in lateral outline; dorsal and ventral margins almost straight, the anterior end slightly higher than the posterior one; lateral surface delicately reticulated, ventral surface ribbed.

Material. — 93 carapaces from the boreholes Żychlin IG1 — depth 512.70 m, Zagłoba 1 — depth 82.50 m, 80.50 m; Szczebłotowo (255) — depth 250.00 m, 246.00 m, 244.00 m.

Dimensions (mm):

	Paratypes			Holotype
	a C			
MUZ PIG	2166/O	2167/O C	2168/O C	2164/O C
length	0.57	0.54	0.54	0.54
height	0.30	0.28	0.22	0.32
width	0.30	0.32	0.30	0.30

Description. — Carapace bean-like with the anterior end slightly higher than the posterior one, widest at midlength. Ventral and dorsal margins almost straight and nearly parallel; anterior end widely rounded, the posterior one less rounded than the anterior. Lateral surface delicately reticulated, ventral surface finely ribbed, dorsal one smooth.

Variability — Inflation of the carapaces slightly variable as well as the anterior height of the carapace.

Remarks. — *T. polonica* is similar to *T. minuscula* (Stankewitch, 1974). It has however, larger carapaces, with straight dorsal and ventral margins and more rounded ends.

Occurrence. — Poland (Kujawy): the upper part of the middle Volgian, the upper Volgian the upper part of zone F and zones E and C.

Family **Cyprideidae** Martin, 1940
Genus *Cypridea*, Bosquet, 1852
Cypridea aleksandrowiensis sp.n.
(pl. 6: 1, 2)

Holotype: value MUZ PIG 2350/90/O; pl. 6: 2.
Type horizon: upper Volgian, level C.
Type locality: Aleksandrów KT/1, depth 94.2 m.
Derivation of the name: coming from Aleksandrów.
Diagnosis. — Valve delicate slightly inflated, elongater; right valve overlaps the left one, cyathus narrow, crescent shaped, rostrum short; on lateral surface 35—40 fine, short spines.
Material. — One damaged carapace, 90 valves (almost fully filled with sediment) from the boreholes Kcynia IG2 — depth 301.00 m; Aleksandrów KT/1 — depth 103.50 m, 102.00 m, 94.20 m, 90.00 m.
Dimensions (mm):

	Paratypes						Holotype
	a RV			a LV		a LR	
MUZ PIG	2350/O	2351/O	2352/O	2353/O	2354/O	2355/O	2350/O
length	0.72	0.76	0.80	0.96	0.74	0.77	0.82
height	0.43	0.48	0.45	0.43	0.44	0.45	0.48
length/ height	1.68	1.58	1.77	2.21	1.67	1.71	1.70

Description. — The right valve overlaps the left one; both valves similar in outline elongated, very thin, suboval in lateral view; the highest point at the anterior cardinal angle, the posterior cardinal angle poorly visible; dorsal margin straight, distinctly sloping backwards, ventral margin somewhat concave at the middle, anterior margin widely rounded, the posterior one narrowed. Rostrum delicate, narrow, short, reaching the ventral margin line; alveolus shallow, short; cyathus narrow, crescent shaped; lateral surface covered with net-like ornamentation and 35—40 fine, short spines (spines are usually broken and look like nodes). Marginal pore canals scarce, straight and short.
Variability concerns the width of cardinal angles resulting in varying dorsal margin outline.
Occurrence. — Poland (Kujawy): upper Volgian, the upper part of the zone C, the zone B.

Cypridea binodosa polonica subsp. n.
(pl. 6: 7, 8)

Holotype: carapace MUZ PIG 2209/90/O; pl. 6: 8.
Type horizon: upper *Volgian*, zone C.
Type locality: Wałownica, depth 104.5 m.
Derivation of the name: coming from Poland.
Diagnosis. — Left valve overlaps the right one. Very poorly developed roller-like

swelling parallel to anterior and posterior margins; a small node developed in the anterior and posterior parts of the left valve.

Material. — 323 carapaces, 75 valves from the boreholes Kwilno KT35 — depth 66.80, 65.80; Żychlin IG1 — depth 520.00 m, 518.00 m, 517.00 m, 512.20 m; Kcynia IG2 — depth 314.00 m, 313.60 m, 312.60 m; Wałownica — depth 109.00 m, 107.00 m, 106.50 m, 105.00,m, 104.50 m; Wypychów TK76 — depth 85.40 m, 84.40 m.

Dimensions (mm):

	Paratypes						Holotype
	a C				a RV		
MUZ PIG	2210/O	2211/O	2212/O	2213/O	2214/O	2215/O	2209/O
length	1.17	1.24	1.27	1.22	1.17	1.13	1.22
height	0.79	0.73	0.86	0.77	0.75	0.72	0.77
width	0.57	0.59	0.64	—	—	—	0.64
length/ height	1.48	1.70	1.48	1.58	1.56	1.57	1.57
length/ width	2.05	2.10	2.10	—	—	—	1.90

Description. — Carapace rather solid, subovate in lateral outline, highest at the anterior cardinal angle; lateral outlines of both valves similar. Dorsal margin slightly arched, gently sloping backwards; ventral margin almost straight; anterior end widely rounded, posterior one slightly narrowed; left valve overlaps the right one. Rostrum small, pointed, its end not reaching the ventral margin line; alveolus poorly developed, shallow, cyathus distinct but small, triangular; anterior cardinal angle poorly marked, posterior one almost invisible; indistinct roller-like swelling parallel to the anterior and posterior margins; on the anterior and posterior swellings of left valve, poorly developed node; lateral surface covered with networke-like ornamentation with irregular meshes and tiny irregularly distributed ribs. Duplicature well developed, in the anterior part of the valve wide, in the posterior one narrow; limen distinct, muscle scars of the main group formed of three scars; posterior to it another scar is present.

Variability concerns the roller-like swelling which can be more or less developed. However, this as well as the development of the nodes depend on the shape of carapaces. Carapaces with poorly developed swellings are egg-shaped when seen from above, while those with distinct swellings are more or less rectangular. In the dorsal margin varies from almost straight to slightly arched.

Remarks. — *C. bindosa polonica* is similar to *C. binodosa binodosa* Martin, 1940 but it differs in considerably less pronounced roller-like swellings and nodes, dimensions smaller and lower L:H and L:W indices. Meshes on the lateral surface are shallower and smalller, the posterior margin is less rounded and cyathus less developed in the new subspecies.

Occurrence. — Poland (Kujawy, Pomorze), upper Volgian, zone C.

Cypridea dunkeri spinosa subsp. n.

(pl. 7: 5, 6)

Holotype: valve MUZ PIG 2396/90/O; pl. 7: 6.

Type horizon: upper Volgian, zone B.

Type locality: Aleksandrów KT/1, depth 87.7 m.

Derivation of the name: Lat. *spinosus* — spinose: the valve covered with spines.

Diagnosis. — Right valve overlaps the left one; ventral rib well developed on the right valve only, narrow; 30—40 spines on lateral surface, rostrum distinct, long and narrow.

Material. — 14 carapaces, 40 valves from the borehole Aleksandrów KT/1 — depth 87.70 m, 86,20 m.

Dimensions (mm):

	Patatypes						Holotype
	a C			a LV			a RV
MUZ PIG	2399/O	2400/O	2401/O	2405/O	2406/O	2407/O	2396/O
length	0.86	0.93	0.88	0.90	0.81	0.86	0.93
height	0.57	0.61	0.52	0.66	0.48	0.50	0.64
width	0.36	0.32	0.36	—	—	—	—
length/ height	1.50	1.52	1.69	1.36	1.68	1.72	1.45
length/ width	2.30	2.90	2.44	—	—	—	—

Description. — Carapace delicate, ovate in lateral outline, highest at the anterior cardinal angle; anterior cardinal angle distinct, wide, posterior one almost invisible; right valve overlaps the left one. In the right valve, the dorsal margin slightly arched, strongly sloping backwards, ventral margin with distinct, narrow, slightly arched ventral rib. Anterior end widely rounded, the posterior one distinctly narrowed. Left valve subrectangular in lateral outline, its dorsal margin more arched than that of the right valve; ventral margin somewhat concave, without any rib. Rostrum distinct, narrow and long. Cyathus very slightly marked. Lateral surface covered with distinct net-like ornamentation and bearing 30—40 spines of various sizes. Duplicature well developed, particularly anteriorly. Limen very narrow, distinct. Adductor muscle scars formed of four scars in the main group and two scars in front of it and one behind it.

Variablity concerns the degree of the ventral rib development and the number of spines.

Remarks. — In comparison with other subspecies, *C. dunkeri spinosa* subsp. n. has much better developed and very narrow ventral rib. It has more delicate spines than *C. dunkeri carinata* Martin, 1940, but larger and more numerous spines than *C. dunkeri dunkeri* Jones, 1885. The height of its carapace is smaller than that in *C. dunkeri inversa* Martin, 1940 and has spines, which are lacking in the Polish specimens of the latter subspecies. From *C. dunkeri sowerbyi* Martin, 1949, it differs in a more arched dorsal margin and narrower posterior end as well as in more numerous and delicate spines. *C. dunkeri spinosa* has the smallest carapace among the subspecies of *C. dunkeri* Jones found in Poland.

Occurrence. — Poland (Kujawy), upper Volgian, zone B.

Cypridea granulosa polonica subsp. n.

(pl. 5: 5. 6)

1989. *Cypridea granulosa forma polonica*; Marek *et al.*: table 1.
1950. *Cypridea granulosa forma polonica*; Marek *et al.*: table 1.

Holotype: carapace MUZ PIG 2221/90/O; pl. 5: 6.
Type horizon: upper Volgian, zone C.
Type locality: Pagórki IG1, depth 1307.10 m.
Derivation of the name: coming from Poland.

Diagnosis. — *Cypridea granulosa* with valves devoid of tubercles and with very small rostrum.

Material. — 40 carapaces from the borehole Pagórki IG1 — depth 1318.20 m, 1315.30 m, 1311.10 m, 1310.40 m, 1307.10 m, 1305.00 m, 1304.00 m, 1300.00 m, 1299.00 m.

Dimensions (mm):

	Paratypes					Holotype
	a C				a R	
MUZ PIG	2223/O	2224/O	2225/O	2226/O	2227/O	2221/O
length	1.08	1.11	1.17	1.06	1.06	1.09
height	0.68	0.73	0.75	0.66	0.66	0.73
width	0.54	0.54	0.59	—	—	0.52
length/ height	1.58	1.52	1.56	1.60	1.60	1.48
length/ width	2.00	2.05	1.98	—	—	2.09

Description. — Left valve overlaps the right one. Carapace solid, subrectangular in lateral outline, with maximum height at the anterior cardinal angle; cardinal angles widely obtuse, the anterior one more distinctly marked than the posterior one. Ventral and dorsal margins straight, the latter slightly sloping backwards; anterior end widely rounded, the posterior one slightly narrowed. Rostrum small, its end not reaching the ventral margin line; alveolus shallow, poorly marked. Lateral surface covered with net-like ornamentation with irregularly shaped meshes particularly distinct in the central part of the surface.

Variability concerns the shape of ventral margin. Most specimens have it straight, only in a few ones it is slightly arched.

Remarks. — *C. granulosa polonica* differs from the known subspecies of *C. granulosa* in the lack of nodes on lateral surfaces of the carapace. According to Anderson (1971: 64) there is a tendency to reduce the nodes within this species. The most numerous and distinct nodes are found in *C. granulosa granulosa* (Sowerby, 1936); less numerous, but large nodes are observed in *C. granulosa fasciculata* (Forbes, 1855). The smallest and most scarce nodes occur in *C. granulosa protogranulosa* Anderson, 1971. Anderson (1971) maintains that the subspecies in question can cooccur. According to him *C. altissima* Martin, 1940, the species without any nodes, should be considered as a subspecies of *C. granulosa* (Sowerby, 1836), as it represents an extreme form in *C. granulosa* line. According to Martin (1940) tuberculation of *C. granulosa* carapaces depends on ecological conditions. We may suppose that these

conditions were not identical in south-east England and in Kujawy in Poland. The environmental difference may have caused the lack of granulation in *C. granulosa polonica*. In comparison with *C. altissima* the new subspecies has much shorter carapce and its ventral margin is less rounded.

Occurrence. — Poland (Kujawy): Upper Volgian, zone D and the lower part of zone C.

Cypridea lata polonica subsp. n.

(pl. 5: 3, 4)

Holotype: valve MUZ PIG 2233/90/O; pl. 5: 3.

Type horizon: upper Volgian, zone D.

Type locality: Wałownica, depth 122.00 m.

Derivation of the name: coming from Poland.

Diagnosis. — *Cypridea lata* with ventral margin very slightly arched; L:H index relatively small.

Material. — 80 carapaces, 10 valves (partly filled with sediment) from the borehole Wałownica — depth 122.50 m, 122.00 m, 119.50 m, 118.00 m, 117.00 m, 115.50 m, 104.00 m.

Dimensions (mm):

	Paratypes						Holotype
	a C			a RV			
MUZ PIG	2238/O	2239/O	2240/O	2241/O	2242/O	2243/O	2235/O
length	1.13	1.08	1.20	1.13	1.13	1.15	1.18
height	0.84	0.79	0.81	0.79	0.77	0.79	0.84
width	0.62	0.60	0.65	—	—	—	—
length/ height	1.34	1.36	1.48	1.43	1.46	1.45	1.30
length/ width	1.8	1.80	1.84	—	—	—	—

Description. — Carapace massive, triangularly ovate in lateral outline, highest at the anterior cardinal angle. Left valve overlapping the right one. The valves differ in shape. In the right valve the cardinal anterior angle widely obtuse, quite distinct, posterior cardinal angle very wide, rather indistinct; dorsal margin slightly bent, strongly sloping backwards, ventral margin almost straight. In the left valve both cardinal angles widely obtuse, indistinct, dorsal margin strongly arched, ventral margin slightly arched. In both valves the anterior ends videly rounded, posterior ones slightly narrowed; rostrum small, its end passes a little over the ventral margin line; alveolus relatively shallow, short; radial pore canals very short, simple, not numerous; cyathus small, triangular; lateral surface covered with a net-like ornamentation; duplicature wide in the anterior part, relatively narrow in the posterior part.

Variability concerns the rostrum *C. lata polonica* subsp. n. which may reach the ventral margin line or even cross it. When the rostrum is shorter alveolus is almost invisible. Dorsal margin may be more or less arched while the ventral one slightly arched or almost straight.

Remarks. — *C. lata polonica* is larger than *C. lata lata* Martin, 1940, moreover it differs in almost straight or slightly arched ventral margin, more distinct anterior cardinal angle and considerably less truncate posterior margin. In comparison with *C. lata senilis* Anderson, 1971, *C. lata polonica* has more distinct and bigger meshes, shorter and more delicate rostrum, more arched ventral margin and shallower and shorter alveolus. The new subspecies differs from *C. lata latissima* Anderson, 1971 is smaller cyathus, less arched ventral margin and much less truncate posterior margin.

Occurrence. — Poland (Kujawy): upper Volgian, zones E—D.

Cypridea obliqua polonica subsp. n.

(pl. 5: 7, 8)

Holotype: valve MUZ PIG 2249/90/O; pl. 5: 7.

Type horizon: Riazan?, zone A.

Type locality: Konarzew KT31, depth 69.60 m.

Derivation of the name: coming from Poland.

Diagnosis. — *C. obliqua* with a roller-like swelling paralleling the anterior margin.

Material. — 175 valves, from the boreholes Kwilno KT35 — depth 68.30 m, 66.80 m, 65.80 mm; Przyrudka TK7 — depth 178.60 m; Konarzew KT31 — depth 71.40 m, 69.30 m, 68.30 m; Aleksandrów KT/1 — depth 90.00 m, 89.50 m; Wypychów TK76 — depth 57.80 m, 57.20 m, 56.50 m, 55.40 m, 54.30 m, 53.30 m; Żychlin IG- — depth 48.90 m; Kcynia IG2 — depth 294.15 m, 293.70 m.

Dimensions (mm):

	Paratypes						Holotype
	a RV			a LV			
MUZ PIG	2251/O	2252/O	2253/O	2254/O	2255/O	2256/O	2249/O
lenght	1.13	1.11	1.18	1.20	1.26	1.18	1.26
height	0.75	0.73	0.75	0.81	0.79	0.82	0.88
length/ height	1.50	1.52	1.57	1.48	1.59	1.43	1.43

Description. — Left valve overlapping the right one; carapace rather massive, triangularly ovate in lateral outline, highest at the cardinal angle. Cardinal angles distinct, widely obtuse, the posterior one somewhat more prominent than the anterior one. Dorsal margin straight, in its middle part slightly concave, sloping slightly backwards; ventral margin almost straight; the anterior end widely rounded, the posterior one slightly narrowed; poorly marked roller-like swelling parallel to the anterior margin. On lateral surface two suboval, low nodes, one below the anterior cardinal angle, the other below the posterior one; ventral side relatively wide; rostrum distinct, its end not reaching the ventral margin line; alveolus not very wide. Lateral surface covered with regular net-like ornamentation; on ventral surface the meshes gradually become smaller and shallower towards the ventral margin. Duplicature narrow along the anterior margin and very narrow allong the posterior margin. Limen poorly developed. Adductor muscle scars formed of four scars of the main group and one scar in front and one behind the group.

Variability concerns the development of the nodes, roller-like swelling and the size of rostrum and alveolus.

Remarks. — In *C. obliqua polonica* the nodes below the dorsal angles are better developed on left valve than on right one. Cyathus has been preserved in few specimens. *C. obliqua polonica* differs from *C. obliqua obliqua* Wolburg, 1959 in the presence of a roller-like swelling parallel to the anterior margin and nodes below cardinal angles.

Occurrence. — Poland (Kujawy): sea-brackish Riazan, zone A.

Cypridea praealta iuvencula subsp. n.

(pl. 8: 5, 6)

Holotype: valve MUZ PIG 2280/90/O, pl. 8: 5.

Type horizon: upper Volgian, zone B.

Type locality: Kcynia IG2 borehole, depth 300.50 m.

Derivation of the name: Latin *iuvenculus* — young.

Diagnosis. — *C. praealta* with delicate subrectangular carapace.

Material. — 10 carapaces (all damaged), 40 valves, from the boreholes Kcynia IG2 — depth 304.30 m, 303.60 m, 302.60 m, 301.00 m, 300.10 m, Pagórki IG1 — depth 1300.00 m, 1297.80 m, 1296.00 m, 1295.00 m, Wypychów TK76 — depth 62.85 m, Konarzew KT31 — depth 77.40 m, 73.80 m, Przyruda TK7 — depth 176.80 m.

Dimensions (mm):

	Paratypes						Holotype
	a C			a RV			a LV
MUZ PIG	2281/O	2282/O	2283/O	2284/O	2285/O	2286/O	2280/O
length	1.17	1,11	1.04	1.08	1.04	1.02	1.18
height	0.79	0.79	0.75	0.68	0.68	0.66	0.84
width	0.67	0.55	0.59	—	—	—	—
length/ height	1.48	1.40	1.38	1.58	1.52	1.54	1.40
length/ width	1.74	2.01	1.76	—	—	—	—

Description. — Carapace delicate, subrectangular in lateral outline, highest at the anterior cardinal angle, left valve overlapping the righ one; cardinal angles widely obtuse, the anterior one more than the posterior one. Dorsal margin somewhat arched, slightly sloping backwards; ventral margin almost straight, anterior end widely rounded, the posterior one slightly narrowed. Rostrum distinct, small, its end not reaching the ventral margin line. Alveolus short, shallow. Limen poorly developed. Marginal canals scarce, distinct. Lateral surface covered with distinct net-like ornamentation; duplicature narrow in the anterior part of the valve, in the posterior one very slightly developed; adductor muscle scars composed of three scars of the main group and one scar behind.

Variability is small and concerns the width of carapace and its lateral outline. Specimens with straight ventral margin dominate.

Remarks. — *C. praealta iuvencula* differs from *C. praealta praealta* Bielecka,

1975 in smaller size, less distinct cardinal angles, poorly developed rostrum and more delicate ornamentation. From *C. alta alta* Wolburg (1950) it differs in more elongated carapace (higher L:H index).

Occurrence. — Poland (Kujawy): Upper Volgian, level B — sea-brackish Riazan, zone A.

Cypridea tumescens granulosa subsp. n.

(pl. 8: 7, 8)

Holotype: valve MUZ PIG 2324/90/O; pl. 8: 8.

Type horizon: upper Volgian, zone C.

Type locality: Wypychów T76, depth 83.10 m.

Derivation of the name: Lat. *granulosus* — granulated, a name corresponding to character of ornamentation.

Diagnosis. — *Cypridea tumescens* with carapace lateral surfaces bearing rare granules.

Material. — 34 carapaces, 15 valves (all filled with sediment) from the borehole Wypychów TK76 — depth 82.50 m.

Dimensions (mm):

	Paratypes						Holotype
	a C				a RV		
MUZ PIG	2328/O	2329/O	2330/O	2331/O	2332/O	2333/O	2327/O
length	1.15	1.18	1.17	1.09	1.17	1.11	1.26
height	0.75	0.86	0.70	0.61	0.73	0.68	0.81
width	0.54	0.50	0.55	—	—	—	0.55
length/ height	1.53	1.37	1.67	1.78	1.60	1.63	1.56
length/ width	2.13	2.36	2.12	—	—	—	2.29

Description. — Carapace rather massive, suboval in lateral outline, highest at the anterior cardinal angle; left valve overlaps the right one, cardinal angles widely obtuse, the posterior one more obtuse than the anterior one. Dorsal margin almost straight, in the middle part of the left valve slightly arched, distinctly sloping backwards. Ventral margin rather widely arched, anterior margin widely rounded, the posterior end narrowed. In the right valve the dorsal margin almost straight. Rostrum small, narrow; alveolus shallow, short; cyathus triangular, small. Lateral carapace surface with net-like ornamentation and 10—15 small, low granules irregularly distributed in the anterior and posterior parts of the carapace.

Variability concerns the lateral valve outline, the number of granules on lateral surface and the size of the rostrum.

Remarks. — *C. tumescens granulosa* differs from the remaining subspecies in the presence of granules on the carapace surfaces.

Occurrence. — Poland (Kujawy): Upper Volgian, zone C.

Cypridea wandae sp. n.
(pl. 7: 2, 3)

Holotype: valve MUZ PIG 2410/90/O; pl. 7: 2.

Type horizon: upper Volgian, level E.

Type locality: Zagłoba, depth 79.00 m.

Derivation of the name: species dedicated to Wanda, the author's sister.

Diagnosis. — Carapace solid. Right valve overlaps the left one; in its posterior part a small distinct swelling, on the ventral margin a roller-like rib; rostrum long and wide not reaching the margine line; alveolus deep; cyathus poorly developed.

Material. — 23 carapaces, 13 valves from the boreholes Bedlno TW9 — depth 134.50 m; Mąkolice KT38 — depth 60.80 m, 49.30 m, 48.60; Zagłoba — depth 79.00 m, 78.00 m.

Dimensions (mm):

	Paratypes						Holopyte
	a C			a LV			a C
MUZ PIG	2412/O	2412/O	2413/O	2417/O	2418/O	2419/O	2410/O
length	1.13	1.18	1.20	1.08	1.08	1.04	1.13
height	0.73	0.73	0.64	0.61	0.68		0.73
width	0.46	0.50	0.50	—	—	—	0.46
length/ height	1.54	1.63	1.64	1.69	1.63	1.52	1.54
length/ width	2.45	2.36	1.40	—	—	—	2.45

Description. — Carapace solid, oval in lateral outline, highest at about mid-length; right valve overlaps the left one along the entire free margin. Cardinal angles obtuse, wide. In the posterior part of the right valve small, nody swelling and roller-like rib along the ventral margin. Distal margin of the right valve slightly arched, distinctly sloping backwards, ventral margin a little rounded, the anterior end widely rounded, the posterior one narrowed; left valve lateral outline similar to that of the right one. Rostrum wide and long, but not reaching the valve margin line; alveolus elongated, distinct, deep; cyathus narrow, elongated. Lateral surface covered with numerous, very fine pits. Duplicature quite wide and distinct in the anterior part, very narrow in the posterior one. Limen distinct, wide; adductor muscle scars formed of four scars of the main group and one scar in front and two behind it.

Variability concerns dorsal and ventral margins which can be variably arched and a position of the highest points on carapaces: most often they are at mid-length of carapaces, but in some specimens they are situated near the anterior cardinal angle.

Occurrence. — Poland (Kujawy): upper Volgian, zones E—D.

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JANINA SZTEJN

MAŁŻORACZKI Z PURBEKU POLSKI ŚRODKOWEJ

Streszczenie

W pracy ukazano zróżnicowanie zespołów małżoraczkowych w purbeku Kujaw (figs. 1—4, tabele 1—2) oraz przedstawiono opisy i ilustracje (pls. 1—8) 4 nowych gatunków (*Limnocythere biverrucosa, Timiriasevia polonica, Cypridea aleksandrowiensis, C. wandae*) i 7 podgatunków (*Cypridea binodosa polonica, C. dunkeri spinosa, C. granulosa polonica, C. lata polonica, C. obliqua polonica, C. prealta iuvencula, C. tumescens granulosa*).

Dotychczasowe badania zespołów małżoraczków purbeckich były oparte na stosunkowo niewielkiej liczbie gatunków. Znaczne powiększenie kolekcji, które się dokonało w ciągu ostatnich lat, umożliwiło przeprowadzenie rewizji uzyskanych dotąd wyników. Nowe obserwacje pozwoliły utrzymać dotychczasowy, lokalny podział stratygraficzny purbeku na 6 poziomów małżoraczkowych, określonych literami od F do A (por. Bielecka i Sztejn 1966). Na podstawie nowych danych można polskie poziomy małżoraczkowe wiązać z poziomami z Europy zachodniej.

Osady purbeku w Polsce są w pełni wykształcone tylko na Kujawach i tylko tam można stwierdzić obecność wszystkich lokalnych poziomów małżoraczkowych. W poziomie F, osady facji purbeckiej tworzyły się w środowisku morskim o okresowo mniejszym lub większym zasoleniu. W poziomie E, w centralnej części zbiornika oberwuje się mikrofaunę środowiska morskiego, a wśród osadów ewaporatowych (we wkładce wapiennej) nieliczne małżoraczki, które najprawdopodobniej reprezentują środowisko hypersalinarne. Ubożenie taksonomiczne i masowy rozwój małżoraczków rodzaju *Cypridea* świadczą o okresowym wysładzaniu się zbiornika, które powiększało się następnie w poziomie D. W poziomach C i B środowisko

stało się brakiczno-słodkowodne, a następnie w poziomie A, przez zwiększenie zasolenia, stało się środowiskiem morsko-brakicznym.

Analogicznie do purbeku Anglii (por. Anderson 1985), w polskim purbeku wyróżniono zespoły małżoraczków charakterystyczne dla trzech faz ekologicznych: brakiczno-słodkowodnej fazy C, morsko-brakicznej fazy S oraz hypersalinarnej fazy E Na Kujawach przeważają małżoraczki fazy S (fig. 2).

W polskim purbeku obserwuje się zdecydowaną przewagę małżoraczków nad otwornicami. Stwierdzono tu obecność następujących nadrodzin małżoraczków. Cytheracea, Darwinulacea i Cypridacea. Szczególnie wiele rodzajów należy do Cytheracea. Niektóre małżoraczki, jak *Klieana alata* Martin, *Rhinocypris jurassica* (Martin), *Cypridea prealta prealta* Bielecka i *C. lata polonica* subsp. n. występują masowo i w kolekcji liczą od około tysiąca do kilku tysięcy skorupek. Inne są reprezentowane zaledwie przez kilka lub kilkanaście egzemplarzy, do nich należą *M. (Macrodentina) maculata* Malz, *M.* (*Dictyocythere*) aff. *mediostricta transfuga* Malz i *Protocytheropteron brodiei* (Jones).

Otwornice, to nieliczne formy zlepieńcowate. Wśród nich najlepiej jest reprezentowany rodzaj *Ammobaculites*, wykazujący bardzo dużą tolerancję na zmiany zasolenia w środowisku.

EXPLANATION OF PLATES 1—8

Plate 1

1. *Saccammina placenta* (Grzybowski), borehole Kcynia IG 2, depth 292.6 m, zone A: lateral view, MUZ PIG 2490/90/F, ×133.
2. *Ammobaculites kcyniensis* Sztejn, borehole Kcynia IG 2, depth 299.7 m, zone A: lateral view, MUZ PIG 2498/90/F, ×33.
3. *Ammobaculites pseudospirale gracilis* Lacroix, borehole Kcynia IG 2, depth 295.2 m, zone A: lateral view, MUZ PIG 2502/90/F, ×57.
4. *Verncuilinoides inaequalis* Bartenstein et Brand, borehole Kcynia IG 2, depth 294.7 m, zone A: lateral view, MUZ PIG 2511/90/F, ×106.
5. *Eoguttulina liassica* (Strickland), borehole Mąkolice KT 38, depth 59.0 m, zone F: lateral view, MUZ PIG 2518/90/F, ×189.
6. *Spirillina infima* (Strickland), borehole Zagłoba, depth 162.1 m, zone F: lateral view, MUZ PIG 2514/90/F, ×164.
7. *Haplophragmoides* sp., borehole Kcynia IG 2, depth 296.7 m, zone A: lateral view, MUZ PIG, 2494/90/F, ×113.
8. *Ammobaculites*, sp., borehole Kcynia IG 2, depth 309.1 m, level C, lateral view, MUZ PIG, 2507/90/F, ×50.

Plate 2

1. *Klieana alata* Martin, borehole Pagórki IG 1, depth 1318.2 m, zone D, left valve, lateral view, female specimen, MUZ PIG 2055/90/O; ×132.

2—4. *Klieana kujaviana* Bielecka et Sztejn: borehole Kcynia IG 2, depth 299.1 m, zone A; *2* right valve, lateral view, female specimen, MUZ PIG 2064/90/O, ×101; *3* left valve, lateral view, female specimen, MUZ PIG 2062/90/O, ×100; *4* left valve in lateral view, female specimen, MUZ PIG 2063/90/O, ×98.

5. *Galliaecytheridea elegans* (Sharpova), borehole 3E Wieniec-Zdrój, zone F: left valve in lateral view, male specimen, MUZ PIG 2071/90/O, ×63.

6. *Galliaecytheridea postsinuata* (Wolburg), borehole Kcynia IG 2, depth 297.7 m, zone A: a right valve in lateral view, female specimen, MUZ PIG 2078/90/O, ×41, b pore canal with a sieve-like outlet, SEM, ×2000.
7. *Cypridea primaeva* Anderson, borehole Wałownica, depth 104.0 m, zone C: left valve in lateral view, MUZ PIG 2301/90/O, ×45.

Plate 3

1. *Damonella pygmaea* (Anderson), borehole Szczebłotowo (255), depth 246.0 m, zone F: right valve in lateral view, MUZ PIG 2182/90/O, ×100.
2. *Damonella ellipsoidea* (Wolburg), borehole Żychlin IG 1, depth 512.1 m, zone C: carapace, right valve in lateral view, MUZ PIG 2177/90/O, ×62.

3,4. *Nodophthalmocythere kcyniensis* Bielecka et Sztejn, borehole Kcynia IG 2, depth 300.5 m, zone A: *3* right valve in lateral view, male specimen, MUZ PIG 2133/90/O, ×78; *4* carapace in dorsal view, female specimen, MUZ PIG 2134/90/O, ×78.

5,6. *Limnocythere biverrucosa* sp.n., borehole Łowicz IG 1, depth 615.0 m, zone E: *5* holotype, carapace, left valve in lateral view, female specimen, MUZ PIG 2092/90/O, ×98; *6* paratype, carapace in ventral view, female specimen, MUZ PIG 2098/90/O, ×92.

7. *Scabriculocypris trapezoides* Anderson, borehole Bedlno TW 9, depth 114.7 m, zone C: carapace, left valve in lateral view, MUZ PIG 2437/90/O, ×58.

8,9. *Timiriasevia polonica* sp.n., borehole Szczebłotowo (255), depth 246.0 m, zone F: *8* holotype, carapace, lateral view of right valve, MUZ PIG 2164/90/O; × 112; *9* paratype, carapace in ventral view, MUZ PIG 2162/90/O, ×90.

Plate 4

1. *Darwinula leguminella* (Forbes), borehole Wypychów TK 76, depth 83.1 m, zone C: carapace, left valve in lateral view, MUZ PIG 2169/90/O, ×65.
2. *Darwinula oblonga* (Roemer), borehole Żychlin IG 1, depth 512.1 m, zone C: carapace, right valve in lateral view, MUZ PIG 2173/90/O, ×52.
3. *Fabanella boloniensis* (Jones), borehole 3E Wieniec-Zdrój, depth 81.2—82.0 m, zone D: left valve in lateral view, male specimen, MUZ PIG 2112/90/O, ×46.
4. *Macrodentina (Macrodentina) maculata* Malz, borehole 3E Wieniec-Zdrój, depth 123.95 m, zone F: carapace, right valve in lateral view, ?juvenile specimen, MUZ PIG 2150/90/O, ×76.
5. *Macrodentina (Dictyocythere)* aff. *mediostricta transfuga* Malz, borehole Kcynia IG 2, depth 291.1 m, zone A: left valve in lateral view, female specimen, MUZ PIG 2154/90/O ×87.
6. *Rhinocypris jurassica* (Martin), borehole Żychlin IG 1, depth 512.1 m, zone C: right valve in lateral view, MUZ PIG 2189/90/O, ×83.
7. *Theriosynoecum forbesi forbesi* (Jones), borehole Bedlno TW 9, depth 131.8 m, zone E: left valve in lateral view male specimen, MUZ PIG 2100/90/O, ×63.
8. *Dicrorygma (Orthorygma) groenwalli* Christensen, borehole Bedlno TW 9, depth 131.8 m, zone E: carapace, right valve in lateral view, male specimen, MUZ PIG 2142/90/O, ×159.
9. *Prothocytheroptheron brodiei* (Jones), borehole Mąkolice KT 38, depth 62.2 m, zone F; left valve in lateral view, female specimen MUZ PIG 2158/90/O, ×124.
10. *Schuleridea* sp., borehole 3E Wieniec-Zdrój, depth 122.6—123.2 m, zone F: carapace, right valve in lateral view, male specimen, MUZ PIG 2126/90/O, ×65.

Plate 5

1. *Fabanella ansata* (Jones), borehole 3E Wieniec-Zdrój, depth 123.95 m, zone E: right valve, lateral view, male specimen, MUZ PIG 2107/90/O, ×47.
2. *Mantelliana purbeckensis* (Forbes), borehole Mąkolice KT 38, depth 48.0 m, zone C: carapace, right valve, lateral view, female specimen, MUZ PIG 2420/ /90/O, ×56.

3, 4. *Cypridea lata polonica* subsp. n., borehole Wałownica, depth 122.0 m, zone D: *3* holotype, left valve, lateral view, MUZ PIG 2233/90/O, ×40; *4* paratype, right valve, lateral view, MUZ PIG 2232/90/O, ×39.

5,6. *Cypridea granulosa polonica* subsp. n., borehole Pagórki IG 1, depth 1307.1 m, zone C: *5* paratype, carapace, right valve, lateral view, MUZ PIG 2222/90/O, ×41; *6* holotype, carapace, left valve, lateral view, MUZ PIG 2221/90/O, ×48.

7, 8. *Cypridea obliqua polonica* subsp. n., borehole Konarzew KT 31, depth 69.6 m, zone A: *7* holotype, left valve, lateral view, MUZ PIG 2249/90/O, ×40, *8* paratype, right valve, lateral view, MUZ PIG 2247/90/O, ×44.

Plate 6

1, 2. *Cypridea aleksandrowiensis* sp.n., borehole Aleksandrów KT/1, depth 94.2 m, zone C: *1* paratype, left valve in lateral view, MUZ PIG 2349/90/O, ×63; *2* holotype, right valve in lateral view. MUZ PIG 2350/90/O, ×59.

3. *Cypridea dunkeri inversa* Martin, borehole Wałownica, depth 108,5 m, zone C: carapace, right valve in lateral view, MUZ PIG 2375/90/O, ×54.
4. *Pachycythereidea compacta* (Wolburg), borehole Pagórki IG 1, depth 1294.0 m, zone A: a right valve in lateral view, male specimen, MUZ PIG 2119/90/O, ×41, b pore canal with a sive-like outlet, SEM, ×2000.

5, 6. *Cypridea binodosa binodosa* Martin, borehole Kcynia IG 2, depth 314.6 m, zone C: *5* carapace in ventral view, MUZ PIG 2194/90/O, ×47; *6* left valve in lateral view, MUZ PIG 2193/90/O, ×45.

7, 8. *Cypridea binodosa polonica* subsp.n., borehole Wałownica, depth 104.5 m, zone C: 7 paratype, carapace in dorsal view, MUZ PIG 2208/90/O, ×42; *8* holotype, carapace, left valve in lateral view, MUZ PIG 2209/90/O, ×46.

Plate 7

1. *Cypridea posticalis* Jones, borehole Kcynia IG 2, depth 292.1 m, zone A: left valve, lateral view, MUZ PIG 2268/90/O, ×46.

2, 3. *Cypridea vandae* sp.n., borehole Zagłoba, depth 79.0 m, zone E: *2* holotype, carapace, right valve in lateral view, MUZ PIG 2410/90/O, ×48, *3* paratype, carapace, left valve in lateral view, MUZ PIG 2409/90/O, ×40.

4. *Cypridea dunkeri dunkeri* Jones, borehole Bedlno TW 9, depth 101.25 m, zone C: carapace, right valve, lateral view, MUZ PIG 2366/90/O, ×64.

5, 6. *Cypridea dunkeri spinosa* subsp.,n., borehole Aleksandrów KT/1, depth 94.2 m, zone C; *5* paratype, left valve, lateral view, 2397/90/O, ×66; *6* holotype, right valve, lateral view, MUZ PIG 2396/90/O, ×64.

7. *Cypridea tumescens praecursor* Oertli, borehole 3E Wieniec-Zdrój, depth 113.5— 115.5 m, zone E: carapace, left valve, lateral view, MUZ PIG 2397/90/O, ×33.

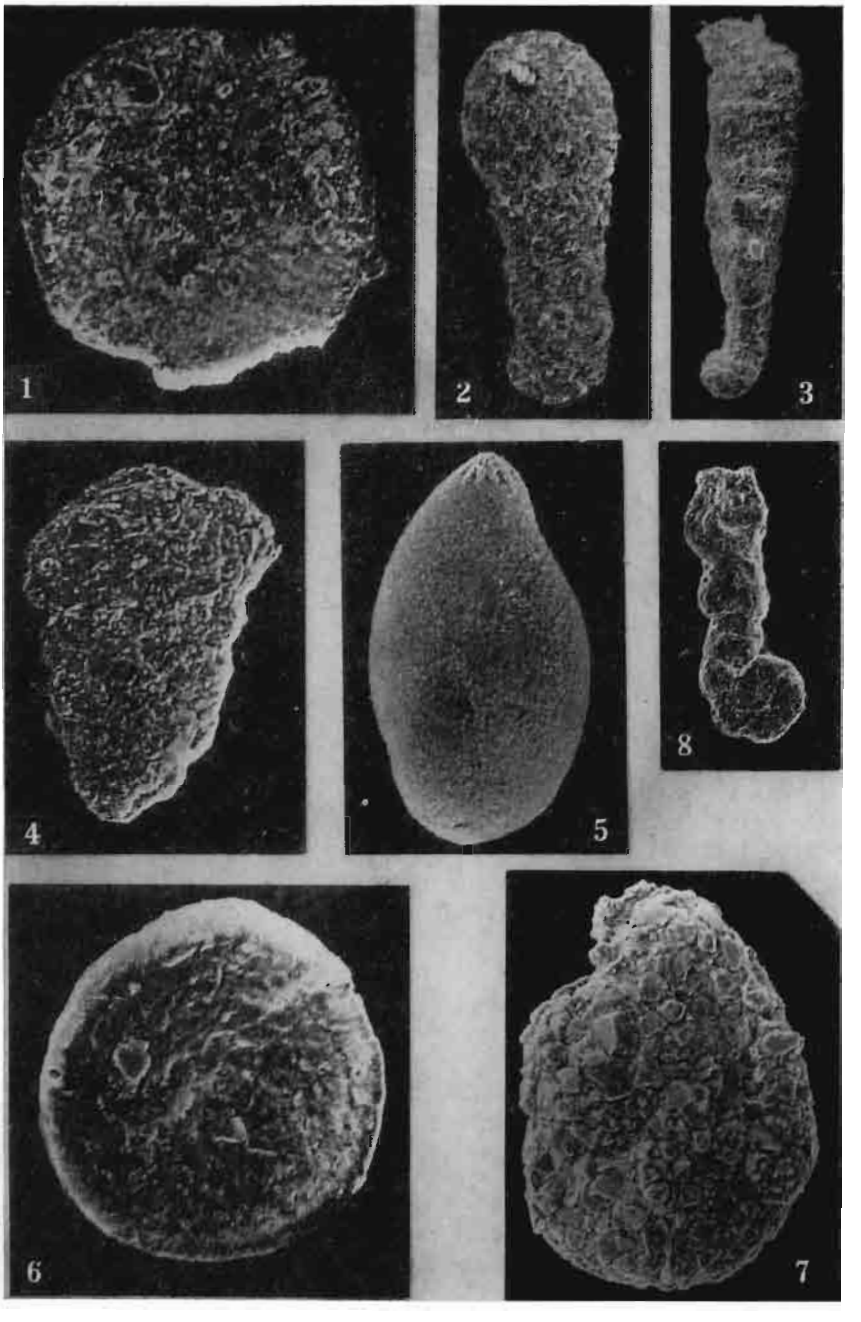
8. *Cypridea dunkeri carinata Martin*, borehole Wałownica, depth 100.5 m, zone C: left valve, lateral view, MUZ PIG, 2357/90/O, ×67.

Plate 8

1. *Cypridea peltoides peltoides* Anderson, borehole 3E Wieniec-Zdrój, depth 82.6 m, zone D: carapace, left valve, lateral view, MUZ PIG 2257/90/O, ×50.
2. *Cypridea dunkeri sowerbyi* Martin, borehole 3E Wieniec-Zdrój, depth 113.5—115.9 m, zone E: left valve, lateral view, MUZ PIG 2387/90/O, ×44.
3. *Cypridea tumescens acrobeles* Anderson, borehole Żychlin IG 1, depth 510.5 m, zone C: carapace, left valve, lateral view, MUZ PIG 2311/90/O, ×46.
4. *Cypridea praealta praealta* Bielecka, borehole Kcynia IG 2, depth 309.1 m, zone C: left valve, lateral view, MUZ PIG 2290/90/O, ×42.

5, 6. *Cypridea praealta iuvencula* subsp.n., borehole Kcynia IG 2, depth 300.5 m, zone A: 5 holotype, left valve, lateral view, MUZ PIG 2280/90/O, ×50; *6* paratype, left valve, lateral view, MUZ PIG 2278/90/O, ×58.

7, 8. *Cypridea tumescens granulosa* subsp.n., borehole Wypychów T 46, depth 83.1 m, zone C: 7 paratype, carapace, left valve in lateral view, MUZ PIG 2323/90/O, ×43; *8* holotype, right valve in lateral view, MUZ PIG 2327/90/O, ×42.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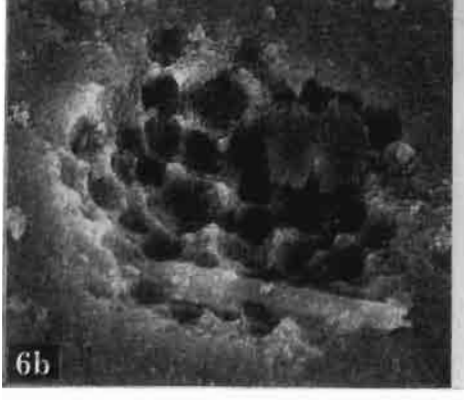
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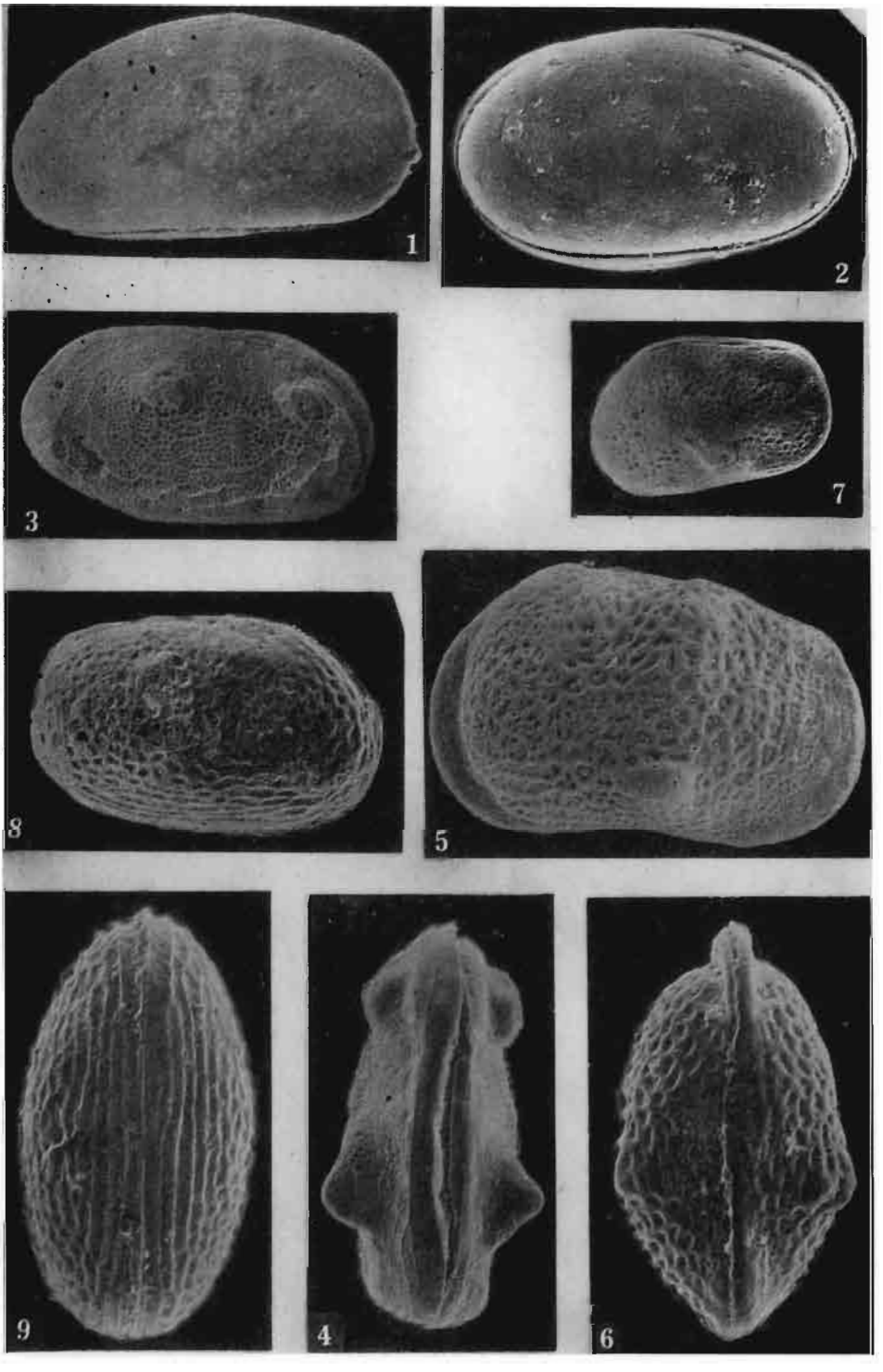
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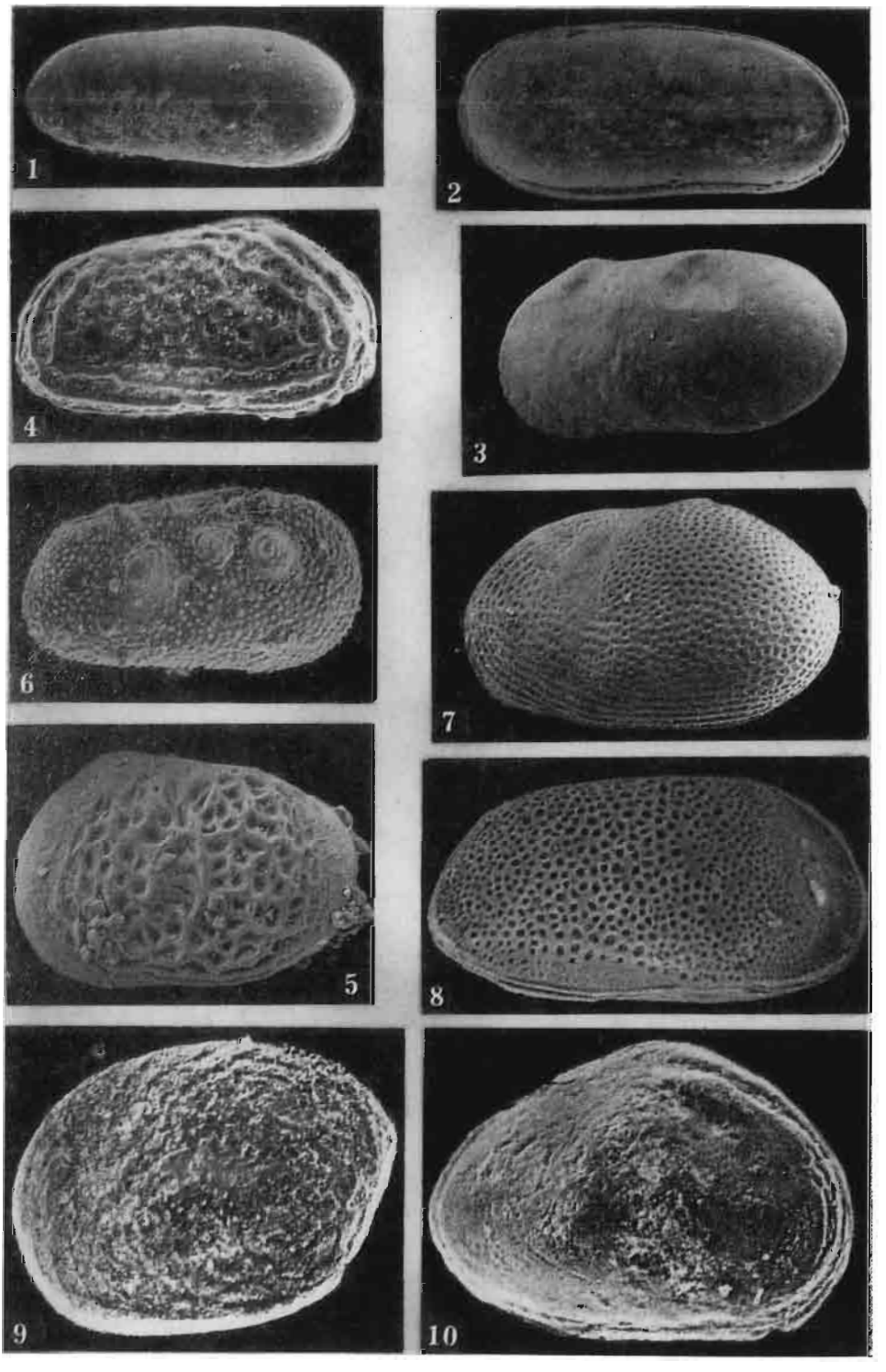
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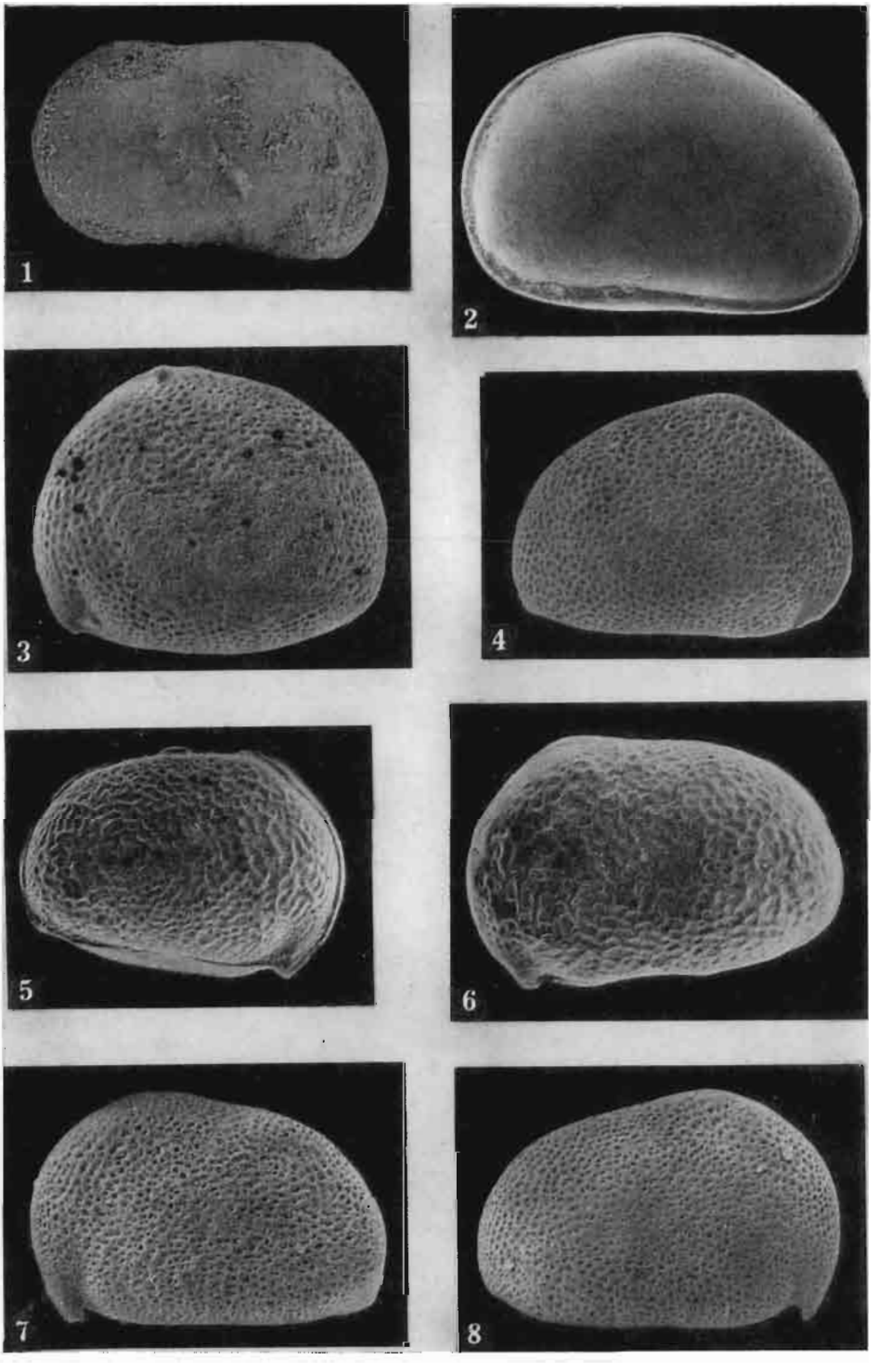
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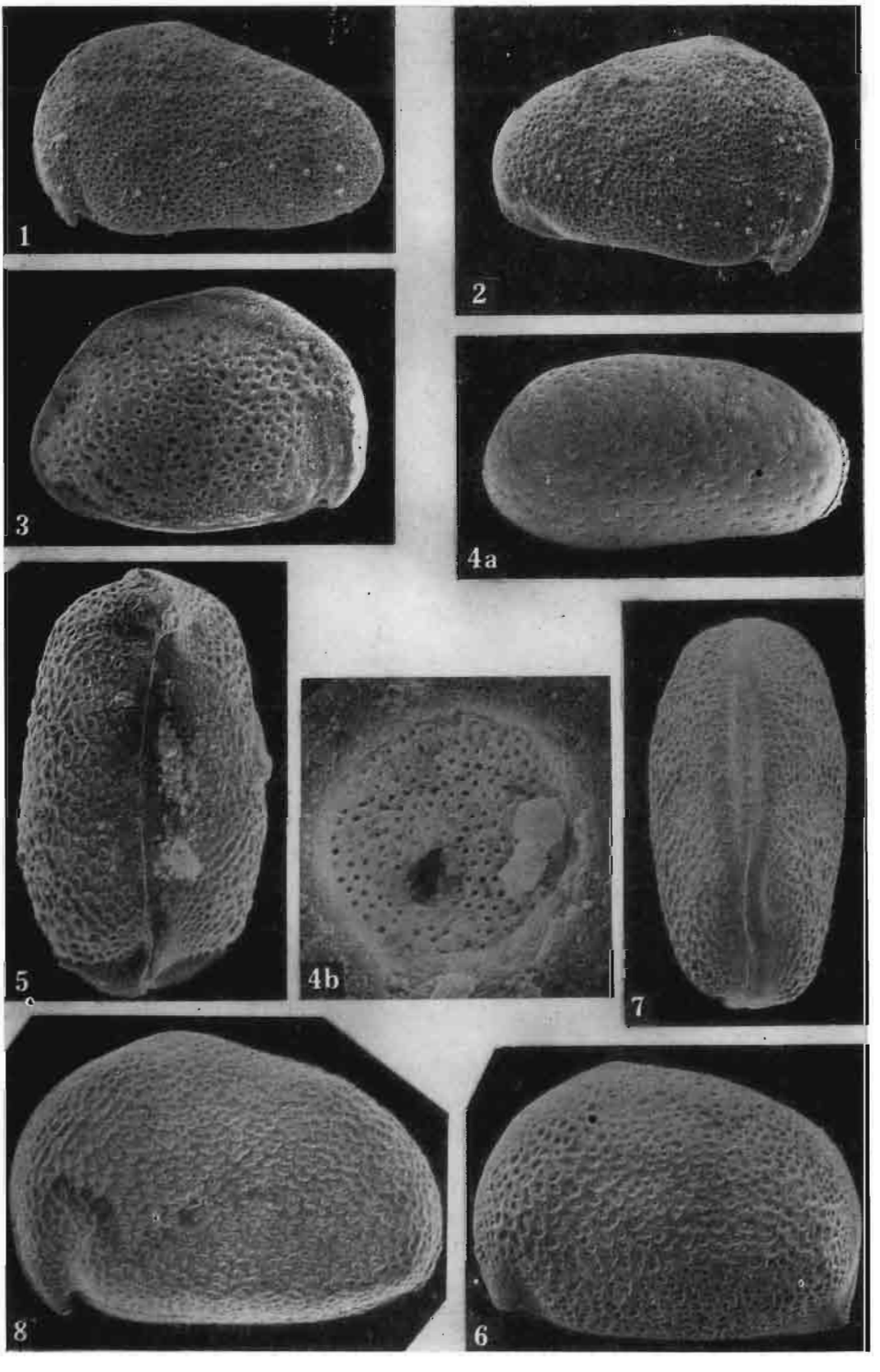
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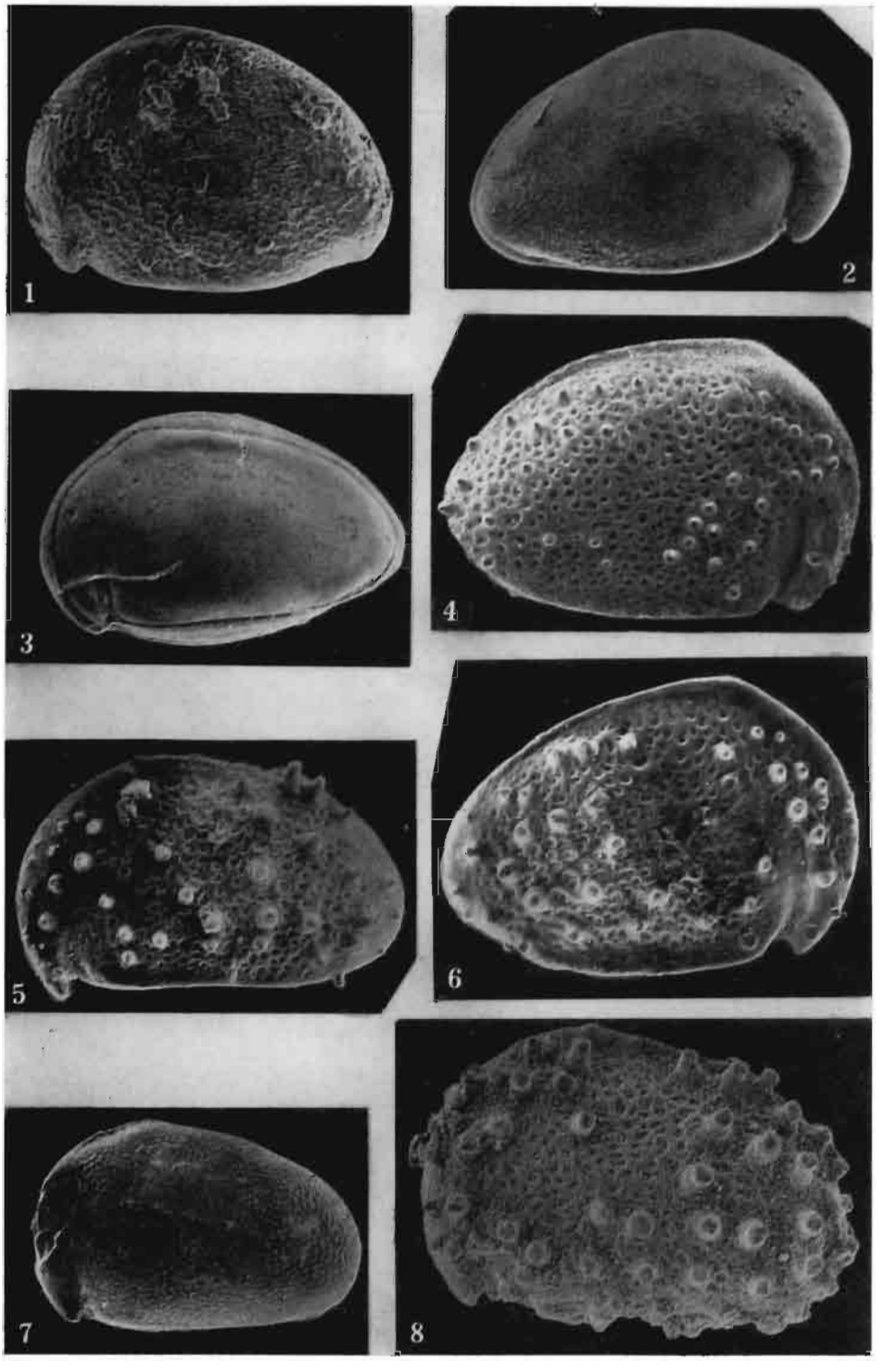
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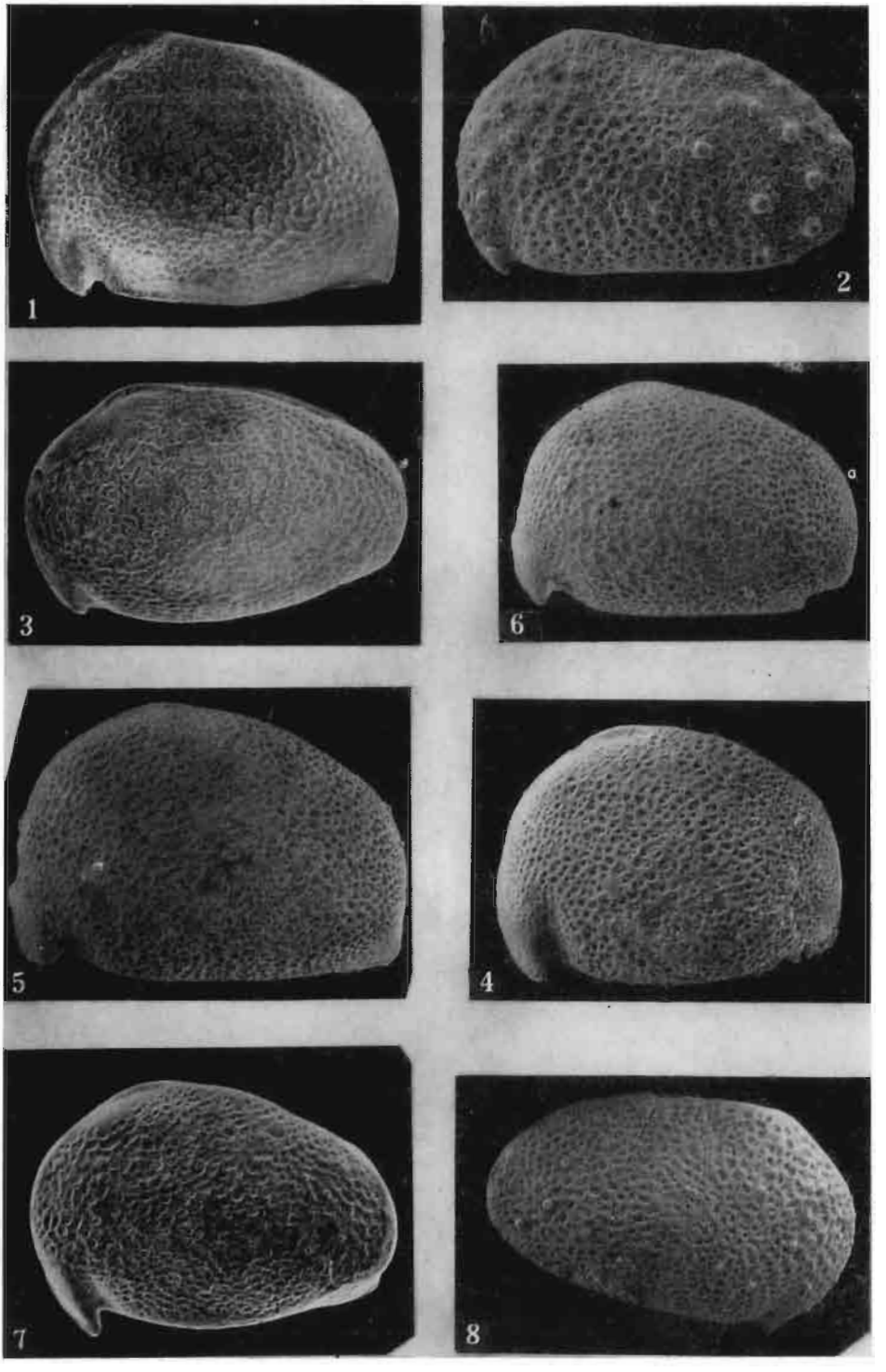
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